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Management of Plastics, Polymer wastes and Bio-polymers and Impact of Plastics on the Eco-system

April - June, 2008

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INSIDE

Envis
Volume 6 Issue 2 April - June, 2008

Subscription Information:
ENVIS is sent free of cost to all those interested in the information on Plastics and Environment

Name of the ENVIS Centre

INDIAN CENTRE FOR PLASTICS IN THE ENVIRONMENT

ICPE Mumbai has moved to new location

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Area of Activity

Capacity Enhancement Programme on Management of Plastics, Polymer Wastes and Bio-polymers, Impact of Plastics on Eco-System

Editorial

Wish You All A Happy Diwali and Prosperous New Year

We had made certain modifications in the design of ICPE ENVIS Newsletter in the last issue as per the guidelines of ENVIS Directorate of MoEF.

In the current issue, we have made some modifications in the contents also. We have included a Feedback Form in a common format. We have also started a new column on Data Collection. Data on various traits in areas of responsibility entrusted to ICPE would be collated and separately published in this column regularly, for the convenience of the reader.

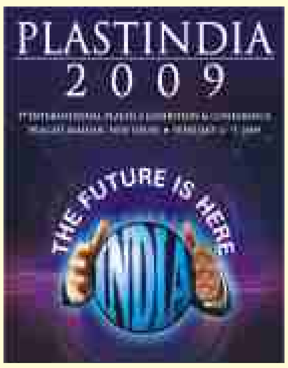
We have also been able to get articles from International Magazines in the subject area. We hope to bring more such articles on Plastics and Environment for your information.

Your suggestions and comments are welcome.

T. K. Bandopadhyay
Editor - ICPE-ENVIS Newsletter

Forthcoming Event

PLASTINDIA 2009



7th International Plastics Exhibition and Conference
February, 4 - 9, 2009
Pragati Maidan, New Delhi

For more info:
Website : www.plastindia.org

Readers are welcome to send their suggestion, contributions, articles, case studies, and new developments for publication in the Newsletter to the ICPE-ENVIS address.

For more information on ENVIS and about the contents, please contact editor.

Cover Story

Bioplastics

Bioplastics are made predominantly from renewable raw materials, and are often biodegradable and compostable.

These terms are not always connected. Products made from renewable resources do not necessarily have to be biodegradable or compostable, while some petrochemical-based polymers are certified biodegradable and compostable.

Petrochemical resources

Conventional fossil-fuel derived plastics provide excellent properties in every area of modern life. Polymers are versatile and deliver an almost unlimited array of applications. In 2005, 230 million tonnes (Mt) of plastics were consumed worldwide. Some 22 Mt of used plastics were collected, and 10.4 Mt of these were recovered (4 Mt through recycling and 6.4 Mt through energy recovery). The remaining 11.6 Mt were landfilled.

The future for these oil-based plastics seems assured. However, many of the characteristics of plastics are also the reason why they can cause environmental concerns. Conventional plastics are long-lived, they are made from finite, non-renewable resources. They have a visible presence in household waste and in litter.

Renewable resources

A 2007 report from Urban Mines for the Resource Efficiency KTN suggests that by around 2010 the total global manufacturing capacity for bioplastics may reach one million tonnes per annum. However, this will only represent around 0.5 per cent of the global plastics market at the time.

For bioplastics to become practical, they must have properties that allow them to compete with the fossil fuel-based plastics on the market; bioplastics must be capable of being made strong, resilient, flexible, elastic, and above all, durable. It is the durability of traditional plastics that has helped them in the marketplace, and has been a major goal of plastics research throughout the years.

Bioplastics owe much of their popularity to a perceived and claimed range of environmental benefits. As is often the case with environmental issues, it is never possible to declare with certainty that one material type is always preferable to another.

Petrochemical resources can be used to process, manufacture and transport bioplastics, while renewable energy is often used in the production of petrochemical plastics.

Plastics that break down

Bioplastics can be made from the natural chemicals (triglycerides) found in oilseeds such as canola, and starches, such as those found in corn, sugar beets and potatoes, or from proteins found in soybeans.

