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CONTENTS

DROWNING IN THE MAINSTREAM: STRATEGIES TO SURVIVE AND SUCCEED FOR DYSLEXIC ADOLESCENTS

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ABSTRACT

Identification of dyslexics in a target group of undergraduate students with structured assessment tools and recommendation and facilitation of remediation techniques to overcome learning difficulties.

1. Adolescent Dyslexia and the Need for Assessment

Dyslexia is a neurological condition which results in deficiencies in literacy skills and/or maths, and is usually associated with difficulties in concentration, short term memory and organization. Persistent problems with reading and writing, spelling uncertainty, directionality confusions, illegible handwriting caused by visual-motor co-ordination problems, are some of the factors which contribute to a dyslexic being branded intellectually deficient by teachers and peers. Hence the urgent need for an early diagnosis and remedial help at the school level. But a survey conducted among college students revealed that dyslexia remains a formidable barrier to academic achievement. Lack of awareness, specially among the economically and socially deprived communities, see many undiagnosed dyslexics reach colleges frustrated with their academic non-performance. At the college level, adolescent dyslexics display

weaknesses in short term memory, phonological skills, sequencing and structuring information, perception, as well as difficulty with physical coordination. Dyslexia becomes a social problem when it generates dropouts in schools and colleges or creates students who drift through the academic scenario and end up as failures in life despite high intelligence and earnest endeavour. Correct diagnosis can help dyslexics bypass their mental roadblocks and put them on the way to a more fulfilling life with remedial support. It has been proved that even dyslexic adolescents respond successfully to appropriate intervention.

2. Methodology and Data Analysis

This study uses as its methodology a multi-tiered instructional approach that focuses on problem identification of students who are at risk of academic failure and in need of behavioural support, so that interventional help can be provided at appropriate stages. As a Tier 1 proactive approach, an assessment was conducted. A questionnaire compiled to measure developmental, medical, behavioural, academic and family history was the first tool of analysis. The target group was two hundred and two first semester students, who were subjected to a general screening test to identify those with learning difficulties. At the next level, a comprehensive test of general intellectual functioning, cognitive processing, specific oral language skills related to reading and writing and phonological processing was done. The study found that sixty five students (32%) showed moderate to severe reading/ writing/ organisation difficulties. In about 50% of these cases, the difficulty was circumstantial - lack of exposure to English which is the medium of instruction, lack of opportunities, lack of conducive learning environment at home, and

extreme deprivation. Ten students showed a below average intelligence level, and twenty three (10-11%) had clear symptoms and signs of dyslexia and dyspraxia.

At the Tier II Level, dyslexic students were given more targeted interventions and individual attention to overcome specific difficulties. Apart from the counseling sessions arranged, the students were apprised of strategies recommended by educational psychologists to help them prevail over their difficulties in areas of reading, writing, memory and perception. Facilitating use of appropriate technological aids and highlighting tips to overcome organizational difficulties and to manage emotional stress were major steps in remediation. Tier III is the stage where referral for professional counseling and recommendation for special education programmes were given to a couple of students who were in need of more intense, specialized intervention. It was found that the mere realization that the problem was physiological, with no bearing on their intelligence or attitude, made students with dyslexia more reconciled to their handicap and eager for any support that would serve as a lifeline to hold on to as they struggled to get back into the mainstream.

Note

Brief report of Minor Research Project done in 2011 with UGC Assistance under XI Plan.

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EXPLORING THE THEATRICAL POTENTIAL OF HISTORY IN RAMU RAMANATHAN'S PLAY *MAHADEVBHAI* (1892-1942)

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Abstract

Ramu Ramanathan in his play Mahadevbhai re-examines the narrative and theatrical potential of Indian political history to highlight the struggle and fortitude put by our freedom fighters especially Mahatma Gandhi through a biographical account of his personal secretary, Mahadevbhai. He adopts the techniques of a docudrama and thereby depends on various recorded documents to prove his point. This is a solo play where a single actor enacts the roles of more than thirty characters. As a blend of narrative, documentation and drama, this play challenges the readers and viewers to react to the past and the present. This experimental play is an exhortation to cast off negative views like anti-Gandhism and a critical attitude towards democratic institutions. Incorporating a historical narrative into the text of a drama the playwright succeeds in displaying the content of a sociopolitical order.

Ramu Ramanathan's play Mahadevbhai (1892-*1942*) is an exploration of Gandhian principles and ideology of our times through the eyes of Gandhi's personal secretary, Mahadevbhai. Traversing through several acts and moments that dotted the history of our nation the playwright gives us deep insights into the nobility of thought and

expression of a few great souls who brought India freedom. History juxtaposed with times present lays bare the changes that happened through these years. This is a re-examination of political history where several historical characters rally on stage recreating the struggle and fortitude of our freedom fighters. Through the representation of events from the past, history is made available to us for information and interpretation.

Mahadevbhai (1892-1942) was a turning point in Ramu Ramanathan's career as a playwright and it turned out to be a very successful play. It tells the story of freedom struggle through the biographical account of Gandhi's aide Mahadevbhai. Premiered at the Prithvi Theatre Festival in 2002, *Mahadevbhai* is a solo play. Jaimini Pathak, who played the role of the narrator-cum-actor by delivering a monologue of more than one hour presents a stupendous theatrical performance. Introducing himself as a budding actor, he establishes a link to Mahadevbhai through his grand uncle. Mahadevbhai, Gandhi and several other characters relive in front of him through the conversations with his grandfather.

Ramu Ramanathan is interested in a history as represented and recorded in written documents. The aim is not to represent the past as it really was but to present a new reality by re- situating it. In a letter to Lakshmi Chandra, the writer says what inspired him to write *Mahadevbhai.*

> For me, *MAHADEVBHAI* is a response to the politics of our times. To start with, anti-Gandhism is rampant and then there is the systematic discrediting of democratic institutions. As I see it,

there are a couple of reasons for this. For one, our politics has been communalized. This automatically makes Gandhiji an easy target. Since these days, anyone who has been perceived as pro-Muslim will be attacked. Then there are the caste politicians, who are constantly playing the anti-Gandhi card. In this sense Ambedkar and Gandhi, become foes without their politics being understood. The point is, the modus operandi of the criticism against Gandhi is cloaked in subterfuge. As you're perhaps aware, there have been 3-4 anti-Gandhi plays and even mainstream films in the past decade; And all of them very popular. MAHADEVBHAI was my attempt to set the record straight, in a small way.

In this sense, I was clear about devising a play that will reach-out to the uninitiated, and those members of the audience who are hostile to Gandhiji and his tenets. For me, *Mahadevbhai* became a *tantra* to reach that *tatva*. (Chandra)

Mahadevbhai is a docudrama with a performance narrative dealing with the past. The life of Mahadevbhai after his entry in politics as the close associate of Gandhi is documented incorporating dramatic elements. The playwright has brought to use the recorded facts in the meticulously kept, daily written dairies of Mahadevbhai and various other sources. His diligent research of more than five years helped him with the desired facts for writing the play.

This is a biography drama on Mahadevbhai, which starts with the mentioning of Mahadevbhai's birth in 1892 and ends with his death in 1942. But the highlight of the play is Gandhiji -the great organizer. Gandhiji could easily unite all the classes by providing a programme for

action. Many inspired by his leadership gave up their jobs willingly to join his movement. They were involved in different constructive community programmes. Education of children, education on hygiene and sanitation, women empowerment, free medical services were a few activities on the agenda. Gandhiji taught his followers lessons on self-reliance. There was training to wash clothes, scrub toilets and clean roads. Thus, Gandhiji ensured that they didn't let off the villagers. This not only symbolized protest against the British but inspired tremendous self-respect and confidence amongst the villagers. He was a strong advocate of non-violence, economic processes that favour the poorest of the poor, religious tolerance and removal of untouchability.

Gandhiji's policies of non-violence and Satyagraha were not easy methods to follow. At times, he and his followers were put in jail. When situations went out of hand Gandhiji and his Gandhianism would be blamed with words like *"A CORRUPTER OF YOUTH"* (Chandra: 275) or "*The British Government has a free police officer in Gandhi. What else should we expect from a BANIA*" (276) etc.

The writer maps a few momentous episodes in history like the Godhra Political Conference, Champaran agitation, promulgation of the Rowlatt act, Bardoli Satyagraha led by Vallabhbhai Patel, Dandi March also known as the Salt Satyagraha, the historic Yeravda Pact and the Quit India Movement of 1942. The same year Mahadevbhai passed away. The playwright makes clear that Gandhiji was not against development or machinery but he was against the craze for machinery. He stresses the relevance of Gandhian methods in today's world. He also tries to remind

the viewers and the nation what is forgotten or unrealized and gives voice to those who have not had one.

Any document taken from the past is a product of ideology. History constitutes the thoughts and beliefs of a past world. According to the historian Jacques Le Goff, 'the document is not objective, innocent raw material, but expresses past society's power over memory and over the future' (Goff: xvii). The objective nature of history is obscured giving way to interpretation. The readers and viewers are enriched when they re-examine history in this way. When history is chosen as the material for a drama, the dramatist in a way becomes a historiographer. Through careful examination, evaluation and selection of material the writer offers narrative presentation of history in dramatic form.

Ramu Ramanathan leans heavily on research materials to develop an intellectually demanding experimental play. Form appears to him as important as the content and hence his readiness to take on challenges. The form of the text allows the inclusion of different authentic materials like speeches, letters, Mahadevbhai's diary, quotations, history textbooks, musical compositions from Braj literature, poems of Kabir, Rabindranath Tagore etc. There is a careful selection, arrangement and editing of these primary sources into an aesthetic composition. The manner of arrangement and editing itself from the message or intent of the play. It can be rightly said that his intellectual creativity has found its modern idiom.

The actor turns to various primary sources during the narrated moments of the play when factual or expositional information is given. This effective stage device conveys the message that every word uttered has the force of the swearing of an oath. The actor begins his narration reading a few lines

from a scroll written by Vinoba Bhave about Mahadevbhai. Then he establishes his connection with Mahadevbhai by holding up a black and white photograph of Mahatma Gandhi, Mahadevbhai and his granduncle. There are several readings from different sources in the course of the play. For instance, the passage read from Narhari Parikh's *Mahadevbhainun Poorvacharithra* tells of Mahadevbhai's decision to join Gandhiji's freedom movement.

The form chosen is simple story telling interspersed with humour. As the play has more than thirty characters, doing *Mahadevbhai* as a one-man show seems to be quite feasible. The performance wouldn't have been effective if there were as many actors as the characters. The single man performance conveys a simplicity and vision in tune with the ideas presented. The actor becomes the actual participant in the historical event. He resorts to fictional narrative techniques with the intention of reporting reality. The play which is a blend of narrative, documentation and drama, sets forth a moral view of reality, challenging people to react to the past and the present.

The actor executes his role of a performer of history with élan. It was in Godhra, then the most backward area in Gujarat, Mahadevbhai and his wife Durga Ben join Gandhi in his travel. Godhra in 1917 became the venue of a Political Conference where Gandhi spoke about Hindu- Muslim unity and prevailed upon the communities to remain free from suspicion and fear of one another. He said: *"I have only one object in view and it is a clear one, namely that God should purify the hearts of Hindus and*

Musalmaans and the two communities should be free from suspicion and fear of one another" (Chandra:263).

What happened in Godhra in the recent times highlights the irony of the situation. From there Mahadevbhai went to Champaran in Bihar. The first jottings in his diary began on 13th November 1917. Since then he maintained a daily diary till 14th August 1942 the day before he passed away. But his 27 volume diary doesn't mention the birth of his son Narayan. The words jotted down in Mahadevbhai's diary are quoted in the text in italics.

There are bits and pieces the narrator acts as he travels back and forth in time. The story of the freedom struggle narrated is a chronological one. The underlying chronology remains intact, though the actor exits the story in between to come to the present. The sequences that fall outside the chronology deal with the actor's life in the present. The episodic structure results in multiple lines of development. Instead of an orderly unfolding, the narrative is split resulting in a fluidity of time and space. The ultimate aim is to show the impact of Gandhian ideals in the lives of different characters.

A few dramatic episodes from the present may appear as diversions but they are closely connected with the narrative. In one episode, the actor enacts his history teacher Madam Priscilla teaching tinkatiya arrangement introduced by the British in Champaran. (Tinkatiya arrangement was an exploitative system in which the British planters had involved the cultivators in agreements that forced them to cultivate indigo on 3/20th of their holdings and surrender the entire harvest as rent to the landlords.) Instead of sensitizing students to the problems faced by our

freedom fighters Miss Priscilla only wanted her students to get equipped with details to write exams. To take another sample from the text the actor wants to know more about the Rowlatt Act.

HE asks : "Miss, Miss, Dadaji tells me that the Rowlatt Act was a bit like *MISA, TADA, POTA*… with a subtle difference…

"MISA, TADA and POTA are not in the syllabus and so don't waste our time!!!"

There will be a 5-mark fill-in-the-blanks on the Rowlatt Act in the unit test. Write down everything I am saying carefully and in neat handwriting" (Chandra: 274-275). There is a subtle hint that history teachers are responsible for a wrong attitude towards history.

A few conventions used in the play are drawn from epic theatre. As a one-man show, the play employs the technique of breaking the fourth wall. In an interview to Karishma Attari, for PT notes, Sept 2004 Jaimini Pathak, the actor had this to say: "All the theatre we generally do is about removing the fourth wall and ignoring the audience, almost. I had to talk to them, and I could see them react" (Gupta :52). In Act One, the actor invites the audience to spend time together with him so that he enlightens the audience about Mahadevbhai. He introduces himself as a budding actor and directly addresses and acknowledges the audience. He says: "But who is *MAHADEVBHAI* and why am I – a meek and humble, subservient and lowly actor-talking about him! Wait! For patience is a great virtue, mon ami! Hold your fire. Hang on to those horses. We will pass time together. Me and you. You and me" (257).

This Brechtian technique makes the audience face the action and take decisions. It also arouses them into action.

The actor manages multiple roles in a sequence. With his histrionics, he portrays around thirty characters. Besides the narrator, Mahadevbhai and Gandhiji, he recreates Motilal Nehru, Sardar Vallabhbhai Patel, Rajendra Prasad, Mohammed Ali Jinnah, B. R. Ambedkar, Rabindranath Tagore, General Smuts of South Africa, Jawaharlal Nehru, Dadaji, Mishraji, Rajani Kaki, Meera Mami, Madam Priscilla, Shahenshah etc. on stage. He is involved in "objective acting."

Erwin Piscator wrote:

…See how the situation changes when his (actor's) eye meets the audience. The whole stage seems to come alive. Through the directness of that glance a truth establishes itself between the actor and the audience and brings back a vital contact and a greater reality to the action.

Objective acting is not performance technique, it's an aesthetic position (Malina: 150).

The actor doesn't attempt to make a psychological understanding or internalization of the character. He tries to go outwards and connect with the audience. He breaks away from the Aristotelian paradigms of illusion and identification. The character portrayal is based on a kind of measuring. He shows each character in action rather than going for a full on characterization. He plays out a character if there was a description. What was told is of more importance than the characters.

When history is narrated, the language used undergoes decontextualisation. The sequences of talk maintained in the original context undergo a change. The actor adapts them to suit the intentions and

communicative purpose of the writer. The text is delivered in the past tense interspersed with occasional present tense. Though the narration is in English the actor freely resorts to multilingualism. There is code-switching from English to Hindi and Gujarati. When he played the roles of his father and Mishraji, he used Hindi. Dadaji spoke to him in Gujarati. The actor tries to get some details about Mahadevbhai from his father. "So I asked my father, arre daddyji, *YEH MAHDEVBHAI KAUN HAIN?* So, my father asked his father, arre pappaji, *AAH MAHADEVBHAI KAUN CHE?* To cut a long story short, my dadaji sent a letter to my daddyji" (Chandra: 258). Even Gandhiji made use of expressions like "Sugnya Bhaisri", "Chi Durga" as forms of address in his letters. The actor also assimilates voice modulations and pitch changes to suit the different characters enacted.

The various devices employed stresses on the importance of theatre in society and highlights the political goals of the performances. The literary device of 'a play within the play' is made use of during the course of action. The actor goes back in time to his school days and becomes a character in a Nautanki play written by Anonymous. The character he plays is an ageing Shahenshah. He drags a trunk onto centre stage and pulls out a beard which he wears in that scene. This metatheatrical device results in a distancing effect in the audience.

The notion of theatricalism forms a technique once again in the setting of the play. The stage set is simple and Gandhian. There are jute mats, khadi material and flowers on the stage. The setting serves dual purposes of highlighting the importance of Gandhian simplicity in today's

world and allows the audience to maintain the emotional objectivity necessary to learn the truth about contemporary society.

Lighting on stage has only one purpose i.e., to enable viewers enjoy the performance clearly. Achieving pathetic fallacy is not an aim here. The stage is divided into three sections. Stage left has a raised platform with an old writing desk. Almost all the letters and correspondence are read behind the writing desk. Stage right has two elegant chairs, lots of books and a theatre trunk. All Dadaji scenes are enacted here. There is a mike on the stand where all public announcements are made. Centre stage is the space in which the actor/narrator refers to the events and persons or addresses the audience (Chandra: 256)

Music is a technique used which sets the mood for what is narrated and enacted on stage. Though the composition is not sung in full, recorded music played on stage drives the narrative along through a variety of moods and leads to a deeper understanding of the subject matter. The play opens with *MHARAO PRANAM* by Kishori Amonkar. This is a Meera bhajan and is a fine example of Braj literature. *HARI TUM HARO JAN KI BHIR BY M S* Subbulakshmi is played on the occasion when Mahadevbhai sets his eyes on Gandhi the first time. In this short song, Meerabhai praises Lord Krishna as a protector of the weak and the infirm. Act one ends with Pandit Paluskar's rendering of *RAGHUPATI RAGHAVA RAJA RAM*, a popular bhajan that was a favourite of Gandhi. The poet Kabir Das's *UD JAYEGA HANS AKELA* by Kumar Ghandharva, a song in the mystical music tradition is sung soon after the resolution of the Yeravda Pact and Gandhiji's fast unto death. The different bhajans and songs played take the

viewers to pietistic heights. Music as a whole becomes a tool for regeneration in Gandhian humility and simplicity.

According to Hegel, "a genuinely historical account had to display not only a certain form… but also a certain content namely a sociopolitical order" (qtd. in White: 11). Incorporating a historical narrative into the text of a drama *Mahadevbhai (1892-1942)* is an eye-opener to what Gandhiji and other freedom fighters stood for. It comes as a powerful corrective to all those who remain blind, evasive and indifferent to the values of the past. Thus, as Hayden White maintains, the form of a text as a content or essence becomes its ideology.

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ചരിത്രം പുനർജ്ജനിക്കുന്ന ചെറുകഥകൾ : 'ജൂതതെരുവിനെ' ആധാരമാക്കി ഒരു നിരീക്ഷണം

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സംഗ്രഹം

എൻ.എസ്. മാധവന്റെ 'ലന്തൻബത്തേരി, പോഞ്ഞിക്കര റാഫിയുടെ 'സ്വർഗ്ഗദൂതൻ' എന്നീ നോവലുകൾ കേരളത്തിലെ ലത്തീൻ പാരമ്പര്യത്തിന്റെ നേർക്കാഴ്ചകളായി വായനയുടെ ലോകത്ത് നിറംപിടിച്ചുനില്ക്കുന്ന കൃതികളാണെങ്കിൽ കേരളത്തിന്റെ പടിഞ്ഞാറൻ തീരത്തിന്റെ മിടിപ്പും സംഘർഷങ്ങളും ചരിത്രദൃഷ്ട്യാ പുനരാവിഷ്ക്കരിക്കുന്ന ഉജ്ജ്വലകൃതിയാണ് സെബാസ്റ്റ്യൻ പള്ളിത്തോടിന്റെ ജൂതതെരുവ്. ബൈബിൾ പശ്ചാത്തലമൊരുക്കുന്ന ഒരു സംസ്കാരവും കൃതിയെ സമ്പന്നമാക്കുന്നു.

കടലിന്റെ ഉപ്പേറ്റു വളർന്ന തീരദേശമനസ്സിലേക്കുള്ള യാത്ര എന്നാണ് പള്ളിത്തോടിന്റെ ആദ്യനോവലായ 'ആഞ്ഞുസ്തേയി' യെ കെ.സി.നാരായണൻ വിശേഷിപ്പിച്ചത്. 'ജൂതതെരുവാ'കട്ടെ കാലഘട്ടത്തിനു മായ്ക്കാനാവാത്തവിധം മലയാളത്തിന്റെ മണ്ണിലും വിണ്ണിലും അലിഞ്ഞുചേർന്ന ലത്തീൻ സംസ്കാരവിശേഷങ്ങളുടെ അകപ്പൊരുളുകളാണ് വായനക്കാരന്റെ മുന്നിൽ തുറന്നുവയ്ക്കുന്നത്.

'ലത്തീനികൾ' എന്ന കഥയിൽ, അഞ്ഞൂറുവർഷം മുമ്പ് ഫോർട്ടുകൊച്ചിയിലെ കുരിശിങ്കൽകാരുടെ പായ്ക്കപ്പലുകൾ സുഗന്ധവ്യഞ്ജനങ്ങളുമായി അറബിക്കടൽ കടന്നുപോയതിനെ ചരിത്രമാക്കുന്നതിനാണ് വാസ്ക്കോ ഡി ഗാമ കൊച്ചിയിലെത്തിയത് എന്ന പ്രാരംഭത്തോടെ, ലത്തീൻ സംസ്കാരചരിത്രം അനാവൃതമാവുകയാണ്. കൊച്ചിയിലും പരിസരത്തും നിലനിന്ന ലത്തീൻ ജനസമൂഹത്തിന്റെ ജീവിതകഥയുടെ അടരുകൾ ഓരോന്നായി ചുരുൾ നിവർന്നു തുടങ്ങുന്നതും ഇതിൽ വായിക്കാം.

ബെർളി മാസ്റ്ററിന്റെയും കെ.ജെ.ഹർഷലിന്റെയും മുത്തച്ഛന്മാരുടെ കുടുബം അഞ്ഞൂറ്റിക്കാരാകുന്നതിനും മുമ്പുള്ള ചരിത്രം എന്നാണ് അറുകുലശ്ശേരിൽ ക്ലീറ്റസ് ഇതേക്കുറിച്ച് കഥാനായകനായ ബനവന്തൂരിനോട് പറയുന്നത്. വാസ്കോഡിഗാമയും അൽഫോൻസോ ഡി ആൽബക്വർക്കും കാപ്പാട്ടും കൊച്ചിയിലും പിന്നീടു കൊല്ലത്തും നങ്കൂരമുറപ്പിക്കുമ്പോൾ,

അതിനും എത്രയോ മുമ്പ് നസ്രായന്റെ വിലാവിൽ വിരലാഴ്ത്തിയവൻ ഇവിടെ ഏഴരപ്പള്ളികൾ പണിതെന്നും അതും കഴിഞ്ഞ് നെയ്തൽതിണയുടെ തീരംപറ്റി ശൗര്യാരുപുണ്യാളൻ വന്നെന്നും സാക്ഷാൽ ഇഗ്നേഷ്യസ് ലയോളയുടെ ശിഷ്യനായി സ്പെയിനിൽ നിന്നെത്തിയ, ഡോക്ട്രിനാ ക്രിസ്റ്റയുടെ ആ ഗ്രന്ഥകാരനാണ് ഫ്രാൻസിസ് സേവ്യറായതെന്നും മറ്റുമുള്ള ചരിത്രഗതിയിലേക്ക് ഈ കഥ വെളിച്ചം പകരുന്നു .

കൊച്ചീശീമയിൽ ലത്തീൻകാരുടെ ഉദയം ഫ്രാൻസിസ് സേവ്യറിലൂടെയാണെന്നിരിക്കേ, കടലിൽപ്പോകുന്ന അഞ്ഞൂറ്റിക്കാരനും കരയ്ക്കിരിക്കുന്ന എഴുന്നൂറ്റിക്കാരനും പൗരാണിക കൊച്ചീരൂപതയിൽ നിന്നു പൊട്ടിപ്പിളർന്നു പലവഴിയേ പിരിഞ്ഞപ്പോഴും ഉദയംപേരൂർ സൂനഹദോസ് അവരെ പരാമർശിക്കാതെ വിട്ടുകളഞ്ഞതെന്തേ എന്ന ചോദ്യം കഥാകാരൻ ഉന്നയിക്കുന്നു .

നസ്രാണിസമാജത്തിന്റെ പ്രസിഡന്റായിരുന്ന ക്ലീറ്റസും അറുകുലശ്ശേരിയിലെ ക്ലീറ്റസും തമ്മിലുള്ള അകലം ഏറെയാണ്. വംശവൃക്ഷത്തിന്റെ പട്ടികയിലൊന്നിലും ര ാമൻ ഇടംപിടിച്ചില്ല. വടക്ക് കോട്ടപ്പുറം മുതൽ തെക്കു കൊല്ലം വരെയുള്ള ലത്തീനികൾക്ക് അംഗങ്ങളായിരിക്കാൻ വ്യവസ്ഥ ചെയ്യപ്പെട്ട നസ്രാണിഭൂഷണസമാജത്തിന്റെ നിയമാവലികളിലൊന്നിലും മത്സ്യത്തൊഴിലാളികൾ ഇടംപിടിച്ചില്ല. ചാളപിടിത്തക്കാരനായ ലത്തീനി, ഇരുന്നൂറു തേങ്ങയും അഞ്ചു പറ ചെട്ടിവിരിപ്പിന്റെ ക വുമുള്ള, നീലം മുക്കിയ കമ്മീസയിടുന്ന ലത്തീനിക്ക് അയിത്തക്കാരനായി. ഇതാണ് ലത്തീനിക്കുള്ളിലെ ചാതുർവർണ്ണ്യമെന്നും കഥ ചൂ ിക്കാട്ടുന്നു. ശൂദ്രൻ ശൂദ്രനെ കളംതിരിച്ചു നിർത്തുന്ന അനാര്യമായ മേൽക്കോയ്മ എന്നാണ് കഥാകാരൻ ഇതേക്കുറിച്ച് വ്യക്തമാക്കുന്നത്. ഒരായിരം വർഷത്തിന്റെ പഴക്കമില്ലാത്ത നമ്പൂതിരിത്തത്തെ ര ായിരം വർഷം മുമ്പെത്തിയ തോമ്മാശ്ലീഹ മാമ്മോദിസ മുക്കിയതിലെ അയുക്തികത എത്ര ആലോചിച്ചിട്ടും പിടികിട്ടുന്നില്ലെന്നും കഥയിൽ നിന്നു വായിക്കാം.

ഗോവയിൽ മീൻപിടിക്കുന്ന ഗൗഡസാരസ്വതനും കടലിൽ പോകുന്ന ലത്തീൻകാരനുമിടയിലുള്ള വിടവിന് അശ്ലീലം നിറഞ്ഞ ഒരർത്ഥംമാത്രമേ ബാക്കിയുള്ളൂവെന്ന് സമൂഹത്തിനു ബോധ്യപ്പെടുത്തിക്കൊടുത്ത കൊച്ചുത്രേസ്യയെപ്പോലുള്ള ഇമ്മിണിവല്യ ത്രേസ്യമാരും അന്നു കൊച്ചിയിൽ നിവസിച്ചുവന്നുവെന്ന് വിവരിച്ച് ചരിത്രത്തിലെ വളവുകളിലേക്കും കഥ കടന്നു ചെല്ലുന്നു .

വിശുദ്ധരായ രക്തസാക്ഷികളുടെ അനുസ്മരണദിനങ്ങളിൽ കുർബ്ബാനയ്ക്കണിയാൻ പുരോഹിതനു കടുംചെമന്ന നിറമുള്ള വെൽവെറ്റിന്റെ കുപ്പായങ്ങൾ, പുരോഹിതന്റെ നാടകീയമായ അംഗവിക്ഷേപങ്ങൾ - ഇതൊക്കെ രാജാപാർട്ടു വേഷങ്ങളുടെ ഓർമ്മകളുണർത്തുന്നുവെന്ന് ഹരി കൊച്ചുത്രേസ്യയെ കളിയാക്കുന്നു . തൊ തുറക്കാതെ മൂക്കുകൊ ആലപിക്കുന്ന ലത്തീനിലുള്ള ലൂത്തിയാനകൾ, ഓരോ പ്രനോബീസ് പോലെ അർത്ഥബോധം പകരാത്ത പദപ്രയോഗങ്ങൾ - ഇതെല്ലാം ഹരിയുടെ വിമർശനത്തിനു വിധേയമാകുന്നു. വാസ്തവത്തിൽ ഇത്തരമൊരു പശ്ചാത്തലമൊരുക്കുന്നതിലൂടെ കേരളത്തിൽ നിലനിന്ന ഗതകാല ലത്തീൻ സംസ്കാരത്തിന്റെ പകർച്ചയാണ് കഥാകാരൻ ഉദ്ദേശിക്കുന്നത്.

ലത്തീൻ സംസ്കാരത്തിലെ ഭക്ഷണക്രമങ്ങളിലേക്കും പ്രാദേശികമായ സ്ലാങ്ങുകളിലേക്കും കഥ പ്രവേശിക്കുന്നു . " ഒരു പച്ചക്കണ്ണൻ ചൊറകെടീ... ദേ .. ഇത്തറേമൊ , ഉണക്കമൊളകും കൊത്തമല്ലീം തേങ്ങാപ്പീരേം വറുത്തരച്ച് ഒരു പാട് ഉള്ളീം പച്ചമുളകും ഇഞ്ചീം

അരിഞ്ഞിട്ട് കടുകുംപൊട്ടിച്ച് ഓട്ടുപുളീമിട്ട് നല്ലൊരു കറിവച്ച്...നമുക്കിഷ്ടപ്പും പച്ചക്കറീന്നു വച്ചാ മീഞ്ചാറാ ....”

‘കടൽ കടന്നുവന്ന സംസ്കൃതി അവരെ കുരിശിന്റെ തണലിൽ ചേർത്തു നിർത്തി. അതൊഴിച്ചുള്ളതെല്ലാം ദുർമ്മതക്കാരന്റെ അന്ധവിശ്വാസമാണെന്നു വേദോപദേശ പുസ്തകങ്ങളിൽ നിന്ന് അവരെ പഠിപ്പിച്ചതു പുരോഹിതന്മാരായിരുന്നു. അമേരിക്കയിൽ നിന്ന് സൗജന്യമായി അയച്ചുകൊടുത്ത പാൽപ്പൊടിയിലും ചാവുദോഷത്തിന്റെ ഭീഷണിയുണർത്തുന്ന കുമ്പസാരങ്ങളിലും പുത്തൻപാനയുടെ ഇഴയുന്ന ഈണത്തിലും ഞെറിച്ചിലാട്ടി നടന്ന പെമ്പിളമാർ ബാവാതമ്പുരാന്റെ കൃപകൊ ് കിടാങ്ങളെയൊത്തിരി പെറ്റുകൂട്ടി’ എന്നു കഥാകാരൻ വിവരിക്കുന്നത് തെല്ലുഹാസ്യത്തിന്റെ മേമ്പൊടി കലർത്തിയാണെങ്കിലും, അത്തരം വിവരണങ്ങളിലെല്ലാം കേരളീയ ലത്തീൻ ജീവിതത്തിന്റെ സംസ്കാരചരിത്രം കാഴ്ചച്ചിത്രങ്ങളായി നിലകൊള്ളുന്നു.

ബൈബിൾ പശ്ചാത്തലത്തിന്റെ സമ്പന്നത.

‘അന്നു വെള്ളിയാഴ്ചയായിരുന്നു’ എന്ന കഥയിൽ ദൈവത്തിരുച്ചിത്തത്തിന്റെ പാതയിൽ സഞ്ചരിക്കുന്നവരെ കാത്തിരിക്കുന്ന അവസാനവിധിയായ പ്രലോഭനങ്ങളെക്കുറിച്ചാണ് വിവരിക്കുന്നത്. ഒരര നിമിഷത്തിന്റെ മനശ്ചാഞ്ചല്യം മതി ഇതുവരെ നേടിയതത്രയും നഷ്ടപ്പെടാനെന്ന് കഥ ഓർമ്മിപ്പിക്കുന്നു. അത്രയ്ക്കു ജാഗ്രത്താണ് ഇരുട്ടിന്റെ ശക്തി. ലോകവും ശരീരവും മാത്രമല്ല, സാത്താനും ഉറങ്ങുന്നില്ല.

