(Confidential)

Report on National Study

"Promotion of recycling technology for post consumer Plastics waste "

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Submitted to

DEPARTMENT OF CHEMICALS & PETROCHEMICALS
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EXECUTIVE SUMMARY

I BACKGROUND:

Department of Chemicals & petrochemicals, Government of India has entrusted the assignment for carrying out a National study on " Promotion of recycling technology for post consumer Plastics waste" to Central Institute of Plastics Engineering & technology (CIPET), Corporate, Chennai.

The Terms of the Reference (ToR) of the study are:

1. To assess the type and nature of recycling technology being employed in the country, both on pilot and commercial terms.
2. To interact and deliberate with all concerned stakeholders.
3. To report on the existing infrastructure facilities available in the urban local bodies/municipal bodies in management /disposal of post consumer plastic wastes.
4. To suggest the viable and appropriate recycling technologies for used indigenous plastics, relevant to type and availability.
5. To assess the requirement of infrastructure, both in terms of capital including plant & machinery and manpower and inputs / raw materials.
6. To identify the Short Term, Medium Term and Long Terms objectives and the targeted Deliverables based on which the recycling technologies required to be promoted are to be made operational.
7. Best practices prevailing in the various areas in India.

II ACTIVITIES UNDERTAKEN FOR THE STUDY:

- Field survey of recycling industries in different regions of the country for collection of factual data on various aspects of recycling in India.
- Review the status of recycling technologies adopted by Indian recycling industries with special reference to the processing machinery / methodology used, quality of the recycled materials, safety and environmental issues.
- Work out Strategies for systematic plastic waste collection, segregation and recycling technologies to improve the quality of recycled materials and

application development in comparison with the technologies adopted by the developed countries.

- To present a **SWOT analysis** of Indian recycling industries and recommendations for upgradation and improvement.
- Review of recycling technologies for mixed plastics waste which cannot be segregated, mixed plastics waste commingled with other non-plastics waste except metal, glass and vegetable waste.
- Identification of probable value added recycled products in Indian context.
- Recommendations on creating plastics waste recycling clusters according to waste products/plastic materials for collection of waste at source, effective and value added recycling techniques in different locations in India.

III RECOMMENDATIONS/STUDY FINDINGS:

The major findings of the study & few recommendations are:

1) The Technology levels of Indian recyclers can be classified into 4 different tiers:

***Tier I*:** Low end Recycling technology by mechanical route, unhygienic condition of waste Sorting, cleaning & working atmosphere. Local machinery & improper process control for temperature. Overall, technology or operation of these recyclers is not in line with the norms of Pollution Control Boards; hence most of the Units are not willing to follow the norms of Registration. However, these Units are responsible for Waste Management of considerable volume of Plastics waste generated in the country. The materials recycled by the Tier I recyclers are Polyethylene (PE), polypropylene (PP), Polyvinyl Chloride (PVC), Polystyrene (PS) etc.

Depending upon the capacity, the investment in Plant & machinery ranges between Rs.10.00 lacs. to Rs.50.00 lacs. for semi-automatic plants, whereas, for complete automation, minimum investment in plant & machinery would be around Rs.2.00 Crores.

Tier II: In the recent years, with increase in PET Bottles consumption for Mineral water, soft drink, Edible oil packaging, an organised Recycling segment, having better technology, has been evolved. These PET recycling Units claimed that by mechanical recycling, they are able to convert PET bottle waste in PET chips/pellets with properties almost equivalent to virgin PET material. One Unit (M/s Futura Polyester Ltd.) near Chennai has got recognition worldwide for their unique process with blend of Chemical & mechanical route of recycling technology & their product- 100% recycled PET is FDA approved in USA as well.

For PET Recycling plants a minimum investment in Plant & Machinery would be Rs.3.00 Crores for a capacity of 100 tons per month.

Tier III: For mixed waste, which includes non plastics waste in the streams of Plastics Waste like Paper, Aluminium Foil, Card board etc, the technology of High intensity mixing, then Lumber production and Compression moulding of different shapes & products which can be replacement of Wood products, few specialized recyclers are available in the country.

The imported technology is available at minimum cost of about Rs 10 Crores in Plant & machinery.

Under this category, the recycling of Engineering plastics, Blends & alloys can also be included by mechanical recycling technique with Twin Screw or specialized Single screw design to handle waste of Polycarbonate (PC), PC/ABS Blend, Polyphenylene Sulphide(PPS). The source of these waste are automotive products, mobile phones, computer/TV parts etc.

Tier IV: Non conventional routes of recycling like- Plastics Waste into Fuel & Use of Plastics waste for Road construction (blend with Bitumen). These technologies are used by few Stakeholders, but the validation of technology & successful commercial operation has not been proved yet. During the Study, it was understood that Plastics waste to fuel

technology by a Nagpur Based Indian inventor, is not new, as such technologies were already in use in European countries. Similarly the use of Plastics waste in road construction is based on the late 80s invention on the subject, which recommend use of polymer modified Bitumen for road construction.

For waste to fuel plants, as per the information available from imported technology, minimum investment in plant & machinery is to the tune of Rs.7.00 Crores for a plant capacity of 6.0 to 7.0 tons per day. The commercial scale plant near Chennai is yet to commence its operation. Hence, the viability on commercial lines is yet to be established for this technology in Indian context.

2) SWOT Analysis of Indian Plastics recyclers:

STRENGTH:

- Well developed Local Expertise in Mechanical Recycling
- Vast range of low cost products which are saleable for poor/weaker section of the society.
- Employment generation- both direct & indirect
- Low cost technology & better options for value addition
- Operative in Cluster mode.

WEAKNESS:

- Health & safety standards are not in line with Government regulations or as per International norms. Most of the units are not registered and operate illegally.
- Child labours are employed in the supply chain ,which is not legal
- Low end technology with poor process control, affects on the quality of recycled granules or products.
- Not recognised as main stream processors (due to reasons indicated above).

OPPORTUNITIES:

- Increased Plastics consumption in the country would increase opportunities for recycling industries particularly for Automotive & E-waste.
- Polymer price fluctuations increase the demand of good quality recycled granules for cost effectiveness..
- Favourable Government of India Policy on Waste management by Recycling to produce value added products.
- Under National Policy on petrochemicals, recycling has been earmarked as one of the thrust areas for intervention.
- Mandatory orders/guidelines for compulsory recycling (*High Court of Delhi ordered for proper recycling of plastics waste to tackle the problem of plastics carry bags in NCR)*

THREATS:

- Improper & unhygienic conditions at recyclers Units pose a threat of banning these Units by Pollution control boards or Ministry of Environment & forests.
- Chinese invasion of low cost Plastics products in India
- "Ban plastics" implementation in few states will affect on availability of Plastics Waste.
- Illegal status of Units attracts penalty, ban, force closure by appropriate authority of state or central government.

IV FEW STATISTICS ABOUT PLASTICS RECYCLING INDUSTRIES IN INDIA

The study team interacted with Recyclers and Associations across the country for collection of authentic information on the statistics of recycling industries in India. Also, Central Pollution Control Board (CPCB) and State Pollution Control Boards have been approached to collect the registered information on status of Recycling Industries in the country. Accordingly, Data from Central Pollution Control Board (CPCB) was obtained on the State-wise status of Plastics Waste Management in the country, which is enclosed as Annexure - I. The source of CPCB Report is as on December 2006 and as per the CPCB data, the total number of Recycled Units is 2079.

Apart from the CPCB and industry department data, based on the field survey, the study team arrived at the following statistics for recycling industries in the country:

- Numbers of Organised Recycling Units: **3500**
- Numbers of Unorganised Recycling Units: **4000**
- Major Types of Plastics Recycled: **PE, PP, PVC, PET, PS, ABS,PMMA**
- Manpower directly involved in Plastics Recycling: **around 6,00,000**
- Manpower indirectly involved in Plastics Recycling: **around 10,00,000**
- Quantum of Plastics Recycled per annum: **36,00,000 Tons (3.6 Million Tons)**
- Estimated Investment in Ingenious Plant & Machinery for Recycling Industries (Mostly Tier – I): **about Rs. 150.00 Crores.**
- Future growth Trends in Recycling Technology for Plastics:

    a. PET Bottle Recycling (Conversion in Flake, Pellets and products like box strapping, Fibre, injection moulded products, Extruded sheets, etc.
    b. Recycling of Automotive parts and reuse as blend with virgin material.
    c. Recycling of E-Waste (Electrical / Electronic / Computers parts.
    d. Recycling route for Plastics Waste to Fuel.
    e. Energy recovery route from plastics waste (incineration).
    f. Mixed waste recycling.
    g. Use of PE&PP waste for Road construction(Concept of bitumen modification by Polymer)

V. PROPOSED SHORT TERM, MEDIUM TERM AND LONG TERMS INTERVENTIONS

Based on the exhaustive field work by study team and the Stakeholder suggestions obtained during formal & informal interactions, for promotion of recycling technology in the country, following Short-term, Medium-term and Long-term interventions are desired jointly by Government agencies and Plastics Industry.

a) Short-term

Setting up of recycling Plants at major Metros under the aegis of Metro/Municipal Corporation **(New Delhi, Chennai, Mumbai & Kolkata).** The study team is of the view that the awareness about plastics waste and its usefulness need to be

propagated amongst Civic & Municipal authorities and initially, the plastics waste management cell at Metro Cities can be created by setting up of mechanical recycling plants.