The term biodegradable means that a substance is able to be broken down into simpler substances by the activities of living organisms, and therefore is unlikely to persist in the environment.

There is a significant difference between what is merely biodegradable, and what is **compostable** and

biodegradable. Biodegradability will depend on the circumstances (eg. within a composting facility), so standard exist for what is biodegradable **and** compostable.

Where the environment cannot be controlled it is difficult to establish what is biodegradable. This has been achieved for soil through Vincotte's OK Biodegradable Soil standard which is applicable to many (but not all) climatic regions, and is relevant to mulch film.

All composting standards require compliance with four criteria:

- biodegradation
- disintegration
- heavy metals / ecotoxicity
- compost quality

Plastics from starch

Starch, a natural polymer, is a carbohydrate produced by plants during photosynthesis. Starch can be processed directly into a bioplastic but, because it is soluble in water, articles made from starch will swell and deform when exposed to moisture.

This problem can be overcome by modifying the starch, using micro-organisms to transform it into lactic acid, a monomer.

The lactic acid is chemically treated to cause the molecules to link into long chains (polymers), which bond together to form a plastic called **polylactide** (PLA).

Other materials such as Mater-Bi use restructured starch in combination with renewable, synthetic and natural polyesters to manufacture biodegradable and compostable products.

PLA can be used for products such as plant pots and disposable nappies. However, in its pure form it is not suitable for film. It has been commercially available since 1990, and certain blends have proved successful in medical implants, sutures and drug delivery systems because of their capacity to dissolve away over time.

Innocent smoothies: PLA to rPET

In 2007, drinks brand innocent opted to favour 100 per cent PET recycled plastic bottles, over the PLA bioplastic alternative. The company preferred to use waste material (recycled plastic), rather than create bottles from new (even if renewable) materials.

Plastics from bacteria

Another way of making biodegradable polymers involves manipulating bacteria to produce granules of a plastic called **polyhydroxyalkanoate** (PHA). Bacteria are grown and the plastic is then harvested. Genes can be taken from this kind of bacteria and stitched into corn plants, which then produce plastic in their own cells.

Cost

Unfortunately, as with PLA, PHA is more expensive to produce than traditional plastics. Biodegradable plastic products currently on the market are from 2 to 10 times more expensive than traditional plastics. But environmentalists argue that the cheaper price of traditional plastics does not reflect their true cost when their full impact is considered including collection and waste disposal or recycling.

In order to reduce costs, the Cooperative Research Center (CRC) for International Food Manufacture and Packaging Science in Australia is exploring ways of using basic starch, which is relatively cheap to produce, in a variety of blends with other more expensive biodegradable polymers to produce a variety of flexible and rigid plastics. These are being made into film and injection moulded products such as plastic wrapping, shopping bags, bread bags, mulch films and plant pots.

Mulch films are laid over the ground around crops, to control weed growth and retain moisture. Usually farmers use polyethylene black plastic that is pulled up after harvest and trucked away to a landfill (taking with it topsoil and humus).

Mulch film on tomato and capsicum crops have shown it performs just as well as polyethylene film, but can simply be ploughed into the ground after harvest. It's easier, cheaper and it enriches the soil with carbon.

Another biodegradable plastic product is a plant pot produced by injection moulding. Farmers can place potted plants directly in to the ground. The pots break down to carbon dioxide and water, eliminating

Petrochemical base	Manufacturer (trade name)	Application
Polyester (certain types)	BASF (Ecoflex)	Flims, mouldings
Polyester amides (Certian types)	Various	
Polyvivyl alcohol	Various	Flims
Renewable base	Manufacturer (trade name)	Application
Starch-based polymers	Novamont (MaterBi) Rodenburg (Solanyi) Plantic Technologies Bioplast (Biotec) Biop	Films,mouldings, extrusions
Polyhydroxy-alkanoates	Kaneka	Moulding
Polylactic acid (PLA)	Natureworks (PLA) Hycail	Films, mouldings
Cellulose (-acetate)	Innovia Films (NatureFlex) FKuR	Flims

double handling and recycling of conventional plastic containers.