ജന്മനാ കുരുടനായ ജോരൂസിന്റെ കഥയാണ് ആവിഷ്ക്കരിക്കുന്നത്. ട്രെയിനിലെ സൗജന്യ യാത്രാനുകൂല്യത്തിന്റെ പിൻബലത്തിൽ ചെന്നെത്താൻ കഴിയുന്ന ധ്യാനകേന്ദ്രങ്ങളിലെല്ലാം ചെല്ലുന്നയാൾ. മറൈൻ ഡ്രൈവിലെ പുൽമൈതാനത്തും മണ്ണഞ്ചേരിയിലെ സന്ധ്യാപ്രാർത്ഥനയ്ക്കും അയാൾ ചെന്നു. അപ്പോഴൊക്കെയും കളിമണ്ണിൽ തുപ്പലിന്റെ പശ ചാലിച്ച് കൺപോളകൾക്കു മീതെ പുരട്ടുന്ന ഒരു കാരുണ്യസപ്ർശം തന്നിൽ നിന്ന് എത്രമാത്രം അകലെയാണെന്നറിഞ്ഞ് അയാൾ വേദനിച്ചിട്ടു ്. ഒടുവിലാണ് കാറ്റാടിയിലെ ധ്യാനകേന്ദ്രത്തിൽ അയാളെത്തുന്നത്. സിക്കമൂർമരത്തിന്റെ കൊമ്പിലായിരിക്കുമ്പോൾ തന്നെ തിരിച്ചറിയാതിരുന്നവൻ ഇന്നു തന്നെ വാരിപ്പുണരുമെന്ന് ജോരൂസ് കരുതി. പക്ഷേ, അതു സംഭവിക്കും മുമ്പ് ആ കാരുണ്യം അവന്റെ കണ്ണുകളെ സ്പർശിച്ചു.

അപ്പോൾ അടുത്ത സന്ധ്യയിൽ രോഗശാന്തി ശുശ്രൂഷാപ്രാർത്ഥനകൾക്കു മധ്യേ പ്രയോഗിക്കേ പൊടിക്കൈകളെക്കുറിച്ച് ആലോചിച്ചുകൊ ിരുന്ന ഫാദർ വിജയാനന്ദിന്റെ ഹൃദയം വല്ലാതെ ചഞ്ചലപ്പെട്ടു. ശരീരത്തിൽ നിന്ന് അരൂപിയുടെ ശക്തിയും വരപ്രസാദങ്ങളും ആരോ പിഴുതെടുക്കും പോലെ ഒരു നൊമ്പരം. നോക്കുമ്പോൾ ജോരൂസിന്റെ ചുറ്റും ആളുകൾ കൂടിയിരിക്കുന്നു. എല്ലാവരും പിരിഞ്ഞുപോകണമെന്നും ജോരൂസിനെ ബാധിച്ചിട്ടുള്ളത് ദുരാത്മാവാണെന്നും ഫാ.വിജയാനന്ദ്. ജോരൂസിനെ അടച്ചിട്ട മുറിയിലേക്ക് മാറ്റി. നാളെ സന്ധ്യയ്ക്ക് സാക്ഷ്യം പറഞ്ഞാൽ മതിയെന്നു ജോരൂസിനു നിർദ്ദേശവും നല്കി. ജോരൂസ് ഇപ്പോൾ കാണുന്നത് മായക്കാഴ്ചയാണ്. യഥാർത്ഥ കാഴ്ച നാളെ സന്ധ്യയ്ക്കു കാണും. വിജയാനന്ദ് ഇരുട്ടിലേക്കിറങ്ങി. താനിപ്പോൾ ശരിക്കും ഒരു കള്ളനെപ്പോലെ ആയിരിക്കുന്നുവെന്ന് അയാൾക്കു തോന്നി. ചെറുക്കാനീരിന്റെ കയ്പുനിറഞ്ഞതും അശ്ലീലവുമായ ഒരു ഗന്ധം

അവിടെ പടർന്നൊഴുകുന്നതറിഞ്ഞ് നെറ്റിയിൽ കുരിശുവരയ്ക്കാൻ അയാൾ കൈയുയർത്തി. ആചാരാനുഷ്ഠാനങ്ങൾ കൃത്യമായി നിർവ്വഹിക്കുകയും ജീവിതത്തിൽ തന്റെ ആചാര്യനു വിരുദ്ധമായ തിന്മകൾ പ്രവർത്തിക്കുകയും ചെയ്യുന്നവരുടെ കുറ്റബോധം നിറഞ്ഞ മനസ്സിന്റെ ചിത്രീകരണമാണ് ബൈബിൾ പശ്ചാത്തലത്തിൽ കഥാകാരൻ കോറിയിടുന്നത്.

സംശോധിത കൃതികൾ

1. ജൂതതെരുവ് - സെബാസ്റ്റ്യൻ പള്ളിത്തോട്
2. ലന്തൻബത്തേരി - എൻ.എസ്.മാധവൻ
3. സ്വർഗ്ഗദൂതൻ - പോഞ്ഞിക്കര റാഫി

मातृत्व का नया समाजशास्त्र-'रानी माँ का चबूतरा' के परिप्रेक्ष्य में

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संक्षेप

समाजशास्त्र साहित्य से भिन्न और स्वतंत्र अनुशासन है। दरअसल, सामाजिक संबंधों तथा गतिविधियों का अध्ययन करनेवाले विज्ञान के रूप में समाजशास्त्र का विकास हुआ है।दरअसल, सामाजिक संबंधों तथा गतिविधियों का अध्ययन करनेवाले विज्ञान के रूप में समाजशास्त्र का विकास हुआ है। जिस तरह अर्थशास्त्र ,राजनीतिशास्त्र, मनोविज्ञान, नृतत्वशास्त्र आदि सामाजिक विज्ञान व्यक्ति के अलग अलग व्यवहारों का अद्यन करते हैं वैसे ही समाजशास्त्र समाज की विभिन्न स्थितियों और समस्याओं के अद्यन में सहायक हैं ।समाजशास्त्र की दृष्टि से 'रानी माँ का चबूतरा' को परखते समय कहानी की वस्तुनिष्ठता के बहुलार्थी संदर्भ विवृत होते हैं। साथ ही साथ वह हमें भारतीय यथार्थ से भी जोडता है।

रचनाकार अपनी रचनाओं का चयन सामाजिक संदर्भ के साथ जुड़कर करता है। किसी भी भारतीय भाषा की रचना का समाजशास्त्रीय सन्दर्भ में विश्लेषण करते समय हमें भारतीय परिवेश को समेटना पड़ता है। मन्नू भंडारी के लेखन का समय परिवर्तन का समय था। अपने समय के समाज में जो अंतर आ पडा उसके प्रभाव ने उन्हें झकझोर दिया। अपनी रचनाओं द्वारा काल-परिवर्तन के आवेगों को उन्होंने प्रत्यक्षीकृत किया है। उन्होंने स्वयं कहा है कि उन्होंने जब लिखना शुरू किया तब देश में सामाजिक परिवर्तन हो रहे थे। आज़ादी के बाद हुए सामाजिक परिवर्तनों में परिवार, मानवीय संबन्धों और स्त्रियों की स्थितियों में बदलाव आदि प्रमुख रहे। मध्यवर्ग से आयी महिला कथाकार मन्नू भंडारी उन्नीस सौ पचास के बाद के बदले भारतीय परिवेश से अछूती न रही।

उन्होंने जीवन की नयी परिस्थितियों तथा नये अनुभवों और उनसे उत्पन्न समस्याओं को अपनी रचनाओं में शब्दबद्ध कर दिया। यह समाजशास्त्रीय मान्यता है कि ''समाज की संस्कृति व्यक्ति को प्रभावित करती है और संस्कृति के रूपायन में व्यक्ति सहायक निकलता है।''[1]

श्रीमती मन्नू भंडारी नारी के आँचल को दूध और आँखों को व्यर्थ के पानी से भरा दिखाने में विश्वास नहीं रखनेवाली है। 'रानी माँ का चबूतरा' नामक अपनी बहुचर्चित कहानी के द्वारा उन्होंने एक ओर स्त्री की समर्पण की बात कही है जो प्राचीनकाल से होती आयी है तो दूसरी ओर संघर्ष की बात बताई है जो आधुनिक काल की देन है। प्रस्तुत कहानी को समकालीन भारतीय परिवेश से जुड़कर परखते वक्त मालूम पड़ता है कि उन्होंने मातृत्व की चुनौती को सकारात्मक पृष्ठभूमि प्रदान की है। एक ही कहानी में मातृत्व के दो काल-भेदों को उभारकर उन्होंने उसकी महनीयता पर चार चाँद लगाया है।

मातृत्व नारी जीवन की सबसे श्रेष्ठ अवस्था है जिसको निभाने के लिए स्त्री को ज़िन्दगी भर मेहनत करनी पडती है। स्त्री के मातृत्व की तुलना में पुरुष के पितृत्व की भूमिका एक संकुचित दायरे में घूमती-फिरती है। स्त्री के अंडाशय में अपने बीज को डालकर पुरुष स्वस्थ हो जाता है। उसके बाद, शारीरिक रूप से पुरुष में कोई 'चेंज' नहीं आती, उसकी प्रकृति में कोई बदलाव नहीं आता, वह वही का वही रह जाता है। मगर, स्त्री को देखिए, सचमुच वह पूर्ण रूप से बदल जाती है। गर्भवती बन जानेवाली स्त्री ठीक उसी दिन से मानसिक, शारीरिक और वैकारिक ढंग से परिवर्तित होती जाती है और यह परिवर्तन उसकी ज़िन्दगी के अंतिम दिन तक होता रहता है। गर्भस्थ शिशु का वहन करते वक्त वह कितने ही शारीरिक, मानसिक और वैकारिक संघर्षों का मुकाबला करती है। गर्भावस्था से एकदम भिन्न फिर उसकी ज़िन्दगी मातृत्व के अतिविशिष्ट स्थान को ग्रहण कर लेती है। समय की पूर्ति में अपनी माँ के उदर से बाहर आनेवाला शिशु एक ही साथ अपनी माँ को पीडा और आह्लाद देता है। वैकारिकता के इस मूर्त रूप का एक पुरुष कभी भी स्वामी नहीं बन पाता। माँ से नानी या दादी बनने तक यह वैकारिक सुख केवल स्त्री को ही प्राप्त होता है।

मातृत्व की इस महनीयता को केन्द्र बनाकर मन्नू भंडारी ने ''रानी माँ का चबूतरा'' को अलंकृत किया है। यह दो माताओं की कहानी है और दोनों मातृत्व की दैवी आभा को बनाये रखने

के लिए संघर्ष करती हैं। नगर सेठ की पत्नी रानी माँ अपने बीमार बच्चे के प्राण को बचाने के लिए अपने प्राण तजती है। शीतला माई के कोप से पीडित अपने बच्चे की सेवा-शुश्रूषा करते पहले ही क्षीणित रानी माँ, और एक बार भी देवी की परीक्षा का पात्र बन जाती है। घर में आए साधु के, जो वास्तव में देवी का ही प्रतिरूप है, उपदेश से सात दिन तक अन्न-जल न छू कर, अपने बच्चे के प्राण को लौटा देकर, वह उस अग्निपरीक्षा में विजयी निकलती है। उसके इस त्याग को देवी से तारीफ इस तरह हुई कि जब रानी माँ की अरथी उठा दी गयी तो आकाश से केसर की बूँदें केवल उसकी ही अरथी पर छिटक गयी। इस तरह देवी ने लोगों के सामने मातृत्व की महनीयता का प्रत्यक्ष प्रमाण दिया। सेठजी ने अपनी प्रिय पत्नी का इतना बड़ा आदर किया कि अपने बगीचे में उसके लिए एक चबूतरा बनाया। बस्तीवाली स्त्रियाँ उस भागवंती नारी के देवी रूप से लाभान्वित होने के लिए हर पूरनमासी को रानी माँ के चबूतरे पर दिया जलाकर अपने बच्चों के लिए मनौती मानती है। सचमुच रानी माँ मातृत्व का अलौकिक रूप है।

कहानी की दूसरी माँ एक साधारण मज़दूरिन स्त्री है जो भागवंती है या न भागवंती, चिन्तनीय बात है। ऐसा लगता है, वह भागवंती कभी नहीं थी, क्योंकि उसे जीवन-भर संघर्ष करना पड़ा। साथ ही साथ उसे न भागवंती भी नहीं कहा जा सकता, क्योंकि उसके जीवन-संघर्ष जीवन की अंतिम घडी में आकर लोगों से ममतामयी माँ की सूची में नाम भराने को मज़बूर करते हैं। इस तरह देखा जाय तो वह भागवंती नारी है।

नकामयाबी, शराबी पति को घर से भगानेवाली, नौकरी करके अपने दो बच्चों का पालन-पोषण करनेवाली, अपने घर की मरम्मत स्वयं करनेवाली, सारे बस्तीवालों से हमेशा लडनेवाली, यहाँ तक कि बस्ती की रीति-रिवाज़ों के अनुसार अपने बच्चों के लिए रानी माँ के चबूतरे पर मनौती नहीं माननेवाली गुलाबी, दरअसल, बस्तीवालों के लिए एक अवाँछनीय अंग ही नहीं है। वह सबके लिए झगडालू और चुडैल है। बस्तीवाले उसे एक ममतामयी माँ नहीं समझते हैं। उनके लिए वह ऐसी एक माँ है जो बच्चों को मारने के लिए तुले हो। काकी कहती है - ''बडे बच्चे पाल रहे हैं, मूँह-झौंसी! सबेरे उस काल-कोठरी में बंद करके जाती है तो शाम को आकर खोलती है।''[2] जब

रामी कहती है कि धन्नी ने गुलाबी से एक बच्चे को पालने की इच्छा प्रकट की तो भी काकी कहती है - ''वह क्यों देने लगी? वह तो उनको कोठरी में बंद करके मारेगी।''[3]

गुलाबी को केवल अपनी ज़िन्दगी से ही नहीं, बल्कि अपने परिवेश से और अपने समाज से भी संघर्ष करना पड़ता है। यह संघर्ष उसे इतना रूखा और हठीला बना देता है कि वह हँस भी नहीं पाती। अतः भीड में वह अकेली बन जाती है। बस्ती में केवल एक ही व्यक्ति काका ही उसे समझता था या केवल वही उससे हमदर्दी दिखाता था। कहानी का यह प्रसंग बडा मार्मिक लगता है - ''चबूतरे पर उस समय काका अकेले बैठे थे, गुलाबी को बड़बड़ाती हुई जाते देखा तो टोक दिया : 'किसे कोस रही है गुलाबी? अरे, कभी तो तू भी हँस - बोल लिया कर।''

'हँस बोलकर मुझे किसी को रिझाना नहीं है? बडे आये हैं सीख देनेवाले! तुम्हें तो नहीं कोस रही? कोस रही हूँ उस दारुखोर को जो मेरी जान को ये कीडे-मकोडे छोड गया।'

'अरे मैं तो तेरे भले की बात कह रहा हूँ। चार जनों के बीच आकर बैठा कर तो तेरा भी मन बहल जाये, पर तू तो सबको काटने को दौडती है।'

'हाँ-हाँ मैं तो कटखनी हूँ, क्यों मेरे मूँह लगते हो? ज़्यादा बकवास की तो दो-चार तुम्हें भी सुना दूँगी। बडे आये हैं दरद दिखानेवाले।''[4] मगर यही रूखी हठीली गुलाबी मातृत्व की कोमलतंतुओं के स्पर्श से एकदम हार जाती है। मातृत्व की दैवी प्रेरणा उसे अतिरिक्त काम करने को मज़बूर करती है, अपनी भूख की परवाह न करके, अपने स्वास्थ्य की खैरियत न करके, बच्ची के लिए हरी चूडियाँ और बच्चे के लिए 'शिशु सुरक्षा केंद्र' के पाँच रुपये की टिकट खरीदने के लिए विवश करती है। उसके जीवन-संघर्ष अंतिम घडी में आकर बस्तीवालों से उसे ममतामयी माँ की सूची में नाम भराने को विवश करते हैं।

इन संघर्षों के बीच में भी गुलाबी अपने मातृत्व को एक 'बोझ' नहीं मानती जैसेकि आजकल की मातायें मानती हैं। आजकल मातृत्व एक बोझ-सा बन गया है। मातृत्व को निभाना स्त्रियों के लिए एक चुनौती बन गयी है। मातृत्व का बोझ स्त्रियों को आत्महत्या के आसान सुरक्षा

केंद्र में पहूँचा देता है। विडंबना की बात यह है कि मातायें केवल अपने का ही खूनी नहीं बनती बल्कि अपने बच्चों का भी खूनी बनती हैं। यह प्रवृत्ति आधुनिक काल की देन है। पुराने ज़माने में मातृत्व जीने का, ज़िन्दगी को आगे ले जाने का एक अगाध और अदम्य प्रेरणा थी, तो अब वही ज़िन्दगी को खत्म करने का सबसे बड़ा कारण बन जाता है। जब वे ऐसा करती हैं तो इसका प्रत्याघात केवल उनके परिवार या बन्धु-मित्रों को ही नहीं बल्कि पूरे समाज पर भी होता है। जब 'मीडिया' ऐसी वार्तायें प्रसारित करती है तो दुर्बल-मानसों को न जाने कौन-सी दुष्प्रेरणा मिलती है कि ऐसी माताओं की संख्या दिन-ब-दिन बढ़ती जाती है। आजकल 'मीडिया' ने अपने जालों को इतना फैला दिया है कि चाहे कोई भी समाचार पत्र हो या दूरदर्शन का कोई भी चैनल हो, वार्ताओं को live बनाने की होड में है। 'मीडिया' के इस अतिप्रसार से लोगों का दिल ठप्प सा हो गया है। पत्रकारिता का धर्म है - वह कुछ ऐसी घटनाओं को चित्रित करने में 'सेनसरिंग' का इस्तेमाल करे ताकि वे लोगों के दिल पर धक्का न छोड दे। पत्रकारिता का यही धर्म आज 'चैनलों' का 'सेनसेशन' बन गया है। वे ऐसे चित्र प्रसारित करते हैं जो लोगों पर feeling जगाये। इस 'सेनसेशन' ने feeling जगाते जगाते लोगों के दिल को feelingless बना दिया है। आज मनुष्य कोई भी दुर्घटना को या हृदयभेदी वार्ता को बिना किसी feeling के देख-पढ सकता है। लोगों के दिल से करुणा, त्याग आदि मानवीय गुण अप्रत्यक्ष हो गये हैं। भूमंडलीकरण, उपभोगी संस्कृति, शिक्षा में वृद्धि, तकनीकी का विकास, स्वतंत्र जीवन आदि भारतीय समाज के रहन सहन, सोच-विचार आदि में गहरा अंतर लाये हैं। स्त्रियों की दशा भी कुछ और नहीं है। पर इस अंतर ने जब बुराई की राह पकड ली तो सामाजिक विच्छृंखलता उत्भूत हुई। मैनेजर पांडेय का कथन विचारणीय है - ''भारतीय समाज में व्याप्त भेद-भाव का सबसे भयावह असर स्त्री-जीवन पर पड़ता है।''[5] करुणा की मूर्ति स्त्री जो मानव-समूह की प्रत्याशा थी, पथभ्रष्ट हो गयी। आजकल women-criminals की वार्तायें बराबर आती हैं। उनकी चालाकी या धोखापन पुरुष से बढिया है। ''जहाँ पुरुष शारीरिक बल से धोखा-बाज़ी करता है, वहाँ स्त्री अपने मेधा-बल का प्रयोग करती है।''[6]

स्त्री को अलंकृत करनेवाले गुणों में मातृत्व सबसे श्रेष्ठ है, मगर आज की स्त्री इस श्रेष्ठता को खोती जाती है। कितनी ही ऐसी मातायें हैं जो धन पाने के लिए अपनी वयस्क या अवयस्क पुत्रियों को बेचती हैं, अपने स्वार्थ-सुख के लिए बच्चों की उपेक्षा करती हैं, पति के होते अपने प्रेमी के साथ जीने के लिए बाधा बनने वाले बच्चों को पीडित करती हैं या मारती हैं। गुलाबी के मातृत्व की प्रासंगिकता यहीं पर है। अपने अस्तित्व को बनाये रखने के लिए संघर्ष करती गुलाबी अपने मातृत्व को भी निभाती है।

साहित्य जब समाजशास्त्र का सहारा लेकर अध्ययन प्रस्तुत करता है तो उसका लक्ष्य सपाट सामाजिकता का सामान्य अंकन नहीं है, अपितु गहन सामाजिकता की गंभीर स्थितियों का आकलन करना है। 'रानी माँ का चबूतरा' को इस परिप्रेक्ष्य में आँका जाना ज़रूरी है।

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DOUBLE GRAPH AS AN INTERCONNECTION NETWORK MODEL

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ABSTRACT

The double graph of a graph D(G) is defined as the lexicographic product of G with the compliment of K_2. In this paper, we include some results regarding the connectivity and diameters of double graphs.

Key words: Double graph, connectivity, diameter
AMS Classification: 05C40, 05C99

1. Introduction

The architecture of an interconnection network can always be represented as a graph, where the nodes represent the vertices and the links between the nodes represent the edges of the graph. Reliability and efficiency are important criteria in the design of interconnection networks. It is not easy to design a network that is optimum from all aspects. But graph theoretic techniques can be used to determine the efficiency and reliability of a network model. Several interconnection networks and their

graph parametrical studies can be referred in the classical book 'Graph Theory and Interconnection Networks' by L H. Hsu end et.al, [5].

The diameter of a graph G is the maximum distance between any two vertices in G and it will give the maximum communication delay in the corresponding network model. The vertex connectivity of G, $\kappa(G)$ is the smallest number of vertices in G whose deletion from G increases the number of components of G or leaves K_1. A graph is n-connected if $\kappa(G) \geq n$. The edge connectivity of a graph G, $\kappa'(G)$ is the least number of edges whose deletion increases the number of components of G. By Menger's theorem, a graph G is k-connected if and only if there exists at least k internally vertex disjoint paths between any two vertices of the graph G. By the edge version of Menger's theorem, a graph G is k-edge connected if and only of there exists at least 'k' edge disjoint paths joining any two vertices of G. The minimum degree of vertices in G is denoted by $\delta(G)$.

Hsu [4] defined wide diameter to unify the concepts of connectivity and diameter of a graph. The wide diameter of G is denoted by $D_w(G)$ and it is the minimum number l such that in between any two vertices of G, there exists 'w' internally vertex disjoint paths of length at most l.

In this paper, we consider finite connected graphs only. For any other notions not defined here, refer [9]. The detailed proofs of some theorems are omitted and they can be referred in [6].

The lexicographic product of two graphs G and H denoted by G□ His the graph with V(G□ H) = {(u, v): u Є V(G) , v Є V(H)} and any

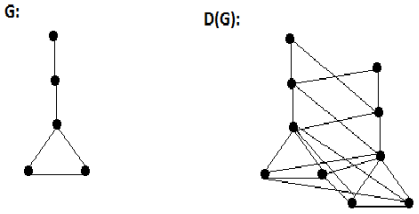
two vertices (u_1,v_1) and (u_2,v_2) in G □ H are adjacent if one of the following holds.

(i) $u_1 - u_2 \in E(G)$

(ii) $u_1 = u_2$ and $v_1 - v_2 \in E(H)$.

The double graph of a graph G, D(G) is defined inn [7] as the lexicographic product of G with the compliment of K_2 .

As an eg:-



2. The structure and parameters of Double graphs

By the construction it is clear that G is an induced subgraph of D(G).

Theoerm

G is connected if and only if D(G) is connected.

Proof: The necessary part is clear from the definition of D(G).

Suppose that D(G) is connected. If possible assume that G is not connected. Let u_i and u_j be any two vertices in different components of G. Since D(G) is connected, there exists a path between (u_i, v_1) and (u_j, v_1) in D(G). Let the path be $P = (u_i, v_1),(u_1, v_a),(u_2,v_b)$ $...(u_j, v_1)$. Then there exists a path $u_i, u_1, u_2, ..., u_j$ in G.

Lemma
For a complete graph G, diam(D(G))=2. For any other simple connected graph G, diam(D(G))=diam(G).

Theorem
For any connected graph G, $\kappa(D(G)) = 2\kappa(G)$.

Theorem
For any connected graph G, $2\kappa'(G) \leq \kappa'(D(G)) \leq 4\kappa'(G)$.

Corollary
In a connected graph G, if $\kappa'(G) = \delta(G)$ then $\kappa'(D(G)) = 2\kappa'(G)$.

Theorem
The wide diameter of D(G) is the same as wide diameter of G.

3. Concluding remarks

As we have noted, the double graph of a graph G has lesser diameter (If G is not a complete graph) and higher connectivity (both vertex connectivity and edge connectivity) than G. As we know, a good interconnection network model prefers smaller diameter and higher connectivity for a better communication. So, if we consider the graph G of a good interconnection network model then D(G) will be a better model. Further a good interconnection network model prefers a small wide diameter as it enables fast multipath communication. In this chapter, we have proved some results regarding the wide diameter of double graphs which proves that the double graph has lesser (or equal) diameter than the original graph. So D(G) will be a good model for interconnection networks.

4. Scope for further study

- Graph theoretic techniques help to determine the efficiency and reliability of a network model. One has to design a suitable network depending on the properties and requirements. The graphs that are proposed are referred as 'good graphs'. So using the help of graph theory more good graphs can be invented. They may be the graphs that are already in the literature or new constructions.
- More graph theoretic properties that are useful in the study of interconnection networks are discussed in [5]. We have studied some of them in Double graphs. Many of them are left for further study.
- From the point of view of interconnection networks, some studies have been done in a few graph operations such as [3]. Many graph operators can be referred in [8]. So, research can be done to find 'good graphs' from the possible graph operators defined and studied in [8].
- Since diameter is the maximum communication delay in any network, the distances defined in [2] may have some role in the study of efficiency. Studies can be done in this regard.
- Many known graph classes such as 'perfect graphs', 'clique graphs', 'block graphs', 'split graphs' etc that can be referred in [1] and some of them may be good models for networks.

Acknowledgment

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A PHOTOACOUSTIC CELL FOR REAR SIDE ILLUMINATION OF THIN FILM SAMPLES

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ABSTRACT

A photoacoustic cell which can be used for the measurement of thermal diffusivity of thin films using rear surface illumination method has been fabricated. Thin /thick films of Indium, Aluminium, Silver and CdS having thickness of the order of 18-690μm prepared from vacuum coating technique have been used for measurements. The experimental method involves the determination of the variation of the phase of the photoacoustic signal as a function of the chopping frequency for a monochromatic incident beam. The thermal diffusivity values obtained for each of the samples using this cell show close agreement with the previously reported results.

1. Introduction

The photoacoustic (PA) technique has been recently revived as very useful tool for the spectroscopic investigation of samples where the conventional optical absorption and reflectance spectroscopy cannot be

used. The main factor behind the interest in photoacoustic spectroscopy is that it cannot be used. The main factor behind the interest in photoacoustic spectroscopy is that it can be used as a powerful tool for studying the thermal properties of samples in any form. Detection of acoustic waves after absorption of modulated optical radiation provides information of thermal properties of the material in a very elegant way. As shown by several authors [1-6] thermal waves are very sensitive to change in thermal characteristics of the materials. The thermal properties, especially, those of thin films, are of growing interest in microelectronics and micro systems, the heat removal from highly integrated devices becomes a serious problem requiring practical solutions. Knowledge of thermal diffusivity value in thin films helps one to select microelectronic materials systematically and to get precise input data for microelectronic device modeling. In particular, CdS is a II-VI group semiconductor and it has received considerable attention as an important photonic material because of its potential use in the fabrication of solar cells [7-11] as well as in other areas of photonics.

Various methods have been developed to measure the thermal diffusivity by means of the PA effect [12-14]. In the rear surface illumination method, chopped light is allowed to fall on thin substrate (copper), the farther side of which is deposited with sample, and the PA signals are generated on its free surface. Here, the thermal wave generated at the surface, where the light beam is incident, starts propagating through the sample and is eventually generates the acoustic signal in the gas medium. Therefore the PA signal amplitude and phase directly depends on

the thickness of the sample and its thermal diffusivity. Thus the samples thickness is found to be an important parameter in these measurements. In order to find the thermal diffusivity of thin films samples, the films are deposited on a copper substrate. The phase of the PA signals with the copper substrate alone and that with thin film on copper substrate for different modulation frequencies ω are measured using a lock-in amplifier. Thus from the relative phase difference between the substrate and substrate + thin film, the thermal properties of the thin film alone can be determined. In the present investigation, the thermal diffusivity values of the thin films of Indium, Aluminum and CdS deposited on copper substrate are measured by the rear surface illumination method.

2. Outline of the theory

When intensity modulated light beam falls on the rear surface of the sample. This result the propagation of thermal waves through the thickness I_S of the sample. The thermal diffusion equation along the thickness can be expressed as

$$\frac{d^2\theta_S}{dx^2} - \frac{1}{\alpha_S}\frac{d\theta_S}{dt} = 0$$

where θ_S is temperature at the sample surface and α_S , the thermal diffusivity of the sample. The real part of the solution of above equation is

$$\theta_S(x,t) = \theta_0 \ \exp(-a_S x) \ \cos(\omega t - a_S x) \ .$$

This expression represents the temperature distribution along the thickness of the sample and it is evident that the thermal wave gets attenuated exponentially as it traverses through the sample. The term which represents the phase of the thermal wave is $a_s\, x$ where a_s is the thermal diffusion coefficient of the sample and x is the position where temperature is found to be θ_s . θ_0 is the complex amplitude of the periodic temperature of the sample gas boundary. Therefore the total phase difference between the front surface and rear surface of the sample is expressed as $\Delta\varphi = a_S I_S$. The thermal diffusion coefficient

$a_S = \left(\frac{\omega}{2\alpha_S}\right)^{1/2}$, ω being the angular frequency of the intensity modulated light beam. Thus the graph between $\sqrt{\omega}$ and $\Delta\varphi$ will be a straight line and its slope is $\left(\frac{1}{2\alpha_S}\right)^{1/2} I_S$. The thickness I_S of the thin film is measured using optical method [15].

3. Experimental method

The experimental setup used for the measurements of thermal diffusivity of thin films is shown in Figure 1. An Ar^+ laser beam (Liconix-5000 series) at a power level of 30mW is used as the light source and targets are Indium, Aluminium, silver and CdS thin films deposited on identical copper discs (0.3 mm thick). The materials were obtained in the form of thin / thick films by means of thermal evaporation process. Copper was used as the substrate material so that rear surface illumination method can be conveniently adopted for PA measurements. For the present

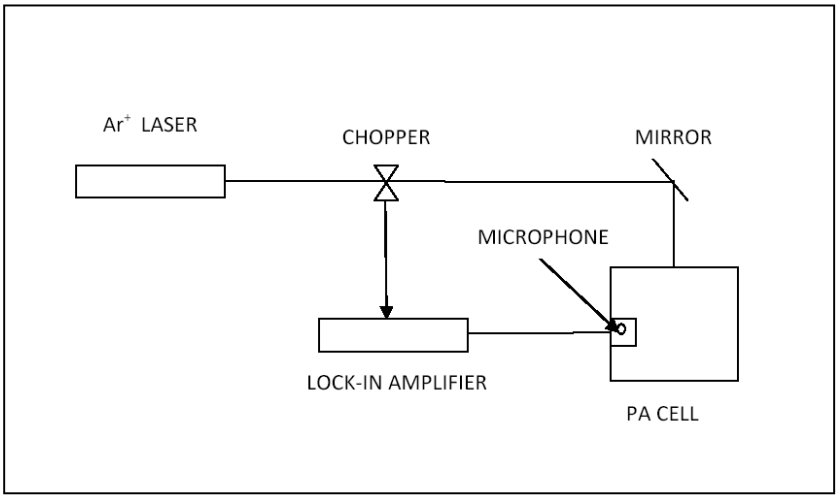

Fig. 1 Experimental setup used for the measurement of thermal diffusivity

measurements we have made use of a PA cell which is capable of measuring thermal diffusivity of thin films using rear surface illumination method. The signal is detected by highly sensitive electret microphone (Knowel's model BT 1753) and analyzed using lock-in amplifier (EG&G Princeton Applied Research model - 5208). The phase of the photoacoustic signal is measured for various chopping frequencies in between 20 and150 Hz.

Schematic diagram of the small volume rear side illumination cell used for room temperature measurements is shown in Figure 2. It has a cylindrical cavity of height 1 cm and diameter 0.8 cm made in a solid block of stainless steel. Window holders and microphone compartments are also made up of using stainless steel. Two windows are provided, one for front side illumination and another for rear side illumination of the sample. The cell volume is acoustically isolated from outside using O-rings on the window holders. The electret microphone used in the cell is

also kept in a separate port which can be removed from the cell body. It has got a flat frequency response in the range 10 to 2000 Hz. The microphone output is taken using a BNC connector attached to the micro-phone port and is fed to the lock-in amplifier. Microphone is also sealed with O-rings and air at atmospheric pressure acts as the coupling gas medium. In order to avoid 'drum effect' the sample is rigidly fixed in the PA cell using O-ring seal.