It is proposed that at 04 Metro Cities, the recycling facilities can be established with an investment of Rs.20.00 Crores (Rs. 5.00 Crores each) and awareness programmes, publicity campaign through Media & School /Colleges, training of staff of municipal corporation would be a prerequisite during preparatory phase before setting up of recycling plant.

The budget for awareness, training and publicity campaign would be to the tune of Rs.3.00 Crores at each Metro (Rs.12.00 Crores for 04 metros). Hence, total investment would be around Rs.32.00 Crores for Short-term intervention in Metro-cities.

b) Medium-term

The adoption of an existing Recycling Cluster by Government like Dhoraji region in Gujarat and to develop it in line with International norms can be a medium term objective to promote Recycling of plastics waste as main stream industry alike any manufacturing activity. **The investment for upgradation of a recycling cluster like Dhoraji in Gujarat with 200 units would be to the tune of Rs.25 Crores.** It is suggested that Dhoraji in Gujarat, one of the oldest recycling cluster of the country, can be adopted by Government to develop it as a model recycling cluster, which can be replicated in other recycling cluster, already operating in the country.

c) Long-term

It is proposed that Government of India, State Government, local municipal corporations, NGOs, Civic authorities, Plastics Industry, etc. can create Plastics Recycling Park/Zone by allocation of Land exclusively for Plastics Waste handling (Plastics Waste Depot) alike any Special Economic Zones (SEZ) and the model can be operated in PPP Mode. These recycling plastics parks can be established in major States of the country to tackle the plastics waste menace due to littering and indiscriminate plastics waste management by local authorities.

"PROMOTION OF RECYCLING TECHNOLOGY FOR POST CONSUMER PLASTICS WASTE"

I RECYCLING OF PLASTICS – INTRODUCTION

Recycling of plastics was started almost simultaneously with the development of processing techniques for thermoplastics. Various technologies are involved in the recycling of post consumer plastics waste for wide variety of plastics waste from various consumer and industrial products. The uses of Plastic products are increased day by day due to the enormous advantage over many materials and its flexibility to modify or manipulate the properties and customise the material as per the requirements and need. Its no longer a material is used as toiletries is the material is used in electronics, telecommunications, information & technologies, engineering, medicals & advance medicals, defence, space etc. Development of newer plastics now open the mind of scientists to think beyond their imaginations what plastics can do in these fields. Along with the conventional commodity plastics the amount of newer engineering & speciality plastics, customised plastics in the form of blends, multi-component through the use of multi-layers, laminates, composites, formulates and modifiers such as fillers, pigments, antioxidants and flame-retardants are available as plastics waste.

Why Recycling of Plastics Waste ?

Worldwide, Plastic consumption has grown at a tremendous rate over the past two or three decades. The per capita consumption of plastics in India is about 5.0 kg as against the world's average of 26 kg. Many of the plastics applications are having life-cycle of less than one year and then the vast majority of these plastics is discarded and become part of Municipal Solid Waste (MSW). Furthermore, the increased use of plastics products, about 50% of which go for packaging applications alone and hence are discarded immediately after using the content has increased the quantity of plastics in the solid waste stream to a great extent.

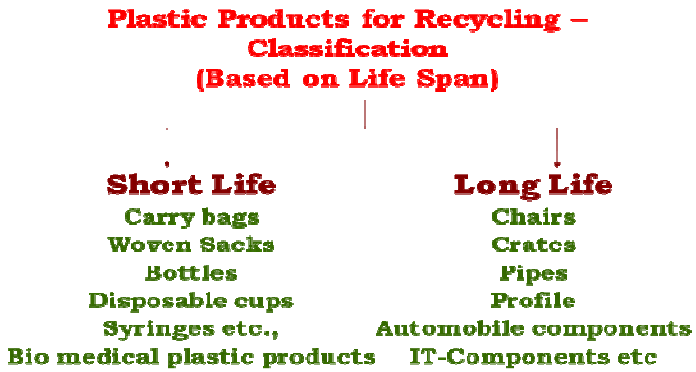
Indian plastics waste recycling industry is able to recycle about 3.6 Million tons of plastics waste per year by mechanical recycling. In India, the plastics waste constitute only about 1-5% in MSW as compared to 8-10% in the developed countries of the world. However, the 60% of plastics waste in India is mechanically

recycled as compared to world average of only 15 - 20%. Energy recovery by incineration of MSW is also widely practised in countries like Japan, Canada, UK, USA, Germany, etc. **In Japan, about 140 incinerators produce about 700 MW of power. Similarly, the technology for mixed waste or commingled plastics waste has been developed in France, USA, Canada for conversion of waste into value added products**

Due to chemical inertness or non-biodegradability of the plastics, it is imperative to recycle or reuse the plastics waste by proper technique for effective plastics waste management.

Recycling of Plastics can be broadly classified into Mechanical, Chemical (feedstock) recycling and Energy recovery through Incineration and divided into four categories:

Plastic products which available for recycling are based on their life cycle:



II TYPES AND SOURCES OF WASTE

a. Plastics in Municipal solid waste:

The most important potential source of plastics waste is found in Municipal Solid Waste (MSW), Plastics constitute between 8 – 10 weight % of MSW in developed countries whereas, in India it varies between 1 – 2 weight %. Most of the plastics waste found in MSW are mainly packaging materials, consisting of various grades of PE, PP, PVC, PS, PET. Engineering plastics may occur under the form of kitchen utensils, consumer, electrical & electronic products, etc. About 95% of plastics consumption in House-hold & packaging applications is discarded as waste.

b. Plastics waste from the agriculture sector:

Agriculture primarily uses PE, PP and PVC plastics. The plastic materials used in agriculture generally have a short to medium life-span.

Examples:- **Short-lived:** Nursery bags, Covering of Greenhouses and Fertilizer Sacks,
Medium-lived: Irrigation Pipes, Drums, Tanks

The waste generated is estimated at 60% of the plastics consumption in Agriculture.

c. Plastics waste from the automotive sector:

Currently, 20 – 25% of an automobile points is made of non-metallic materials (glass, rubber, plastics, etc.). It is estimated that about 35% of plastics used in automotive are being discarded as waste.

d. Plastics waste from the construction sector:

The construction industry uses mainly PE and PVC plastics. The construction sector typically uses plastics in applications for much longer than any other major industry sector, making it difficult to estimate the waste generated based on consumption. 10% of current consumption of plastics in construction becomes part of waste-stream.

e. Plastics waste from the large industry and distribution sectors:

This sector is the second after the MSW to produce large amount of plastics wastes. It includes bags, drums, containers, packaging film, etc. It is estimated that 90% of the consumed plastics are discarded.

f. Processing Industry:

This plastics wastes are generated during the plastics processing. Plastics consist of, runners, distorted and incomplete formed products, surpluses, products rejected during quality control and material arising during the starting-up or the shutting-down of the plant.

In the competitive environment, no industries can afford to waste these raw materials. Waste is carefully segregated at the source, according to its nature, colour, and additives. Contamination by dust, oil or burned (i.e. thermally decomposed) material is avoided. In general, the plastics wastes is ground and recycled, either directly in the same or a similar production, or in a less critical application.

g. Polymer Manufacturers:

Plastics wastes generated by polymer manufacturers consists of:

- Production wastes, such as the deposits formed on the walls of polymerization vessel or the drivers, or sludge separated from process waters;
- Off grade products;
- Extrusion purging and lumps;
- Floor sweepings;
- Wastes arising during quality control and laboratory testing.

h. Hospital and Medical Waste:

Plastics is widely used in different healthcare and medical applications. The waste from hospital requires special care due to contamination and hazardous

nature. Eco-friendly, clean recycling or incineration technique is preferred for managing hospital and medical waste.

III COLLECTION & SEGREGATION OF WASTE

a. Collection of Plastics Waste:

- In India, sorting is not carried out before disposal of the plastics waste at source as being practiced in developed countries. The plastics waste from the domestic use, consumer and in public places are mixed waste consisting of plastic bottles, disposable cups and plates, packaging material, milk pouches, PVC foot wear, carry bags, shopping bags, etc. The problem with household waste is, it is dirty having food contaminants and difficult to separate by any mechanical means.

- Plastics waste is collected from houses, garbage and junkyards. The plastics waste collected from these sources by rag-pickers and sold to scrap dealers. The scrap is segregated by rag-pickers based on quality and the grade of the material and visual identification. The manually segregated plastics waste material is sold to re-processors by the scrap dealers.