Landfilling bioplastics

To maximise the benefit of the new bioplastics new ways will have to be found for disposing of waste, as simply substituting new plastics for old won't save space in landfills.

Bioplastics from CO_2

Novomer, a start-up US materials producer, has secured £3.3m in funding to develop bioplastics made from carbon dioxide.

The firm's catalyst technology, developed at Cornell University in New York State, uses carbon dioxide and carbon monoxide as feedstock to make biodegradable plastic materials, for use in applications including packaging, rather than the grains and plants.

There is a popular misconception that biodegradable materials break down in landfillm sites. Rubbish deposited in landfills is compressed and sealed under tonnes of soil. This restricts oxygen and moisture availability, essential requirements for microbial decomposition. For biodegradable plastics to effectively decompose they need to be treated more like compost.

Composting packaging and contents

Composting may be the key to gaining the real environmental benefit of biodegradable plastics. One of the impediments to composting organic waste is that it is often mixed with non-degradable plastic packaging and it is uneconomic to separate them.

Consequently, the mixed waste-stream ends up in landfill. If biodegradable plastics are used to package organic produce, it may be possible to set up large- scale composting facilities in which packaging and material it contains could be composted as one with the resulting compost put into plant production, growing the starch to produce more biodegradable plastics.

Standards

Biodegradable and degradable plastics must be distinguished from compostable plastics, as they have different technical definitions and lack standardisation testing.

Bioplastics include the categories of compostable and biodegradable plastics, and compostable plastics have been extensively studied.

The American Society for Testing & Materials international (ASTM) established standards for compostability (D6400-99), and stated that compostable plastics must meet at least three essential requirements:

- they must biodegrade at a rate comparable to garden and kitchen waste
- they must disintegrate, so that no large plastic fragments remain to be screened out
- they must disintegrate and biodegarde safely so

The Sydney Olympics

More than 660 tonnes of waste was generated each day at its many venues. Of this, an impressive 76 per cent was collected and recycled. Part of this success was due to the use of biodegradable plastics used in the packaging of fast food, making the composting of food scraps an economic proposition as it eliminated the need for expensive separation of packaging waste prior to processing.

Din Certo - Compostable Label

The compostable logo can be used by products that meet one of the following standards:

- European: EN 13432:2000u
- Germany: DIN V54900

DIN CERTCO, based in Germany, operates a certification scheme for compostable products made of biodegradable materials and licenses the use of the corresponding logo, which was developed by European Bioplastics. The testing certification process for a new product can take 6-8 months and can cost up to €20,000.

that the compost is able to support plant growth ("leaves no visible or detectable toxic residue")

There are now biodegradable and compostable plastic certification systems in Europe, North America and Asia:

- in Europe, there is OK Compost run by Vincotte in Belgium; DIN Certco in Germany uses European Boiplastic's Seedling logo, and the smiling apple.

There are also certification schemes / logos in Italy and Spain

- in Asia, the BPS in Japan has started the GreenPla symbol for biodegradable products
- Canadians use the Environmental Choice symbol

The same fundamental criteria are used by all bodies to evaluate products:

- conversion to carbon dioxide
- disintegration
- safety - no phytotoxicity

EN13432 is a unified European norm; a required standard in all EU member states. Din Certco/Vincotte are the main certifiers in Europe, while in the UK, The Composting Association works with Din Certco acting as the certification body. En13432 is required due to the Packaging Regulations which specify organic recovery of packaging which in turn lead to the development of the standard by CEN.

Recovery Options

Even if many bioplastics are biodegradable, they are not intended to be disposed of in nature. They must be recovered in a controlled and eco-efficient way, to ensure that they contribute neither unacceptable environment nor amenity (littering) impacts.

Bioplastics can be recovered and recycled like conventional plastics by:

- thermal recovery: using the energy content of the substance to produce heat and electricity (specific criteria to be met)
- organic recycling (composting): the resulting compost is used to improve soil quality and replace fertilisers
- chemical recycling: an option especially for polyester types (like PLA or PHA). The polymer chain can be fragmented, and resulting monomers purified and re-polymerised. Sufficient source separated collected material is a pre-condition for this method. The same arguments apply for recycling back to plastics.