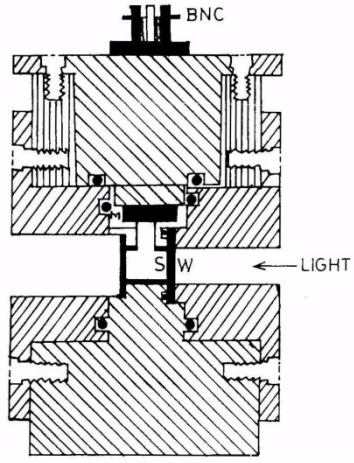

Fig. 2 Schematic diagram of the small volume rear side illumination cell

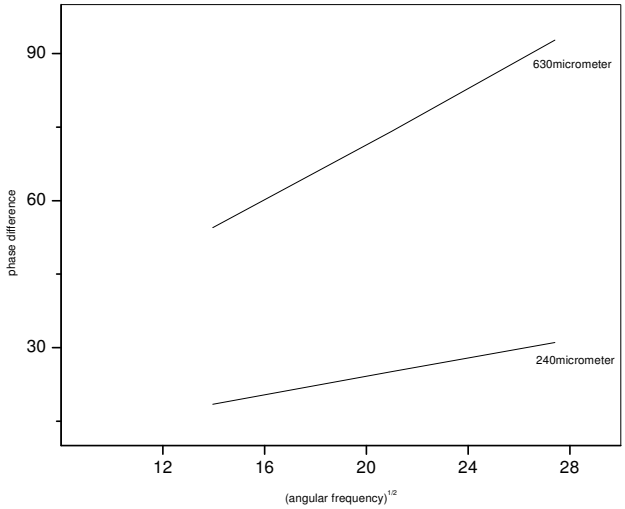

Fig. 3 Variation of phase difference with square root of angular frequency

Figure 3 shows the variation of PA phase difference $\Delta\varphi$ (between copper and copper + Indium thin film) with the square root of the modulation frequency ($\sqrt{\omega}$) at two different thicknesses of Indium thin films (240 µm and 630 µm). From the straight line graphs the slopes are found to be

2.416×10^{-2} and 6.463×10^{-2} respectively for 240 µm and 630 µm. The corresponding α_S values obtained are 0.4935 cm^2/sec and 0.4755 cm^2/sec.

By following the same procedure, the thermal diffusivity value of Aluminium, Silver and CdS has been determined. Measured values and literature values are shown in Table I. In our view, this shows extremely good agreement between the calculated values of α_S and its known value [16,17]. In view of the simplicity of the experimental set up, one can strongly recommend the present technique for determining the thermal diffusivity of thin films. However, the sample thickness is found to be an important parameter in these measurements. This does not pose any serious problem since there are a number of standard methods for fairly accurate determination of sample thickness. Alternatively, with known

Table 1

Measured and literature values of thermal diffusivity

Material	Thickness of thin film (Is) µm	Measured value of α_S cm^2/sec	Literature value of α_S cm^2/sec
Indium	240	0.4935	0.4787
	630	04755	
Aluminium	400	0.8156	0.8200
	600	0.8072	
Silver	530	1.746	1.75
	690	1.768	
CdS	18	0.1412	0.153
	26	0.1440	

values of thermal diffusivity it is possible to estimate the sample thickness with fair amount of accuracy using the PA technique described above.

4. CONCLUSION

Thermal diffusivities of thin films can be accurately measured by the photoacoustic method. Because of its controlling effect and common occurrence in heat flow problems, thermal diffusivity determination is often necessary and knowledge of it can in turn be used to calculate the thermal conductivity.

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GAUSSIAN EFFECTIVE POTENTIAL STUDY OF FINITE DENSITY PHASE TRANSITIONS IN ϕ^4 MODEL

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ABSTRACT

We study the gaussian effective potential of a self interacting U(1) symmetric ϕ^4 model at finite temperature and finite bosonic density in the cutoff and autonomous formulations and show the existence of temperature or bosonic chemical potential induced multiple phase transitions. The temperature and density dependence of the effective scalar boson mass is also analyzed.

Key words: effective potential, bosonic density, multiple phase transition

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1. Introduction

The study of phase transitions at high temperature and high density is a topic of current interest. In unified gauge models with spontaneous symmetry breaking (SSB), in addition to fermionic matter, bosonic matter

is present in the form of Higgs particles. In recent times, much attention has been focused on the study of Higgs particles mainly with a view to obtain more stringent limits on their physical properties and possible implications. In this context studies of models including the chemical potentials of charged bosonic matter are of interest. In previous papers [1] we reported the results of a perturbative analysis of finite temperature and finite bosonic density phase transitions in $\lambda \phi^4$ and abelian Higgs models at the one-loop level. We have shown by the effective potential method that in these models spontaneously broken O(2) symmetry is restored at a higher value. Since these results are somewhat unconventional and appear to have some new implications, it seems worthwhile to do a non-perturbative analysis of these finite temperature and finite density (FTD) phase transitions to arrive at definite conclusions.

Gaussian approximation is a non-perturbative variational method and has been extensively developed along the lines initiated by Stevenson, Consoli and others [2, 3]. These various works differ in certain technicalities in the computation. It has been established that, in four dimensions a simple and viable, non-trivial theory called precarious theory arising from a bare coupling constant of a particular negative infinitesimal form exist. Without regularization this is stable, but does not possess SSB. However using a finite ultraviolet cutoff for the momentum integral SSB can be induced. This cutoff version gaussian effective potential (GEP) has been applied to various scalar and fermionic models [4]. Another version of GEP that has been shown to exist is the autonomous form which

possesses SSB and allows a positive value for the bare coupling constant [5-7]. Finite temperature evaluation of the GEP in scalar models have been done and are shown that increase of temperature restores the spontaneously broken symmetry.

In this paper we make a GEP study of FTD phase transitions in $\lambda\phi^4$ model making use of both the cutoff and autonomous versions of GEP. It is shown that in the presence of SSB at finite non-zero temperatures, increase of bosonic chemical potential induces a sequence of symmetry restorations and symmetry breakdowns. For an asymptotically large value of chemical potential, these multiple phase transitions end in a symmetry broken phase. Similarly in the case of SSB at a finite non-zero value of bosonic chemical potential, increase of temperature induces a series of symmetry restoring and symmetry breaking phase transitions. For an asymptotically large value of temperature, symmetry remains restored. With zero chemical potential increase of temperature only restore the SSB phase without any multiple phase transition. We also study the FTD behaviour of effective Higgs mass.

The remaining part of the paper is arranged as follows. In Sec. 2 we present a FTD study of the cutoff version of GEP for the $\lambda\phi^4$ theory. Sec.3 is devoted to the autonomous version of GEP. Our conclusions are presented in Sec. 4.

2. Cutoff version GEP

In this section we evaluate the Gaussian effective potential at finite temperature and bosonic density (FTDGEP) by introducing explicitly a finite and very large cutoff Λ for the momentum. This allows the bare constants to assume a positive value and to have SSB.

The GEP at zero temperature and chemical potential is defined by

$$\overline{V}_G(\phi_0) = \left[V_G(\phi_0,\Omega)\right]_{\Omega=\Omega_{min}} = \left[{}_{\Omega,\phi_0}\langle 0|\mathcal{H}|0\rangle_{\Omega,\phi_0}\right]_{\Omega=\Omega_{min}} \quad (1)$$

where $\mathcal{H}$ is the Hamiltonian density, $|0>_{\Omega,\phi_0}$ is a normalized Gaussian wave functional centered on $\phi = \phi_0$ and Ω_{min} is the value of the mass parameter Ω which minimizes $V_G(\phi_0,\Omega)$. We study the model of a self interacting 2-component spinless field in 3+1 dimensions with an O(2) invariant interaction described by the lagrangian

$$\mathcal{L}(\phi_a(x)) = \frac{1}{2}\partial_\nu\phi_a\,\partial^\nu\phi_a - \frac{1}{2}m_B^2\phi_a\phi_a - \frac{\lambda_B}{4!}(\phi_a\phi_a)^2, \quad a = 1,2 \quad (2)$$

A study of GEP for this model with a cutoff Λ shows the ground state of (2) possess a SSB phase under the conditions [9]

$$0 < \lambda_B < \frac{4}{J_2(\frac{\rho}{\Lambda})} \quad \text{and} \quad -m_B > \eta_c\Lambda^2 \quad (3)$$

where

$$J_2\left(\frac{\rho}{\Lambda}\right) - \frac{1}{2\pi^2}\left(\ln\left(\frac{\Lambda}{\rho} + \sqrt{\left(\frac{\Lambda}{\rho}\right)^2 + 1}\right) - \frac{\Lambda/\rho}{\sqrt{(\frac{\Lambda}{\rho})^2 + 1}}\right)$$

$$\eta_c = \left(\frac{\chi_c}{\sqrt{{\chi_c}^2 + 1}}\right)\frac{\lambda_B}{16\pi^2} \leq \frac{\lambda_B}{16\pi^2}$$

with $\chi_c = \frac{1}{2}\exp\left(\frac{8\pi^2}{\lambda_B} + 1\right) \gg 1.$

We shall follow Stevenson's method [3] in calculating the GEP by writing the field ϕ as $\phi_0 + \hat{\phi}$ where ϕ_0 is a constant classical field and $\hat{\phi}$ is a quantum free field of mass Ω. This yields the GEP at zero temperature and zero density for the model described by (2) as

$$\overline{V_G}(\phi_0) = \frac{1}{2}\, m_B^2\phi_0^2 + \frac{1}{4!}\lambda_B\phi_0^4 + I_1(\Omega) + \frac{1}{2}(m_B - \Omega^2)I_0(\Omega) + \frac{1}{4}\lambda_B I_0(\Omega)\phi_0^2\ (\Omega) + \frac{1}{8}\lambda_B I_0^2(\Omega) \quad (7)$$

where the I_N integrals are given by

$$I_N(\Omega) = \frac{1}{2}\int \frac{d^3k}{2\pi^3}\left(K^2 + \Omega^2\right)^{N-\frac{1}{2}}. \quad (8)$$

Minimizing the expression (7) with respect to the variable parameter Ω give the optimum value of Ω to be used and is a solution of the gap equation

$$\bar{\Omega}^2 - m_B^2 + 12\,\lambda_B\left(I_0(\bar{\Omega}) + \phi_0^2\right) = 0. \quad (9)$$

In equilibrium thermodynamics the GEP at finite values of temperature T and chemical potential μ is evaluated by minimizing the Helmholtz free energy F of a quantum field system in a finite volume V calculated from the partition function Z

$$Z = \mathrm{Tr}\exp(-\beta H + \beta\mu), \qquad \beta = \frac{1}{kT} \tag{10}$$

and

$$F = \frac{-1}{\beta}\ln Z \quad . \tag{11}$$

Minimization of F/V with respect to the variational parameter Ω leads to the FTDGEP. This amounts to a replacement of the integrals

$$I_1(\Omega) = I_1(\Omega) + I_1^{\beta,\mu}(\Omega) \quad \text{and} \quad I_0(\Omega) = I_0(\Omega) + I_0^{\beta,\mu}(\Omega) \tag{12}$$

where

$$I_1^{\beta,\mu}(\Omega) = \frac{1}{\beta}\int \frac{d^3k}{(2\pi)^3}\ln(1 - \exp(-\beta\omega_k + \beta\mu)) \tag{13}$$

and

$$I_0^{\beta,\mu}(\Omega) = \int \frac{d^3k}{(2\pi)^3}\,\frac{1}{\omega_k\,(\exp(\beta\omega_k - \beta\mu) - 1)} \tag{14}$$

with $\omega_k^2 = k^2 + \Omega^2$. The fields in (2) carry a conserved bosonic charge and hence we introduce a bosonic chemical potential μ corresponding to this charge. Making use of the FTD conversion expressions (12) – (14) in (7) we get the FTDGEP in the form

$$\overline{V_G^{\beta,\mu}} = I_1(\Omega) + \frac{1}{2}\left(m_B^2 - \Omega^2\right)I_0(\Omega) + \frac{1}{2}m_B^2\phi_0^2 + \frac{\lambda_B}{4!}\phi_0^4 + I_1^{\beta,\mu}(\Omega) + \frac{1}{2}\left(m_B^2 - \Omega^2\right)I_0^{\beta,\mu}(\Omega) + \frac{1}{4!}\lambda_B\left[6I_0(\Omega)\phi^2 + 3I_0^2(\Omega) + 6\phi_0^2 I_0^{\beta,\mu}(\Omega) + 6I_0(\Omega)I_0^{\beta,\mu}(\Omega) + 3(I_0(\Omega))^2\right]. \quad (15)$$

The complete FTD dependence of the effective potential (15) is carried by the integrals $I_0^{\beta,\mu}$ and $I_1^{\beta,\mu}$. But it is cumbersome to analytically evaluate these integrals in a closed form and hence to understand the characteristics of (15), we resort to numerical methods. In figures 1-3 we show the results of numerical studies made on the expression for the effective potential (15). Values of the various parameters in (15) are selected in accordance with (3), so as to have SSB.

In Figure 1, we plot the $\overline{V_G^{\beta,\mu}}$ for various temperatures in the absence of any chemical potential. It shows the usual finite temperature behavior; starting from a SSB phase, the increase of temperature restores the symmetry at a particular critical temperature.

In Figure 2, $\overline{V_G^{\beta,\mu}}$ is plotted for various chemical potentials at a non-zero temperature. We see that, with the increase of chemical potential the symmetry is restored and is broken a number of times and for an asymptotically large value of μ, the symmetry remains broken. In Figure 3 we show the $\overline{V_G^{\beta,\mu}}$ for various temperatures at a at non-zero chemical potentials. As in Fig.2 this also shows the existence of a temperature induced multiple phase transition. For a very large value of temperature the symmetry is eventually restored, whatever is the chemical potential.

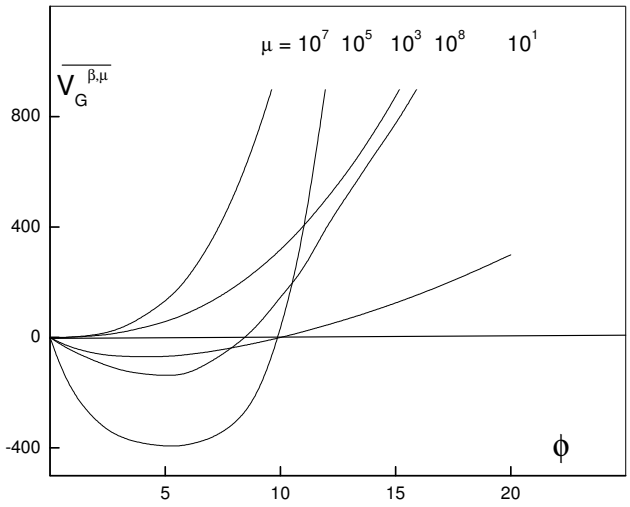

Fig. 1 FTDGEP for various chemical potential at a non-zero temperature

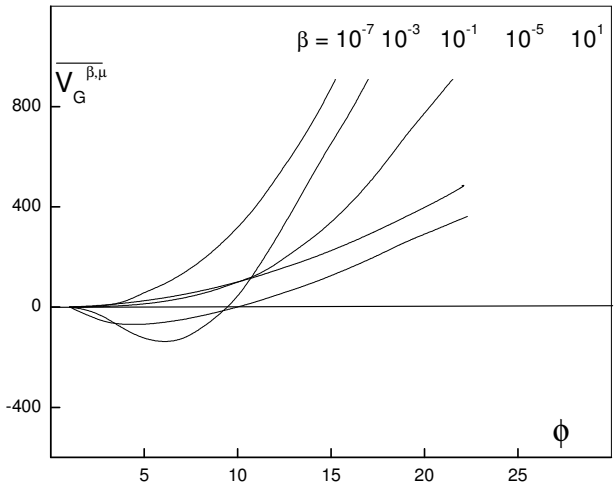

Fig. 2 FTDGEP for various temperatures at a non-zero chemical potential

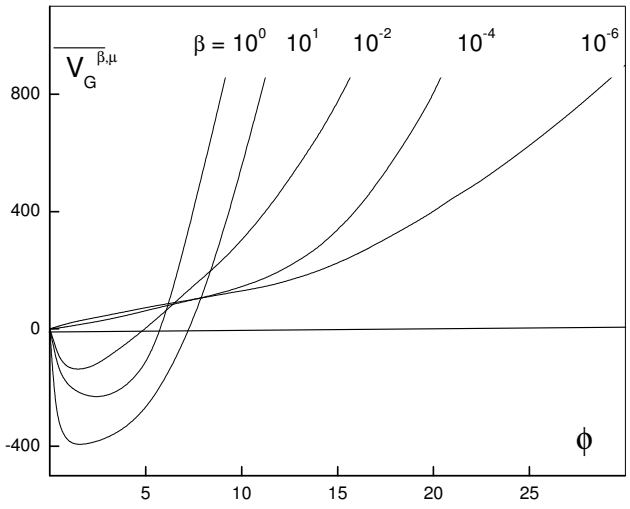

Fig. 3 FTDGEP for various temperatures in the absence of any chemical potential

At zero temperature, variation of the chemical potential has no influence on the spontaneously broken symmetry.

Another method of demonstrating the existence of multiple phase transition is to compute the finite temperature and finite density dependent effective Higgs boson mass $m_{\beta,\mu}$ from (15) by means of the relation

$$m^2_{\beta,\mu} = \frac{\partial^2 \overline{V_G^{\beta,\mu}}}{\partial \phi^2} \Big|_{\phi=0} . \qquad (16)$$

This give

$$m^2_{\beta,\mu} = m^2_{\beta} + \frac{1}{2}\lambda_B \left(I_0(\Omega) + I_0^{\beta,\mu}(\Omega) \right) \qquad (17)$$

Numerical evaluation of the expression (17) can be done and the results are shown in Figures 4 and 5. The variation of $m^2_{\beta,\mu}$ with chemical potential at a non-zero temperature is shown in Figure 4. Figure 5 shows the variation of the $m^2_{\beta,\mu}$ with temperature at non-zero chemical potential. These figures also indicate the same FTD behaviour we found in figs. 1-3.

To confirm the existence of temperature and density induced multiple phase transitions, we shall now carry out an analytical study of effective potential (15) employing a high temperature approximation. To do this, we Taylor expand the integrals $I_0^{\beta,\mu}$ and $I_1^{\beta,\mu}$ in β to $O(\beta^2)$ to obtain

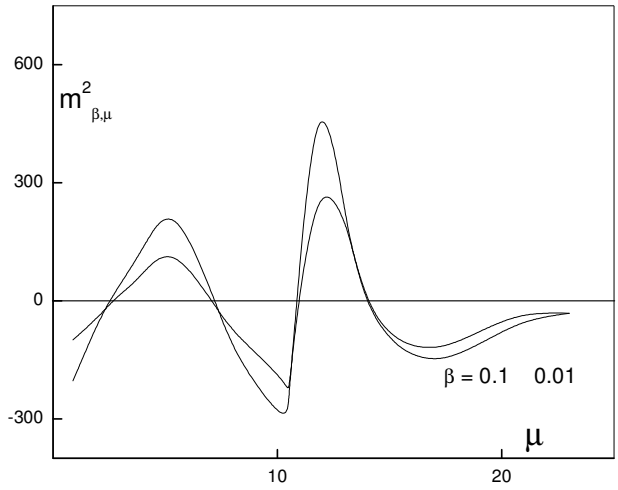

Fig. 4 Variation of effective mass with chemical potential at a non-zero temperature

$$I_0^{\beta,\mu}(\Omega) = \frac{1}{2\pi^2\beta}\left(\frac{\pi^2}{6\beta} + \mu\beta(\Omega-\mu) - \mu\ln\left(\exp\left(\beta(\Omega-\mu)\right)-1\right) - \frac{\Omega^2\pi}{4(\Omega-\mu)} + \frac{\Omega^2\beta}{4}\ln\left(\frac{\beta(\Omega-\mu)}{4\pi}\right)\right) + O(\beta^2) \quad (18)$$

and

$$I_1^{\beta,\mu}(\Omega) = \frac{\Omega^2}{24\beta^2} + \frac{\Omega^2\mu(\Omega-\mu)}{4\pi^2} - \frac{\Omega^2}{8\pi\beta(\Omega-\mu)} - \frac{\mu}{2\pi^2\beta}\ln\left(\exp\left(\beta(\Omega-\mu)\right)-1\right) - \frac{\Omega^2}{8\pi^2}\ln\left(\frac{\beta(\Omega-\mu)}{4\pi}\right) + O(\beta^2) \quad (19)$$

The integrals I_0 and I_1 are evaluated using a cutoff Λ for the momentum [8]. They yield

$$I_0(\Omega) = \frac{1}{4\pi^2}\left(\frac{\Lambda}{\Omega}\sqrt{\left(\frac{\Lambda}{\Omega}\right)^2+1} - \ln\left(\frac{\Lambda}{\Omega} + \sqrt{\left(\frac{\Lambda}{\Omega}\right)^2+1}\right)\right) \quad (20)$$

and

$$I_1(\Omega) = \frac{1}{8\pi^2}\left(\frac{\Lambda}{\Omega}\sqrt{\left(\left(\frac{\Lambda}{\Omega}\right)^2+1\right)^3} - \frac{\Lambda}{2\Omega}\sqrt{\left(\frac{\Lambda}{\Omega}\right)^2+1} - \frac{1}{2}\ln\left(\frac{\Lambda}{\Omega}+\right)\right). \quad (21)$$

We calculate the critical values of temperature and density for these phase transitions from the condition of vanishing of effective mass $m^2_{\beta,\mu}$ in (17). For $\mu = 0$, the high temperature approximated expression (18) yield $I_0^{\beta,\mu}(\Omega) \approx \frac{1}{12\beta^2}$. Hence the critical temperature is

$$\frac{1}{12\beta_c{}^2} = -6\ m_\beta^2 - 6\lambda_0\ I_0(\Omega)\ . \quad (22)$$

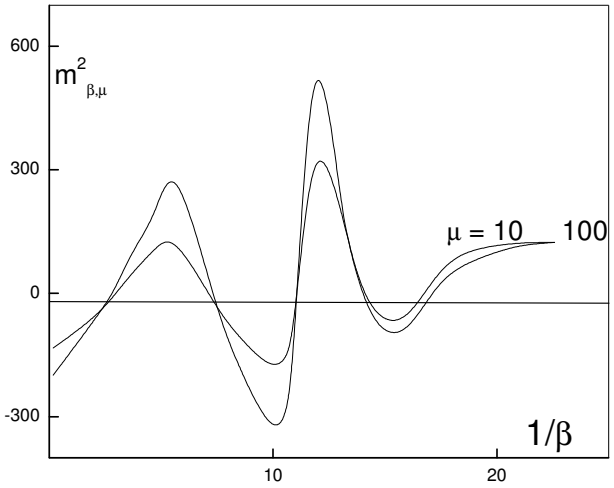

Fig. 5 Variation of effective mass with temperature at a non-zero chemical potential

There is only one critical temperature and this temperature corresponds to the symmetry restoration transition. However for $\mu \neq 0$, the integral $I_0^{\beta,\mu}$ given in (18) contain terms corresponding to $\frac{1}{\beta^2}$, $\frac{1}{\beta}$, β, β^2,… Inclusion of each higher order term in $I_0^{\beta,\mu}$ raise the power of $\frac{1}{\beta}$, term and μ term in (17) and hence lead to the existence of multiple solutions. This will result in the possibility of temperature and density dependent multiple phase transitions.

3. Autonomous Theory

The GEP in the autonomous version is obtained by performing a special type of wave function renormalization, keeping the bare coupling

parameter λ_B positive but infinitesimal. This allows the momentum cutoff $\Lambda \longrightarrow \infty$ and can also exhibit SSB.

Consider the scalar model described by the Lagrangian (2). By means of the usual prescription for GEP this leads to the zero temperature and zero density GEP given by eqn. (7). There are many divergent terms appearing in this expression. In the autonomous version of GEP, to renormalize these terms we do the following substitutions

$$\lambda_B = \frac{1}{12 I_{-1}(\rho)} \tag{23}$$

$$\phi_0^2 = I_{-1}(\rho)\, \Phi_0^2 \tag{24}$$

$$m_\beta^2 + 12\lambda_B I_0(0) = \frac{3\, m_0^2}{2\, I_{-1}(\rho)} \tag{25}$$

where ρ and m_0^2 are finite parameters with the dimension of mass. It is convenient to make the replacements in GEP through the expression for $\frac{\partial \overline{V_G}}{\partial \phi_0^2}$ to obtain

$$\frac{\partial \overline{V_G}}{\partial \phi_0^2} = \frac{1}{2} I_{-1}(\rho) \left(\Omega^2 - \frac{2}{3} \Phi_0^2 \right). \tag{26}$$

We also convert the $\overline{\Omega}$ - equation (9) into the renormalized form and make the FTD replacements using eqn. (12) to get

$$\overline{\Omega}^2 = \frac{2}{3}\Phi_0^2 + \frac{1}{I_{-1}(\rho)} \left(m_0^2 + \frac{\overline{\Omega}^2}{24\pi^2} \left(\ln\left(\frac{\overline{\Omega}}{\rho^2}\right) - 1 \right) + \frac{2}{3} I_0^{\beta,\mu}(\overline{\Omega}) \right), \tag{27}$$

where we used the relations

$$I_0(0) - I_0(\bar{\Omega}) = \frac{1}{2}\bar{\Omega}^2\left(I_{-1}(\bar{\Omega}) + \frac{1}{8\pi^2}\right) \tag{28}$$

and

$$I_{-1}(\bar{\Omega}) - I_{-1}(\rho) = \frac{-1}{8\pi^2}\ln\left(\frac{\bar{\Omega}^2}{\rho^2}\right). \tag{29}$$

Since I_{-1} is a logarithmically divergent integral, we find

$$\bar{\Omega}^2 \approx \frac{2}{3}\Phi_0^2 + 0\left(\frac{1}{I_{-1}(\rho)}\right). \tag{30}$$

From (26) and (27) the leading terms are

$$\frac{\partial\,\overline{V_G^{\beta,\mu}}}{\partial\Phi_0^2} = \frac{m_0^2}{2} + \frac{\bar{\Omega}^2}{48\pi^2}\left(\ln\left(\frac{\bar{\Omega}^2}{\rho^2}\right) - 1\right) + \frac{1}{3}I_0^{\beta,\mu}(\bar{\Omega}) \tag{31}$$

On performing the integration FTDGEP is obtained as follows

$$\overline{V_G^{\beta,\mu}}\left(\Phi_0^2\right) = D + \frac{1}{2}\,m_0^2\Phi_0^2 + \frac{1}{144\pi^2}\Phi_0^4\left(\ln\left(\frac{2\Phi_0^2}{3\rho^2}\right) - \frac{3}{2}\right) + I_1^{\beta,\mu}\left(\bar{\Omega}^2\right) \tag{32}$$

evaluated at $\bar{\Omega}^2 = \frac{2}{3}\Phi_0^2$, where D is the FTD independent vacuum energy constant. A numerical study of eqn. (32) demonstrates the same FTD behaviour as we have come across in Sec.2. This is also analytically verified using the high temperature approximation (19) for $I_1^{\beta,\mu}$ in eqn.(32).

4. Conclusion

In this paper we have studied the finite temperature and or bosonic density behaviour of GEP of scalar model in 3+1 dimensions. Making use the cutoff and autonomous versions of the GEP, we have demonstrated

existence of temperature or bosonic chemical potential induced multiple phase transitions in ϕ^4 model with SSB. For a fixed value of chemical potential as temperature is varied after a finite number of transitions symmetry is finally is restored; In contrast at a fixed temperature as chemical potential is increased after a finite number of transitions symmetry remains broken. Relevance of these results in the context of superconductivity and phase transitions in early universe are reported separately.

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CALOPHYLLUM INOPHYLLUM OIL AS PLASTICIZER IN NATURAL RUBBER COMPOUNDS

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ABSTRACT

Mineral oils and synthetic oils are being widely used as plasticizers in rubber compounds for improved processability, filler uptake and reduced price. Non renewable nature of the mineral oils and the synthetic origin of the ester type oils make these plasticizers less acceptable. Natural oils are viable alternatives for these plasticizers. Mechanical properties and the thermal degradation characteristics of these compounds were compared to that of the control compound containing naphthenic oil. The cure characteristics of the Calophyllum Inophyllum oil mixes were comparable to the mixes containing naphthenic oil. The compounds containing Calophyllum Inophyllum oil showed improved tear strength and modulus. Resilience, abrasion resistance and cure time values were comparable to the control compound. Hardness and compression set were higher than than the naphthenic oil mixes. Thermal studies showed an increase of 8^0C in the temperature of initiation of degradation and an increase of 6^0C in temperature at which the peak rate of degradation

occurred. The peak rate of degradation was comparable to the control mix containing naphthenic oil.

Key words : Natural rubber, plasticizer, calophyllum inophyllum oil, naphthenic oil and mechanical properties.

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1. Introduction

Plasticizers are low molecular weight, non–volatile substances, which improve flexibility and processability of rubber compounds. Even small quantities of plasticizer markedly reduce the Tg of the polymer. This effect is due to the reduction in cohesive forces of attraction between polymer chains. Plasticizer molecules penetrate into the polymer matrix and establish polar attractive forces between the polymer chains and increase the segmental mobility, thereby reducing the Tg value.

Plasticizers are also one of the critical components in a typical rubber formulation, used to get better product properties by improving processability and filler dispersion. They also help in controlling the viscosity to desired levels. Generally used plasticizers include mineral oils, synthetic ester and some of the natural products such as wood rosin and animal glue[1]. Of these the petroleum based oils are being used quite intensively in rubber compounds. The fast depleting petroleum resources calls for exploration of alternatives as replacement or substitutes. The vegetable oils are potential alternatives in this area. The renewable nature of the source and the presence of other natural products such as tocopherol and free fatty acid can be advantageous in these applications.

Vegetable oils, especially drying oils and their derivatives have occasionally been used as additives in plastics and elastomers. Vulcanized vegetable oil (Factice) was used in elastomers for low temperature flexibility and low hardness.[1] Epoxidized linseed oil was used as a vulcanizing agent in carboxylated nitrile rubber (XNBR)-ionomer blends.[2] Linseed oil as such is used as a multipurpose additive in NBR to improve its mechanical properties and processability and to reduce cure time.[3] Soybean oil was used as a plasticizer in NR[4] and as a plasticizing agent in cold vulcanized rubber.[5] Blown Soya bean oil is used as a plasticizer in ester gums,[6] castor oil as plasticizer in nitrocellulose,[7] in polystyrene film,[8] in rubbers containing acrylonitrile and styrene[9] and in NR to enhance certain mechanical properties.

RAW MATERIALS

Natural rubber (ISNR5) was obtained from Rubber Research Institute of India, Kottayam. Zinc oxide and stearic acid were supplied by M/s. Meta Zinc Ltd., Mumbai and Godrej soaps (Pvt.) Ltd., Mumbai, respectively. Mercaptobenzthiazyldisulphides(MBTS) and tetramethylthiuramdisul-phide (TMTD) were supplied by Bayer Chemicals, Mumbai and Polyolefins Industries Ltd., Mumbai, respectively. Sulphur was supplied by Standard Chemical Company, Pvt. Ltd., Chennai. Carbon black (HAF N -330) used in the study was supplied by M/s. Philips Carbon, Kolkata.

Naphthenic oil obtained from Hindustan petroleum Ltd, Mumbai, had the following specifications, specific gravity 0.98, Aniline point 78^0C, Viscosity gravity constant 0.87.

Commercial grade calophyllum inophyllum oil was obtained from local market. It is the seed oil calophyllum inophyllum a tree generally

seen in tropical countries. It is a non edible oil and also comes under the category of non drying oil. The oil consists of 60.1% refined lipids. Total lipid consists of 92% neutral lipid, 6.4% glycolipids and 1.6% phospholipids. Out of the neutral lipids 82.3% is triglyceride and 7.4% free fatty acid. The major fatty acids present are palmitic acid, palmitoleic acid, stearic acid, oleic acid and linoleic acid. Small amounts of other fatty acids like calphynnic acid, crepenefinic acid and dihydrocrepenefinic acid are also detected.

2. Experimental

Compounding : - Mixes were prepared on a laboratory size two roll mixing mill (16 x 33cm) at a friction ratio of 1:1.25 as per procedure given in ASTM D 3184 – 89 (2001) over a time period of 18min. The compounding formulation employed is given in Table 1. Before the addition of accelerators and sulphur the batch was thoroughly cooled.

Curing: - Cure characteristic at 150^0C were determined by using Goettfert Elastograph Model 67.85. The machine has two directly heated, opposed biconical dies that are designed to achieve a constant shear gradient over the entire sample chamber. The specimen was kept in the lower die, which was oscillating through a small deformation angle ($\pm$ 0.2^0) at a frequency of 50 oscillations per minute. The torque transducer on the upper die senses the force being transmitted through the rubber.