- After collection the wastes are separated into different categories based on the type of the resin, grade and colour. Most of the sorting is done manually because of the low cost. In India, Sorting of plastics waste by mechanical means or by using automatic devices are very difficult to use because of the high contamination and mix of various items of plastics waste which are collected from the garbage. However, in the developed countries, where waste is sorted at source itself automated equipments for cleaning sorting & recycling are feasible option.

b. Segregation of plastics waste by simple Identification techniques

To determine if a plastic is a thermoplastic or a thermoset, take a piece of wire just below red heat and press it into the material. If the wire penetrates the material, it is a thermoplastic; if it does not it is a thermoset. A coding system has also been introduced in different countries across the globe to aid identification of plastics for reclamation. It is based on the ‘Recycle Triangle’

with a series of numbers and letters to help with identification. (please refer page no.66)

- There are several simple tests that can be used to distinguish between the common types of polymers so that they may be separated for processing.
- *The water test.* After adding a few drops of liquid detergent to some water put in a small piece of plastic and see if it floats.
- *Burning test.* Hold a piece of the plastic in a tweezers or on the back of a knife and apply a flame. Does the plastic burn? If so, what colour, smoke and odour?
- *Fingernail test.* Can a sample of the plastic be scratched with a fingernail?

Test	PE	PP	PS	PVC*
Water	Floats	Floats	Sinks	Sinks
Burning	Blue flame with yellow tip, melts and drips.	Yellow flame with blue base.	Yellow, sooty flame – drips.	Yellow, sooty smoke. Does not continue to burn if flame is removed
Smell after Burning	Like candle wax.	Like candle wax – less strong than PE	Sweet	Hydrochloric acid
Scratch	Yes	No	No	No

* *To confirm PVC, touch the sample with a red-hot piece of copper wire and then hold the wire to the flame. A green flame from the presence of chlorine confirms that it is PVC.*

Size Reduction

Size reduction techniques can be classified as cutting techniques using shredders, granulators and rotary grinders. Densification process such as agglomerators and compactors. Pulverization process using disc pulverizers, turbo mills, hammer mills, cryogenic pulverization and the novel technique of solid-state shear extrusion. Size reduction of waste plastics products is necessary to convert them to a form that is appropriate for convenient transport, metering and feeding into downstream recycling process. Size reduction process also frequently used for material liberation from composite or multilayer products. The size reduction techniques are as follows:-

<u>Cutting Processes</u>

Shredders:

There is a large range of plastic shredding machines. Their operating principle is usually based on two asynchronised or four synchronised counter-rotating shafts equipped with cutting discs and distance collars (Figure: 1). The shredding action occurs between adjacent discs. The degree of crushing/shredding is determined by the number of 'hooks' on the circumference of the cutting disc and the width of the cutting disc..

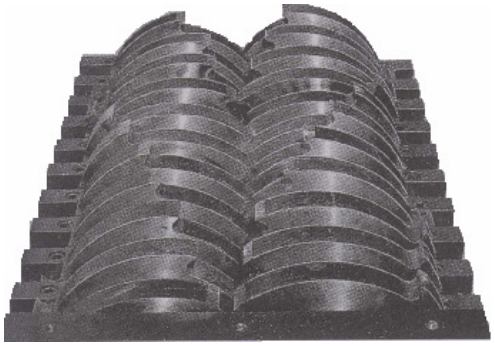


Figure 1: An industrial plastics shredder with cutting discs and distance collars

The throughput of a shredder depends on:

- the density, shape and nature of the plastic material being processed,
- the characteristics of the cutter (e.g. the width of the cutter, the number of cutting teeth and the size of the cutter opening),
- the diameter of the exit sieve raster

An example of Size reduction of PE drum in an industrial shredder is shown in figure 2.

Figure2: Size reduction of a PE drum in an industrial shredder.

Rotary Grinders:

A rotary grinder is equipped with steel blocks (or elements) about 2.5-5 cm in size, mounted on a rotor. These steel blocks chip fragments from the incoming material as

it is forced into the teeth by a ram. Rotary grinders thus produce a smaller particle size than conventional shredders. It has been found that rotary grinders are well suited to the size reduction of automotive and durable plastics.

Rotary knife Cutters (Granulators):

One of the most common types of size reduction machines used in the plastics recycling industry are rotary knife cutters. These are also known as knife mills or cross-scissors cut granulators. Such cutters are used widely both for the in-house reclamation of scrap as well as the size reduction of post consumer plastic waste. These machines employ a system of rotating knife blades (Figure: 3). Knife mills or rotary knife cutters are characterised by multiple rotating knives and three of four stationery knives, depending on the specific application. The plastic scrap is reduced in size by the cutting action between rotor knives and stationery bed knives. The rotating blades (or fly knives) are set at slight angle with respect to the rotor shaft and the fixed blades or bed knives) are set at the same angle but in the opposite direction. This configuration ensures a constant cutting nip across the knife width. Extremely close knife-to knife clearances ensure good cutting efficiency.

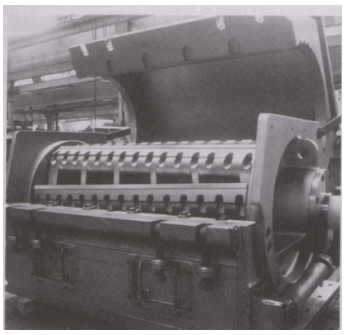


Figure 3: Rotary Knife cutter

Wet Size Reduction:

Wet Size reduction as its name suggests, uses water in a combined cutting and washing stage. In this process, the cutting edges of the knife cutters are cooled by direct water-cooling and this helps prevent contaminants adhering to the plastic from being rubbed into the plastic. Furthermore, the addition of water actually significantly extends the service life of the knives.

Slicers:

Slicers also known as guillotine shears are generally used for the size reduction of waste plastic items such as fibres, rolled-up web or rubber bales. The material is fed into the slicer via a trough equipped with either a conveyor belt or a hydraulic ram. In contrast to the operation of the shredder, the slicer generally operates in a clockwise manner where the slicing knife progressively cuts the material from the top and works its way downwards. The sliced material is then further size reduced in a secondary process.

Screw Cutters:

Screw Cutters are employed for the size reduction of voluminous plastic materials that have low toughness (such as polymer foams). These cutters have a large feed hopper, which can accommodate over-sized plastic products, which can be fed using a power shovel, into independently rotating screw shafts equipped with tearing teeth.

Densification Process

Agglomerators:

Plastic waste based on packaging film, textile fibres and foam is extremely voluminous in nature and needs to be agglomerated or densified in order to convert it into free-flowing granules. Plastic film or foam typically has a bulk density somewhere between 20 and 40 kg/$m^{3.}$ However, to facilitate transportation, conveying, metering and feeding, it is desirable to increase the density of the material to about 400 kg/m^3 using an agglomeration process. Such agglomeration processes do not actually melt the polymer, but soften it using local and transient heating so that it readily undergoes a caking phenomenon. The agglomerate produced by agglomerating waste plastics can be used directly in extrusion operations, in a manner similar to polymer granules.

Compaction of packaging waste is usually conducted between 135° and 140°C. This heat is supplied by frictional heating of the polymer. It is important that the melting temperature of the polymer is not reached since compaction processes become unstable when fed molten polymer.

The advantages of agglomeration and compaction of waste plastics are:

- Reduced storage volume

- Economical bulk transport
- Improved flowing properties
- Improved metering properties
- Absence of nuisance dust.

Filtration Requirements for Different Recycled Polymers

Important melt filtration requirements for polymers with poor flow and temperature sensitivity (e.g. unplasticized PVC) are:

- There should be minimal pressure variation across the filter and during screen changes (even a slight rise in pressure over the pressure limit for the material can cause degradation and line interruptions)
- Minimum melt dwell time
- Prevention of hang-up of the melt
- Rheologically optimized flow paths

For recycled PVC it has been found that continuous wheel screen changers are the most suitable considering its generally high contamination levels and the amount of back pressure developed during processing. Back-flush screen-changers (such as the piston types designed primarily for HDPE) are too convoluted for the PVC melts and, since PVC does not shrink on cooling, it is more difficult to remove from the screens than HDPE.

Air Classification

Air Classification techniques use controlled forced air handling equipment for separation. Numerous styles of air classifiers have been evaluated for removing the liberated "lights" fraction, which may contain materials such as foam, labels, dirt and fine particles (including dirt), but all work on a similar principle of subjecting the material to a controlled velocity air stream.

The lights/heavies cut is determined primarily by the airflow velocity, which can be adjusted by a simple baffle in the air-handling conduit. It is usually adjusted to the point where rigid plastic flakes just begin appearing in the lights stream. It is usually preferred to lose a small amount of product in an attempt to remove as much of the foreign materials as possible. Experiments have demonstrated that multiple passes

through this type of equipment can result in improved separations and recovery rates. Complete separation is usually not accomplished in a single pass because materials are entangled or physically attracted to one another, sometimes due to simple static charges. This is especially the case with foam materials, which tend to maintain static charges rather well.

IV PLASTIC-PLASTIC SEPARATIONS

Based on Density

The techniques rely on the fact that the target plastic will often have a different density from the foreign materials, including other plastics. The target plastic stream can be separated from undesirable materials having different density, by placing the commingled material in a medium having an appropriate density. If a medium is chosen with a density between that of two different types of plastic having sufficiently different densities, a separation can be effected by simply placing the plastics in a vessel containing the medium. The material less dense than the media will float and the more dense material will sink. The most simple density separations use sink-float tanks and various versions have been used by plastic beverage bottle recyclers for years, often using only water.