However unlike conventional plastics most bioplastics types can be organically recycled by composting, provided they comply with EN 13432.

Studies show that there is no single "best" option in recovery and recycling. Ecological and economical evaluation results differ when regarding different application of plastics, even if the same resin type is regarded.

Composting is a useful and often preferred method for mulch film and biowaste bags, also for gardening articals and shopping bags, offering the "second life option'' of being also an organic waste bag. In all these applications biodegradability is an added value. Used food packaging can be processed with high eco-efficiency by composting, especially when short life easily spoiled food is packed. Then the packaging can be recovered togther with the spoiled content without further treatment.

Nevertheless the eco-efficiency is dependent on the given infrastructure at a place or in a region. Production of bioplastics may involve using large areas of land for necessary crops which may push up food prices.

Compostable materials should go to composting, not recycling and strenuous efforts are needed to make this clear to the public.

Identification, public awareness and communications are essential. For example, the use of the term **degradable,** is misleading, as the public assume this means **biodegradable,** which in the public mind can be synonymous with **good.**

Degradable plastics undergo significant chemical changes under specific environmental conditions, resulting in a loss of some properties.

Degradable materials are not acceptable in most international standards for composting/composted outputs whereas certified compostable materials are accepted.

The stabilising additives in degradables are persistent in recycling systems which means the additive will contaminate the whole batch eg a recycled PE carrier bag is now likely to be degradable which has serious implications for shelf life and performance. Compostable materials such as those used to create compostable waste bags play an important role in areas of Northen Italy, Norway and the UK - in food waste collection systems these products improve significantly public participation, capture rates and purity.

Cost is an issue but where the whole system from initial purchase to distribution to collection efficiency, final treatment and landfill avoidance are considered, the overall benefits are high - apart from areas where there is no fiscal incentive or political will to avoid landfill.

Degradable plastic bags

A number of retailers have introduced degradable carrier bags. These bags are made from plastics which degrade under certain conditions or after a certain time. Degradable plastics are already being used in Austria and Sweden, where McDonalds has been using biodegradable cutlery for three years. This enables all catering waste to be composted without segregation.

Compostable materials such as Mater-Bi are being use for packaging electronics due to their intrinsic anti-static character. Nokia are using a renewable material (not compostable) for some phones cases. These are bioplastic applications, not degradable applications.

Concerns

There are a number of concerns over the use of degradable plastics. Firstly, these plastics will only degrade if disposed of in appropriate conditions. For example, a photodegradable plastic product will not degrade if it is buried in a landfill site where there is no light.

Secondly, some biopolymers can generate methane if they degrade anaerobically. However, some studies indicate that degradation can only be initiated under particular sets of circumstances.

Thirdly, the mixture of degradable and non-degradable plastics may compromise plastics sorting systems. Last but not the least, the use of these materials may lead to an increase in plastics waste and litter if people assume wrongly that discarded plastics will simply disappear.

Bioplastics typically have a lower melting point than traditional plastics. This means that even a small amount entering the recycling stream can weaken the line, often leading to their removal at recycling facilities. As they are made from fossil fuel sources, the manufacture of oxobiodegradables contributes to greenhouse gas emissions and fossil fuel dependency.

Many oxobiodegradables will degrade into small fragments of polymer, which then persist in the environment for months of years. As a result of consumers must research proper disposal methods of their bioplastics, as the requirements for each brand and type can vary significantly.

Compostable packaging is optimised for recovery in composting operations. The temperature and humidity conditions in these industrial facilities are virtually never found in nature, which means that decomposition can take considerably longer. Even under ideal decomposition conditions, they remain recognisable as packaging for a period of time, and represent an unattractive blight on the landscape and a potential hazard to wildlife.

It is imperative for the consumer to continue to be conscious of the fact that no matter what type of packaging, it must be subject to a regulated recovery process. This is the only possibility for re-use and recycling to occur.

Most bioplastics manufacturers claim to have no intention to displace traditional plastics, but rather to provide solutions where waste management falls short; eg food contacted film/trays which can then be composted either by the consumer at home, via collection or by commercial back of store collections for composting. Compostable materials are also beginning to play a role in event /catering waste management.