2. 1 *Tensile Strength, Modulus and Elongation at Break* : - Tensile properties were measured using Shimadzu Universal

Table 1 - Formulation

MIX NO.											
Ingredients*	**C_0**	**C_2**	**C_4**	**C_6**	**C_8**	**C_{10}**	**N_2**	**N_4**	**N_6**	**N_8**	**N_{10}**
NR	100	100	100	100	100	100	100	100	100	100	100
Zinc oxide	5	5	5	5	5	5	5	5	5	5	5
Stearic acid	2	2	2	2	2	2	2	2	2	2	2
Vulcanox HS	1	1	1	1	1	1	1	1	1	1	1
Vulcanox 4020	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
HAF	45	45	45	45	45	45	45	45	45	45	45
Cal. Ino.oil	0	2	4	6	8	10	-	-	-	-	-
Naphthenic oil	-	-	-	-	-	-	2	4	6	8	10
Sulphur	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
MBTS	1	1	1	1	1	1	1	1	1	1	1
TMTD	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

C_o- Mix without oil

Testing Machine Model AG-I 50 KN according to ASTM D 412. Samples were punched out from the moulded sheets both along and across the grain direction with a dumb-bell die (die E). The grip separation speed was 500 mm/min. The ultimate strength, modulus at different elongations and ultimate elongation were noted.

2.2 *Tear Strength*: - The tear strength was determined using Shimadzu Universal Testing Machine Model AG-I 50 KN according to ASTM D 624 (die C). The samples were cut from the compression moulded sheets parallel to the mill grain direction. The test was carried out on the zwick universal testing machine. The speed of extension was 500 mm/min and the temperature 28 ±2ºC.

2.3 *Hardness*: -The hardness of the sample (Shore A) was determined using Zwick 3114 hardness tester according to ASTM D 2240 - 86. Samples having dimensions of 12 mm diameter and minimum 6 mm thickness were used. A load of 12.5 N was applied and the readings were

taken 10 seconds after the indentor had made a firm contact with the specimen.

2.4 *Abrasion Resistance* : - Abrasion resistance of the samples was measured using a DIN abrader based on DIN 53516, both in the longitudinal and transverse directions. Samples having a diameter of 12 ± 0.2 mm and a thickness of 16 - 20 mm were placed on a rotating holder and a load of 10 N was applied. A pre-run was given for conditioning the sample and the sample weight was taken. Weight after the test was also noted. The difference in weight is the weight loss of the test piece after its travel through 40 m on a standard abrasive surface. The results were expressed as volume loss per hour.

$$V = \frac{\Delta M \text{ x } 27.27}{\rho}$$

where V= Abrasion loss in cm^3/hr, ΔM = mass loss and ρ = density of the sample.

2.5 *Rebound Resilience*: - Rebound resilience was determined by vertical rebound method according to ASTM D 2832 - 88. In this method, a plunger suspended from a given height (400 ± 1mm) above the specimen was released and the rebound height was measured. The resilience scale was marked in 100 equally spaced divisions and hence the rebound height is equal to the resilience (%).

2.6 *Heat Build Up*: - Heat buildup was tested using Goodrich Flexometer as per ASTM D 623 - 78 method A. The samples were 25 mm in height and 19 mm in diameter. The oven temperature was kept constant at 50°C. The stroke was adjusted to 4.45 mm and the load to 10.05 kg/cm^2. The samples were preconditioned at the test temperature in the oven for 20

minutes prior to the test. The heat development at the base of the sample was sensed by a thermocouple and relayed to a digital temperature indicator. The temperature rise (ΔT°C) at the end of the specific time interval was taken as the heat buildup.

2.7 *Compression Set*: - Compression set at constant strain was measured according to ASTM D 395 - 86 method B. Samples with 6.25 mm thickness and 18 mm diameter were compressed to constant strain (25%) and kept for 22 hours in an air oven at 70°C. At the end of the test period the test specimens were taken out, kept at room temperature for 30 minutes and the final thickness was measured. The compression set in percentage was calculated as follows.

$$\text{Compression set (\%)} = \frac{T_i - T_f}{T_i - T_s} \times 100$$

Where Ti and T_f are the initial and the final thickness of the specimen respectively and T_s is the thickness of the space bar used.

2.8 *Thermal Analysis*: - Thermogravimetric analyses of the specimens were carried out on Universal V3 2B TA Instrument with a heating rate of 10°C/min under nitrogen atmosphere. The following characteristics were determined from the thermogravimetric curves: the temperature of onset of degradation, the temperature at peak rate of decomposition, the peak rate of degradation and the weight of residue remaining at 600°C.

3. Results and Discussion

Table 2 gives the cure characteristics of different mixes. The maximum torque is found to be decreasing at higher loading of

Table 2 – Cure characteristics of the mixes

Mix no.	Max. torque (Nm)	Min torque (Nm)	Cure time(t_{90}) min.	Scorch time(t_{10}) min.	Tmax-min Nm	Cure rate Nm/min.
C_0	0.43	0.02	3.8	1.7	0.41	0.25
C_2	0.59	0.03	4.1	1.9	0.45	0.26
C_4	0.58	0.04	3.9	1.8	0.54	0.34
C_6	0.54	0.04	4.5	2.0	0.51	0.28
C_8	0.53	0.03	4.3	1.9	0.49	0.27
C_{10}	0.48	0.03	4.4	1.9	0.45	0.24
N_2	0.42	0.02	4.1	1.9	0.39	0.22
N_4	0.41	0.02	4.0	1.9	0.396	0.23
N_6	0.41	0.02	3.8	1.8	0.39	0.24
N_8	0.38	0.02	4.1	1.9	0.36	0.20
N_{10}	0.34	0.02	4.1	2.0	0.32	0.19

calophyllum inophyllum oil. The cure time and scorch time remain unaffected by the level of calophyllum inophyllum oil, while the cure time is marginally higher than that of mixes containing naphethenic oil mixes. Higher $T_{max-min}$ value is evident from the cross link density values of naphthenic oil mixes.

Fig.1 shows the variation of tensile strength of the vulcanizates with different loading of calophyllum inophyllum oil. The values are lower than that of the control mix. It may be noted that the cross link density of the vulcanizates with calophyllum inophyllum oil is higher than that of control mix. But this does not reflect on tensile strength. So it is assumed that the cross link density values are beyond this limit with which it affects tensile strength. Lower tensile strength may be due to improper

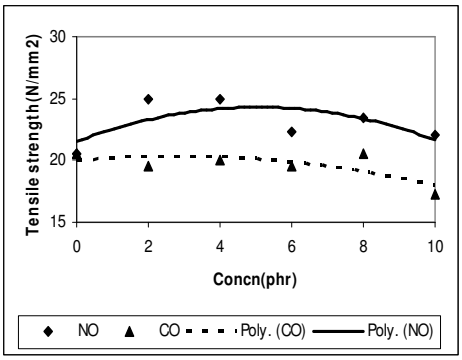

Fig.1 Variation of tensile Strength (N/mm^2) with plasticizer content

♦NO -Naphthenic oil mix

■ CO Calophyllum Inophyllum oil mix

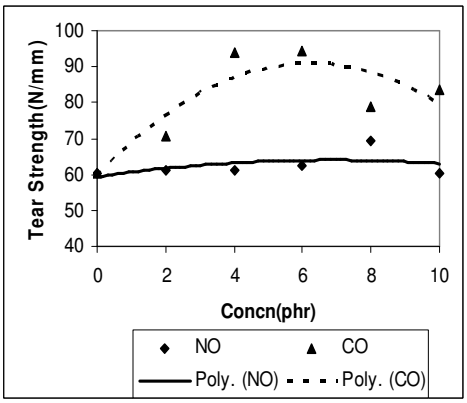

Fig.2 Variation of tear Strength (N/mm) with plasticizer content

♦NO -Naphthenic oil mix

■ CO-CalophyllumInophyllum oil mix.

dispersion of filler. Fig.2 shows the variation of tear strength of the vulcanizates with different loading of calophyllum inophyllum oil. The values are better than the control mix containing naphthenic oil even though the tensile strength is lower. Fig. 3 compares the modules of the compound with that of the con troll mix is marginally higher than the control mix and this in agreement with their observed better value of cross link density. Table 3 compares the hardness, resilience, compression set, heat buildup, cross link density, abrasion resistance and flexes crack resistance of the calophyllum inophyllum oil mixes and naphthenic oil mixes. The abrasion resistance and flex crack resistance of both the oils

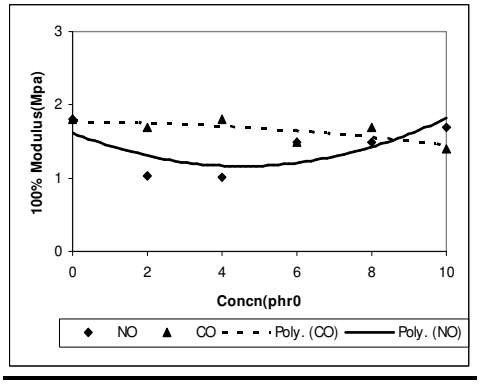

Fig.3 Variation of Modulus at 300% elongation (N/mm^2) with plasticizer content

♦NO -Naphthenic oil mix

■ CO - Calophyllum Inophyllum oil mix

are in the same range. The compression set values are high compared to the naphthenic oil mixes which is agreement with higher heat buildup

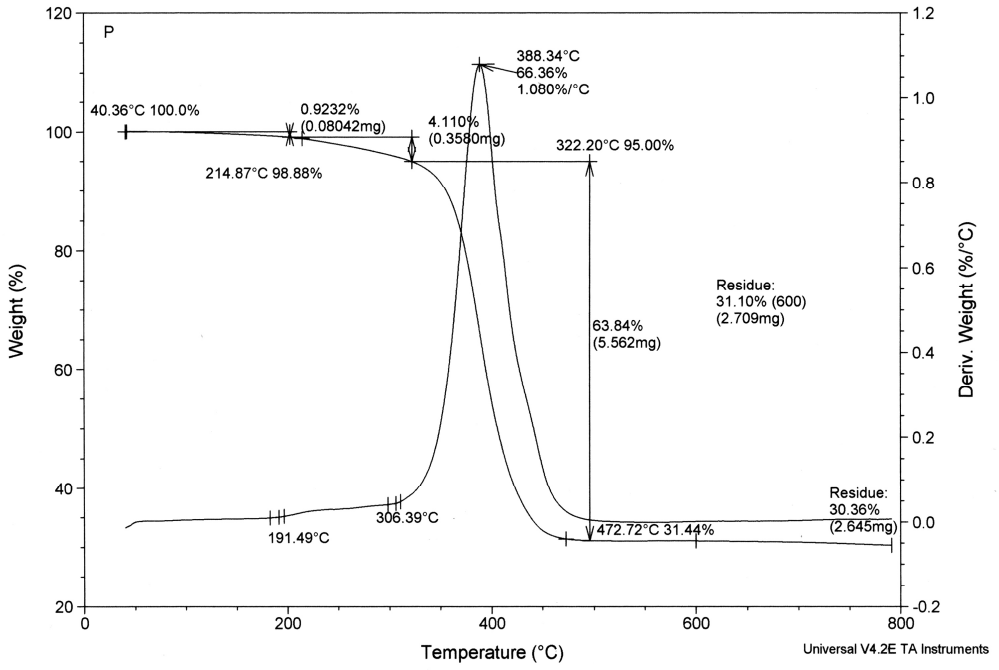

Fig.4a Thermogravemetric Curve of mix with (4phr) Calophyllum Inophyllum oil

values of calophyllum inophyllum oil mixes. The resilience values of calophyllum inophyllum oil mixes are comparable to the naphthenic oil compound. The heat buildup of the vulcanizate without plasticizer also shows a higher value. The resilience and hardness values are almost lower showing a lower influence the cross link density on these properties.

Fig.4a shows the thermogram of reference compound at 4 phr concentration and figure 4b shows the thermogram of calophyllum inophyllum oil mix at 4 phr concentration. Improvement in thermal stability is evident from the higher

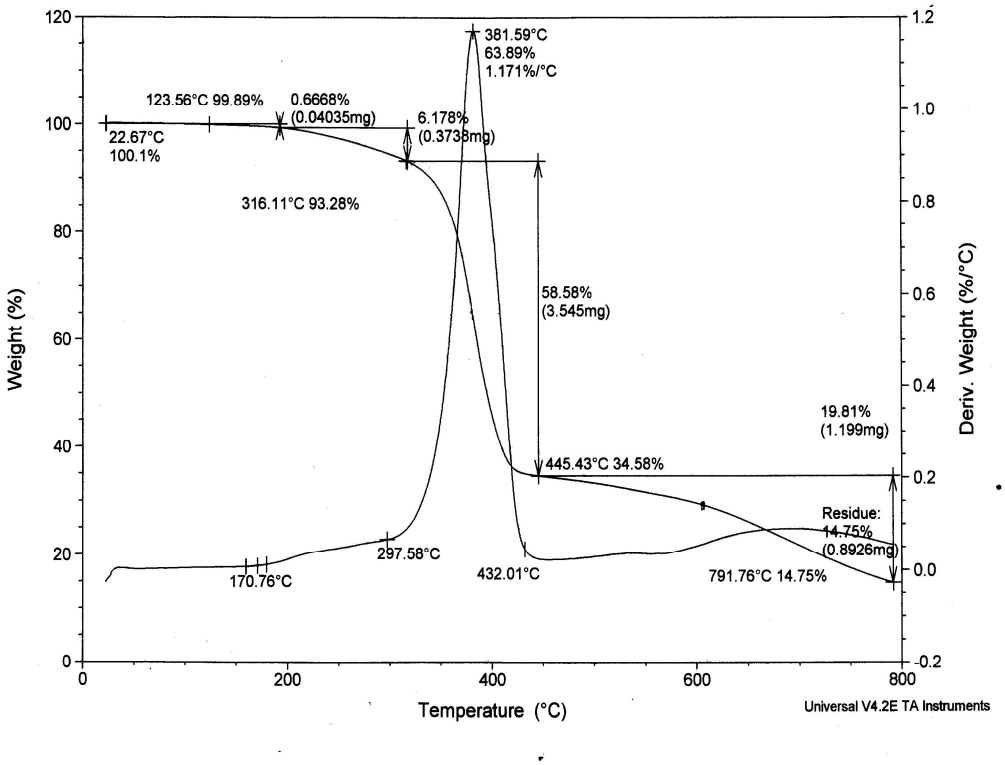

Fig.4b Thermogravemetric Curve of mix with (4phr) Naphthenic oil

Table 3 – Hardness, compression set, resilience, abrasion loss, cross link density and heat buildup

Mix No	Hardness (Shore A)	Compression Set(%)	Resilience (%)	Abrasion loss	Cross link density x	Flex cracking (in lakhs)	Heat build up (^{O}C)
C_0	52	43	36	3.1	2.9	> 5	22
C_2	53	40	38	4.4	2.6	> 5	16
C_4	59	36	36	4.6	2.9	> 5	14
C_6	56	46	35	4.5	3.1	> 5	16
C_8	53	49	35	4.5	2.8	> 5	18
C_{10}	57	49	38	4.6	2.7	> 5	14
N_2	64	31	35	4.8	4.0	> 5	12
N_4	63	28	36	4.5	3.0	> 5	14
N_6	62	29	38	4.4	2.9	> 5	15
N_8	60	32	42	4.7	2.9	> 5	13
N_{10}	58	27	44	4.8	3.0	> 5	15

Table 4 – Degradation characteristics of mixes

Mix	Temperature of initiation (Ti)	Peak temperature (Tmax) (^{0}C)	Peak rate of decomposition (% / min)	Residue at 600^{0}C (%)
N_{nap} (4phr)	298	382	1.17	29.6
$N_{cal.oil}$ (4phr)	306	388	1.08	31.1

temperature of initiation (by 8^0 C) and higher peak degradation temperature (6^0) when the values of reference compound and calophyllum inophyllum oil mix at (4 phr) are compared. It also shows a lower rate of degradation and higher residual weight.

4. Conclusion

Calophyllum Inophyllum oil can be used a substitute for Naphthenic oil in the compounding of natural rubber even though all the vulcanizate properties are not similiar. The vulcanizate properties like tear strength modules were improved while, resilience, abrasion loss and cure time were comparable. A marginal disadvantage is seen in tensile strength, compression set, hardness and heat buildup. The optimum loading of calophyllum inophyllum oilis in the 4-8 phr range for 45 phr HAF loaded natural samples.

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OXIDATION OF ETHYL BENZENE OVER NANO CERIA MODIFIED WITH CHROMIUM

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ABSTRACT

Supported metals are used in large scale in heterogeneous catalysis. Highly efficient heterogeneous catalysts consisting of nano ceria modified with different weight% of Cr successfully oxidized ethylbenzene to acetophenone by tert-butyl hydroperoxide (TBHP) using acetonitrile as solvent. Ceria modified with chromium (XCeCr) were synthesized using sol-gel method. The catalytic activities of the newly developed chromium modified samples were evaluated in the liquid phase oxidation of ethylbenzene using tert-butyl hydroperoxide (TBHP) as oxidant.

Keywords: Nano ceria, chromium, ethyl benzene, oxidation, heterogeneous catalyst.

1. Introduction

Autoxidation reactions are very important milestones in the development of new petrochemical processes. These kinds of reactions use the most abundant and cheapest oxidant that minimizes the production and

use of pollutants. As these reactions follow a complex radical mechanism, it is difficult to reach high selectivity at high conversion levels. The development of catalytic systems that allows good yields could be a great challenge in the "green chemistry". Selective oxidation reactions of relatively inert C–H bond of hydrocarbons is one of the most desirable and challenging reactions, since the obtained products are itself important or act as valuable intermediates for industrial organic chemicals [1]. In recent years a considerable interest has been shown in materials with grain size in nano scale. Preparation of nano size cerium oxide and chromium incorporated cerium oxide catalysts were done by sol-gel method. The catalytic activities of the systems were studied by conducting oxidation of ethyl benzene using tert-butylhydroperoxide as the oxidizing agent Liquid-phase oxidations of hydrocarbons are potentially very attractive reactions for the preparation of intermediates and fine chemicals. In this work we tried to prepare ceria using sol-gel method using cerium nitrate ($Ce(NO_3)_3.6H_2O$) as the precursor.

2. Experimental

2.1 Materials and Methods

2.1.1 Synthesis: - Chromium nitrate Nona hydrate ($Cr(NO_3)_3 \cdot 9H_2O$; Alfa 98.5%), $Ce(NO_3)_3.6H_2O$ (IRE), and ammonia were used as sources for chromium, cerium and alkali respectively.Cerium hydroxide was prepared by adding 5% aqueous solution of $Ce(NO_3)_3$ drop wise to 1: 1ammonia with constant stirring for 10 hours. It is kept overnight, filtered and washed to free from nitrate. Cerium hydroxide thus obtained was peptized

with nitric acid at a nitrate to ceria mole ratio of 0.27 to get ceria sol. Sol obtained was dried at 80°C to get the gel. Gel was oven dried at 110°C for 12h. Powdered sample was calcined at 500°C for 5hours with constant flow of air [2].

2.1.2 Preparation of Chromium incorporated Cerium oxide: - 0.5M nitrate solution of Cr (NO3) 3.9H2O) containing required amount of metal (2, 5 and 8 weight%) was added to the previously prepared ceria sol and was mechanically stirred for 4h. Kept overnight and dried at 80°C to get the gel which was further dried at 110°C for 12h. Powdered and calcined at 500°C to obtain metal incorporated cerium oxide

2.1.3 Characterisation Techniques: - A detailed investigation of physico-chemical characterization of the catalytic systems was performed by various analytical and spectroscopic techniques, viz., powder X-ray diffraction (XRD; Rigaku D MAX III VC), thermo gravimetry-differential thermal analysis(TGDTA; Perkin Elmer TG analyzer), inductively coupled plasma - atomic emission spectroscopy (ICP-AES; Labtam Plasma 8440), diffuse reflectance ultraviolet-visible(UV-Vis-DRS ; Shimadzu UV-2101 PC spectrometer); FT-IR spectra (Shimadzu FT-IR 8201);SEM analysis (JEOL JSM-840 A (Oxford make model16211) and N2adsorption–desorptionstudies (Micromeritics Tristar 3000 surface area and porosity analyser).The acidity measurements of the prepared samples were done by Temperature Programmed Desorption (TPD) of ammonia [3].The catalytic activities of the newly developed chromium modified samples were evaluated in the liquid phase oxidation of ethylbenzene using tert-butyl hydroperoxide (TBHP) as oxidant.The effect of different

parameters on the conversion is also studied to optimize the reaction conditions. Excellent selectivity towards acetophenone was obtained under optimized conditions.

2.1.4 Reaction procedure -Liquid phase oxidation of ethyl benzene: -

The experimental procedure adopted for the catalytic activity measurement is described below. The liquid phase oxidation of ethyl benzene [4] was carried out in a 50 ml R.B flask fitted with a condenser. The temperature was maintained using an oil bath. In a typical run, 0.1gm of the catalyst was added to ethyl benzene in acetonitrile solvent. The reaction mixture was magnetically stirred. After attaining reaction temperature tert- butylhydroperoxide was added drop wise. The aromatic compound being taken less, the yields were calculated based on the amount of the ethyl benzene. The products were analysed by gas chromatography (Chemito 8610 Gas Chromatograph equipped with a flame ionization detector, SE-30 Column-2m length, column temperature was adjusted between 80 to 280°C at a heating rate of 10°C/ min, injector-250°C, detector-250°C). The major product obtained was acetophenone. The reaction conditions were optimized for the molar ratio of the substrate to the oxidizing agent, catalyst weight, temperature, duration of the run, and type and volume of solvent. The present work also attempted to study the metal leaching to understand the molecular aspects of the reaction.

3. Results and Discussion

Wide angle XRD analysis clearly shows peaks corresponding to the crystalline cubic fluorite ceria phase (PDF-ICDD34-0394) only, even after

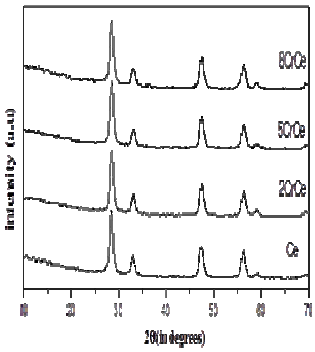


Fig. 1 XRD patterns of chromium doped ceria series

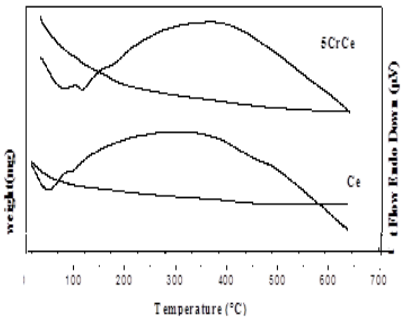
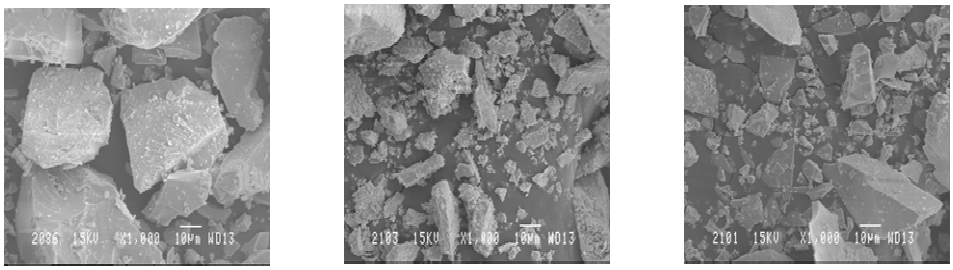


Fig. 2 TG-DTG curves for pure and & 5% Cr doped ceria systems

modification with 8% chromium (Fig.1) [5]. This shows that the metal is evenly distributed on the support. The TG curves of pure and modified ceria (Fig.2) show weight loss near 100 ^{0} C which is due to the loss of physisorbed water from the surface of the catalyst. No further weight loss is observed up to 600°C confirming the structural stability of the catalyst systems.



CeO_2 5CrCe 8CrCe

Fig. 3 SEM pictures of chromium modified ceria systems

To examine the effect of chromium incorporation on the particle size of the catalysts, pictures of pure ceria and chromium modified ceria were taken and the results are presented in figure 3. FT-IR spectra of representative samples were taken and are depicted in the figure 4. The broad absorption band located in the area from 3200 to 3600 cm^{-1} approximately corresponds to the O-H stretching vibration, and the one located in the area from 400 to 750 cm^{-1} to the CeO_2 stretching vibration. The absorption peaks at 1629 and 1062cm^{-1} correspond to the H_2O bending vibration and Ce-OH stretching vibration respectively [6].

Figure 5 shows UV-vis DRS profiles of chromium incorporated ceria systems with different chromium loading. From Fig.5 it is evident that a single characteristic band around 250nm is present in all cases. No additional bands are observed by the incorporation of chromium. The position of ligand to metal charge transfer (LMCT, $O^{2-} \rightarrow Ce^{4+}$) spectra depends on the ligand field symmetry surrounding the cerium centre. The electronic transition around 250nm is due to the tetra coordinated environment of Ce^{4+} species. Results given in the table 1 indicate that the incorporation of chromium exert a positive effect when 5weight% chromium is incorporated into the system. This can also be attributed to the homogeneous distribution of the metal in the sol-gel of cerium oxide. The surface area and porosity of the sol-gel derived ceria materials are very satisfactory and suggest good thermal stability in terms of preservation of surface area and porosity after calcinations for 5h at 500^{o}C.

Table 1

Surface area and pore volume of Chromium incorporated ceria systems

Catalysts	Surface area (m^2g^{-1})		Pore volume (m^3g^{-1})*
	BET	Langmuir	
Ce	58.05	88.36	0.068
2CrCe	59.3	90.41	0.066
5CrCe	63.3	97.13	0.0663
8CrCe	57.9	88.98	0.067

* Pore volume measured at p/p_0 of 0.997

The EDX data (Table 2) give the surface composition of the catalyst sample. The elemental analysis of the prepared samples clearly indicates that the expected catalyst profile can be successfully achieved by the sol-gel method.

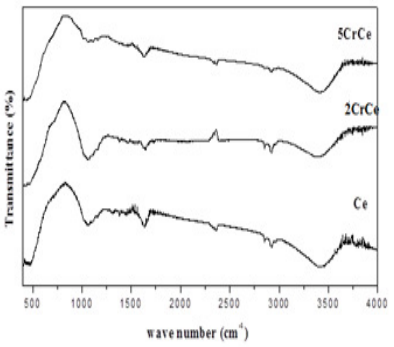


Fig. 4 FT-IR spectra of Ceria, 2CrCe and 5CrCe

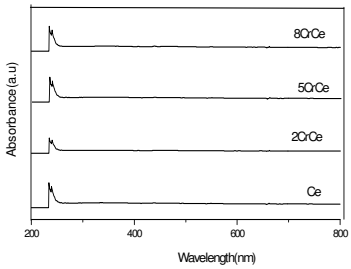


Fig. 5 Diffuse reflectance spectra of Chromium incorporated systems

This is evident from the EDX data, which show the theoretical atom% of the samples as very close to the experimental values. Thus, by this method it is possible to get desired loading of the metals in ceria catalyst. The TPD of ammonia was used to characterize the acid site distribution and furthermore to obtain the quantitative amounts of the acid sites in the specified temperature range [7]. Table 3 represents the acid strength distribution of the simple as well as chromium incorporated ceria systems. Here also pure cerium oxide exhibits lowest surface acidity among the different systems. Considerable enhancement of weak, medium, strong and total acidity is observed after chromium incorporation. Among chromium-modified systems, cerium oxide modified with 5wt% chromium has lower weak, strong and total surface acidity than 2 & 8wt% systems. The TPD data of the chromium oxide

Table 2

EDX data for Chromium modified catalyst systems.

Catalyst	Atom % (Theoretical)		Atom % (Experimental)	
	Ce	Cr	Ce	Cr
Ce	100	-	100	100
5CrCe	85.8	14.2	85.6	14.4
8CrCe	79.0	21.	77	23.0

doped ceria systems points to an increase of strong acid sites than the simple system.

4. Catalytic study

The catalytic activity of the prepared catalyst systems was tested for a well known industrially important reaction- oxidation of ethyl benzene.

4.1 Process Optimization

Ethyl benzene oxidation carried out in liquid phase under atmospheric pressure is found to be extremely sensitive to the variation in reaction conditions. The effect of operating parameters such as reaction temperature, time, ethyl benzene to tert-butylhydroperoxide ratio, nature of the solvents, volume of the solvent, weight of the catalyst and effect of metal percentage in the systems were studied .the optimization process is done using 0.1g of representative samples from chromium (5CrCe) . The results of the observations are given in the following section.

Table 3

Ammonia TPD studies on Chromium incorporated ceria systems

Sample	Amount of ammonia desorbed (mmol /gm)			
	Weak 100-200 ^{o}C	Medium 201-400 ^{o}C	Strong 401-600 ^{o}C	Total 100-600 ^{o}C
Ce	0.09	0.03	0.03	0.15
2CrCe	0.15	0.04	0.13	0.32
5CrCe	0.12	0.07	0.04	0.23
8CrCe	0.26	0.12	0.07	0.45

4.2 Catalyst efficiency of different systems

Under the optimized process parameters of temperature, time, molar ratio, and volume of the optimized solvent, catalyst weight all the prepared systems were tested for the oxidation of ethyl benzene using TBHP as the oxidizing agent. The activity of different catalytic systems in terms of percentage conversion and acetophenone selectivity are given in the Table 4.The Table 4 shows that compared to ceria, the modified systems are more active. For chromium modified systems the metal content plays a crucial role with catalytic activity. On increasing the metal

Table 4

Activity of the catalyst systems in the oxidation of ethyl benzene

Catalyst	**Ethylbenzene Conversion (wt %)**	**Acetophenone selectivity(%)**	**Others* (%)**
Ce	1.7	72.5	27.5
2CrCe	32.9	93.9	6.1
5CrCe	59.0	95.7	4.3
8CrCe	40.9	93.9	6.1

Ethyl benzene to TBHP mole ratio -1: 3, Temperature- 70°C, time -6h,Acetonitrile-10mL, (Others mainly includes 2-phenylethanol, o/p-hydroxyacetophenones, Phenyl acetaldehyde etc)*

content from 2 to 5% a two-fold increase in activity is observed. The selectivity remains more or less same >90%. 5CrCe is more active than the other two systems. Chromium modified ones are more active and more selective towards acetophenone. No absolute correlation is noticed between the surface acidity and catalytic activity. 5% metal content is found to be optimum for ethylbenzene oxidation.

4.3 Structural stability of the catalysts

An important requisite for a heterogeneous catalyst for a better catalytic performance is the stability of its active sites under the reaction conditions. Major causes that can lead to the deactivation of a catalyst include the disruption of the crystalline structure and changes in chemical composition during the reaction. The leached metal cation in solution can enhance the reaction rate whereby the pure heterogeneity of the reaction is lost. The regeneration of the catalyst after several repeated reaction runs also gives an idea about the stability of the system towards a particular reaction. Thus it becomes important to test the metal leaching on the catalytic activity and regeneration ability of the present systems. 5CrCe is taken as the representative sample for these investigations.

4.4 Effect of metal leaching

A very important subject to be considered for the solid catalyst is the leaching phenomenon to find out the true nature of the catalytic reaction whether it is homogeneous or heterogeneous. Leaching can take

place during a catalyzed reaction without an induction period and the nature of the reaction may gradually change from heterogeneous to homogeneous without any indication in the reaction profile. To prove the heterogeneous nature of the reactions, the solid catalyst was removed by filtration after 3hours from the reaction mixture at the reaction temperature. The mother liquor is again subjected for the reaction at the same conditions for three more hours. The results obtained using 5CrCe are shown in Table 5.

From the results it is clear that the conversion remains more or less constant after the removal of the catalyst showing that metal ions are not leaching from the catalyst surface during the oxidation process. The investigation reveals the true heterogeneous nature of the reaction over modified ceria catalysts.

Table 5

Effect of metal leaching in oxidation of ethyl benzene

Catalyst	Time (h)	Conversion (Wt %)	Acetophenone Selectivity(%)
5CrCe	3	38.6	93
	6	39.0	96

5. Conclusion

Ceria modified with Cr can be successfully utilized for the selective oxidation of ethyl benzene to more desirable product acetophenone with 96% selectivity in 6 hours using only 0.1g of the catalyst under milder condition.

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MECHANICAL AND MORPHOLOGICAL PROPERTIES OF SHORT NYLON FIBER REINFORCEDPS/HDPE COMPOSITES

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ABSTRACT

Blending of two or more polymers offers a good possibility to modify thermoplastic material so as to improve their properties .Polystyrene and high density polyethylene (PS/HDPE) are two widely used commodity plastics. In this study it is proposed to upgrade the blends using nylon 6 fibers. In order to generate high modulus and strength a Polystyrene rich blend PS/HDPE (80/20) was selected for the study. The prepared blends have been characterized for mechanical properties such as tensile strength and tensile modulus, flexural strength, impact strength etc. Characterization done using SEM

Keywords: Polymer composites, Polymer blends, Nylon fibers, Mechanical Properties.