Most rigid plastics from durable goods are denser than water, so the density of the medium used in the tank must be increased to greater than that of water by adding a modifier to the water or using a different liquid to create "heavy media". Salt-water solutions using sodium or calcium chloride can reach approximately 1.2 specific gravity, which is usually sufficient for most separations. Higher density salt or other solutions are also possible and used frequently by other industries. The major drawbacks to using heavy media include economic and environmental considerations associated with lost heavy media and residual media contamination on the recovered plastic. Adequate rinsing can address the residual media concern for many plastics.

Hydrocyclones are often used to enhance the effectiveness of density separations from both a throughput and purity standpoint, but their operation is less well understood. They can provide a greater driving force (centrifugal verses gravity) to the separation, enhance material wetability and increase throughput.

Non-Density Separations

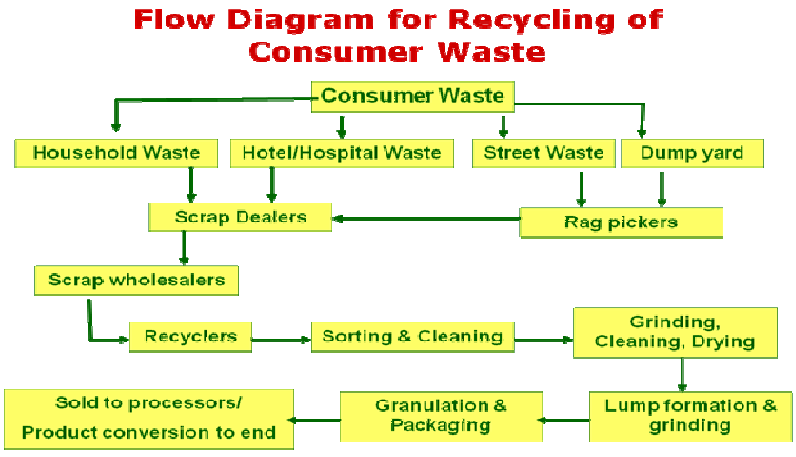
A number of non-density based techniques are under investigation by researches around the world. Many are just now going beyond the laboratory stage, especially when applied to the recovery of plastics from durables. They are mentioned here for completeness. Examples include:

- Froth flotation (which comes from the mining industry)
- Triboelectric (a variation on electrostatic separations mentioned earlier)
- Flake identification and sorting (the most common being colour and PVC sorters)

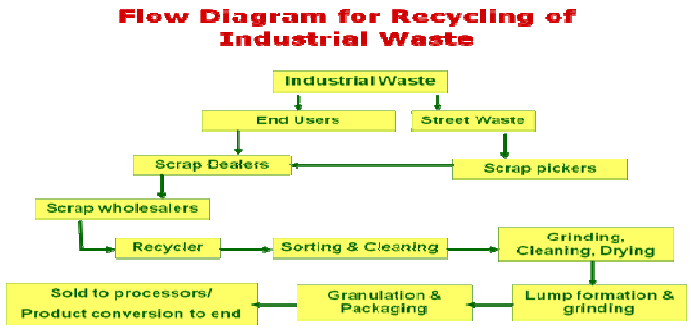
The first of these techniques, which is more broadly referred to as air flotation, depends on surface chemistry differences between different plastic types, which are common because the plastics differ in chemical structure. Some of the practical problems with this techniques include coatings like paint and metals that cover the chemistry of the underlying plastic; dirt, grease and other coatings that accumulate during use and handling; and finding polymer-specific surface active agents that will cause air bubbles to attach to only the specific target polymer, floating it away from the other materials in the mix.

Triboelectric separators also depend on surface differences between plastics so these too experience problems with coated and dirty materials. Humidity and surface wetness can effect the performance of this techniques since it is electrical in nature.

Sources of Plastics Waste (Flow Diagram)



Another source of plastic waste is the industrial waste which are directly recycled in-house or sold to the scrap dealer for further recycling.



In industry (the automotive industry for example) there is a growing move towards reuse and reprocessing of plastics for economic, as well as environmental reasons, with many praiseworthy examples of companies developing technologies and strategies for recycling of plastics.

V RECOVERY & RECYCLING CONCEPTS OF PLASTICS

In developing countries like India the scope for recycling of plastics is enormous as the plastics consumption has grown significantly in the recent year and reached about 5 million tones, which is expected to touch about 12.5 Million tonnes in year 2010. In case of Plastics waste, due to its non-biodegradability, a system of integrated waste management is essentially required to manage waste in an environmentally and economically sustainable way. The integrated waste management includes value addition to the waste by Recovery and Recycling processes, which are depicted in Figure: 4.

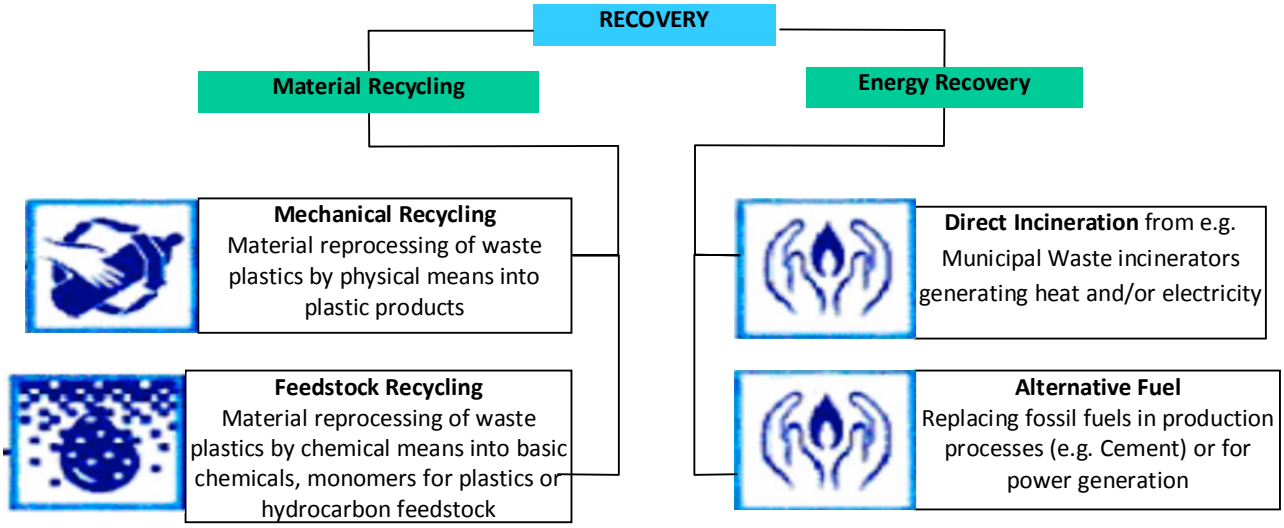


Figure 4: Flow chart for Recovery and recycling of plastics waste by different routes/techniques

VI ACTIVITIES UNDERTAKEN AS PER ToR OF STUDY

The Terms of Reference for the study on "*Promotion of Recycling Technology for Post Consumer Plastics Wastes are as follows:*

1. To assess the type and nature of recycling technology being employed in the country, both on pilot and commercial terms.
2. To interact and deliberate with all concerned stakeholders.
3. To report on the existing infrastructure facilities available in the urban local bodies/municipal bodies in management /disposal of post consumer plastic wastes.
4. To suggest the viable and appropriate recycling technologies for used indigenous plastics, relevant to type and availability.
5. To assess the requirement of infrastructure, both in terms of capital including plant & machinery and manpower and inputs / raw materials.
6. To identify the Short Term, Medium Term and Long Terms objectives and the targeted Deliverables based on which the recycling technologies required to be promoted are to be made operational.
7. Best practices prevailing in the various areas in India.

Considering the above ToR of the Study, a Questionnaire (copy is enclosed as Annexure - II) with regard to the following cited points has been prepared and was circulated to various Plastics Manufacture Associations such as **AIPMA**, **ICPE**, **GSPMA**, **IPF**, **Plastindia Foundation** etc.

- **Type of recycling technology adopted (Mechanical / Chemical)**
- **Name of the machine**
- **Plant production capacity**
- **Percentage utilization**
- **Product range**
- **Total investment**
- **Incineration / Energy recovery**
- **Environmental norms/ clearance details**

- **Foreign collaborator, if any**

The information and evidence collected by the study are incorporated in this report. *It is to mention that Units were not ready to reveal the facts about monetary involvement, tax related issue, Industrial safety regulations, pollution control issues, which are a matter of concern.*

Following questions were not answered meticulously by most of the recycling units:

- *Turnover of the units*
- *Investment*
- *Amount of Plastics Recycled per annum*
- *Connected Load*

However by utilising the expertise and experience of the study team members most of the facts have been assessed.

VII TYPE AND NATURE OF RECYCLING TECHNOLOGY BEING EMPLOYED IN THE COUNTRY, BOTH ON PILOT AND COMMERCIAL TERMS.