Courtesy: warmer bulletin, issue 113, February 2008.

GSPMA School Awareness Programme

Mr. Anupam Desai, RIL is displaying the ICPE School Book, while Mr. Navin Trambadia, President GSPMA looks on.

Gujarat State Plastics Manufacturers' Association had organized an Awareness Programme for school students, to educate and encourage them to keep the Environment clean, on 1st August, 2008 at Anand Niketan School, Ahmedabad.

About 960 students from Class II to IX, attended the programme in 5 sessions. The programme started with a brief introduction by Shri. Navin Trambadia, President, GSPMA. He informed students about GSPMA's aim of coming to the school to provide information to students about a proper waste management system. This was followed by screening of an educational CD on this subject and a Questionnaire session, which was the longest. Mr. Anupam Desai of Reliance Industries Limited, representing ICPE, attended the session and answered the technical questions. ICPE had provided schoolbooks for distribution and screened the awareness film " Living in the Age of Plastics".

Mr. Tushar Parikh, Chairman, Tech. Seminar Comm., handled the session. It was very encouraging that each and every student from II & III std. had a question and that too, on relevant issues. A few of the faculty members were also under the impression that Plastics were harmful to the society. But the team was successful in explaining them with several examples, and clearing such myths about plastics.

The Principal, Trustee and staff of the school confirmed that they would keep separate dustbins for wet and dry waste. The trustee requested GSPMA to provide separate bins to the school for collecting waste. He informed that whatever income was generated by selling the plastic waste, would be utilized for buying books related to plastics for the school library. They took special interest in the programme and participated and motivated students to implement the suggestions in day-to-day life. Mr. Kamal Mangal, Trustee, had announced to keep a Quiz and Painting competition on this subject, in the school in the coming days. He made the students realize that Plastics are not harmful but the way we dispose it after use, is not proper. So it is we, the citizens, who are at fault. The session ended with a distribution of gifts and booklets to the students.

A beautiful card was prepared by the students with the words, "WE SAY YES TO PLASTICS". GSPMA requested PLASTINDIA and ICPE to take this School Awareness Programme on a wider scale, all over India, as it is very important to take this matter urgently on a National as well as Regional level.

ICPE assured continuing its support and assistance in conducting more such school programmes.

GSPMA team is making the Awareness Presentation to the students.

Awareness Programme at Happy Public School, Daryaganj, New Delhi

An awareness programme on "Plastics and the Environment" was held at Happy Public School, Daryaganj, New Delhi, on 1st April, 2008. Around 400 students of class 6th, 7th and 8th attended the programme. Teachers of all these classes also were present.

The programme was initiated with an introduction by the school faculty and ICPE. Ten students were divided into two groups of five students each, which alternatively spoke both about the benefits that plastics have provided to the modern world as well as the menace caused by littering and the irresponsible use and disposal of plastics. The students stressed on the responsibility of every citizen in protecting the environment and maintaining clean ambience in towns and cities.

This was followed by a presentation by Ms. Savita Pradeep, Technical Manager-ICPE, on Plastics and Waste Management. The presentation covered the various applications of plastics; Comparison of plastics with paper, glass and metal; Resource conservation; Myths and Realities of plastics; Garbage segregation and bin culture; various methods of recycling of plastics and glimpses of waste management projects of the ICPE. The presentation was followed by a question and answer session. ICPE awareness films were shown to the students. Prizes were awarded to the best three speakers among the ten students who presented their views on waste management and mementos were distributed to the participants. Awareness booklets (It's My World) were distributed among all the students. Samples of products made out of recycled plastics, and panels and awareness booklets on plastics and the environment, were also on displayed to the students.

The school faculty was appreciative of ICPE's efforts in waste management and in generating awareness among the students.

Students of Happy Public School are participating in the Awareness Programme.