1. Introduction

Polymer blending offers an effective route for the production of new engineering materials, and it is of special interest for the modification of

commodity low cost polymers. Polystyrene (PS) and Polyethylene (PE) are two of the most widely used commodity plastics in the world. The hybridisation of PS/PE blends with nano structured ingredients should be effective implement in the commercial applications. Commercial success of an immiscible blend requires improvement of interfacial adhesion between the components of blends, necessary to achieve stability of morphology and improvement in mechanical properties. Polystyrene and poly methyl methacrylate are two examples of high modulus materials that have limited impact resistance, whereas polyethylene and polypropylene are two high tough materials that have poor stiffness. An increase in impact strength of PS can be achieved by adding PE which is having high impact strength. [1,2] For this reason PS/PE blends exhibit more balanced properties which is advantageous for a number of applications, e.g., in packaging where different barrier properties of PE and PS can be beneficially combined. The PS/PE blends are very important for mixed plastic waste recycling [3] .The present trend in reducing the municipal solid waste is to recycle the polymer waste instead of incineration and land filling [4]. PS is incompatible with PE. Therefore PS/PE blends exhibits weak interfacial adhesion and poor dispersion of the component, which results in heterogeneous morphology with macro phase separation and poor mechanical properties. The nylon fibre is used as a reinforcing material in polymer blends. The nylon fiber reinforced plastics is used in a variety of applications such as building construction, marine, automotive industries etc.

The field of polymer blends or alloys has experienced enormous growth in size and sophistication over the past two decades in terms of both the scientific base and technological and commercial development.

New engineering plastic composites have been developed which are creating a materials revolution. So there is more scope in the field, study of 'polymer blends'. Now days' composites are the most commonly used materials because of their light and higher strength. Metals can be replaced using composites in order to reduce their weight. Some of the composites are stronger than steel so they can be used as engineering plastics. They found more applications in aircrafts, space vehicles and very useful in automotives because they play a very important role in weight reduction. So more studies are inevitable in this area.

Polymer composites are playing an increasing role as construction materials in a wide variety of applications. In particular, thermoplastic polymer composites are falling under increasing scrutiny due to their potential to be easily repaired and/or reshaped, making them easier to recycle and reuse compared with thermosetting matrix composites. Short fiber reinforced thermoplastic molding materials are very widely used in industry. They are attractive because the addition of short fibers to the thermoplastic results in some very cost effective property improvements whilst retaining the processibility of the thermoplastic. The main applications are for relatively small intricate, load bearing components. These vary from small mechanical details, such as gear wheels, pawls and levers to castings for electric hand tools and electronic equipment's. The properties of short fiber reinforced composites mainly depend on the type and concentration of the fiber, the orientation and distribution of the fiber, Fiber aspect ratio, fiber-matrix interaction, short fiber length, fiber orientation and barrel residence time are the major factors which affect the properties of the injection molded thermoplastic composites [5-12].

The aim of the present of the work is to investigate mechanical properties, morphological and processibility of PS-HDPE (80/20) blends and also to upgrade the PS/PE blend system using Nylon fiber as a reinforcing material. Objective of this work are,

- Use process-waste nylon fibres for reinforcement.
- Generate recyclable PS and HDPE composites by reinforcing them with short nylon fibers.
- To determine the critical fibre length for the PS/HDPE—Nylon fibre reinforced composite.
- To study the mechanical ,morphological properties of PS-HDPE(80/20) blend and nylon reinforced composites
- To study the properties of these composites with varying compositions of nylon fiber

2. Experimental

2.1 Materials: - Polystyrene (General purpose polystyrene) supplied by Supreme Petro Chem Ltd; Mumbai, India; MFI -12gm/10 min (200^0 C/5 kg).High density polyethylene (HD50MA180), Reliance polymers Ltd, Mumbai, MFI-20gm/190^0C/2.16kg). Nylon-6 fibers obtained from Apollo Tyres, Chalakudy

2.2 Preparation of the composites: - PS/ HDPE granules and nylon fibers were dried by keeping them in an oven at a temperature of 100 ^{0}C for four hours. Nylon fiber reinforced PS / HDPE composites were prepared by adding nylon fibers to PP or HDPE melt in a Thermo Haake Rheocord600mixing chamber with a volumetric capacity of 69 cm3 fitted

with roller type rotors. PS /HDPE together with the nylon fibers were added to the chamber. The temperature was kept at 180 C which ensured proper melting of PS or HDPE keeping the nylon fibers intact. Five sets of nylon fiber-PS/HDPE composites have been prepared. Each containing 10% fiber content and varying fiber length viz., 2mm, 4mm, 6mm, 8mm, 10mm. Each time 36 gm. of 80:20 PS/HDPE and 4gm of nylon fiber was taken. The temperature was kept at 180^{o}C, which ensure proper melting of PS and HDPE. A mixing time of 8 minutes was given at a rotor speed of 50 RPM. In all cases the torque stabilized to a constant value in this mixing time. The hot mix from the mixing chamber was immediately pressed in hydraulic press and then cut in to pieces. The test specimens were prepared using an automatic micro injection-molding machine, with a barrel temperature of 190^{0}C, again ensuring that the polyamide fibers were not melted. In the second series,5, 10, 20 and 30-wt% of nylon reinforced PS/HDPE composites were prepared by above procedure. Table 1 (It was based on the ability of the thermoplastic material to be softened by heat and to harden when cooled. The process then consists of softening the granular material in a heated cylinder and injected to the mold cavity).

Dump bell shaped specimen and rectangular shaped specimen were prepare using corresponding molds for the tensile properties and flexural properties respectively. These properties are studied using universal testing machine and optimized the fiber length for the composite. In the second phase, variation in tensile properties with varying compositions was studied

2.3 Determination of mechanical properties: - Tensile and flexural properties were evaluated using Shimadzu Autograph AG-1 series

Universal testing machine with a load cell of 10 KN capacity according to the ISO 527 at a crosshead speed of 50mm/min, and ISO 178 at a cross head speed of 5 mm/min on rectangular bar samples respectively .The Izod Impact test on unnotched rectangular bar samples were carried out following ASTM D 256 test method on a pendulum type tester. RESIL IMPACT JUNIOR (CEAST).

2.4 Scanning electron Microscopy (SEM): - SEM was used to investigate the morphology of the fractured surfaces. The tensile fractured surface was sputter coated with gold and examined under Scanning Electron Microscope. SEM images were taken using a JOEL model JSM 6390LV

3. Results and discussion

3.1Tensile properties of short nylon fiber reinforced PS/HDPE composites

3.1a Effect of fiber length: - To study the effect of fiber length on the tensile strength of the present system 10%nylon fiber filled PS/HDPE composite were prepared with different average fiber length of 2, 4, 6, 8

Table 1

% composition of nylon fibre	Weight of components taken in grams		
	PS	HDPE	Nylon
5%	30.4	7.6	2
10%	28.8	7.2	4
20%	25.6	6.4	8
30%	22.4	5.6	12

and 10 mm. When the fibers are of finite length, stress is assumed to be transferred from the matrix to the fiber by a shear transfer mechanism. For a given fiber, there is a minimum fiber length required to build up the shear stress between fiber and resin to the value often sile fracture stress of the fiber. Over or equal to this length, the maximum value of the load transfer from the matrix to the fiber can occur. If the fiber length is less than this length, the matrix cannot effectively grip the fiber to take the strain and the fibers will slip and be pulled out, instead of being broken under tension. The composite will then exhibit lower mechanical performance. This shortest fiber length (pull-out length) is called the critical fiber length (or the maximum value of load transfer length). This fiber length is an important system property and affects ultimately the strength and elastic modulus of composites. The tensile strength of the pure PS/HDPE blend; an increase of 4N/mm^2 is composites (Figure 3a.2) is maximum at 8 mm length. Hence 8 mm length was taken as optimum fiber length for further studies. The above experimental data shows that

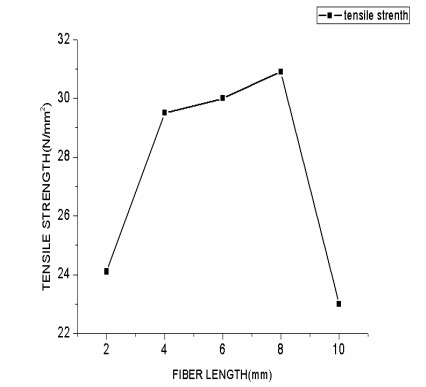


Fig.1 Variation of tensile strength with fibre length

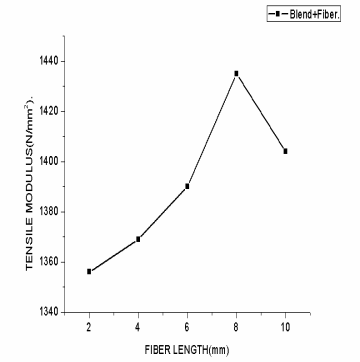


Fig. 2 Variation of fibre length with tensile modulus

maximum tensile strength is obtained when the nylon fiber length is 8mm. When compared with the tensile strength of observed when PS/HDPE is inforced with 8 mm nylon fiber. It is graphically represented as fig 1, 2. Tensile modulus of PS/HDPE is found to increase when it is reinforced with nylon fibre of varying length. It increases up to a level i.e., up to source and then decreases. So source is taken as the critical length (length of the nylon fiber at which the composite have the maximum tensile strength) of the PS/HDPE-nylon fiber composites. The graph obtained from the UTM for pure PS/HDPE critical length is shown below fig. 3, 4.

3.1b Effect of fiber loading and orientation on tensile properties

Figures 5 and 6 shows the variation of tensile strength and tensile modulus respectively, of the nylon Fiber PS/HDPE composites with fiber loading. The tensile strength and tensile modulus for different compositions using the critical length are given. The tensile strengthincreases with fiber loading up to 10% but decreases thereafter. The decrease in strength at higher loading is probably due to crowding of fibers which prevents efficient matrix-fiber stress transfer. When more and more fibers are aggregate to one position, it shows minimum tensile strength. In 10% there is not much crowding of nylon fiber, but when the composition increases crowding also increases and this will result in the weakening of matrix fiber reinforcement.

From these results we can conclude that PS/HDPE-nylon fibre composites have maximum tensile strength at 10% composition (using 8mm fibre length).

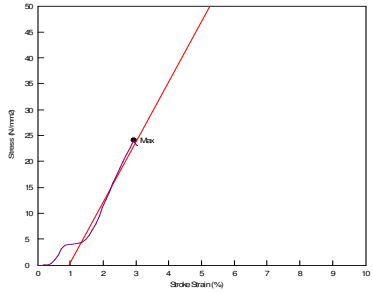


Fig. 3 Stress –Strain graph for pure PS/HDPE

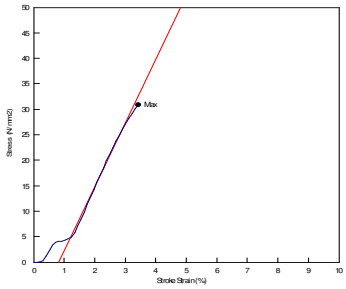


Fig.4 Stress-Strain graph for critical length

3.2 Flexural properties of short nylon fibre reinforced PS / HDPE composites

3.2a Effect of fiber length and composition: - The flexural strength of PS/HDPE/Nylon fibre composites increases with increase in the fibre length. Flexural modulus is directly related to the stiffness, so when flexural modulus increases stiffness of the material also increases. The graph showing the variation of flexural strength with nylon fiber length is given below in figures 7, 8. The flexural strength varies with the fibre length. In this case the flexural strength increases with increase of fiber length. The percentage composition of nylon fibre increases the flexural strength decreases.

3.3 Impact properties of short nylon fiber reinforced PS/HDPE composite

3.3a Effect of fiber length and composition: - In the above two tests, we got some what good properties. So impact test is an important one. The test result obtained from the impact test of PS/HDPE-short nylon fiber composites are given below in TABLE 2. From the result we can see that PS/HDPE has moderate impact strength. When short nylon fibers of fixed

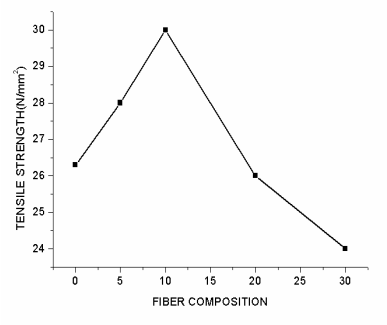


Fig. 5 Variation of tensile strength with fiber length with fiber composition

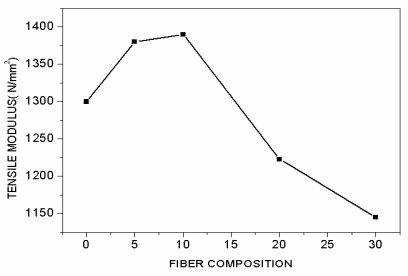


Fig. 6 Variation of tensile modulus

lengths are introduced in to it, the impact strength also increases. It is graphically shown below in Fig. 9 and 10. No regular trend is seen in impact strength with varying fibre length. But a significant increase of 95.74J/m energy in impact strength is recorded when PS/HDPE reinforced with 8mm nylon fibre, so critical length is optimized as 8mm, but when the concentration of the nylon fibre increases i.e., varying compositions the impact strength increases and a sudden increase in 20% and 30%.

4. Scanning Electron Microscopy (SEM)

For the morphological studies, the SEM of the blend gives the more details. The SEM of pure blend and 8mm nylon reinforced blend is shown below. In a two phase system such as PS/HDPE, morphology is a major determinant of properties. Thus the shape size and spatial distribution of the dispersed phase along with the interfacial characteristics decide the mechanical properties. The control of phase morphology is the key issue when the desirable mechanical properties have to be imparted to the polyblends. In an incompatible blend premature failure occurs when

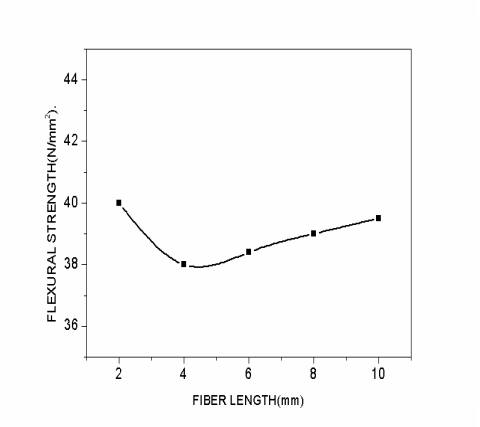


Fig. 7 Variation of flexural strength fiber length

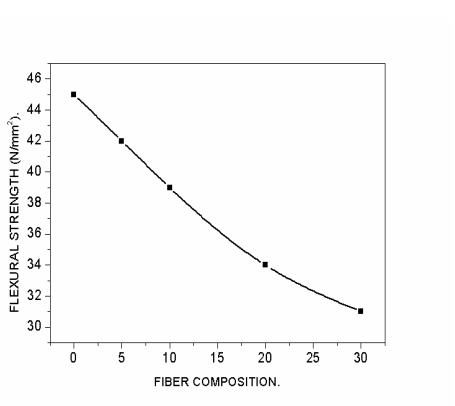


Fig. 8 Variation of Flexural strength with fiber composition

subjected to a mechanical load due to lack of adhesion between the two. The tensile measurements give an idea about the maximum load bearing capacity of the material.

TABLE 2

SPECIMEN	ABSORBED ENERGY (J)	RESILIENCE KJ/m^2	ENERGY J/m
NEAT BLEND	0.180	4.47	44.7
Blend+2mm nylon fiber	0.223	5.51	55.1
Blend+4mm nylon fiber	0.412	10.19	101.98
Blend+6mm nylon fiber	0.342	9.44	94.4
Blend+8mm nylon fiber	0.566	14.04	140.44
Blend+10mm nylon fiber	0.527	13.04	130.44

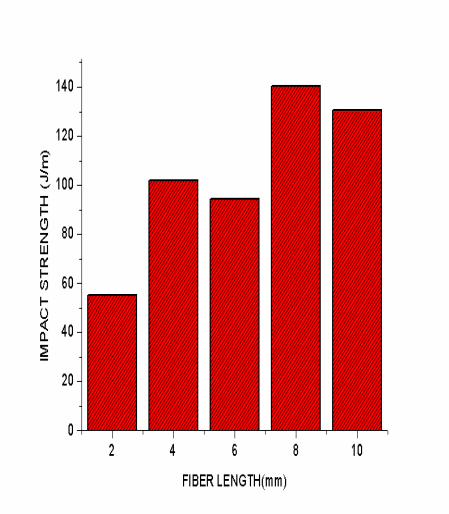


Fig. 9 Variation of impact strength with fiber length

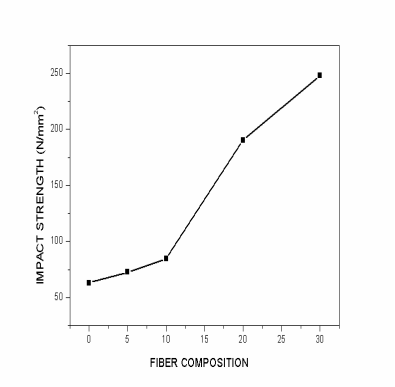
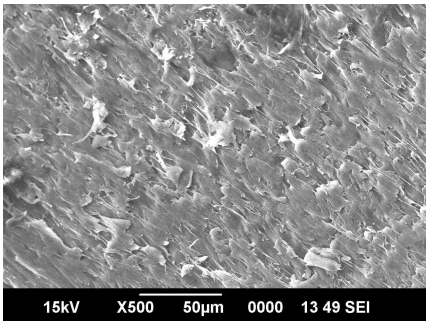


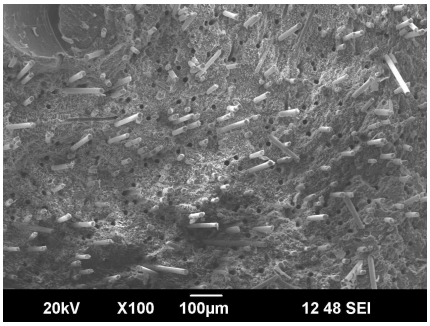
Fig. 10 Variation of impact strength with fiber loading

5. Conclusions

The study shows that standard plastics like polystyrene/high density polyethylene blend can be reinforced by adding nylon short fibers. Compared to the conventional glass reinforced thermoplastics this novel class of reinforced thermoplastics has the major advantage of recyclability.



SEM of neat blend



SEM of 8mm nylon fibre

Hence such composites represent a new spectrum of recyclable polymer composites. The fiber length and fiber orientation are critical parameters. The mechanical properties viz; the tensile strength, tensile modulus, flexural strength and impact strength are found to increase when PS/HDPE/nylon fibre composites, fibre length optimized as 8mm. The reinforcement is effective when the fibre length is 8mm and fibre content is 10%. Since the reinforcement is provided by a thermoplastic material, the composites are recyclable. Hence these composites are environment friendly. Thus Short nylon fiber is found to be a good reinforcing agent for PS/HDPE blend

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PREPARATION OF NANO ALUMINA THROUGH GEL COMBUSTION METHOD

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ABSTRACT

Nanoalumina was prepared by gel combustion method. X-ray diffraction (XRD) and scanning electron microscopy (SEM) and Energy-dispersive X-ray spectroscopy (EDAX) were used to characterize the nanoalumina. The results show that the prepared alumina was in nano meter range.

KEYWORDS: Nanoalumina, gel-combustion method, XRD, SEM, EDAX

1. Introduction

Ultrafine and nanosized single-metal oxide powders have been given a lot of attention as a possibility for functional materials of electrical parts and structural materials of mechanical parts. In recent years, increasing attention has been focused on the development of nano crystalline Al_2O_3 powders. One of the phases of alumina, γ-alumina finds

wide applications in industry as adsorbent, catalyst, coating, and soft abrasive, because of fine particle size, high surface area, and high activity of the surfaces[1,2].

However, nanoscale alumina (Al_2O_3) powder is difficult to obtain, because of two reasons: First, Al_2O_3 is in a stable phase after calcining at high temperature, which easily prompts the grain growth of powder, and make it difficult to get nano scale particles. Secondly, Al_2O_3 particles tend to aggregate during dehydration process in wet chemistry method. Therefore, it is necessary to develop new methods to overcome this problem.

Conventional synthesis process of Al_2O_3 involves mechanical milling, vapor phase reaction, precipitation, sol-gel, hydrothermal and combustion methods. Mechanical synthesis of Al_2O_3 requires extensive mechanical ball milling which easily introduces impurities. Vapor phase reaction for preparation of fine Al_2O_3 powder from a gas phase precursor demands high temperature above 1200°C. The precipitation method suffers from its complexity and time consuming (long washing times and aging time). The direct formation of Al_2O_3 via the hydrothermal method needs high temperature and pressure. Sol-gel, a commonly used technique, involves the formation of an amorphous gel from a precursor solution. Some advantages of the sol-gel method are better homogeneity and purity from raw material, lower preparation temperature which save energy cost and the ability to form unique composition. Combustion synthesis has emerged as a simple fast and economically viable method to prepare pure and nano structured powers[3,4]. This quick, straight forward process can

be used to synthesis homogeneous, high purity, crystalline oxide ceramic powder including ultrafine alumina with a board range of particle sizes[5]. In present work gel-combustion method is used for the preparation of nano alumina. XRD, SEM, and TGA studies were used to investigate the phase, size and purity of alumina. Aluminum nitrate was used as the precursor and gelatin as the gel medium.

2. Materials and methods

Aluminum nitrate and gelatin were supplied by Merck India Limited. Aqueous solutions of $Al(NO_3)_3.9H_2O$ and gelatin were prepared. The molar ratio of aluminum nitrate to gelatin was calculated as 1:3. Both the solutions were sonicated for 20 min. Gelatin solution was heated and Aluminum nitrate solution was added to the hot solution with high speed stirring. After the completion of addition the solution was concentrated to a gel form. Gelatin helps the homogeneous distribution and segregation of the metal ions. Then the gel form is transferred into a silica crucible at 900 c in a muffle furnace for 2hours to obtain pure Al2O3 powder. Phase identification was performed using XRD by Bruker, D8 advanced model employing CuKα. The shape and morphology of the powder were analyzed by scanning electron microscopy (SEM) Joel Model JSM 6390 LV.

3. Result and discussion

3.1 *X-ray diffraction (XRD)*:- X-ray diffraction pattern of the nanoalumina is shown in Figure 1. Peaks corresponding to the 2θ values of 32, 47 and

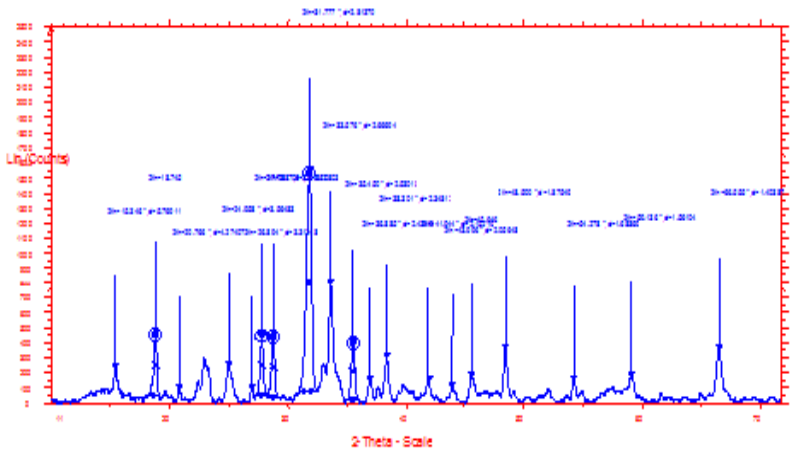

Fig. 1 XRD diffraction pattern of nano alumina

68 degrees indicate that γ-phase is prominent among the phases of the prepared nano Al_2O_3[6].

3.2 Scanning *Electron Microscopy (SEM)*: - Scanning electron microscopic image of the prepared alumina is shown in Figure 2. From SEM photograph it is clear that the prepared Al_2O_3 particles are in nano size, typically 50 to 90 nm. Agglomerates of the particles were also observed.

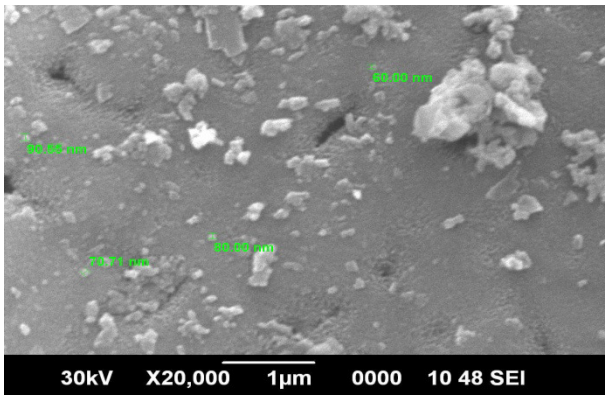

Fig. 2 SEM images of nano alumina

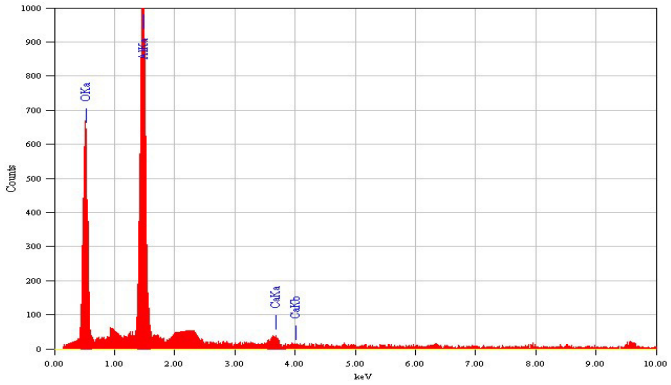

Fig. 3 EDAX spectrum of nano alumina

3.3 EDAX: - EDAX spectrum of the sample showed that the Al/O atomic ratio nearly equals the theoretical value of Al/O which is 1.125. It indicates that the product is highly pure.

4. Conclusion

The sol-gel method using Aluminum nitrate as the precursor and gelatin as the gel medium was successfully used for the preparation of nanoalumina. From XRD results it is observed that γ- phase is the predominant phase in the prepared Al_2O_3. From SEM it is clear that the prepared Al_2O_3 is in the nano meter range. EDAX spectrum shows the high purity of the prepared nano alumina.

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MECHANICAL AND MORPHOLOGICAL PROPERTIES OF ORGANOMODIFIED KAOLIN/ POLYPROPYLENE/ POLYSTYRENE NANOCOMPOSITES

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ABSTRACT

Nanoclay composites based on polypropylene (PP)/polystyrene (PS) blends were prepared by melt mixing in a Thermo Haake Rheochord mixer. The effect of vinyl triethoxysilane modified nanoclay on the properties of PP/PS (80/20) blend was studied. Dimethyl sulfoxide (DMSO)was used as a starting material to expand the interlayer basal spacing of kaolin clay. Modified and unmodified clays were characterized by XRD. The characterization of PP/PS/clay nanocomposites was made by DMA and SEM and the thermal stability was determined by using TGA.XRD results confirms a high degree of exfoliation in nanocomposites.TGA results show an improved thermal stability for nanocomposite than the pure blend.

Keywords: Nanoclay, Mechanical properties, kaolin clay

1. Introduction

Polymer-clay nanocomposites are a class of hybrid materials composed of organic polymer matrix in which layered inorganic particles with nano-scale dimension is distributed with self-assembled pattern uniformly[1]. The development of polymer nanocomposites that contain ultrafine, delaminated or exfoliated Phyllosilicates is increasing every day. Minerals of high aspect ratio provide large interfacial area between the mineral particles and polymer chains which result in improvement mechanical properties[2]. These nanocomposites synergistically integrate the advantages of organic polymers with excellent process properties and inorganic materials which have the characteristic like high modulus and strength.

Polystyrene and Polypropylene are the most widely used commercial polymers; the hybridization of PP/PS blends with nano-structured ingredients should be effective in the commercial applications PP and PS used in this study are immiscible, in which PP constitutes a crystalline and PS an amorphous phase[3, 4]. Several problems of these blends may be caused by poor compatibility of the components. These features can be improved by using compatibilizers[5]. Such a compatibilizers may be a homopolymer, a graft, block or star copolymer. In recent years, a new concept of compatibilization by using nanoparticles such as Nanoclays, nanotube etc has been introduced. Organoclays are being widely used as an attractive alternative to conventional fillers. Much of the work in this area has focused on montmorillonite[6, 7]. Hence, in this study kaolin clay with a 1:1 type layered structure with chemical composition $Al_2Si_2O_5(OH)$

$_4$is proposed to be used. Kaolinite layers are stacked along the basal direction and held together by hydrogen bonds established by aluminol groups of the octahedral sheet and siloxane groups of the tetrahedral sheet. Individual layered consists of both sheets which are closely connected by hydrogen bond between surface hydroxyl groups on the octahedral side and the basal oxygen atoms on the tetrahedral side. Because of hydrophobic properties of kaolinite and hydrophilic character of polymer the modification of kaolinite is necessary. The kind of guest species intercalated between the layers of kaolin is limited due to the hydrogen bonding between the octahedral side and tetrahedral side. Limited no of polar guest species such as N-methylformamide (NMF)[8], Urea[9], Dimethylsulfoxide (DMSO)[10] can be directly intercalated. Intercalation of kaolinite with guest species can be done by displacement reactions. The separation of kaolinite results in particle size reducing and an increase of the specific surface area. The good kaolinite modification result in better intercalation between filler and polymer matrix [11].

In this study, vinyl triethoxy silane has been used as a modifier of kaolin clay while DMSO is used as an intermediate, and the effect of modified filler on the mechanical and morphological properties of PP/PS (80/20) blend has been studied.

2. Experimental

2.1 Materials : - Polypropylene homopolymer (PP): H200 MA, homopolymer, with a Melt Flow index of 25g/10 min (230^0C/2.16Kg) was purchased from Reliance Industries limited, India. Polystyrene (MFI

(200^0C/5Kg) is 12g/10 min) was obtained from Supreme Petrochem LTD India. Kaolin claywas obtained from English India Clays Limited Veli, Thiruvananthapuram, Kerala, India. The clay had a bulk density of 0.2-.03g/cc and a BET specific surface area of 28-30m^2/g.

2.2 Methods

2.2.1 *Modification of kaolinite with DMSO*: - The intercalation of DMSO in the interlayer spacing of Kaolinite clay was done according to the previously published procedures[12- 14]. 10 g of the clay fraction was suspended in DMSO, and the mixture was stirred at 80°C, using a magnetic stirrer occasionally. After one month, the clay–DMSO complex was washed with 1, 4-dioxane to remove excess DMSO. After air-drying for 12 h, the product was gently ground in a mortar.

2.2.2 *Modification of KDMSO with Vinyl triethoxy silane*: - VTES-KDMSO was prepared by displacement of DMSO by vinyl triethoxysilane. The clay particles were sonicated for1 hour to get a homogeneous aqueous dispersion. The dispersion is acidified with 2 N HCl and triethoxy vinyl silane was added slowly. Then the mixture was stirred for 3 min at 70^0C. NaOH solution was then added and the mixture was further stirred for 1 hour at 60^0C. This was then filtered, washed with distilled water and dried to get fine particles of modified nano kaolin clay.

2.2.3 *Preparation of nanocomposite*: - Nanocomposites were prepared by melt mixing using an internal mixer (Haake Rheomix 600) at 180^0C with a rotor speed of 50 rpm/ min, and mixing time of 8 min for each sample. After mixing the melt is pressed in a hydraulic press, cut into pieces and

injection moulded in a DSM Micro 10cc Injection Moulding Machine, with a barrel temperature of 190^0C.

2.2.4 *Characterization*: - Dynamic mechanical analysis (DMA Q-800, TA instruments) was used to study the effect of nanoclays on the viscoelastic properties of PP/PS clay nanocomposites. Rectangular shaped specimens of dimension 35 ×4 ×3 mm^3 were used. DMA tests were conducted at a frequency of 1 Hz. A temperature ramp was run from 38 to 125^0C at 3^0C/min. Thermal stability of the polymer blend/clay nanocomposites was analyzed using TGA Q-50 of TA instruments under N2 atmosphere. The samples weight of about 5–7 mg was heated at a rate of 20^0C/min from ambient temperature to 600^0C.