In India following types of recycling technologies are in practice:

- Mechanical Recycling,
- Chemical Recycling,
- Feedstock Recycling,
- Mixed Waste Recycling, etc.
- Waste to oil (Under trial/pilot stage)
- Incineration (mostly for Biomedical/Hospital waste)

Mechanical Recycling

Mechanical Recycling of Plastics waste is widely used technology across the country for plastics waste recycles. The main reasons for acceptance of this technology are:

- Availability of Low cost Plastic waste through ragpickers / local scrap vendors
- No secret Technology
- Available of local, fabricated or customise machines and equipments
- Low investment

- No skilled manpower required

There are two categories of Mechanical Recycling based on the qualities of recycled products:

(a) Primary (Mechanical Recycling)

Although much of clean thermoplastic manufacturing waste is recycled in a primary sense, remelted and reformed, primary recycling by these methods is at present not a viable economic option for the vast majority of post-consumer plastics or manufacturing wastes that are contaminated. Removing contaminants and separating similar plastic resins has been difficult and costly.

(b) Secondary (Mechanical Recycling)

This technology involves manufacturing of products, with material properties inferior to the original products.

Typical Process flow chart for plastics waste reprocessing by Mechanical route.

The process flow chart for converting plastics waste into value added products by mechanical recycling route is indicated in flow chart is shown in Figure 5

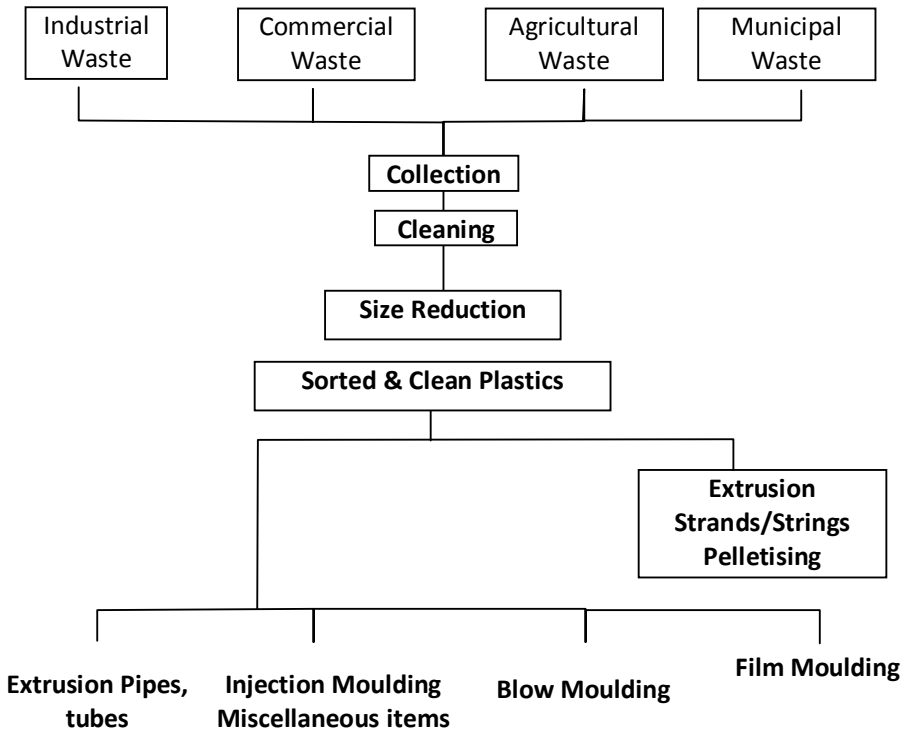
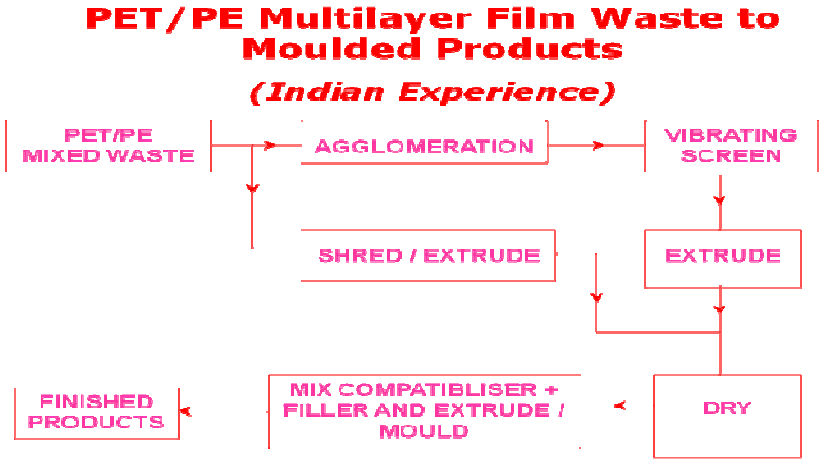
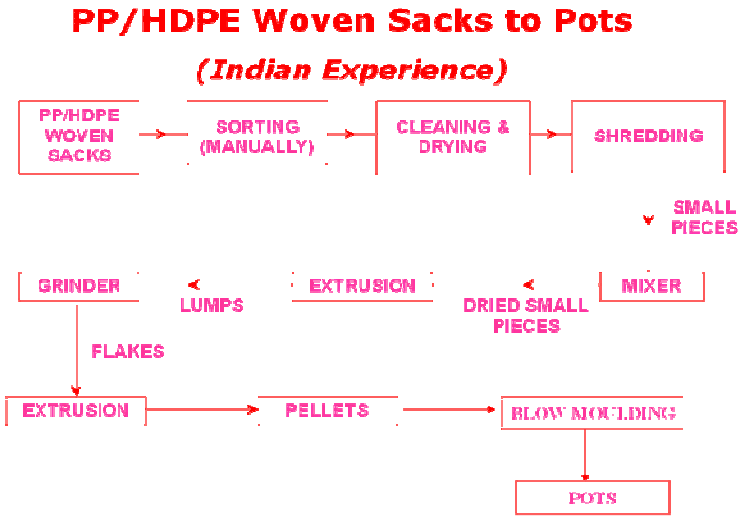


Figure 5: Process flow chart for plastics waste reprocessing by Mechanical route

Flow Chart of recycling of PP/PE Multilayer film to Moulded products



Flow Chart of recycling of PP/HDPE Woven Sacks to Moulded Pots (Kudam)



Basic Mechanical Recycling Plant

Major Mechanical Recyclers in India equipped with local fabricated machines where as very few have standard machineries.

The reasons of using low cost machines are many. Following reasons are come to the knowledge of the study team:

- Due to poor scrap quality; they are not interested to process in high quality machines.

- Scraps coming through ragpickers source contains heavy contaminations like mud, sand, and others even metals
- Wear & Tear of the machines are more
- No or less Maintenance
- Maintenance available from local bodies

Following Process methods are followed in a mechanical recycling unit:

- **Shredder and Scrap grinder:**

  Shredder is the first step before scrap grinding to reduce the size of the mouldings which can be further fed into a scrap grinder to reduce the particle size into flakes.

- **Pre-washing:**

  Pre-washing with a centrifuge is an ideal setup in order to clean plastics scraps which contain a lot of contamination. The contamination can be in the form of dust, mud, cement, fertilizers, chemicals, oil, etc. These contaminations can be removed by washing with a detergent which is commonly used in most recycling lines.

  The centrifuge is coupled with a filter unit to allow collection of contaminants separately after cleaning.

- **Cleaning/washing:**

  The pre-washed plastics waste is again cleaned in a wet process using water to remove the residues of detergent and other contaminating particles.

- **Drying:**

  The cleaned plastics wastes are dried by passing through a conveyor into a hot air-drying unit. The hot air circulation will remove the moisture and make the plastics particles dried for reprocessing.

- **Agglomerator:**

The cleaned and dried plastics films are fed to the agglomerator for converting it into small lumps of uniform size which can be fed into the extruder for reprocessing.

- **Force feeder:**

The force feeder is designed to give a continuous feeding to the extruder. Sometime, the plastics scrap gets struck inside the hopper creating the bridge to the hopper port, thereby the material is not continuously fed into the extruder. The force feeding system has the following advantages:

(i) Homogenizing the material because it keeps on mixing the material due to continuous rotation.
(ii) Constant pushes of the material allows continuous feeding into the extruder.
(iii) Materials of different specific gravities mixed together not allowing heavy materials to fall down first and the lighter weight material left on top.
(iv) Air filter unit connected to the force feeder provides recovery of the dust at the same time.
(v) A filter unit connected to force feeder allows the collection of dust and powdery material.

- **Extruder:**

The heart of the recycling plant is the extruder. A good robust extruder with a L/D ratio of 25-30 is desirable. The most important feature of the extruder is that it should be coupled with a degassing zone in the centre of the extruder. The printing ink, humidity and water particles produce gases, which shall be removed at the degassing zone to obtain a good quality recycling material from the plastics scrap. The degassing chamber connected to the vacuum pump and condensers will serve the purpose.