Environment Day Celebration

Three Mumbai based ENVIS Centres - ICPE, NASWAI (National Solid Waste Association of India) and WWF, assembled together with Institute of Science, Mumbai to celebrate the Environment Day - on 5th June, 2008 in the Campus of the Institute. Dr. Seema Misra Thakur, head of the Environment Department, together with the students of the Department had organized an Workshop where several environmentalists and NGOs were invited.

Prof. (Mrs.) V. V. Mulwad, Director of the Institute, graced the occasion. Dr. Amiya Kumar Sahu, Director of NASWAI, Dr. G. Quadros of WWF and Mr. T. K. Bandopadhyay of ICPE made presentations and interacted with the invitees.

Mr. T. K. Bandopadhyay of ICPE is making a presentation.

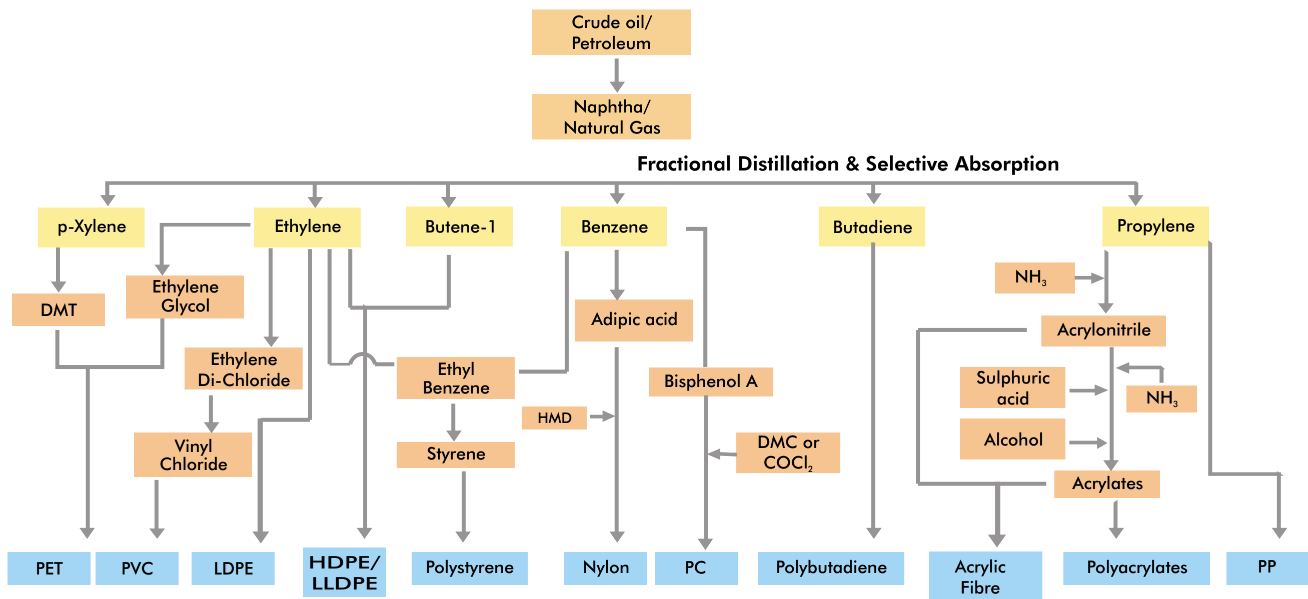
Dr. Quadros of WWF (3rd from left), Mr. T. K. Bandopadhyay, Prof. (Mrs.) Mulwad, Dr. (Mrs.) Thakur and Dr. Sahu are seen with the students of the Institute.

Prof. (Mrs.) V. V. Mulwad, Director of the Institute, is addressing the gathering. Dr. Sahu and Dr. (Mrs.) Thakur are also seen in the picture.

Community Awareness Programme

A Mumbai based NGO - Omkar Sanghatit Mahila Mandal, had organized a Community awareness programme on the occasion of Environment Day in Mankhurd area of the suburban Mumbai. The NGO had selected Plastics Waste Management as one of the issue for the Awareness Campaign. ICPE supported the activity by providing awareness materials on plastics waste management and also screened ICPE film - "Living in the Age of Plastics" in local language. The common mass in the locality were benefitted from the campaign.