The samples were analyzed in a Bruker AXS D8 Advance X-Ray Powder Diffractometer (Cu Ka radiation) in order to find the change in basal spacing of nanocomposites. The samples were scanned in the range of 3^0- 80^0 at increment step of scanning 0.020^0 at a wave length of 1.5Å. Tensile properties were evaluated using Shimadzu Autograph AG-I series universal testing machine at a crosshead speed of 50mm/min according to ASTM D 638. Flexural properties of the samples were measured by three point loading system using UTM (Shimadzu AG-1) with a load cell capacity according to the ASTM D 790. The testing was done at a crosshead speed of 5mm/min. Morphology of the tensile fractured surfaces of the nanocomposite specimens were investigated by using JEOL Model JSM 6390LV scanning electron microscope (SEM). The samples were

subjected to gold sputtering prior to electron microscopy to give the necessary conductivity

3. Results and Discussion

3.1 X-ray diffraction

X-ray diffraction (XRD) is extremely useful to study the structure and morphology of polymer nanocomposites. It provides information on the changes of the inter-layer spacing of the clay upon the formation of nanocomposites. The formation of an intercalated structure should result in a decrease in 2θ, indicating an increase in the d-spacing. If the complete exfoliation takes place, no peak is shown in the XRD pattern and the broadening of the peak is considered to be the result of partial exfoliation[15]. The interlayer d-spacing observed by XRD for polymer - clay nanocomposites has been used to describe the nano-scale dispersion of clay in the polymer matrix. The XRD patterns of unmodified clay, DMSO modified kaolin clay (K-DMSO), Vinyltriethoxy silane modified kaolin clay (VTES-KDMSO) and PP/PS/modified clay nanocomposite is shown in the figure1. The characterization peak for unmodified clay appeared at 2θ=12.442 which corresponds to an interlayer distance of 7.10842 Å. After the intercalation of kaolinite with DMSO, the original peak of kaolinite at 2θ = 12.442^0 is shifted to 7.96^0. The basal spacing of KDMSO expands from 7.10842 Å to 11.069 Å. After the treatment of KDMSO intercalate with vinyltriethoxy silane (VTES) the basal spacing has changed from 11.069 Å to 15.5996 Å with a decrease in the 2 θ value to 5.663^0.VTES displaced the guest molecule (DMSO), as shown by XRD

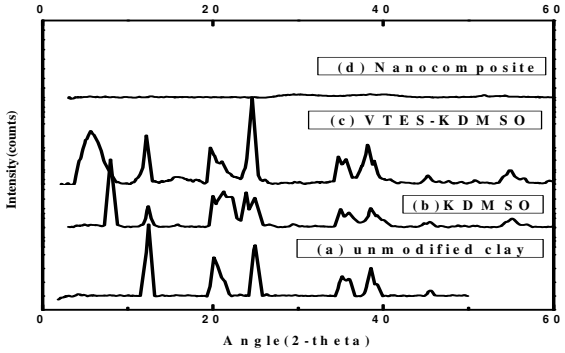

Fig. 1 XRD patterns of
(a) unmodified clay
(b) KDMSO
(c) VTES-KDMSO
(d) PP/PS clay nano composite.

patterns (Figure 1). XRD curves showed in the figure reveals very small and broad peaks in PP/PS clay nanocomposites. This confirms a very high degree of nanoclay exfoliation. When the clay begins to exfoliate, there will be a decrease in the intensity of the diffraction peaks due to a reduction in the degree of crystallinity of the silicate sheets.

3.2 Mechanical Analysis

In this study tensile and flexural tests were performed to examine the mechanical properties of PP/PS/Clay nanocomposites. The tensile strength and young's modulus as a function of clay loadings are shown in the figure 2.The tensile properties increases initially with increasing filler loading reach a maximum and there after begin to decrease. The compatabilized polymer blends will be improved compared to corresponding incompatibilized ones because of the lower interfacial tension and enhanced interfacial adhesion of the compatabilized blends which results in more efficient stress transfer between the phases during

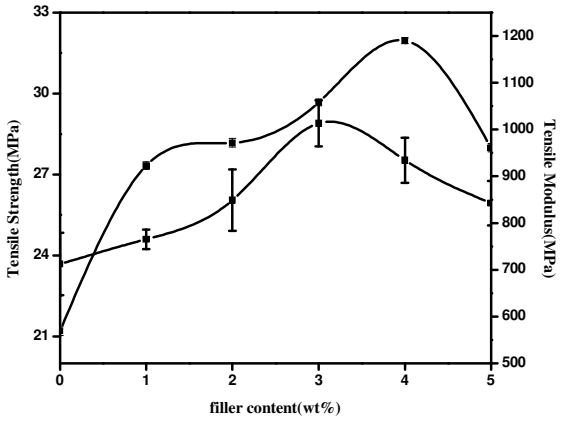

Fig. 2 Variation of tensile strength and Young's modulus on clay loadings.

fracture[16]. The decrease in tensile properties may be due to the agglomeration of clay particles. When the clay agglomerates are present, the stress acting on a small part of the material surface would be much greater than the average stress applied to the test specimen. Effect of organoclay type on flexural properties of nanocomposites is illustrated in Figure 3. The change of flexural strength of the samples with respect to organoclay content shows resemblance to tensile strength change. The increase in flexural strength and modulus indicates that the nanocomposites have become more rigid and less flexible.

3.3 Dynamic Mechanical Analysis (DMA)

DMA is used to study the relaxation in polymers. The DMA measurement consists of the observation of time-dependent deformation behavior of a sample under periodic mostly sinusoidal deformation force with very

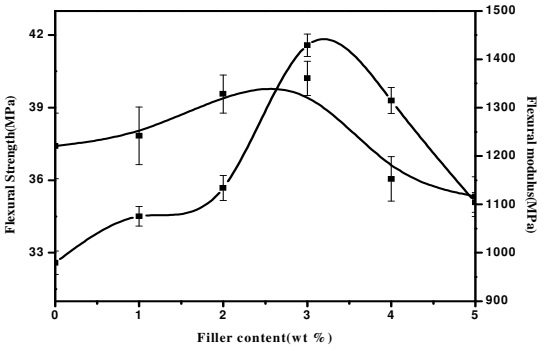

Fig. 3 Variation of flexural strength and flexural modulus on clay loadings

small amplitudes. The storage modulus as well as tan δ for pure PP/PS clay PP/PS blend and PP/PS/clay nanocomposite is shown in the figure 4. Nanocomposite shows the higher storage modulus than pure blend over the entire range of temperature studied (40^0-123^0C). This observation clearly illustrates the effect of intercalation of the polymer in clay layers, leading to dispersion of clay platelets in the polymer matrix [17]. The tan δ curves represent the ratio of dissipated energy to stored energy and relates to the Tg of the polymer. Tan δ is useful in determining the occurrence of molecular mobility transitions such as Tg. From the figure it can be observed that there is a slight decrease in Tg with the addition of nanoclay. The reduction is attributed to the plasticizing action of the surfactant of organically modified clay. Such plasticizing action may be responsible for the improved mobility of polymer chains, which cause reduction of Tg [18].

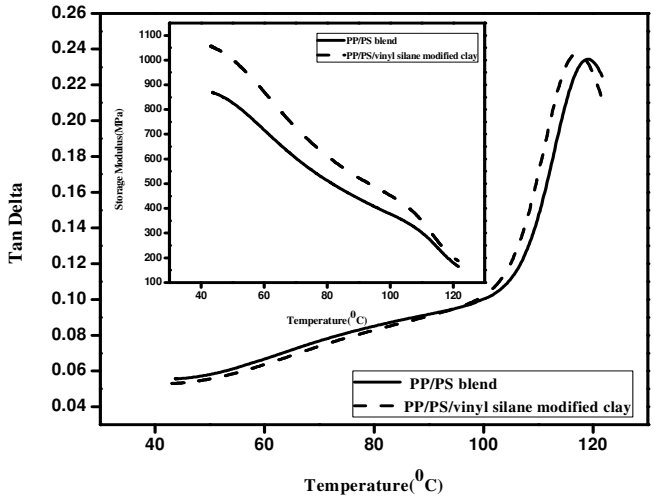

Fig. 4 DMA curves for PP/PS blend and PP/PS VTES-KDMSO nanocomposite

3.4 Thermal Analysis

The thermal decomposition of VTES-KDMSO in nitrogen atmosphere is shown in the figure 5. The modified kaolin clay shows a T peak at 131^0C this can be attributed to the elimination of absorbed water. he maximum degradation for kaolin clay is at 516.43^0C. Table 1 presents the results of VTES-KDMSO, PP/PS pure blend and PP/PS/clay nanocomposite. The temperature at which 10% degradation occurs, onset temperature and temperature at which maximum degradation occurs and residue after the degradation are recorded. Figure 6 shows the TG and DTG curves for PP/PS pure blend and PP/PS clay nanocomposite. Pure blend shows a maximum degradation temperature of 434.39^0C. After the addition of vinyltriethoxy silane modified clay this temperature shifts to 460.15^0C. Improved thermal stability of nanocomposite can be attributed

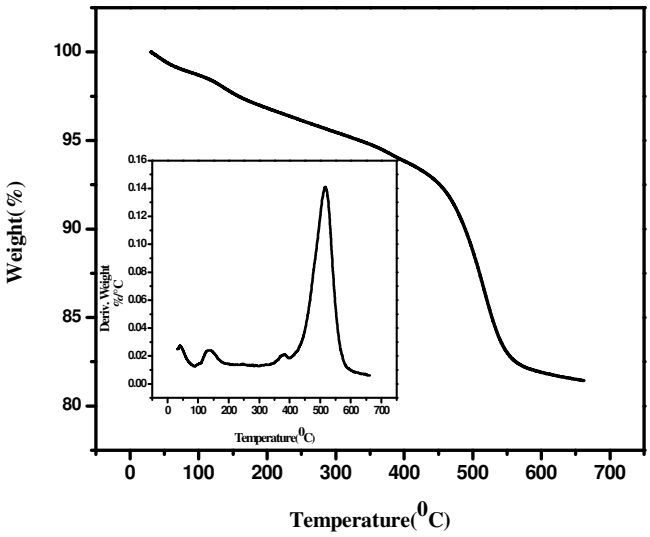

Fig. 5 Tg and DTG curves for VTES-KDMSO clay

to the decreased permeability of oxygen caused by the partial exfoliation of the clay in the nanocomposite. This may result in the formation of highly charred carbonaceous silicate cumulating on the nanocomposite surface. The charred surface layer formed during decomposition shields the thermal shock due to heat penetration to the underlying material; on the other hand such cumulative char layer tends to retard diffusion of O2 and volatile products through nanocomposite[18].

3.5 Scanning Electron Microscopy

The figure 7 shows the surface morphology of vinyltriethoxy silane modified kaolin clay, PP/PS pure blend and PP/PS/modified clay nano-composite. The morphology of the fractured cross sections of the tensile

Table 1 TGA results of VTES-DMSO,PP/PS pure blend, PP/PS/clay nanocomposite

Samples	10% mass loss(^{0}C)	T onset (^{0}C)	T_{max}	Residue at 600^{0}C (%)
VTES-DMSO	488.66	423.68	516.34	81.43
PP/PS pure blend	384.76	370.49	434.39	0.4561
PP/PS/3%clay nanocomposite	397.36	371.28	460.15	1.17

samples is demonstrated in Figure 7. Figure 7(a) shows the morphology of vinyltriethoxy silane kaolin clay. PP/PS pure blend [Figure 7(b)] exhibits a morphology in which spherical domains of PS phase are surrounded by the continuous PP phase, and the interface between the spherical domains and the PP matrix shows weak interfacial adhesion between two phases. After the addition of vinyltriethoxy silane modified kaolin clay [figure7(c)] the

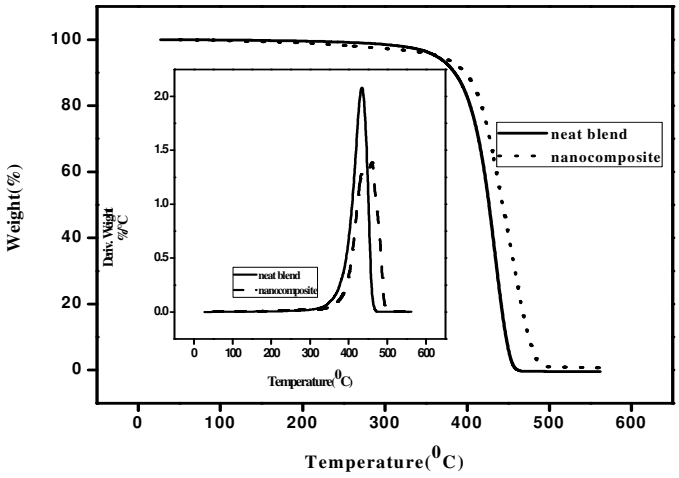

Fig. 6 TG and DTG curves for PP/PS pure blend and PP/PS clay nanocomposite

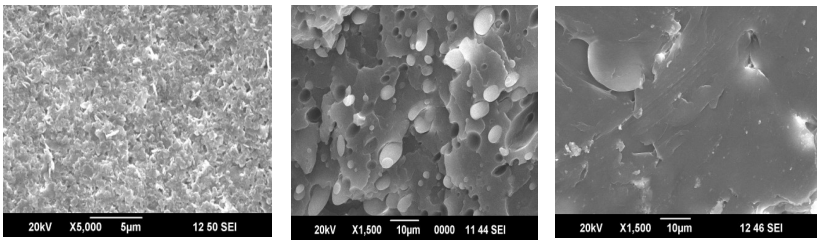

Fig. 7a Fig. 7b Fig. 7c

Fig. 7 (a) VTES-DMSO (b) PP/PS pure blend
(c) PP/PS/VTES-DMSO modified nanocomposite

adhesion between two components can be improved to form a homogeneous morphology. Therefore, the improved homogeneity increases the tensile and flexural properties. This is in complete agreement with the observed mechanical properties and the XRD results in which the nanocomposites with this modified clay exhibit the highest interlayer spacing.

4. Conclusion

The basal spacing of kaolinite expanded with the intercalation of DMSO into the interlayer sheets of kaolinite. The intercalation of KDMSO with vinyl triethoxy silane is intercalated in the interlayer spaces of kaolinite by guest-displacement method. XRD shows an increase in d-spacing of kaolin clay after the addition of vinyl triethoxy silane. TGA shows an increase in the thermal stability after the addition of modified clay. The dynamic mechanical analysis reveals higher storage moduli over a temperature range of 40–125 ^{0}C for nanocomposites. SEM micrographs

show a better adhesion between two phases in the presence of modified kaolin clay.

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EFFECT OF RICE HUSK ASH ON THE MECHANICAL PROPERTIES OF NATURAL RUBBER COMPOSITES

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ABSTRACT

Rice husk is a waste product of the rice processing industry. Rice husk ash (RHA) is the residue left after the combustion of rice husk. In this work, rice husk ash is used as filler in natural rubber (NR) compounding along with other vulcanizing ingredients. The compounding was done in a two roll mill. Different concentrations of RHA (0, 0.5, 1, 1.5, 2 and 2.5) were used. In order to enhance interfacial adhesion between NR and RHA, maleic anhydride grafted NR (MA-g-NR) was employed as a compatibilizer. Characterization of RHA was done by scanning electron microscopy (SEM), Fourier Transform infrared spectroscopy (FTIR), inductively coupled plasma atomic spectroscopy (ICPAES) and particle size analysis. Both uncompatibilized and compatibilized NR-RHA composites were characterized by SEM. Mechanical properties of these composites were also studied. Compatibilized NR-RHA composites showed a substantial increase in mechanical properties compared to uncompatibilized NR-RHA composites.

Keywords: NR, Rice husk ash, Maleic anhydride, Mechanical properties

1. Introduction

Composites are used in variety of applications ranging from house hold appliances to aeronautics [1]. Due to the increasing demand for various composites, polymer industries are on the lookout for new fillers. The performance of natural by-products or industrial waste as filler (natural fibers, saw dust, rice husk ash, fly ash etc.) are comparable to commercial fillers such as carbon black, precipitated silica or talc's [2].

Rice husk ash is commonly called silica ash. RHA is an industrial waste obtained after burning the rice husks. It has approximately 55-97% silica in partially crystalline and amorphous forms depending upon the prior combustion conditions. RHA is thermally stable and a tough material possessing high specific properties. It is also a low cost material and readily available[3].

Rubbers are mixed with fillers to improve their mechanical properties, processability, and to reduce cost. RHA as a filler in rubber compounding assumes significance because of its availability, environmental pollution potential and the current emphasis on the use of renewable sources. Sai- Oui et al investigated the effects of filler loading on the properties of RHA-filled NR materials compared with those of commercial fillers [3]. They found that both grades of RHA, low and high carbon contents, provided inferior mechanical properties (tensile strength, modulus, hardness, abrasion resistance and tear strength) compared to that of reinforcing fillers such as silica and carbon black [3,4].

The previous studies reveal that RHA filled NR composites show poor mechanical properties due to filler-matrix incompatibility and poor filler dispersion[5]. Grafting of maleic anhydride has been used in order to introduce more polar functional groups onto rubbers chains[5]. This leads to NR becoming more polar and consequently, more hydrophilic and hence more compatible with the hydrophilic filler. However, no comprehensive attempt has been made to evaluate the use of RHA as filler in NR matrix so far.

In this study, NR isused as matrix and RHA as filler. In order to improve compatibility between NR and RHA maleic anhydride grafted NR (MA-g-NR) is used as compatibilizer.

2. Experimental

2.1 Materials and Methods

Zinc oxide (ZnO), Sulphur (S), N-Cyclohexyl-2benzothiazole sulfenamide (CBS), Tetra methyl thiuram disulphide (TMTD), Stearic acid and antioxidant HS used were of commercial grade. Natural rubber (ISNR-5) was obtained from Rubber Research Institute of India; Kottayam, Kerala. Maleic anhydride was obtained from Sdfine-chem Ltd, Mumbai

2.2 Preparation of RHA

Rice husk was collected from rice mills. It was washed clean with distilled water to remove grit and dried in an oven at a temperature of 100ºC for 2h. It was burnt in a muffle furnace for 6h at 550ºC temperature.

2.3 Preparation of NR- RHA composites

Compounding of NR was done on a two roll mill as per the formulation given in Table1.NR was masticated for 2 minutes on a two roll mill ((16×33cm^2) and the ingredients were added in the order shown in Table 1. Varying concentrations of filler were added (inparts per hundred rubbers, phr). The samples were then cured at 150^{0}C in an electrically heated hydraulic press to their respective optimum cure time at a pressure of 150 Kg/cm^{2}in a specially designed mould to get sample sheets having thickness 1.5 mm approximately.

2.4 Preparation of maleated natural rubber

Maleated natural rubber (MNR) was prepared by the grafting reaction of maleic anhydride with natural rubber in molten state following Visconte et al. [6]. Natural rubber was first cut into small pieces. It was then dried in a vacuum oven at 40°C for 24 h. The internal mixer (Brabender Plasticorder) was then used to masticate it at 135°C with a rotor speed of 60 rpm for 2 min. 6 phr of maleic anhydride was then added into the internal mixer. The mixing was continued for 10 min at 135°C. The blended product was then dumped out onto the two-roll mill, sheeted out and cut into small pieces.

Table 1
Formulation for NR RHA composites

Ingredient	phr
NR	100
ZnO	5
Stearic acid	2
RHA	Variable (0-2.5)
Compatibilizer	5
CBS	0.6
TMTD	0.1
S	2.5

2.5 Characterization of RHA

2.5.1 *Chemical analysis of RHA*: - Elemental and chemical compositions of RHA were obtained using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPAES). Samples for ICPAES were prepared by first drying the ash in an oven (120ºC, 1h) and then dissolving approximately 100 mg of dried ash in 4 ml of reagent grade, concentrated hydrochloric acid. The mixture was left standing for a couple of hours for complete dissolution. This solution was later diluted to approximately 100 g using distilled water so that the concentration of various elements was within the linear range of detection for the ICPAE Spectrometer. The solution was analyzed for concentrations of P, K, Ca, Mg, S, Zn, Mn, B, Al, Fe, Si and Na by a Thermo Electron IRIS INTREPID II X SP DUO spectrometer.

2.5.2 *Particle size analysis*: - Light scattering: The average particle size of RHA was determined using a particle size analyzer. The sample for particle size analysis was prepared by dispersing 500 mg of RHA in a 5% solution of potassium oleate and sonicating for 6hrs. From this, about 3ml of solution was used for testing. The solution was analyzed by Malvern Zetasizer (Model Nano-S), manufactured by Malvern Instruments, UK. This instrument works on the principle of light scattering.

2.5.3 *Fourier Transform Infrared Spectroscopy*: - FTIR spectra of representative samples were recorded on a Thermo Nicolet FTIR Spectrometer Model Avatar 370. Samples in the form of thin films less than1mm thickness, were employed.

2.6 Cure characteristics

Cure characteristics of RHA filled NR were studied using a Rubber Process Analyzer (RPA2000) as per ASTM standard D 2084-01. Important parameters like cure time, $T_{90}$and scorch time, T_{10} were determined.

2.7 Mechanical properties

Dumb-bell shaped specimens were cut from the cured rubber sheets and tensile strength, elongation at break and modulus, were determined on a Shimadzu Universal Testing Machine (AG1 series), using a cross head speed of 500mm/min as per ASTM D 412-1998. All the tests were carried out at 28+/-20C. Six samples were tested and their average values taken. Tear resistance was also measured using a Shimadzu Auto-graph AG1 series Universal Testing machine (UTM), using a cross head speed of 500mm/min at test temperature 28+/-20C as per ASTM D 624 - 1998. The tear resistances of the samples were reported in N/mm.

2.8 Scanning Electron Microscopy (SEM)

The morphology of the composites was studied using JEOL Model JSM 6390LV scanning electron microscope.

3. Results and discussions

ICPAES (Table 2) indicates that RHA mainly consists of silicon, calcium, magnesium and potassium. Small amounts of aluminum and iron are also present. Light scattering studies (Table 3) reveal that about 9.6% particles

Table 2
Composition of RHA (ICPAES) prepared at 550^0C

Component	Weight (%)
Silicon	64.81
Aluminum	0.26
Boron	2.09
Calcium	4.05
Iron	0.95
Potassium	20.56
Magnesium	5.58
Manganese	0.28
Sodium	1.36
Zinc	0.06

Table 3
Particle size of RHA (5500C) by Light scattering

RHA particle size (nm)	Mean volume (%)
58.77	0.2
68.06	0.6
78.82	2.7
91.28	6.1
105.7	9.2
122.4	11.6
141.8	13.4
164.2	13.5
190.1	12.4
220.2	10.7
255	8.7
295.3	6.2
342	3.4
396.1	1.2
458.7	0.2
531.2	0.8

are below 100nm, 60% in the range 100-200nm, 25.6% in the range 200-300nm and 5.6% above 300nm (upto 531nm)

FTIR of RHA: Fig.1 shows the spectra of RHA. The FTIR spectrum shows a peak at 1106.16 cm^{-1} corresponding to Si-O-Si stretching vibration. The peak at 750 cm^{-1} shows vibration of Al_2O_3 [31]. The peak at 3436.39 cm^{-1} indicates the presence of O-H group in the RHA [30] arising from silanol molecules.

3.1 Effect of RHA loading on the NR composite

a) Determination of cure characteristics: - Fig.2 shows the values of scorch time and cure time of NR composites with different RHA loadings. Thescorch time and cure time decrease (a maximum reduction of almost 50%) with increasing RHA loading. This trend might be due to the presence of various metal oxides in RHA [5]. As filler loading increases, the incorporation time of the filler into the rubber matrix also increases and consequently more heat is generated because of the additional friction. This may be another reason for the reduced cure time.Fig.3 shows that cure time and scorch time of RHA filled NR composites decreases with the addition of MA-g-NR as a compatibilizer.

b) Determination of cure characteristics in presence of compatibilizer

Wagner reports that compatibilizer generally reduces the cure and scorch times to a certain degree depending on the types of accelerator and elastomer [6].

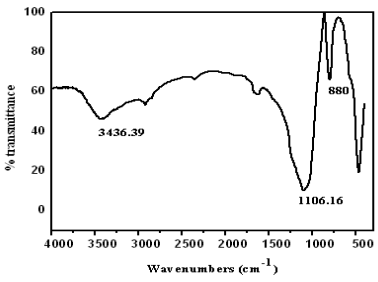


Fig.1 FTIR of RHA

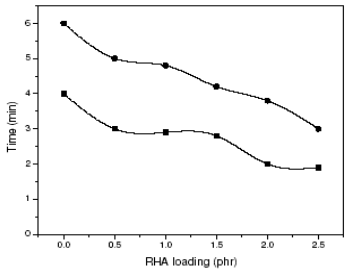


Fig. 2 Cure time and scorch Time of RHA filled NR composites

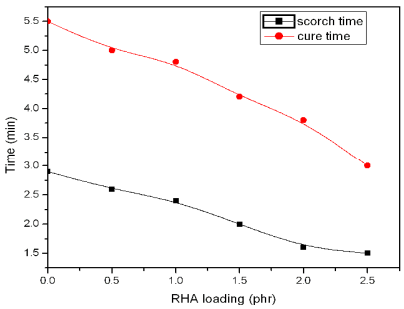


Fig. 3 Cure time and scorch time of NR–RHA composites in presence of compatibilizer (MA-g-NR)

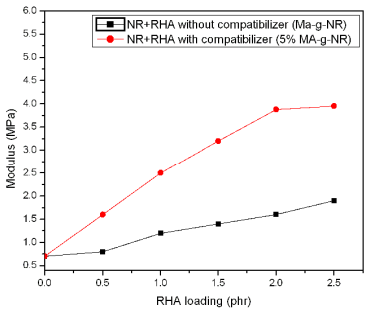


Fig. 4 Tensile modulus of NR-A composites

3.2 Mechanical properties of NR/ RHA composites

Fig. 4 shows the tensile moduli (at 300% elongation) of uncompatibilized NR-RHA composites and compatibilized NR-RHA composites.Tensile modulus increases with increasing filler loading. Addition of RHA into NR matrix improves the stiffness of the composites. This is true of almost all fillers.

Fig. 5 shows that tensile strength of uncompatibilized NR-RHA composites and compatibilized NR-RHA composites. Tensile strength of uncompatibilized NR–RHA composites decreases with the filler loading. The reduction of this property may be due to the geometry of RHA filler. For irregularly shaped fillers, the strength of the composite decreases because of the inability of the filler to support stress transferred from the polymer matrix [7]. In the case of compatibilized NR- RHA composites tensile strength increases with increasing filler loading. Maximum improvement in tensile strength is observed at about 1.5% RHA (an

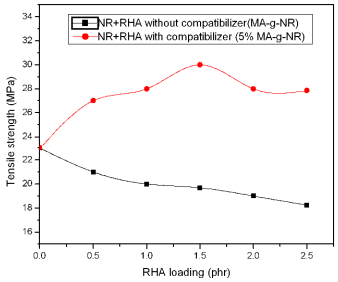


Fig. 5 Tensile strength of NR-HA composites

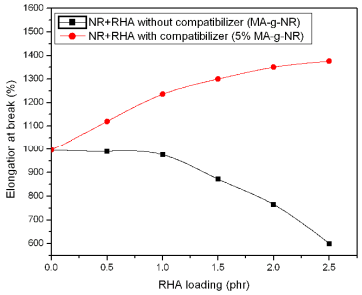
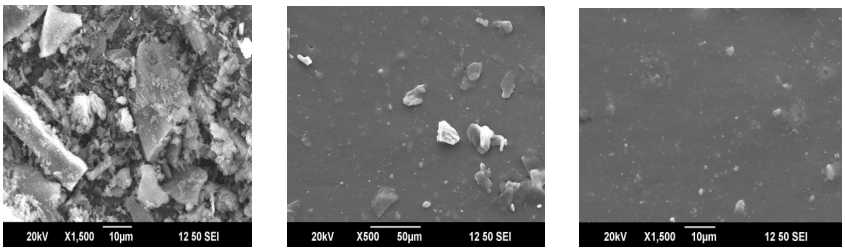


Fig. 6 Elongation at break of NR-RHA composites

increase of about 33%). NR segments of MA-g-NR form miscible blends with the NR and the polar part of MA-g-NR forms hydrogen bonds with the hydroxyl group of the filler at the interfacial region. Stronger adhesion at the filler-rubber interface leads to a higher tensile strength for the NR composite. Fig. 6 shows that elongation at break of uncompatibilized and compatibilzedNR-RHA composites.Elongation at break of uncompatibilized composites decreases with increasing filler loading. The incorporation of filler to the rubber matrix will tend to block the flow of the rubber chain and hence the rubber composites break at lower elongation. Elongation at break of compatibilized NR-RHA composites increases with increasing filler loading. This is due to the presence of the compatibilizerwhich leads to better interaction and interfacial bonds between RHA and NR.

3.3 Scanning electron micrograph (SEM): - Fig. 7(a) shows that RHA particles are of irregular shape and have a tendency to form agglomerates [4]. A micrograph of the failure surface of RHA filled NR without MA-g-



(a) (b) (c)

Fig.7. (a) SEM micrograph of RHA (b) NR-RHA composites (c) NR-RHA composites with compatibilizer

NR is shown in Fig. 7(b). RHA particles in the composite are found to be of widely different sizes presumably due to agglomeration and nonhomogeneous dispersion. In the absence of wetting the particles tend to stick together rather than distributing evenly in the matrix. SEM micrograph Fig. 7(c) of the tensile –fractured surfaces of the compatibilized composites show that the presence of MA-g-NR causes areduction in filler detachment and leads to better interfacial interaction between RHA and NR.

4. Conclusion

RHA mainly consists of silicon, iron, calcium, magnesium, potassium, phosphorous and aluminum compounds. Average particle size of rice husk ash is 270nm as determined by light scattering. Addition of RHA into NR matrix decreases the scorch time and cure time. The tensile modulus increases with increasing RHA loading but tensile strength and

elongation at break exhibits the opposite trend in the absence of combatibilization. The presence of MA-g- NR enhances the mechanical properties, in general. SEM micrographs of the tensile–fractured surfaces of the composites show that the presence of MA-g-NR causes a reduction in filler detachment and better interfacial interaction between RHA and NR.

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A COMPARATIVE ANALYSIS OF THE LEVEL PATTERN AND INEQUALITY OF CONSUMPTION EXPENDITURE OF HOUSEHOLDS IN INDIA AND KERALA

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ABSTRACT

A study on Household Consumer Expenditure has been considered as the primary source of data on various indicators like level of living and pattern of consumption of households at the National and State levels. The distribution of Monthly Per Capita Consumer Expenditure (MPCE) is an effective tool to study the prevalence of poverty and inequality.

1. Introduction

Consumption savings and capital formation as the major macro economic variables are the driving forces behind the economic growth process in any country. In India, the household sector occupies an important role in the development process. The size and pattern of household consumption expenditure is an important indicator of human

living standards. Households' consumption behaviour is determined by preferences as constrained by prices and income which in turn has been influenced by the effects of Globalisation. Therefore, a detailed analysis of the consumption-saving behaviour of the households, the forces determining them and the role of women in influencing the consumption–saving behaviour of households in this era of Globalisation can be illuminating.

Kerala Development Experience has been characterized by low rate of economic development despite high degree of social development. A rural-urban continuum in human habitations, transportation network, accessibility to health services and education exists in the State. Migration in large number reduces the intensity of unemployment and has brought in substantial remittances to households in Kerala and they administer consumerism. The remittances have made significant impact on income distribution, consumption pattern, standard of living and propensity to save of the households. The hypothesis of demonstration effect has its influence in the upper middle class and even amongst the lower income group to embrace high level of material prosperity. Information Technology in Kerala has reached the blooming stage and has attracted foreign investment and generated large employment opportunities, foreign exchange and fresh income, consumption and saving. Further, Micro Finance through 'Kudumbasree' has been identified as one of the best practices for promoting thrift, micro enterprises, consumption standard and empowerment of even poor women for rural development in Kerala. It

is in this background a detailed analysis of the consumption behaviour of the households in Kerala has relevance particularly in the era of Globalisation.

Specific Objectives of the Paper are:

(i) To examine the extent and pattern of consumption behaviour of the households both in the rural and urban areas in the context of Globalisation.

(ii) To identify the motivational factors behind the consumption behaviour of the households.

Research Questions:

1. Whether the average and marginal propensity to consume of the households has changed in the urban and rural areas due to Globalisation.

2. Whether the factors determining the consumption-saving behaviour of the households have changed in the phase of Globalisation.

2. Research Methodology and Sources of Data:

The study is based on data both from primary and secondary sources. To examine the extent and pattern of consumption behaviour of households, data has been collected from NSS Results (various rounds), publications of National Accounts Statistics, C S O and publications from State Planning Board, Trivandrum. A survey among households was

conducted to examine their consumption behaviour on food and on non-food items, to identify the motivational factors influencing their consumption behavior. A stratified multi-stage sampling design has been adopted for the survey. The selection of sample households has been done separately for rural and urban areas in Ernakulam district.

3. Conceptual Framework of the Project:

The various theoretical and empirical studies on consumption and savings constitute the conceptual framework of the project. The Engel's Law of Consumption and other various theories of consumption function and consumer behaviour form the theoretical framework of the study.

I. The Level and Pattern of Consumption Behaviour in India.

Households' consumption expenditure behaviour are of critical importance in the study of consumer behaviour because families or households are the unit of usage and purchaser for many consumer products. Further the family has a major influence on the attitudes and behaviour of individual consumers. Section one focuses on the consumption expenditure pattern of the households and individuals in India and as well as Kerala. Based on the survey conducted in three Taluks in Ernakulam district, section two discusses the trends in percentage distribution of food and non-food expenditure and the factors influencing consumption expenditure of households.

Monthly Per Capita Consumption Expenditure (MPCE) of a Household and of an Individual

The concept of per capita income or per capita expenditure is used for comparison of average living standards between countries, between regions, and between social or occupational groups. For studies of poverty and inequality within populations, one needs to assign a value that indicates level of living to each individual, or at least to each household. The NSS concept of MPCE, therefore, is defined first at the household level (household monthly consumer expenditure ÷ household size). This measure serves as the indicator of the household's level of living.