A vented barrel twin screw extruder with an L/D ratio of 25 –30 with multiple feed port and degassing arrangement will be suitable for reprocessing engineering, plastics scrap, like polycarbonate, blends & alloys, PMMA, etc.

- **Screen changer:**

A screen changer is an indispensable system to filter the material before it is extruded. Moreover, the screen changer allows continuous flow of the material without the need to stop the line due to blocking of the die. An automatic screen changer allows the recyclers to keep the plant running without stopping the system to remove the dirt and foreign particles accumulated inside the filters. Sliding screen changer with an hydraulic movement is most common and very popular. A screen changer is fitted between the die and barrel of the extruder.

- **Strand die:**

The filtered melt is continuously pumped through the die to convert the lump of plasticized melt into strand while passing through the strand die for further granulation into uniform size.

- **Die face cutter:**

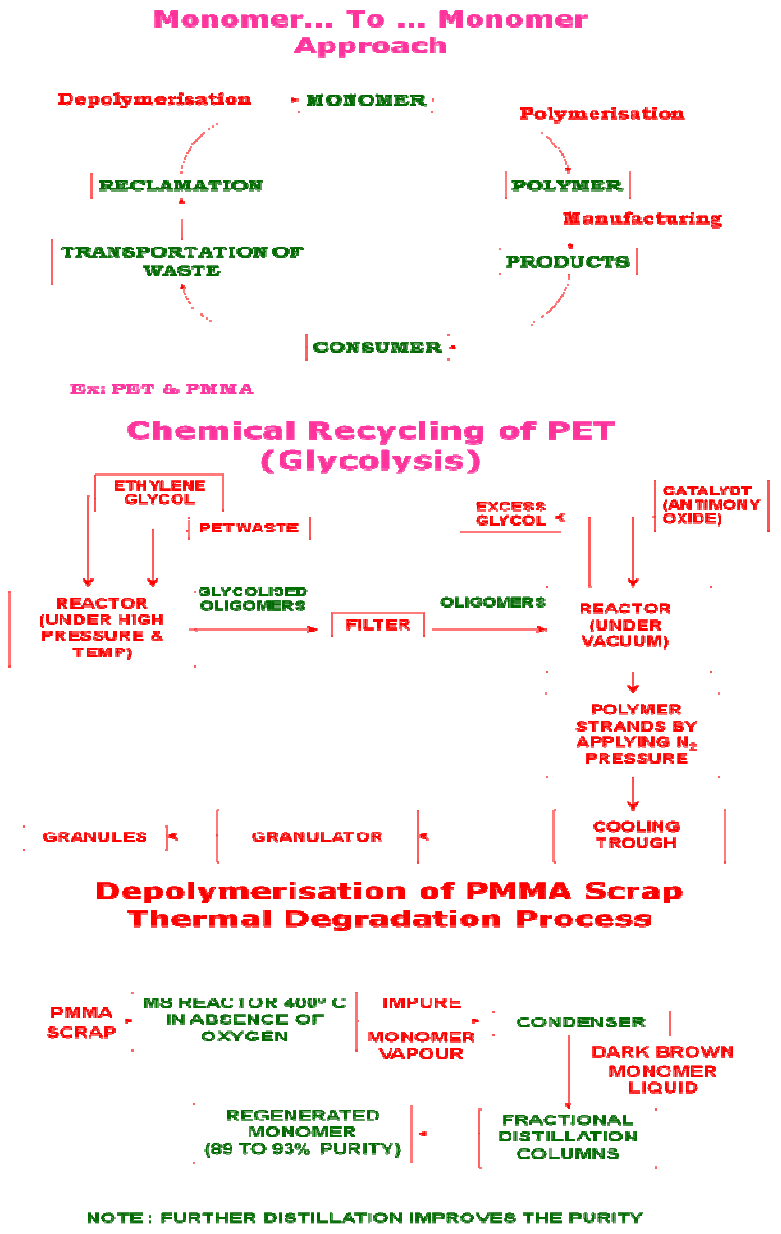
Die face cutter is the last component of recycling line. The material after being extruded in the form of strands, which are subsequently cut into granules. A set of rotating blades rotate on the die plate cutting the strands continuously into small uniform pellets. Due to the centrifugal force, the granules go in a ring of water supplied from a water pump. The material is pooled in the water and to avoid the moisture remain in the granules, the material enter the centrifuge and in a vented cyclone, the granules are completely dried.

Chemical Recycling:

Processes that utilize waste plastics by altering a polymer's chemical structure to manufacture monomers, basic chemicals, or fuels. Tertiary recycling is a range of technological approaches applicable to a wide range of plastic wastes, producing a variety of chemical intermediates, monomers, etc., which can be used for producing polymers or to be used as feedstock for the plastics. Tertiary recycling can be divided into three basic categories:

a) Depolymerisation processes*:*

This requires clean, single-resin plastic wastes and produces monomers or other basic inputs that can be used in the production of new and stainless kind resins. The depolymerisation process is also termed as feedstock recycling, wherein monomers are obtained from plastics or polymer waste by depolymerisation and purification techniques. This type of recycling is widely practised for recycling of nylon 6, PET bottles/wastes, PMMA waste. Flow Charts of different type of approaches are given below:



***b) Tertiary processes**:*

They are applicable to mixed and contaminated plastics waste streams and utilise waste plastics as a substitute for crude oil in refinery operations and as substitutes for basic chemicals in refinery recycling and pyrolysis. M/s. Koen Tech Co. Ltd, Korea has developed a plant for converting plastics waste to fuel oil, similar technologies are available in Japan (Processes flowchart shown in Figure 6)

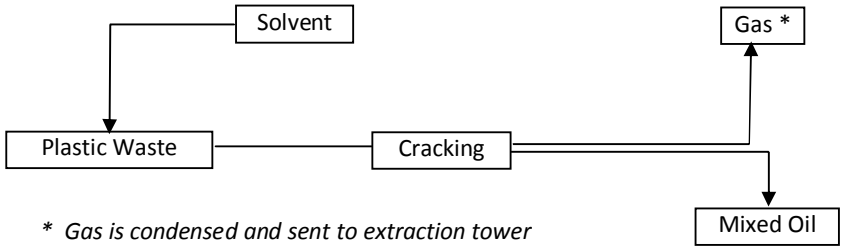


Figure 6: Plastics Waste to Fuel Oil

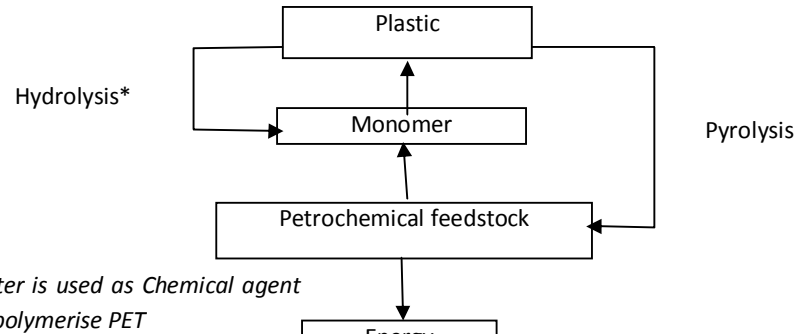
***c) Dissolution processes**:*

These can be applied to mixed and contaminated waste streams to selectively remove individual resins or classes of resins for further processing and recycling.

With the exception of Dissolution, Tertiary recycling achieves closed loop recycling. Most of these technologies are in the developmental stage, and with economic viability they will substantially advance recycling efforts. Some Tertiary technologies allow recovery of nearly pure polymers or their constituents from a waste mixture, and the reaction conditions destroy contaminants, allowing the recovered material to be used in food- packaging applications.

***d)* Quaternary** (Energy Recovery)

The incineration of plastics takes place with heat recovery, either as part of the municipal waste stream or as segregated waste(Process flow chart are shown in Figure 7).



Energy recovery offers an interesting techno-economic alternative to Municipal solid waste recycling. It reduces over dependency on mechanical recycling using rag picker chain.

- Abundant availability of feedstock at nil cost (MSW) in large metros
- Plastics in MSW help to increase calorific value
- Source of low cost energy for city/community needs

Waste plastic contain significant reserves of energy that can be recovered through combustion processes. In most cases, the calorific value of waste plastics is comparable to or higher than coal. The plastics waste can be incinerated for recovering heat energy and in turn to produce electricity.

Plastics waste in municipal solid waste (MSW) can improve the energy content for use as Reuse Derived fuel (RDF) for incineration. Energy level from different source is shown in Figure 8.

Figure 8: Plastics Useful Source of Energy

VIII SELECTION CRITERIA FOR RECYCLING TECHNIQUE/TECHNOLOGY BASED ON TYPE AND SOURCE OF WASTE

The selection criteria for type of recycling technique preferred as a feasible option is given in Table 1:

	Costs increase as more	Types	**Mechanical Recycling**	**Feedstock Recycling**	**Energy Recovery**
↑					

	collection and separation is required for the recovery process	Sorted, single type plastics waste.	++	+	+
		Mixed plastics waste.	+	+	++ (Solid recovered fuel)
		Mixed plastics waste + paper etc.	-	-	+ (Solid recovered fuel)
		Mixed plastics waste + paper etc.	-	-	+ (Municipal solid waste incineration)
- not suitable		**+** realistic option		**+ +** preferred option	

The following Recycling Technologies are becoming popular with proper methodology.