Flow Chart - for manufacture of Plastics Raw Materials from Crude Oil / Natural Gas



DMC - Dimethyl Carbonate
PC - Polycarbonate
LLDPE - Linear Low Density Polyethylene
HMD - Haxamethylene Diamine

PVC - Polyvinyl Chloride
PP - Polypropylene
LDPE - Low Density Polyethylene

PET - Polyester
DMT - Dimethyl Terephthalate
HDPE - High Density Polyethylene

Life Cycle data for Different Materials used for Packaging One lakh ton of 'Atta'

	Jute Bags		Plastic Film Bag	
Material Required (Mt)	1960		680	
	Energy (Thousand GJ)	Water (Thousand Tons)	Energy (Thousand GJ)	Water (Thousand Tons)
Phase I: Production of Raw Material	21.50	1677	38.36	264
Phase II: Production of Bags & Liners	47.19	1506	24.22	296
Total	68.69	3183	62.58	560

	Jute Bags		Plastic Film Bag	
Phase III: Distribution	Fuel (Tons)	Energy (GJ)	Fuel	Energy
	4663		Taken as Basis	

Phase IV: Waste Management	Jute	Plastic Film Bags
Recycling Percent	Energy Savings	Energy Savings (Thousand GJ/680ton)
100%	Not Applicable	17.20
80%		13.76
Incineration	Energy Recovered	Energy Recovered (Thousand GJ/680ton)
100%	Not Applicable	35.24
80%		28.12

Energy Saving - Atta Packaging Jute Vs Plastics

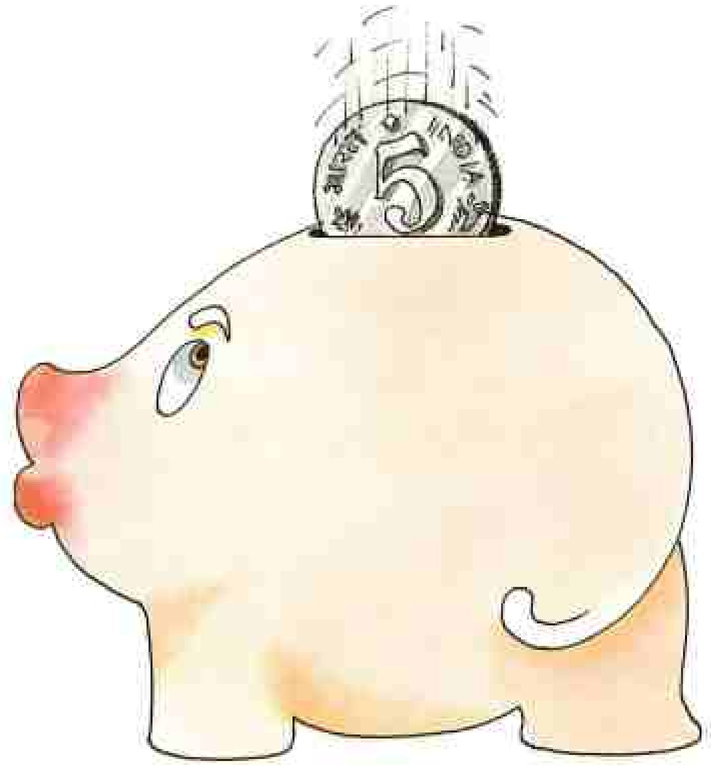
- **Energy Consumption in GJ for**
  - Manufacture of
    - Raw Material
    - Product
    - Transportation of atta

Jute	**Plastic**
330	**63**

- **Energy savings - 81%**
- **Energy recovery with plastics - 35**

Source: Centre for Polymer Science and Engineering, IIT Delhi

Put Plastics in Right Place



Create Wealth from Plastics

Avoid littering plastic bags.

Plastic bags are 100% recyclable and are being already converted into very useful economic products for the masses. **Plastics help conserve: scarce natural resources • water • energy • fuel** and help prevent deforestation. Help the industry initiative on Recycling.

Eco-friendly **PLASTICS** GLOBALLY PREFERRED MATERIAL

REUSE • RECYCLE • REDUCE • RECOVER

ICPE

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