Average Monthly Per-capita Consumption Expenditure (MPCE) in 2009-10 was estimated as Rs.1053.64 in rural India and Rs.1984.46 in urban India (Table 1). Thus the per capita expenditure level of the urban population was on the average about 88 per cent higher than that of the rural population.

The data shows that the poorest 10 per cent of India's rural population had an average MPCE of Rs.453. The poorest 10 per cent of the urban population had an average MPCE of Rs.599. The top 10 per cent of the rural population, ranked by MPCE, had an average MPCE of Rs.2517 – about 5.6 times that of the bottom 10 per cent. The top 10 per cent of the urban population had an average MPCE of Rs.5863 – about 9.8 times that of the bottom 10 per cent. In Table 2, the major States have been arranged in ascending order of average MPCEMMRP in the rural and urban sector. Among the major States, Kerala (Rs.1835) had the highest rural MPCE. It was followed by Punjab (Rs.1649) and Haryana (Rs.1510). In all other major States, average rural MPCE was between

Table 1: Average MPCE(MMRP) Across Decile Classes of MPCE (MMRP), All India

Rural India		Urban India	
Decile Class of MPCE (MMRP)	Average MPCE (MMRP) Rs.	Decile Class of MPCE (MMRP)	Average MPCE (MMRP)Rs.
1st	452.98	1st	599.27
2nd	584.40	2nd	830.96
3rd	675.35	3rd	1011.84
4th	760.79	4th	1196.08
5th	848.07	5th	1397.99
6th	944.35	6th	1633.42
7th	1062.93	7th	1930.96
8th	1220.59	8th	2329.87
9th	1470.33	9th	3050.69
10th	2516.69	10th	5863.25
All Classes	1053.64	All Classes	1984.46

Source: NSSO 66th Round

MMRP = Modified Mixed Reference period

Rs.750 and Rs.1250. Average rural MPCE was lowest in Bihar and Chhattisgarh (around Rs.780), and also low in Orissa and Jharkhand (around Rs.820), as well as in Uttar Pradesh and Madhya Pradesh (around Rs.900). Maharashtra (Rs.2437) and Kerala (Rs.2413) were the two major States with the highest MPCE in the urban sector, followed by Haryana (Rs.2321). The other major States with average urban MPCE higher than the all-India average were Andhra Pradesh (Rs.2238), Punjab (Rs.2109) and Karnataka (Rs.2053). Urban MPCE was lowest in Bihar (Rs.1238). The data thus reveals extent of inequality in the marginal per capita consumption expenditure between States over rural and urban areas.

Table 2

Average MPCE-MMRP and Food Share: Major States

State	Average MPCE Rs.	Per capita Food Expenditure	% share of Food in Consumption	Average MPCE Rs.	Per capita Food Expenditure	% share of Food in Consumption
	Rural India			Urban India		
Bihar	780	505	64.7	1238	655	52.9
Chattisgarsh	784	456	58.2	1647	720	43.7
Orissa	818	507	61.9	1548	749	48.4
Jharkhand	825	503	60.9	1584	816	51.5
Utter pradesh	899	521	57.9	1574	728	46.3
Madhya Pradesh	903	504	55.8	1666	694	41.7
W. Bengal	952	604	63.5	1965	907	46.2
Assam	1003	646	64.4	1755	929	52.9
Karnataka	1020	577	56.5	2053	869	42.3
All India	**1054**	**600**	**57.0**	**1984**	**881**	**44.4**
Gujarat	1110	640	57.7	1909	882	46.2
Maharasthra	1153	623	54.0	2437	999	41.0
Tamil Nadu	1160	635	54.7	1948	876	45.0
Rajasthan	1179	647	54.8	1663	798	48.0
Andhra Pradesh	1234	717	58.1	2238	1002	44.8
Hariyana	1510	815	54.0	2321	1001	43.1
Punjab	1649	795	48.2	2109	933	44.3
Kerala	**1835**	**843**	**45.9**	**2413**	**970**	**40.2**

Source: NSSO 66th Round

Share of Food in Consumer Expenditure (MMRP)

Per capita food expenditure in rural India as a whole was estimated at Rs.600 for rural India and Rs.881 for urban India (Table 2). This means that the share of food in consumer expenditure was 57 per cent in rural India and 44.4 per cent in urban India. It is seen that in rural India, the food share ranges from under 46 per cent in Kerala to 64-65 percent in Bihar and Assam. In the urban sector, the food share ranges from 40.2 percent in Kerala to nearly 53 per cent in Bihar and Assam. Also, States with low average MPCE tend to have a higher share of food in total consumer expenditure.

Trends in the Pattern of Consumption

Table 3 shows changes in percentage composition of MPCE – Uniform Reference Period- (URP) as shown by the 5 quinquennial surveys beginning with 1987-88. The share of food is seen to have declined by about 10 percentage points to 53.6 per cent in the rural sector and by about 16 percentage points to 40.7 per cent in the urban sector over a 22-year period.

Cereals have registered the largest decline in share among all the item groups – from 26.3 per cent to 15.6 per cent in rural India and from 15 per cent to 9 per cent in urban India. In the urban sector, practically all the food groups have suffered a decline in share. For the rural sector, “beverages, etc.” show a distinct rise in share, while pulses, edible oil, sugar, and “salt and spices” show a fall, and for other groups, the evidence is not very conclusive. Pan, tobacco and intoxicants exhibit a distinct

Table 3

Trends in Percentage Composition of Consumer Expenditure Share in Total Consumer Expenditure Since 1987-88.

	Rural					Urban				
Item Group	1987-88	1993-94	1999-00	2004-05	2009-10	1987-88	1993-94	1999-00	2004-05	2009-10
Food	64.0	63.2	59.4	55.0	53.6	56.4	54.7	48.1	42.5	40.7
Non-Food	36.0	36.8	40.6	45.5	46.4	43.6	45.3	51.9	57.5	59.3
Total Expenditure	100	100	100	100	100	100	100	100	100	100

Source: NSSO 66th Round

downward trend, especially in urban areas, while fuel and light appear to show an increase in share in the last decade, especially in urban India, clothing and bedding show an overall fall, and the share of durable goods appears to be picking up. The greatest gainer in share of expenditure is clearly the "miscellaneous goods and services" category (including education and medical care). The share of this group has soared (growing by around 70 per cent of its level in 1987-88) from 14.5 per cent to 24 per cent in rural India and from 23.2 per cent to 37.8 per cent in urban India. (Source: NSSO 66th Round)

II. Analysis of Consumption Expenditure Behaviour of Households in Ernakulam District, Kerala.

The average monthly expenditure of the households in Ernakulam district on food items has been found as Rs. 4438.8 in rural areas and Rs. 5239.3 in urban areas in 2009-10 and found to be higher than the national

average as well as the State average. The three major items of expenditure on food item are shown as fish, meat and egg (1), cereals (2) and on milk and milk products (3) and the order of priority holds good both in the rural and urban areas. The study found that the rural households spent 32.77 per cent and urban households spent around 26.63 per cent of their total expenditure on food items. The details are shown in Table 4 below.

The major non- food items of expenditure of the rural households in Ernakulam district follow the priority of education (1), expenses for payment of house loan or rent (2) and conveyance (3). The cost incurred

Table 4: *Average Monthly Expenditure (Rs.) of Households on Different Items of Consumption in Ernakulam District- Food and Non-Food*

Items	**Ernakulam Rural**		**Ernakulam Urban**		**Ernakulam Total**	
	value	%	value	%	value	%
Cereals	612.96	4.5	667.5	3.4	627.26	4.045779
Pulses	257.15	1.9	288.5	1.5	265.54	1.712713
Milk and Milk Product	462.92	3.4	626.55	3.2	506.46	3.266628
Meat, Fish, Egg	733.95	5.4	857.5	4.4	769.25	4.961604
Edible Oil	183.43	1.4	199.22	1.0	187.6	1.210006
Vegetables	384	2.8	410.31	2.1	390.9	2.521275
Fruits	222.5	1.6	316.33	1.6	248.56	1.603193
Provisions	331.04	2.4	548.04	2.8	386.27	2.491412
Beverages & Refreshment	269.46	1.9	496.15	2.5	316.24	2.039724
Hotels, bakery foods	312.9	2.3	512.5	2.6	368.6	2.377442

Others	668.5	4.9	316.67	1.6	622.61	4.015787
Expenditure of Households on food	**4438.81**	**32.8**	**5239.27**	**26.6**	**4689.29**	**30.24556**
Education	2527.1	18.7	2575	13.1	2540.16	16.38384
Medicine	653.16	4.9	789.48	4.0	689.77	4.448964
Conveyance	829.93	6.3	1192.14	6.1	931.35	6.007136
Rent	1707.14	12.6	3625	18.4	2404.55	15.50916
Consumer services like phone bill, water bill etc.	692.61	5.1	981.79	4.9	789	5.08899
Clothing and Footwear	725.21	5.4	1762.16	8.9	1080.46	6.968884
Entertainment	332.84	2.5	738.85	3.8	458.51	2.957354
Fuel and Light	687.92	5.1	657.5	3.4	677.86	4.372145
Toilet articles	193.75	1.4	256.45	1.3	212.17	1.36848
Tobacco, pan, pan etc	753.75	5.6	1862.5	9.5	1030.94	6.649484
Expenditure on non-Food items	**9103.41**	**67.2**	**14440.87**	**73.4**	**10814.77**	**69.75444**
Consumption expenditure on food and non-food items	**13542.22**	**100**	**19676.27**	**100**	**15504.06**	**100**

Source: Survey Data

for the payment of rent or house loan (1), expenditure on education(2) and on clothing and foot wear (3), tobacco, pan and other intoxicants (4) are the important non-food items of expenditure of the urban households. The survey shows that rural households spent 67.22 per cent of the total expenditure on non-food items and the urban households spent 73.4 per cent on non-food items. The average amount of money spent on non food expenditure of the rural households has been Rs.9103.41 and in urban

areas has been Rs.14440.37. Details of consumption expenditure pattern of households both in the rural and urban is presented in table 4.

The major expenditure on food items both in the rural and urban sectors in the district follow the same pattern and its order of priority are on meat, fish and egg cereals and milk and milk products. But the expenditure pattern on non-food items of rural –urban sectors shows variations. While expenses on education, rent, conveyance and intoxicants are the major items of non-food expenditure in the rural sectors, and that expenditure on rent, education, intoxicants, clothing and footwear and conveyance etc. are the leading non-food items in the urban areas in the district.

4. The Factors Influencing the Consumption Expenditure and Households in Ernakulam District

The factors influencing the consumption expenditure of the households are many and varied. The study found that the major factors determining consumption expenditure of the households in their order of preference are income (rank one) necessity (rank two), price of the product (rank three), quality of the product (rank four) and credit availability (rank five). The details on the factors influencing the consumption expenditure of the households in the study area have been presented in Table 5 below.

The study also reveals that the major factors influencing the consumption expenditure of the households follow more or less the same pattern both in the rural and urban areas. The data shows that the factors like demonstration effect, attractions like door service, installment facility,

Table 5 : Factors Influencing the Consumption Expenditure of the Households

Factors Influencing the Consumption Expenditure	Mean	Rank
Income	11.31	1
Necessity	10.27	2
Price	9.79	3
Quality	9.67	4
Credit Availability	6.91	5
Advertisement	6.73	6
Malls and Supermarkets	6.55	7
Installment Facility	6.49	8
Door Service	6.06	9
To Imitate the Consumption Habits of Others	4.26	10

Source: Survey data

availability of malls or supermarkets have only secondary influence in the consumption decision of the households. This substantiates the fact the majority of consumers in Kerala have rational behaviour while making decisions on consumption expenditure.

5. Conclusion

The study found wide inequality between average MPCE between the rural and urban population and also between the poorest 10 per cent and

top 10 per cent in both rural and urban areas. The average Monthly Per capita Consumer Expenditure in 2009-10 was estimated as Rs. 1053.64 in rural India and Rs. 1984.46 in urban India. For the average rural Indian over 57 per cent of the value of household consumption was accounted for by food, where as for the average urban Indian, 44 per cent of the value was accounted for food.

Though Kerala has the highest average MPCE both in the rural and urban areas as compared to other major States in India, the study shows that percentage share of food in total expenditure is the lowest in Kerala both in the rural and urban areas as compared to other States. The pattern of household consumption expenditure in Kerala reveals that share of non-food items exceed that on the food items which shows the better standard of living and life style of the people in the State. Majority of consumers in Kerala have rational behaviour while making decisions on consumption expenditure. The consumption decisions of the households are primarily influenced by factors like income, prices and quality of the product.

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IS FOREIGN PORTFOLIO INVESTMENT BENEFICIAL TO INDIA'S BALANCE OF PAYMENTS? : AN EXPLORATORY ANALYSIS

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ABSTRACT

As oppose to the expectation, financing of BoP with foreign investment exerted huge cost on India's BoP. Dividend and capital gain are found to be the two cost of FPI on BoP, in which latter would considered as cost on BoP only if it is repatriated. FPI earns huge capital gain as compared to dividend and has significant evidence for repatriation.

Key words: BoP, FPI

1. Introduction

With the onset of liberalisation and consequent drastic change in the economic policies in the 1990's, there has been a shift in the BoP financing from debt flows to non-debt flows. The academicians and policy makers considered it as a positive sign since the non-debt creating flows are expected to remove vulnerabilities in BoP. The underlying logic is that more dependence on non-debt flows or foreign investment for financing BoP would reduce the cost of financing BoP and impart more

stability to BoP. Moreover, in the long run foreign investment is expected to strengthen the BoP by way of additional foreign exchange earnings possibly through export of goods and services from the firm which received the Foreign Direct Investment (FDI). Foreign investment consists of two parts, one is FDI and other is Foreign Portfolio Investment (FPI). FDI actually received by different companies in India whereas most of the FPI goes to secondary market and acquire the shares of different companies through stock market. Unlike debt creating flows, both FDI and FPI have no fixed cost of amortisation. Due to distinct nature of operation of these two capital flows, their respective effect on BoP will be different. In this context, the major objective of this paper is to analyse the extent of Foreign Portfolio Investment (FPI) to finance BoP and its impact on BoP.

2. Foreign Portfolio Investment and its effect on Balance of Payments

Since liberalisation, major proportion of foreign investment in India is coming in the form of FPI. Therefore to a great extent, we used it for financing BoP. Thus it is worthwhile to assess its effect on BoP. FPI essentially consist of three element namely foreign institutional investment (FII), American depository receipts (ADR) and global depository receipts (GDR). In the entire post liberalisation period, FII mainly dominates in the FPI. From 2000 onwards government allowed the FII to invest in debt instruments. However, the investment of foreign institutional investors is mostly concentrating in equities of different companies through stock market. Because of its size and volume of transactions in stock market,

here we consider only the FII part of FPI and its respective effect on BoP. FPI have no fixed cost of amortisation like debt flows, but dividend and capital gain are found to be two cost of FII on the BoP, in which latter would consider as cost only if it is repatriated from India.

For measuring the cost of financing BoP with FII; market capitalisation, capital gain and dividend of FII are calculated with the help of PROWESS data base (CMIE). Market capitalisation means total market value of FII. For getting FII's market capitalisation, we measured the market value of FII investment in Bombay stock exchange (BSE) listed companies. FII market capitalisation is measured at the end of every financial year and it is the average of every March month market capitalisation of FII. This method is adopted mainly to reduce the problem of volatility in the market capitalisation. Market capitalisation of FII is calculated through two variables such as total market capitalisation of each companies and FII share of equities in the respected companies. Market capitalisation of FII in a particular company is arrived by multiplying above two variables. Then add all the companies for getting total market capitalisation of FII. Capital gain of FII is calculated by the difference between the cumulative net investments of FII from SEBI database (historical cost) and total market capitalisation of FII (March month average). FII's dividend is calculated by multiplying the variables dividend per share and FII's latest number of share holding in a company (closer to dividend date). In PROWESS database, FII share holdings are available only on quarterly basis. FII share holding are available in every quarter of financial year.

Dividend earning of FII for a financial year is the sum of quarterly dividend earning in a year. Quarterly dividend is calculated by multiplying dividend per share with FII's share holdings in that quarter[1]. Cumulative net investments of calculated with the help of SEBI database and we have used PROWESS database for calculating market capitalisation of FII. Due to the unavailability of relevant variable in PROWESS database we are not able to calculate market capitalisation, capital gain and dividend earning of FII before 2000.

From Table 1 it can be seen that, apart from capital gain, dividend earned by the FII's is more or less same throughout the study period. High dividend repatriation of $ 479.9 million have found only in 2000-01 and after that it suddenly fell down at $ 208.8 in 2001-02 and since then it is mildly fluctuating around $ 200 million.

According to RBI in 2008-09 total foreign investments (in India) repatriated dividend and profit worth $ 3168 million. As per our calculation FII account for around $ 222 million repatriation in the same year. Hence we can argue that FII cause around 14% in the total dividend repatriation from India in that particular year. In 2005-06, share of dividend by FII is only 10% which is increased to 14% in 2006-07. FII are active traders in the stock market for whom dividend matters little where as capital gain seems to be most important attraction for them.

From Table 1, it is clear that FII earns substantial capital gain from Indian stock market especially from 2003-04 onwards. However, between 2000-01 and 2002-03, it was negative that means their total

Table 1: Foreign Portfolio Investment and its effect on Balance of Payments (values are in millions of US $)

Year (1)	Gross purchase (2)	Gross sales (3)	Net investment (4)	Cumulative Net investment (5)	FII's market capitalization (market value)	Capital gain (7)=(5- 6)	Dividend (8)
1992-93	6	1	4	4	NA	NA	NA
1993-94	1783	149	1635	1639	NA	NA	NA
1994-95	2430	903	1528	3166	NA	NA	NA
1995-96	2898	823	2075	5242	NA	NA	NA
1996-97	4381	1966	2416	7657	NA	NA	NA
1997-98	5030	3427	1603	9260	NA	NA	NA
1998-99	3831	4207	-377	8884	NA	NA	NA
1999-00	13121	10785	2336	11220	NA	NA	NA
2000-01	16209	14035	2175	13394	12785	-609	480
2001-02	10467	8631	1836	15230	12948	-2282	209
2002-03	9724	9169	555	15786	11930	-3856	215
2003-04	31524	21565	9959	25745	32975	7230	235
2004-05	48285	38074	10211	35956	51942	15986	233
2005-06	78372	69006	9366	45322	101906	56584	229
2006-07	114941	108130	6810	52132	121247	69114	234
2007-08	235586	219140	16445	68578	193002	124424	255
2008-09	132287	141957	-9671	58907	72868	13961	222

Source: Computed from SEBI database, PROWESS database (CMIE)
Note: First five columns are calculated from SEBI database and column six, seven, eight are calculated with the help of PROWESS data base database (CMIE). All the values in the tables are first calculated in Rupees and then converted into Dollar the using implicit exchange rate.

market value of shares was lower than the cumulative stock in those years. FII had only $ 7.2 billion worth of capital gain in 2003-04, but it is increased to very high at $ 124.4 billion in 2007-08 and suddenly declined to $ 13 billion in the end of 2008-09 due to global economic crisis. Whole of the capital gain of FII cannot be considered as a cost on BoP, because it would became cost in BoP only when it is repatriated from India. With the available data it is difficult to assess how much capital gain is repatriated from India. Increase in the amount of portfolio outflows in recent years may be a significant evidence for their repatriation of this huge amount of capital gain. For instance, the ratio of gross sales to gross purchase of FII was only about 0.68 in 2003-04. Since then, this ratio is dramatically increasing and it reached very high at 0.93 in 2007-08. Thus, large outflows of FII starting from 2003-04 might have reflecting the repatriation of high capital gain from India. However capital gain and its repatriation are not recorded in the current account, but it would affect only in the capital account and reserve account of BoP[2]. Capital gain and its repatriation of FII could have reduced that much of capital account surplus through FII outflows, therefore it consequently reduce that much of foreign exchange reserve. However, it can be concluded that financing with these forms of foreign investment have not only made instable BoP[3], but also they are exerting huge cost on BoP through capital gain repatriation. But interestingly, this repatriation is seems to be an 'invisible'

element in BoP. Invisible element here means no one can measure the exact amount they repatriated from India.

3. Capital Gain of FII in India, a recent experience

Though there are evidences of repatriating capital gain of FII, but it is difficult to measure the exact amount repatriated and remains as 'invisible' in BoP. Foreign investors cause around $ 15 billion net outflow in financial year 2008-09 and it is one of the major factors responsible for the low capital account surplus in that year whereas in the previous financial year they created net inflows worth $ 20 billion. Why this much of net FII outflows occurred in the year 2008-09?

Quarterly data shows that FII had been continuously showing net outflows in the five successive quarters, in which occurrence of net outflows started from the last quarter of 2007-08 and continues in the entire quarter of 2008-09. The global economic crisis severely affected the third and fourth quarter of 2008-09. Nevertheless, the cumulative sum of net outflows in the fourth quarter of 2007-08 and the first quarters of 2008-09 is at $ 9.3 billion. This is slightly higher than the sum of cumulative net outflows of FII in the last two quarters of 2008-09, in which it caused only at $ 8.4 billion. Sum of net outflows of FII in the last two quarters of 2008-09 occurred in the peak stage of global economic crisis[4] but this period's net outflow seems to be low when we compare sum of net outflows in the last quarter of 2007-08 and the first quarter

Table 2 : Share holding of FII in Bombay Stock Exchange
(Number of shares are in Crores)

Last quarter of financial year	A	B	T	S	TS	Z	Total
2000-01	181.2	33.2	8.4	0.5	0.3	2.3	225.9
2001-02	196.2	31.7	6.2	0.5	0.1	2.7	237.3
2002-03	223.5	34.7	11	0.8	0.2	2.4	272.5
2003-04	360.3	67.5	10.8	1.6	0.3	2.2	442.7
2004-05	566.6	102	12	6	0.6	1.8	688.9
2005-06	961.4	216.6	18.5	17	2	2.1	1217.6
2006-07	1130.7	341.4	35.6	28.5	5.5	1.2	1542.8
2007-08	1341.5	438.5	46.4	50.2	8.3	0.6	1885.5
2008-09	1188.1	382.7	38.2	51.9	38.1	0.4	1699.6

Source: Computed from PROWESS database (CMIE)
Note: share holding of FII measured in the last quarter of every financial (Jan to Mar) year

of 2008-09.In India, there has been high amount of net investment of FII occurred during the first three quarter of 2007-08 which helped the SENSEX to rise above magical figure of 20000 Points[5]. Definitely, capital gain of FII could be very higher in that period. Since then, due to world economic slowdown, FII became a net seller in the market for the five successive quarters (from fourth quarter of 2007-08 and all the quarters of 2008-09) and expect that they repatriated a miniscule amount of huge capital gain they had in the stock market.

Certainly one can ask the question why this much of outflow in the entire quarter of 2008-09 and the last quarters of 2007-08. The heavy

capital gain of FII could be the main reason for such heavy outflows. When there is an uncertainty especially at the time of having high capital gain, they probably have the mentality to sell their share and if they do so, they would get more amount per share than it purchased. Consequently, at the time of having high capital gain of FII, outflow would be more than expected.

Interestingly, most of the FII investment has been concentrating in blue chip shares[6]. For instance, in Bombay Stock Exchange there are six categories of shares namely A, B, T, S, TS, and Z[7]. However, FII investment mostly concentrating around A group shares, in which A group consist of 200 companies. Not only the FII investment is concentrated on A group shares, but also most of their significant market capitalisation are also belong to this group (See Table 3)

In the case of FII, we have seen that gross sales were very higher than gross purchase in the five successive quarters, especially from the last quarters of 2007-08 to last quarters of 2008-09. Sum of the net outflows in all the five quarters is equal to $19 billion, out of which 2008-09 financial year alone contribute $15 billion. Thus one could probably expect that the total number of shares holded by FII in the end of 2008-09 would be probably very lower than the share they had hold in the end of 2007-08. This expectation is because for large FII outflows normally they have to sell large number of shares. We can test this hypothesis by analyzing share holding of FII in Bombay stock exchange.

Table 3: FII market capitalisation in different company categories in BSE (Values are in Rs Crores)

BSE							
Years	**A**	**B**	**T**	**S**	**TS**	**Z**	**Total**
2000-01	52099 (89)	5961(10)	322	20	6	1	58409
2001-02	56720 (92)	4826 (8)	168	14	1	21	61750
2002-03	53529 (93)	3973 (7)	171	44	2	16	57735
2003-04	140088 (93)	10712(7)	456	256	9	2	151524
2004-05	211469 (91)	20002(9)	950	901	59	0	233382
2005-06	393919 (87)	50849 (11)	2072	4048	286	2	451175
2006-07	478002 (87)	59278 (11)	2942	7883	959	1	549065
2007-08	687396 (89)	74447 (10)	3276	10545	994	1	776658
2008-09	312746 (94)	18397 (6)	555	2611	157	0	334465

Source: Computed from PROWESS database, (CMIE)
Notes: Values in the bracket Indicate Percentage share to the Total

FII hold 1699.5 Crores of shares in Bombay Stock Exchange at the end of 2008-09 financial years which shows only a marginal reduction worth 185.9 Crore of shares as compared to the end of previous financial year (2007-08), in which they hold 1885.5 Crores of shares. FII investments are concentrated in A group shares but this group also bears the substantial share in the market capitalisation of FII (See Table 3). But A group shares shows only a reduction in the holding of 153.3 Crores shares in 2008-09 as compare to the end of last financial year (See Table.2). Put it differently, FII have 1188.1 Crores of A group shares in 2008-09 as compared to 1341.5 Crores of share in 2007-08. How the net sales of 153.3 Crores of A group shares can create that much of outflow? Definitely, high capital gain could be the main reason behind the

heavy net outflow of FII. At the time of selling the shares, high capital gain allows the FII to get a higher price for every shares than it purchased. Therefore selling few number of A group share can also make huge outflow from India. Interestingly, other small categories like TS and S, they actually increase their share holding at the end of 2008-09 as compared to the end of previous financial year that again strengthen our argument (See Table 2).

4. FII share of market capitalisation in BSE

FII had $ 124.2 billion worth of capital gain at the end of 2007-08, due to the effect of global economic crisis it got reduced to only $ 13.9 billion in 2008-09. However FII net outflow in 2008-09 was $ 15 billion seems to be very low in relation to the large fall in the capital gain of FII. In other words they were not able to repatriate full amount of capital gain they had in the market. Despite a huge net outflow of FII in 2008-09, having $ 13 billion worth capital gain of FII in the end of 2008-09 found to be interesting. Thus we can argue that in 2008-09, they have had a further more potential for net outflows than they did in that year. Due to the heavy net sales of shares, market capitalisation of BSE is greatly reduced at the end of 2008-09. However, even after the heavy net sales of FII in Indian stock market in 2008-09, FII's share in the total market capitalisation of BSE was at 11% in the end of 2008-09 and this share of market capitalisation of FII is even higher than 2002-03 (See Table 4).

Table 4: FII share in the market capitalisation of BSE
(Values are in Rs Crore)

Year	FII market capitalisation	BSE market capitalisation (March end)	FII share of market capitalisation (%)
2000-01	58409	571553	10
2001-02	61750	612224	10
2002-03	57735	572198	10
2003-04	151524	1201207	13
2004-05	233382	1698428	14
2005-06	451175	3022191	15
2006-07	549065	3545041	15
2007-08	776658	5138015	15
2008-09	334465	3086076	11

Source: Computed from RBI (2009a), PROWESS database (CMIE)

5. Conclusion

To conclude with the available evidence, we can argue that capital gain and its repatriation of FII are very high in India. However high FII outflows as a result of capital gain can affect only the capital account and reserve account of BoP. But capital gains and its repatriation have any effect on current account of BoP because it is not recorded in the current account of BoP. Again the stock market started booming in the initial stage of 2009-10 and trend seems that it would go back to pre crisis levels.

However the situation of uncertainty prevails at any time, in that occasion outflow would be many times higher than it were in the recent past.

There has been an accepted view among the academicians and policy makers that, shift in BoP financing from debt to non debt flows is expected to remove the vulnerabilities in India's BoP. Due to the more dependence of non debt flows, cost of financing BoP is expected to be reduced in the liberalisation period. However the 'years of achievement' of financing BoP with foreign investment in post liberalisation period is mainly due to the contribution from FPI part of foreign investment.

As oppose to the expectation, financing BoP with foreign investment has exerted huge cost on BoP. For measuring the cost of financing BoP with non debt flows we looked for both FDI and FPI. Dividend and capital gain are found to be two cost of FPI on BoP, in which latter would considered as a cost in BoP only if it is repatriated from India. As oppose to dividend earning, FPI earns huge capital gain from India. For FPI, they are not only making huge capital gain from India, moreover there is significant evidence for repatriation. However capital gain and its repatriation would not affect current account of BoP. But capital gain and its repatriation would increase FPI out flows and therefore it would reduce capital account surplus and in turn it would reduce our foreign exchange reserves. Evidence shows that high capital gain of FII would create high FII outflows from especially at the time of uncertainty. When there is an uncertainty at the time of having high capital gain, they probably have the mentality to sell their share and if they do so, they would get more amount

per share than it was purchased. Consequently, at the time of having high capital gain of FII, outflow would be more than expected. And this is what happened in 2008-09 financial year, due to global economic crisis FPI created $ 15 billion worth net outflows.

End Notes

[1]FII share holdings are available only in quarters, so we use latest quarterly share holding of FII closer to dividend announcement date.

[2]Balance of Payment manual 5th edition considered holding of capital gain and losses are not classified as income on investment. Hence it would not record in the current account of Balance of Payment. But all the realized holding gains and losses arising from the transaction are included in capital account

[3]Instable BoP means, for any uncertainty it can go of the country and would make pressure in BoP. Two times it is happened. One situation is happened at the time of Asian Financial crisis and second is happened at the time of Global economic Crisis. In the second time management of BoP became a difficult task in India due to outflow of capital flows particularly FII

[4]After the Lehman brother filed for bankruptcy

[5]BSE Sensex or Bombay Stock Exchange Sensitive Index (SENSEX) is a value weighted index composed of 30 stocks that started January 1, 1986. The Sensex is regarded as the pulse of the domestic markets. It consists of the 30 largest and most actively traded stocks, representative of various sectors, on the Bombay stock exchange. These companies account for around fifty per cent of the market capitalisation of the BSE. The base value of the sensex is 100 on April 1 1979, and the base year of SESEX is 1978-79. The index has increased by over ten times from June 1990 to the present. The Sensex on February 6, 2006 touched 10,003 and crossed 20,000 mark in October 29, 2007and reached its ever time peaks at 21078 in January 8, 2008.

[6]A blue chip shares means shares of a well-established company having stable earnings, no extensive liabilities and having less chance of capital lose to the shareholders. Blue chip stocks pay regular dividends, even when business is faring worse than usual. In Bombay Stock Exchange, blue chips shares are belong to 'A' group categories of shares.

[7]The Bombay Stock Exchange (BSE), India's leading stock exchange, has classified Equity scripts into categories A, B, S, T, TS, & Z to provide guidance to the investors. The classification is on the basis of several factors like market capitalisation, trading volumes and numbers, track records, profits, dividends, shareholding patterns, and some

qualitative aspects. Group A is the most tracked class of scripts consisting of about 200 scripts. Market capitalisation is one key factor in deciding which scrip should be classified in Group A.

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IMPACT OF TOURISM ON ENVIRONMENT: RESPONDING TO GLOBAL CHALLENGES

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ABSTRACT

Tourism is one of the world's biggest and fastest growing industries. It constitutes the major source of income for many regions including those in emerging countries. The environmental and economic risks arising out of climate change have raised serious concern among nations across the globe .At the same time there exists a twofold relationship between tourism and climate change. Climate is the principal resource for tourism industry and more interestingly tourism itself accounts for many of these climatic and environmental issues. This sector is a non-negligible contributor to climate change especially through Green House Gas Emissions (GHG Emissions) and to the issues like depletion of natural resources, environmental pollution and also the physical impacts on nature like degradation of ecosystem. Tourism sector can play a significant role in addressing global environmental challenges, if the

innovativeness and resources of this sector is fully mobilized and oriented towards this common goal.

In this paper the author makes a serious effort to evaluate the challenges posed by tourism on environment. The study also looks in to the various mitigation measures that can be adopted by the tourism industries across the world to reduce GHG emissions as well as to reduce the negative impacts on environment. Strategies that can be taken by tourism industry for facing the challenges put forth by climate change are part of the study. The concept of "sustainable tourism" is the focus of this paper.

Key Words: Tourism, Environmental Challenges, Climate Change, Green House Gas Emissions, Global Challenges.