- PET Bottle Recycling (Conversion in Flake, Pellets and products like box strapping, Fibre, injection moulded products, Extruded sheets, etc.
- Recycling of Automotive parts and reuse as blend with virgin material.
- Recycling of E-Waste (Electrical / Electronic / Computers parts.
- Recycling route for Plastics Waste to Fuel.
- Energy recovery route from plastics waste. (incineration).
- Mixed waste recycling.
- Use of PE&PP waste for Road construction(Concept of bitumen modification by Polymer)

Few of the examples of successful Indian experience of value addition by plastics waste recycling (mostly mechanical recycling) is as follows:

- PP/HDPE Woven Sack waste to Clean and pigmented granules for producing Box strapping (by Extrusion), Pots (used for water storage particularly in Tamil Nadu known as “Kudam” & Injection Moulded Suitcases for luggage application).
- LDPE/LLDPE film, Milk pouch waste to recycled film/sheets, injection-moulded items, floor mats, etc.
- Recycled HDPE can become bottles for laundry products, recycling bins, agricultural pipe, bags, soft drink bottle base cups or motor oil bottles.

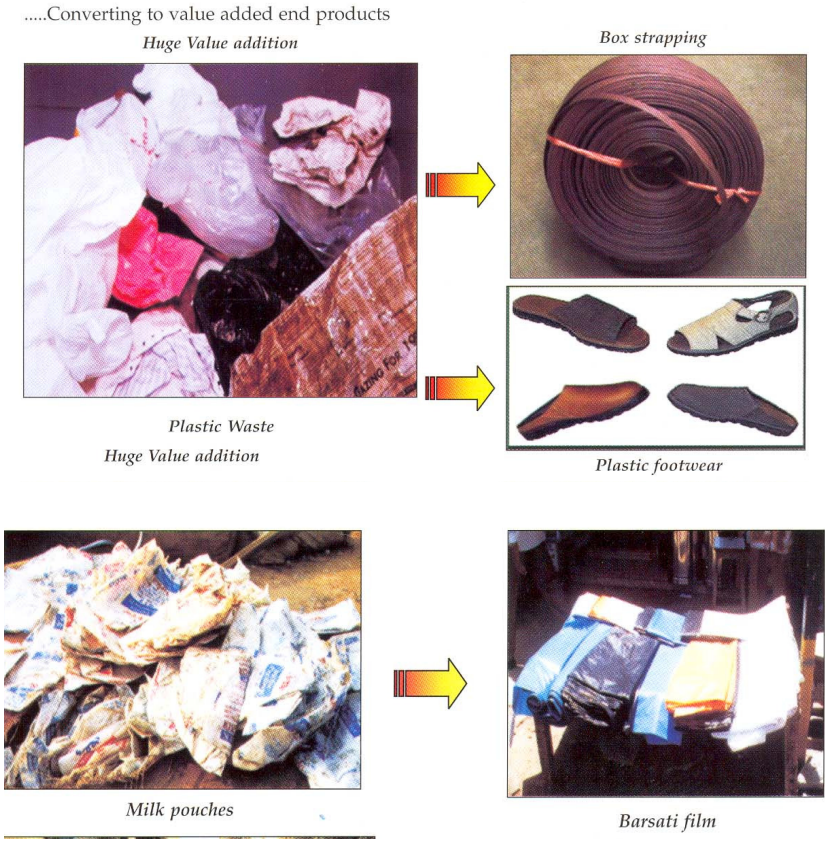
- Recycled PET bottles is used in producing bakery trays, carpets, fibrefill and geotextiles, bottles for non-food applications, sheets, injection moulded products, etc.

- Recycled PVC becomes pipe, fencing, foot wear from the flexible PVC waste, etc.

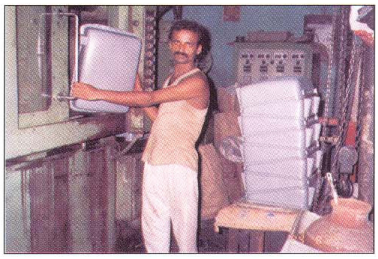
- Recycled PP film is used in end-caps, auto parts, House-hold Injection moulded items, carpets, and Industrial fibres.

- Recycled PS is used in a wide range of products, including office accessories, cafeteria trays, toys and accessories, video cassettes and cases and insulation board.

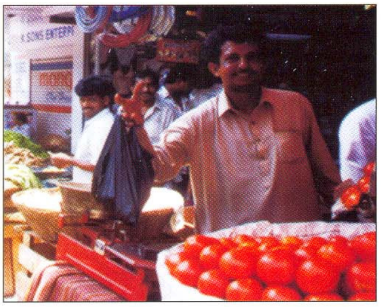
Indian Experience of Value Addition in Plastics Recycling



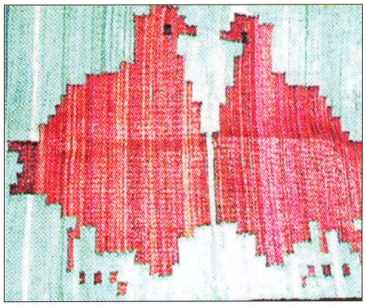
Battery Cases



Luggage



Plastic Carry Bag



Mats

Worldwide, there are numerous examples of value addition of plastics waste to adopt "Waste to wealth approach. Few examples are given in following Table 2:

Type of Plastic Waste	Source of Waste	Application of Recycled Waste
PET	Soft drink and mineral water bottles	Multi-layer soft drink bottles, carpet fibres, fleecy jackets
HDPE	Milk crates, bottles for shampoo and cleaners milk and cream bottles	Waste bins, detergent bottles, crates, agricultural pipes, kerbside recycling crates. Plastic lumber, Plant pots, Traffic cones, Toys, Outdoor furniture
Rigid PVC	Clear cordial and juice bottles, plumbing pipes and fittings	Detergent bottles, tiles, plumbing pipe fittings.
PP	Drinking straws, icecream containers hinged lunch boxes	Composite bins, crates
PS	Yoghurt containers, plastic cutlery	Coat hangers, office accessories rulers, video/CD boxes

IX TECHNOLOGY LEVELS OF INDIAN RECYCLERS

The Technology levels of Indian recyclers can be classified into 4 different tiers:

***Tier I*:** Low end Recycling technology by mechanical route, unhygienic condition of waste Sorting, cleaning & working atmosphere. Local machinery & improper process control for temperature. Overall, technology or operation of these recyclers is not in line with the norms of Pollution Control Boards; hence most of the Units are not willing to follow the norms of Registration. However, these Units are responsible for Waste Management of considerable volume of Plastics waste generated in the country. The materials recycled by the Tier I recyclers are Polyethylene (PE), polypropylene (PP), Polyvinyl Chloride (PVC), Polystyrene (PS) etc.

Depending upon the capacity, the investment in Plant & machinery ranges between Rs.10.00 lacs. to Rs.50.00 lacs. for semi-automatic plants, whereas, for complete automation, minimum investment in plant & machinery would be around Rs.2.00 Crores.

Tier II: In the recent years, with increase in PET Bottles consumption for Mineral water, soft drink, Edible oil packaging, an organised Recycling segment, having better technology, has been evolved. These PET recycling Units claimed that by mechanical recycling, they are able to convert PET bottle waste in PET chips/pellets with properties almost equivalent to virgin PET material. One Unit (M/s Futura Polyester Ltd.) near Chennai has got recognition worldwide for their unique process with blend of Chemical & mechanical route of recycling technology & their product- 100% recycled PET is FDA approved in USA as well.

For PET Recycling plants a minimum investment in Plant & Machinery would be Rs.3.00 Crores for a capacity of 100 tons per month.

Tier III: For mixed waste, which includes non plastics waste in the streams of Plastics Waste like Paper, Aluminium Foil, Card board etc, the technology of High intensity mixing, then Lumber production and Compression moulding of different shapes & products which can be

replacement of Wood products, few specialized recyclers are available in the country.

The imported technology is available at minimum cost of about Rs 10 Crores in Plant & machinery.

Under this category, the recycling of Engineering plastics, Blends & alloys can also be included by mechanical recycling technique with Twin Screw or specialized Single screw design to handle waste of Polycarbonate (PC), PC/ABS Blend, Polyphenylene Sulphide(PPS). The source of these waste are automotive products, mobile phones, computer/TV parts etc.

Tier IV: Non conventional routes of recycling like- Plastics Waste into Fuel & Use of Plastics waste for Road construction (blend with Bitumen). These technologies are used by few Stakeholders, but the validation of technology & successful commercial operation has not been proved yet. During the Study, it was understood that Plastics waste to fuel technology by a Nagpur Based Indian inventor, is not new, as such technologies were already in use in European countries. Similarly the use of Plastics waste in road construction is based on the late 80s invention on the subject, which recommend use of polymer modified Bitumen for road construction.