1. Introduction

At present, tourism is one of the largest and fastest growing sectors in the world. Its massive growth combined with huge volumes of foreign currency inflows positively contribute to the social and economic development of an economy as a whole. Recent statistics on tourism reveals that more than 15% of the world's incomes are being generated by this sector and employs almost one tenth of the world's workforce. According to Pacific Asia Travel association (PATA) tourism forecasts of 2011-2013, international tourist arrivals to India will exceed 8 million and it is expected to cross 6.3 million by 2013. The report also quotes India, China and Thailand as the largest outbound travel markets in the Asia-Pacific region. India is expected to have 40 million foreign tourists by

2020 generating revenue of Rs. one trillion and providing employment to 50 million people.

From the above table (Table 1) it can be observed that there has been a tremendous growth in the international tourist arrivals over the years. In 2007-08, global financial crisis had affected the tourism industry in countries like France, China, Italy and also those among the emerging nations like India, but now the industry has regained its strength and expects a considerable growth by the end of 2012-13.

Table 1

Number of Foreign Tourist Visits to all States/UTs in India, 1997-2012

Year	No. of Foreign Tourist visits (in Million) to States/UTs	Percentage Change Over Previous Year
1997	5.50	9.3
1998	5.54	0.7
1999	5.83	5.3
2000	5.89	1.1
2001	5.44	-7.8
2002	5.16	-5.1
2003	6.71	3..1
2004	8.36	24.6
2005	9.95	19.0
2006	11.74	18.0
2007	13.26	12.9
2008	14.38	8.5
2009	14.37	-0.1
2010	17.91	24.6
2011	19.50	8.9
2012	20.73	6.3

Source: India Tourism Statistics at a Glance 2012

"Climate change as well as poverty alleviation will remain central issues for the world community. Tourism is an important element in both. Government and Private sector must place increased importance on these factors in tourism development strategies and in climate and poverty strategies. They are interdependent and must be dealt with in a holistic fashion" *UNWTO Secretary-General Francesco Frangialli-2007.*

Table 2

Share of Top 10 countries of the World and India in International Tourism Receipts in 2012

Rank	Country	International Tourism Receips(P) in US $ billion	Percentage (%) Share
1	USA	128.6	11.96
2	Spain	55.9	5.20
3	France	53.7	5.00
4	China	50.0	4.65
5	Italy	41.2	3.83
6	Macao(China)	N.A	-
7	Germany	38.1	3.54
8	UK	36.4	3.39
9	Hong Kong(China)	31.7	2.95
10	Australia	31.5	2.93
	Total of Top 10 Countries	467.1	43.45
	India	17.7	1.61
	Others	590.2	54.94
	Total	1075.0	100.00

Source: India Tourism Statistics at a Glance 2012

The recognition of tourism's role in poverty alleviation has led to the involvement of this sector as a significant component in global development activities. By considering all these facts, tourism's actual and potential economic impact is astounding. For emerging countries like India, tourism is a significant source of foreign exchange, *a way to balance foreign trade.*

Table 2 exhibits the foreign exchange earnings of top ten tourist destinations and India's position when compared with them. For India, the share of earnings is expected to increase as per the projected figures of 2012-13.

But, while tourism provides substantial economic benefits for many countries, there are also a number of negative impacts of this rapid expansion. There has been an increased risk of environment pollution and depletion of natural resources. Besides this health hazards are a major area of concern.

In this paper the author makes a serious effort to evaluate the challenges posed by tourism on environment. The study also focuses on the various mitigation measures that can be adopted by the tourism industries across the world to reduce green house gas emissions and other negative impacts on environment. Formulating various strategies that can be used by tourism industry for facing the challenges put forth by climate change is part of the study.

2. Tourism and the Environment

Growth of tourism activities has resulted in unnecessary pressure on natural resources. Negative impact of tourism on environment results from greater use of the existing resources than the actual capability of the

nature. The exploitation of natural resources exceeds the conservation of the same. Uncontrolled tourism is threat to a country's natural resources. Negative environmental impacts of tourism can be clubbed under three broad categories:

- Pollution
- Depletion of Natural Resources
- Physical Impacts

Tourism involves movement of people to various destinations and account for more than 40% of traffic movement across the globe. This leads to considerable increase in transportation by air, rail and road .Air travel itself is a major contributor of green house gas emissions. Ozone layer situated in the upper atmosphere, protects life on earth by absorbing the harmful wavelengths of the sun's ultraviolet radiation. Ozone depleting substances (ODSs) will cause destruction of this layer. Tourism industry as a whole contributes to a greater extent in emission of such

Table 3

Emission from Global Tourism in 2010

	CO_2 (Mt)
Air Transport	617
Other Transport	568
Accommodation	374
Other Activities	465
Total	2,024

Source: UNWTO-WMO 2010

ODSs through various construction activities and by refrigerators, air conditioners and propellants in aerosol spray cans which are widely used in hotel and tourism industry.Waste disposal is a major problem in areas where there is higher concentration of tourist activities and improper waste disposal can be the major despoiler of natural resources especially water. Aesthetic pollution is becoming one of the major threats to nature because of improper planning and use of land.

In many cases, tourism has led to the increase in consumption of scarce resources like water especially fresh water, resources like energy and food causing a threat to the local community living in these places. It has also resulted in direct and indirect impact on land resources like forests, wildlife, fossil fuels through the use of land for providing accommodation and other infrastructure developments.

Physical impacts are the results of continuous conventional tourism activities in an area. The results of such impacts are land degradation, loss of wild life habitats and deterioration of scenic beauty. It also includes severe problems like change in species composition, loss of ground cover, and decrease in air and water permeability.

However, tourism is just one economic activity among many, so it is very difficult to quantify its real impact on the environment.

3. Climate Change: Mitigation Measures

Climate change mitigation relates to reducing green house gas emissions as a result of sustainable technological, economic and socio-cultural changes. Four major mitigation strategies for reducing GHG emissions are: reducing energy use, improving energy efficiency,

increasing the use of renewable energy and sequestering carbon through sinks.

Adaptation is a process by which strategies that aim to moderate, cope with and take advantage of the consequences of climate events are enhanced, developed and implemented (UNDP 2004). The success of all adaptation measures can be ensured only if those at risk are actively involved in the process. Moreover, it will be most effective if it is place-based and taken in local context.

Global climate change is only at its nascent stage. Its intensity will be different for different tourism destinations around the world. "Given that climate change is expected to pose an increasing threat to tourism operations in many destinations, WMO urges governments and the private sector to increasingly use climate information and to take additional steps towards incorporating climate considerations in tourism policies, development and management plans."(WMO Secretary General, M. Michel Jarraud , 2009)

All these, when put together, focus towards a single objective: modern trends in tourism industry should be emphasizing more and more on nature conservation and protection of natural habitats, by minimizing the harmful impacts on environment. **"***Sustainable Tourism***"** should be the focus in future. Sustainability principles refer to environmental, economic and socio-cultural aspects of tourism development, and a suitable balance must be established between these three dimensions to guarantee its long-term sustainability.

Sustainable tourism aims at:

- Optimal use of available resources

- Preserving the cultural heritage and traditional values of host communities
- Helping in poverty alleviation and overall development of the respective regions
- Seeking active participation of all stake holders

4. Ecotourism and Sustainability

Ecotourism is nature-based tourism and is aimed at conserving the environment .It gives greater importance to the well-being of the local people by inviting active participation from them in various tourism related activities. It respects social and cultural tradition. Ecotourism also concentrates on rural development. It's most important objective is to achieve a balance between nature and human beings and ensure sustainable co-existence of both. Sustainable tourism always stresses on conserving the ecosystem and biodiversity. It supports and protects the heritage of host localities by promoting an effective management of environmental systems and also helping in reducing energy consumptions and environmental pollution.

The mantra of ecotourism is a combination of all these factors and now it has become an unavoidable ingredient of sustainable tourism. It concentrates on environmentally sustainable, economically viable and socially acceptable tourism development.

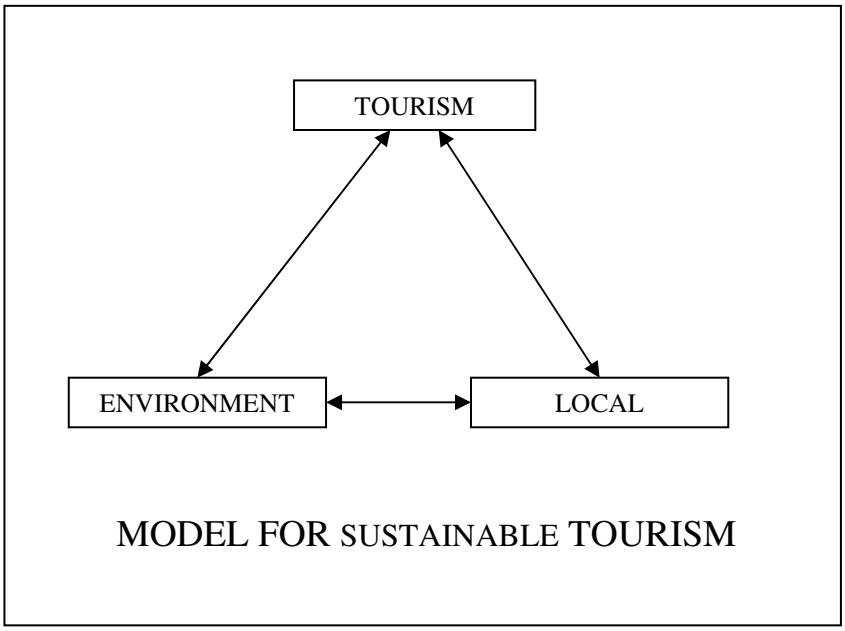
5. Conclusion

Tourism always has an acceptance level higher than other industrial production because it is environmentally friendlier. However,

mass-tourism in an area leads to over consumption, pollution and scarcity of resources in the host locality. To prevent this situation which has negative impacts on the local society it is always good to spread the concept of "*Responsible Tourism*"(RT) as a feasible solution. Responsible tourism is all about people taking responsibility for making tourism more sustainable for all stake holders. Tourism products with RT tag actively encourage local flavour, giving due respect for local people and their heritage.

The below given (Figure 1) is a model proposed by this study for a sustainable tourism in the current scenario taking care of the future generations. All three elements in the model will have to co-exist in an effort to reduce the negative impacts of tourism on environment. Every

Fig.1 Model for sustainable Tourism



locality has its bearing capacity. If tourism tries to protect that limit it will result in sustainable use of resources and in return the industry can generate economic benefits. Making local community play an active role in all tourism activities can help tourism industry in better understanding of local culture and traditions and in preserving these in the due course of tourism development. Local communities also benefit through tourism development by upgrading their living standards without causing any imbalance in their current eco system.

It is very difficult for any industry like tourism to make profit without having any negative impacts on the environment. But such impacts can be reduced to the least possible level if the industry tries to understand the characteristics of the host location and seek the participation of local community in all tourism development activities.

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A STUDY ON THE PERFORMANCE EVALUATION OF SELECTED TOP 10 OPEN ENDED MUTUAL FUNDS WITH JENSEN INDEX

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ABSTRACT

Investing for future financial security is a top priority for people in emerging countries like India. Mutual Funds offer professional investment management for such investors to beat the adverse market conditions. However it is important that we analyse factors like risk and return associated with a particular fund, the fees, charges and net return of the fund in order to achieve the desired result of safe and profitable investment. With this objective in mind the researcher has analysed top ten funds in mutual fund industry .An investor needs to be smart who is aware of the changes in the market conditions for taking wise investment decisions.

Key words: Jensen Index, Mutual Fund Industry, Open Ended Fund

1. Introduction

Mutual fund is a mechanism for pooling the resources by issuing units to the investors and investing funds in securities in accordance with objectives as disclosed in offer document. In other words mutual fund

is a form of collective investment. It is formed by the coming together of a number of investors who transfers their surplus funds to a professionally qualified organization to manage it. They are institutions who collect money from several sources-individuals or institutions by issuing 'units', and invest them on their behalf with predetermined investment objectives & manage the same for a fee.

2. Review of Literature

A number of studies have been done on mutual fund, its different schemes and performance evaluation in India and around the world. Some of the studies are listed below:

a. Dr.Sandeep Bansali, Dr. Surendar Kumar Gupta (2012), studied about the dividend mutual funds with Jensen alpha model. For that they selected 10 randomly selected dividend mutual funds for the period of 4 years from May 2005 to April 2009 on monthly basis and calculated their NAV. They found that 70% of selected mutual schemes have been performed negatively and only three out of ten dividend mutual funds got positive value.

b. Sanjay Sehgal, Manoj Jhanwar (2008), they evaluated the performance of selected equity based mutual funds in India. To study the performance they have selected Jensen model to find the stock selection and the market timing, it refers to the dynamic allocation of capital between broad classes. To evaluate the best market timing model they gone through different models i.e. from Treynor & Mazuy regression to TM model.

Data comprise of dividend adjusted NAV for 60 mutual funds from Jan 2000 to Dec 2004. The result of the study was the performance of fund can be more positive if we selected high frequency data such as daily returns other than monthly or annual returns.

c. Dr. Saritha Bahl, Meenakshi Rani(2012), they investigates the performance of 29 open ended, growth oriented equity schemes for the period from April 2005 to March 2011(6 years) of transition economy. Monthly NAV of different schemes have been used to calculate the returns from the fund schemes. BSE Sensex has been used for market portfolio. The historical performances of the selected schemes were evaluated on the basis of Sharpe, Treynor and Jensen measure. The study revealed that out of 29 samples mutual funds had outperformed the benchmark return. The result also showed that some of the schemes had unperformed, which shows a diversification problem. In the study, the Sharpe ratio was positive for all the schemes which showed that funds were providing returns greater than risk free rate. Results of the Jensen measure revealed that 19 out of 29 schemes were showed positive alpha which indicated superior performance of the schemes.

d. Athya Swaroop Debasish (2009), The author studied the performance of selected schemes of mutual funds based on risk-return relationship model and measures a total of 23 schemes offered by six private sector mutual funds and three public sector mutual funds have been studied over the time period April 1996 to

March 2009 (13 years). The analysis has been made on the basis of mean return, beta risk, co-efficient of determination, Sharpe ratio, Treynor ratio and Jensen alpha. The overall analysis finds Franklin Templeton and UTI being the best performers and Birla Sun Life, HDFC and LIC mutual funds showing poor below average performance when measured against the risk-return relationship models.

3. Objectives of the Study

The present study is concerned with the following objectives:

a. To evaluate the performance of top ten open ended mutual funds in India

b. To make a comparison of the performance of mutual funds

Research Methodology

To analyse the performance of mutual funds; 10 top listed open-ended mutual funds were selected as the sample and they were analysed with Jensen performance measure. All the data related with these mutual funds were secondary information collected from website for the period of three years (April 2009 to March 2012) on annual basis.

4. Data for the Study

Based on the first objective the following top 10 mutual funds were selected for the study:

ICICI Prudential banking & Financial Services fund, Reliance Media & Entertainment, SBI Magnum Sector Funds Umbrella – FMCG, SBI

Table.1

Performance Evaluation of Mutual Funds with Jensen Index & Beta

SL. NO:	Mutual Fund	Beta	(Jensen index) Alpha (%)	Rank
1	ICICI Prudential Bank	.94	4.78	4
2	Reliance Media & Entertainment	.79	10.37	3
3	SBI Magnum - FMCG	.89	-7.3	10
4	SBI Magnum – Emerg Buss Fund	.74	14.19	1
5	Reliance Banking fund	.93	12.61	2
6	Religare Banking	89	3.14	5
7	G S Bank	1.01	1.23	7
8	Principal Emerging Blue Chip	.90	-1.78	9
9	UTI Banking	1.02	.75	8
10	Reliance Shares Banking Exchange Traded	.99	1.69	6

Beta shows the portfolio risk in relation to the market as a whole. A beta of 'less than 1' means that the fund returns are less volatile compared to the broader market. A beta of 'more than 1' means the fund returns is more volatile than the broader market. A beta 'equal to 1' means that fund's volatility is in line with the broader market.

Magnum Sector Funds, Umbrella-Emerg Buss Fund, Reliance Banking Fund, Religare Banking, Principal Emerging Blue Chip, UTI Banking, and Reliance Shares Banking Exchange Traded.

Based on the second objective the performance evaluation of the above said funds were made with the help of Jensen Index. The formula for the Jensen Index is as follows:

$$\alpha_J = R_i - [R_f + \beta_{iM} \cdot (R_M - R_f)]$$

Jensen index or alpha = Portfolio Return - [Risk-free Return + Beta Measurement * (Market Return - Risk-free Return)].

- A high Jensen index suggests a high level of return given the level of risk (systematic or market) on the investment. A low Jensen index, such as a negative number, indicates inferior performance when compared to the risk. It is also called Jensen's alpha or Jensen's measure
- The terms used in the formula are:
- Portfolio return (Ri)– the return received from the portfolio on an annual basis
- Risk free return (Rf)- it is taken as treasury bill rate for 365 days
- Market return (Rm)– the average return on annual basis
- Beta measurement (β)– systematic risk of the portfolio

$$\beta = \frac{n * \varepsilon xy - \varepsilon x * \varepsilon y}{n * \varepsilon x^2 - (\varepsilon x)^2}$$

where, 'n' is the number of year, 'x' is the market return, 'y' is the

portfolio return Table no: 1 depicts that, the G S Bank (1.01) and UTI Banking mutual fund (1.02) have Beta value 'more than 1'. It means that the fund returns from these two mutual funds are more volatile to the broader market.

The Beta value of other mutual funds like ICICI Prudential Bank (.94), Reliance Banking fund (.93),Reliance Shares Banking Exchange Traded (.99),Principal Emerging Blue Chip (.90) are near to '1'.So their funds are also volatile to the broader market.

The other mutual funds are less volatile compare with the above funds; they are Reliance Media & Entertainment (.79), SBI Magnum – FMCG (.89), SBI Magnum – Emerg Buss Fund (.74), Religare Banking (.89).

A high Jensen index or alpha suggests a high level of return given the level of risk (systematic or market) on the investment. A low Jensen index, such as a negative number, indicates inferior performance when compared to the risk. A high rate of Alpha is preferred.

In the above table based on the alpha rank has given to each funds SBI Magnum- Emerge Buss Fund (14.9%) has ranked first, Second goes to Reliance Banking Fund (12.61%), Third & fourth for Reliance Media & Entertainment (10.37%), ICICI Prudential Bank (4.78%), Fifth and sixth position by Religare Banking (3.14%), Reliance Shares Banking Exchange Traded (1.69%), 7th by G S Bank(1.23%), 8 th by UTI Banking(.75%) and Nineth & tenth by Principal Emerging Blue Chip (-1.78%) and SBI Magnum- FMCG (-7.3%)

5. Conclusion

By considering Jensen index SBI Magnum – Emerge Buss Fund has the highest index and its performance is considered as superior and SBI Magnum – FMCG and Principal Emerging Blue Chip Funds, index became negative and they are treated as the lowest performance funds in this sample. This performance has been evaluated by considering the systematic risk of each fund. It's true that mutual funds are volatile in nature and its return is subjected to market risk. But if you are a smart investor and are also quite aware of the well-performing MF in the market, then investment not only becomes easy but also profitable and risk free.

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AN ANALYTICAL REVIEW OF RISING TREND IN INDIAN CAPITAL MARKET

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ABSTRACT

With the automation and liberalization of the Indian stock markets, there has been a perceptible change in the Indian Stock Market towards the later part of the 1990s. Trading system in Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) has reached global standards. It has created a nationwide trading system that provides equal access to all investors irrespective of geographical location, creating an equality among investors. With the introduction of advanced practices, transparency has also increased in the stock market. With the financial sector reforms initiated in 1991, not only FIIs and NRIs are allowed to invest in Indian stock markets, Indian corporate have been allowed to tap the global market with global depository receipts (GDR), American depository receipts (ADR) and foreign currency convertible bonds (FCCB) since 1993. All these changes have led to substantial

improvement in market capitalization, liquidity and efficiency of the Indian capital market. This paper aims to analyse the growth trend depicted by the Indian Capital Market over the past decade.

Key words: Development of market, Efficiency, Indian capital market.

1. Introduction

The capital market is the barometer of any country's economy and provides a mechanism for capital formation. Across the world there was a transformation in the financial intermediation from a credit based financial system to a capital market based system which was partly due to a shift in financial policies from financial repression (credit controls and other modes of primary sector promotion) to financial liberalization. This led to an increasing significance of capital markets in the allocation of financial resources.

The Indian capital market also went through a major transformation after 1992 and the Sensex is hovering around the 19000 mark by the year 2013, which seemed a dream just a few years back, although the beginning of such an initiative could be seen since the second half of 1980's. Since then the market has been growing in leaps and bounds and has aroused the interests of the investors. The reason for such a development was an increasing uncertainty caused due to liberalization and standardization of the prudential requirements of the banking sector for global integration of the Indian financial system. Further,

rise in their non-performing assets led to a decrease in credit from banks to the commercial sector. Liberalization and opening of the gates led to an expansion of three broad channels of financing the private sector namely, a) Domestic capital market b) International capital market (American depository receipts and global depository receipts) and c) Foreign direct investment.

Capital markets play a vital role in channelising the savings of individuals for investment in economic development in country. The investors are not constrained by their individual abilities but by the abilities of the companies which in turn enhance the savings and investment in the country. Liquidity of capital market is an important factor affecting the growth. Since projects require long term finance, but on the other hand investors may not like to relinquish the control over their savings for a long time. A liquid stock market ensures a quick exit without incurring heavy losses or cost. Thus the development of efficient capital market is essential for encouraging investment and economic growth. The Indian Equity market and Debt market together form the Indian Capital Market.

The efficiency of a capital market which can be defined in terms of its ability to reflect the impact of all relevant information in the prices of the securities and the large number of profit driven individuals who act dependently on one another grew tremendously in the Indian context Statement of Problem A developed securities market enables all individuals, no matter how limited their means, to share the increased wealth provided by competitive private enterprise (Jenkins 1991). The players involved in the capital market include small investors, mutual

funds, banks, companies and financial institutions. Equity trading in India was dominated by floor– based trading.

It was not possible for investors to crosscheck these prices. Investors were forced to pay high brokerage fees to undercapitalized individual brokers, who had primitive order processing systems. Gupta (1992) concludes that a) Indian stock market is highly speculative, b) Indian investors are dissatisfied with the services provided to them by the brokers, c) margins levied by the stock exchanges are inadequate and d) liquidity in a large number of stocks in Indian markets is very low. This situation was transformed by the arrival of the new National Stock Exchange (NSE) in 1994. A consortium of government–owned financial institutions, owned NSE. NSE built an electronic order– matching system, where computers matched orders without human intervention. It used satellite communications to make this trading system accessible from locations all over the country. Trading in equities commenced at NSE in November 1994. From October 1995 onwards (11 months after commencement), NSE has been India's largest exchange.

With the objectives of improving market efficiency, enhancing transparency, preventing unfair trade practices and bringing the Indian market up to international standards, a package of reforms consisting of measures to liberalise, regulate and develop the securities market was introduced in the 1990s. The secondary market overcame the geographical barriers by moving to screen based trading, which made trading system accessible to everybody anywhere in the Indian sub-continent. Indian disclosure and accounting standards are as modern, updated, potent and versatile as those of any other market. Today, the

Indian securities market stands shoulder to shoulder with most developed markets in North America, Western Europe and Far East.

There are few other parallels to this episode internationally, where a second exchange displaced the entrenched liquidity on an existing market within a year (Shah & Thomas 2000). The removal of License Raj especially in areas related to private sector financing options, led to a direct increase in market based financing of industrial investments through an expansion in three broad channels, FDI, Global depository receipts (GDR's) in the international market and the last being the Capital market which consists of the secondary market and the new issue market. One important factor that led to the growth of the new issue market was the growing significance of financial assets, with increase in the saving rate and monetisation of the economy. Recently the government and SEBI have initiated a number of healthy measures to develop the capital market.

The present paper makes an attempt to analyse the growth trend depicted by the Indian Stock Market with the help of parameters like resource mobilisation through IPOs and rights issues, Sector wise resource mobilisation, exchange wise cash segment turnover, stock market indicators etc

2. Methodology

The study is descriptive in nature with data drawn from various secondary sources like official websites of NSE, SEBI, RBI and other related literature. The variable adopted for the study are number of IPO and rights issues that have come up, for resource mobilization through IPOs,

Sector wise resource mobilisation, exchange wise cash segment turnover, stock market indicators like market capitalisation ratio, price earnings ratio and business growth in Whole sale Debt market etc.

3. Results and Discussions

a. Resource Mobilisation through Public and Rights Issues

Role of an efficient primary market is critical for resource mobilisation by corporate to finance their growth and expansion. Indian primary market witnessed renewed activity in terms of resource mobilisation and number of issues during 2010-11, continuing its momentum from 2009-10. In view of the recovery witnessed in equity markets post global financial crisis, companies, largely public sector with a divestment mandate, entered the primary market during 2010-11. Investors' response to public issues was encouraging in 2010-11. Capital (equity and debt) was raised to the tune of ` 67,609 crore through 91 issues during 2010-11, higher than 57,555 crore mobilised through 76 issues during 2009-10. The Table 1 given below clears the picture.

b. Sector –wise Resource Mobilisation

Sector-wise classification reveals that 77 private sector and 14 public sector issues mobilised resources through primary market during 2010-11 as compared to 70 private sector and six public sectors issues in 2009-10. These companies raised ` 67,609 crore though 91 issues in 2010-11 as compared to ` 57,555 crore through 76 issues in 2009-10. The

Table 1: Resource Mobilisation Through Public and Rights Issues

Particulars	2009-10		2010-11		% share to total amount	
	No of Issues	Amount	No of Issues	Amount	2009-10	2010-11
Public Issue	47	49,236	68	58105	85.5	85.9
Public issue (equity/PCD/FCD of which	44	46736	58	48654	81.2	72.0
IPOs	39	24696	53	35559	42.9	52.6
FPOs	5	22040	5	13095	38.3	19.4
Public issue (Bond & NCD)	3	2500	10	9451	4.3	14.0
Rights Issue	29	8319	23	9503	14.5	14.1
Total Equity Issue (1.a + 2)	73	55055	81	58157	95.7	86.0
Total Equity & Bond(1+2)	76	57555	91	67069	100	100

Source- Annual Report of RBI for 2011-'12

share of private sector in total resource mobilisation stood at 43.5 percent in 2010-11 as compared to 45.9 percent in 2009-10, consequently, the share of public sector in total resource mobilisation increased to 56.5 percent from 54.1 percent during the same period.

4. Turnover in Indian Stock Market

During 2010-11, turnover of all stock exchanges in India in the cash segment decreased by 15.1 percent to ` 46,85,034 crore from ` 55,18,469

Table 2: Sector-wise Resource Mobilisation

Sector	2009-10		2010-11		% share to total amount	
	No of Issues	Amount	No of Issues	Amount	2009-10	2010-11
Private Sector	70	26438	77	29385	45.9	43.5
Public Sector	6	31117	14	38223	54.1	56.5
Total	76	57555	91	67609	100	100

Source- Annual Report of RBI for 2011-12

crore in 2009-10 . BSE and NSE together contributed almost 100 percent of the turnover, of which NSE accounted for 76.4 percent in the total turnover in cash market whereas BSE accounted for 23.6 percent to the total. Apart from NSE and BSE, the only two stock exchanges which recorded turnover during 2010-11 were Calcutta Stock Exchange (` 2,597 crore) and UPSE (` 0.12 crore). There was no transaction on other stock exchanges.

c. Stock Market Indicators

Market Capitalisation to GDP Ratio :- The market capitalisation to GDP ratio is an important parameter for evaluation of stock markets. The liquidity of the market can be measured by the traded value to GDP ratio, i.e., value of the shares traded to GDP at current market prices. Market capitalization ratio is defined as the market capitalization of stocks divided by the GDP. It is used as a measure that denotes the importance of equity markets relative to the GDP. It is of economic significance since the

Table 3: Exchange – wise Cash Segment Turnover

Stock exchange	2009-10	2010-11	% share
BS	13,78,809	11,05,027	23.
NS	41,38,023	35,77,410	76.
Total	55,16,832	46,82,437	100

Source- Annual Report of RBI for 2011-12

Table 4: Select Ratios Relating to Stock Market

Year	BSE Market Capitalisation to GDP Ratio	NSE Market Capitalisation to GDP Ratio	Total Turnover to GDP Ratio	
			Cash segment (All – India)	Derivatives Segment (BSE +
2003-04	43.4	40.5	58.7	7
2004-05	54.3	50.7	53.4	8
2005-06	84.4	78.6	66.8	134.7
2006-07	85.5	81.2	70.0	178.9
2007-08	109.5	103.5	109.3	284.1
2008-09	55.3	51.9	69.0	197.4
2009-10	94.1	91.7	84.2	269.7
2010-11	86.8	85.1	59.5	371.3
CAGR	9.05%	9.73%		

Source- Annual Report of RBI for 2011-12

market is positively correlated with the ability to mobilize capital and diversify risk. Excluding 2008-09, since 2003-04, there has been a considerable improvement in the market capitalisation to GDP ratio. The BSE market capitalisation to GDP ratio improved from 43.4 percent in 2003-04 to 86.8 percent in 2010-11. Similarly, at NSE also the ratio increased from 40.5 percent to 85.1 percent over the same period (Table 1). The turnover to GDP ratio was the highest in 2010-11 under derivatives segment. The All-India cash turnover to GDP ratio decreased to 59.5 percent in 2010-11 from 84.2 percent in 2009-10. However, in the derivative segment, the turnover to GDP ratio increased from 269.7 percent in 2009-10 to 371.3 percent in 2010-11.

Price to Earnings Ratio :- The valuation of the shares might be gauged from the price-earning ratio. At the end of March 2011, the P/E ratio of BSE Sensex and S&P CNX Nifty were 21.2 and 22.1 respectively as compared to 21.3 and 22.3 respectively as on March 31, 2010. The P/E ratio of two major Indian indices is given in Table.5

Wholesale Debt Market :- During 2010-11, turnover in the Wholesale Debt Market (WDM) segment decreased marginally to ` 5,59,447 crore from ` 5,63,816 crore in 2009-10. Both the net traded value and average daily traded value dropped by 0.8 percent and 4.4 percent, respectively during the same period (Table 2.40). Further, the number of trades decreased to 20,383 in 2010-11 as compared to 24,069 in 2009-10. The highest turnover was recorded in May 2010 (` 73,251 crore) followed by April 2010 (` 61,824 crore) and June 2010 (` 50,143 crore).

Table 5 : Price Earnings Ratio

Year	BSE Sensex	S & P CNX Nifty
2005-06	20.9	20.3
2006-07	20.3	18.4
2007-08	20.1	20.6
2008-09	13.7	14.3
2009-10	21.3	22.3
2010-11	21.2	22.1
CAGR	0.24	1.43

Source- Annual Report of RBI for 2011-12

Number of trades was the highest at 2,555 in May, 2010 followed by 2,094 in September, 2010. Instrument-wise breakup of the securities traded at the WDM segment of NSE indicates the dominance of Government securities (G-sec) The share of the G-sec decreased to 54.5 percent in 2010-11 from 58.2 percent in 2009-10. The share of Treasury bills marginally increased from 16.5 percent in 2009-10 to 17.6 percent in 2010-11. The share of PSU/institutional bonds also rose from 15.4 percent in 2009-10 to 19.6 percent in 2010-11. However, the percentage shares of 'others' which includes mainly corporate debt securities decreased from 10.0 percent in 2009-10 to 8.3 percent in 2010-11

5. Conclusion

The Indian securities market is among the safest and the most efficient trading destinations internationally. The Indian corporate governance

Table 6

Business Growth on the Wholesale Debt Market Segment of NSE

Year	No of Trades	Net Traded Value	Average Daily Traded Value
2005-06	6189	475523	1755
2006-07	19575	219106	899
2007-08	16179	282317	1129
2008-09	16129	335950	1419
2009-10	24069	563816	2359
2010-11	20383	559447	2256
CAGR	21.98%	2.75%	

Source- Annual Report of RBI for 2011-12

code is compared to the Sarbanes Oxley Act of the USA. India has one of the fastest growing and well-developed asset management businesses in the world, with state-owned as well as private sector players. India currently is ranked third in Asia for the overall quality of corporate governance.

The Indian market is often hostage to some scam or the other from time to time. Effective enforcement of compliance is cited as one of the reasons for these unsavory episodes. While greater integration with the world economy and global financial markets have benefited India in several ways over the years, it has also made India become vulnerable to

global shocks, as evidenced by the global financial crisis of 2008. More recently, the European debt crisis and global slowdown have been posing serious challenges to the Indian economy. Global integration—the widening and intensifying of links—between high-income and developing countries has accelerated over the years. Over the past few years, the financial markets have become increasingly global. The Indian market has gained from foreign inflows through the investment of Foreign Institutional Investors (FIIs). Following the implementation of reforms in the securities industry in the past few years, Indian stock markets have stood out in the world ranking. As per Standard and Poor's Fact Book 2012, India ranked 11th in terms of market capitalization, 17th in terms of total value traded in stock exchanges, and 30th in terms of turnover ratio, as of December 2011, which in itself is a proof that the Indian Capital Market has depicted a clear picture of tremendous growth.

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