For waste to fuel plants, as per the information available from imported technology, minimum investment in plant & machinery is to the tune of Rs.7.00 Crores for a plant capacity of 6.0 to 7.0 tons per day. The commercial scale plant near Chennai is yet to commence its operation. Hence, the viability on commercial lines is yet to be established for this technology in Indian context.

X SWOT ANALYSIS OF INDIAN PLASTICS RECYCLERS:

Strength:

- Well developed Local Expertise in Mechanical Recycling

- Vast range of low cost products which are saleable for poor/weaker section of the society.
- Employment generation- both direct & indirect
- Low cost technology & better options for value addition
- Operative in Cluster mode.

Weakness:

- Health & safety standards are not in line with Government regulations or as per International norms. Most of the units are not registered and operate illegally.
- Child labours are employed in the supply chain ,which is not legal
- Low end technology with poor process control, affects on the quality of recycled granules or products.
- Not recognised as main stream processors (due to reasons indicated above).

Opportunities:

- Increased Plastics consumption in the country would increase opportunities for recycling industries particularly for Automotive & E-waste.
- Polymer price fluctuations increase the demand of good quality recycled granules for cost effectiveness..
- Favourable Government of India Policy on Waste management by Recycling to produce value added products.
- Under National Policy on petrochemicals, recycling has been earmarked as one of the thrust areas for intervention.
- Mandatory orders/guidelines for compulsory recycling (*High Court of Delhi ordered for proper recycling of plastics waste to tackle the problem of plastics carry bags in NCR)*

Threats:

- Improper & unhygienic conditions at recyclers Units pose a threat of banning these Units by Pollution control boards or Ministry of Environment & forests.
- Chinese invasion of low cost Plastics products in India
- "Ban plastics" implementation in few states will affect on availability of Plastics Waste.
- Illegal status of Units attracts penalty, ban, force closure by appropriate authority of state or central government.

XI INTERACTION & DELIBERATION WITH STAKEHOLDERS

The study team visited different places like Ahmedabad, Rajkot, Surat, Dhoraji, Indore, Bhopal, Mumbai, Delhi, Kanpur, Lucknow, Kolkata, Balasore, Hyderabad, Chennai, Bangalore, Mysore etc. *The gist of details collected from different Recycling clusters is as follows:*

i. Plastics Recycling Cluster - Dhoraji, Gujrat

- There are 240 Units in the area. One of the oldest cluster for recycling started way back in 1975 with PVC recycling.
- Total Capacity to recycle is about 60 ktpa.
- Sutli, Pipes, Niwar, Boxstraps, Lumps, Ropes, Dori, Pipes etc are the products.
- Nearly 40,000 workers working.
- Contribution of the cluster in cleaning of 500tons per day of solid waste.

ii. Plastics Recycling Cluster MALEGAON (DYANA), Maharastra

- There are 200 Units in the area
- There are 300 Segregation Godowns
- There are 150 Pipe making Units
- Nearly 70,000 workers working in recycling units. Out of which 10,000 are female workers
- 90% Workers are illiterate
- Require ISI standards for recycling pipe made by the Industries as it passes in BIS Specification
- Not getting Govt. Support. From Industries Department

- Bound to do work in un hygienic condition
- Power Supply is Poor
- Literacy Programmes are being Organised by the association

Feedback

- Raw Material: Collected from Mumbai, Pune, Ahmedabad, Surat, Nagpur etc.
- Municipal waste contains 60% Biodegradable waste. Only 40 to 50% Plastics recovered from these waste by weight.
- Manual Segregation done by female unskilled workers.
- After Segregation contamination removed by Zatak Machine (Locally Fabricated)
- These Material forced feed Manually into a local Extruder to form Lumps
- Lumps then Manually cut in the form of small cake called “gittis”
- These cake fed into a scrap grinder to form chips.
- From the chips granules are made.
- Mostly These granules are sold or made into Pipes

iii Plastics Recycling Cluster at Indore, Madhya Pradesh

- Nearly 80+ Units in the Association
- Some Units are in Dhulia, Ujjain, Dewas etc
- Nearly 200+ Units in MP
- Capacity Average 80T per Month per Units
- Nearly 4 Big units are there. Capacity is 5T per Day
- Direct Employment 50 to 60 per Units
- Nearly 8000 workers working in the Units out of which 50% are Female
- Most of the Female workers are illiterate
- Raw Material (15% Industrial Waste through tender and 85% from Waste) getting from Indore (15,000 Ragpickers are on the job), Dewas, Ujjain, Malegaon
- Mostly they are making Granules NO OTHER PRODUCTS
- Grannules sold to Halol (Gujarat), Gwalior, Ujjain, Indore, etc

Feedback:

- Subsidy in Power at least 25%, Sales Tax, Machines etc

- Talk is under process with SISI (MSME) for Recycling Cluster
- They are ready for Cluster and avail CFC (Common Facility Centre) for Cleaning, Washing and water effluents

iv Plastics Recycling Cluster at Delhi, NCR

- Mangalpuri Industrial Area having 4 Phase consisting of Recycling Units
- Nearly 100 Units in 4 phases
- Nearly 50 Units at Bawana Industrial Area which is 22 Kms from Mangalpuri
- The data collected only from through sources known personally.
- Capacity of the Units are in between 30 to 80MT per Month. Average 50MT per Month per Units.
- Most Units are having underground Machineries ,are producing More than 100MT per Month
- Units are Recycling Mostly HDPE / LDPE and PVC
- Nearly 100 to 150 workers (Skilled, Unskilled & Illiterate workers) per units are working.
- No Expectation from Government, **Fear to reveal more details.**

There were three stake holders meeting organised at **Hyderabad on 13th May'2008**, **Kolkata on 11th June'2008** and **Ahmedabad on 11th July'2008** involving various Plastics Mfrs. Association such as TAPMA, APPMA, AIPMA, ICPE, GSPMA, IPF, Plastindia Foundation etc

On deliberation with the Stakeholders at different locations useful suggestions could be gathered. The copies of Minutes of meeting with stakeholders are appended as Annexure-III.

Few of the major suggestions of stakeholders are:

- To make the existing BIS guidelines on recycling compulsory throughout the India and facilitate compliances of the regulations.
- Recognition of Plastics recycling Sector as an important Industry segment (mainstream), schemes for technology up gradation for the Units.
- Government may consider supporting the sector by providing few incentives, promotional measures for export promotion etc.

- To create Common Facility Centre (CFC) for cleaning, washing, drying in the identified Cluster of recycling Industries, Provide additional land in the earmarked recycling Zone.
- Subsidy in Power at least 25%, Sales Tax, Machines etc
- The Recycling Units do not get encouragement or support at local level lie Industries department in States.
- Literacy Programmes are desired for the workers (on social front)

The study team visited various locations and found in most of the cases, the working environments are similar across the country. Following points were observed while carrying out the study:

- Workers are forced to work in unhygienic conditions.
- Unskilled workers working in recycling units coming from below poverty line. So they are being exploited.
- The people are illiterate and less paid.
- Most of the process is done manually like cleaning & drying. The ground condition is very bad & unhygienic.
- The machines are local fabricated low end machines.
- The scrap available is mostly through ragpickers source and very less quantity through industrial source.

Contaminated Plastics Waste Collected through Ragpickers & Scrap Vendors

Contaminated Plastics Waste Collected through Ragpickers & Scrap Vendors

High Value Plastics Waste collected through Scrap Vendors

Wrappers /levels removed from cosmetic / toiletries bottles

Industrial Product waste collected from local industries

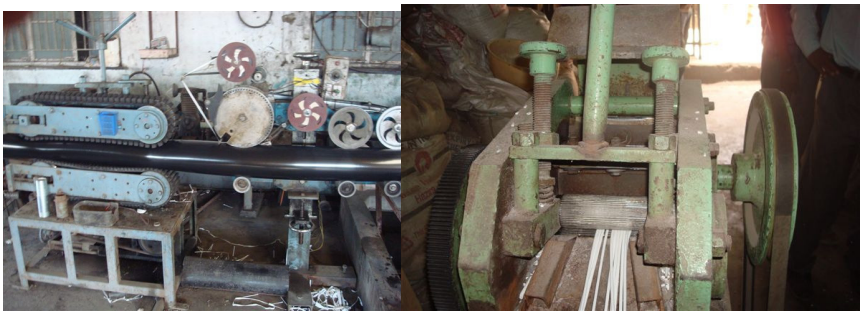
Manual Segregation

Washing & Cleaning

Making of Lumps

Local fabricated Machineries

Local fabricated Machineries



Local fabricated Machineries with low level of safety

Local fabricated Machineries

Manual feeding where no safety maintained

Inadequate Safety measures

Inadequate Safety measures

Finished product as pipes

Finished products as second grade granules

As regards existing infrastructure facilities available in the urban local bodies / municipal bodies in management / disposal of post consumer plastic wastes, during the study it was revealed that no municipal bodies are maintaining a proper disposal system for Plastics waste. **Few ideal examples of Suryapet municipality in Andhra Pradesh, Coochbehar in West Bengal, NGO initiatives at Mumbai, Chennai & Bangalore have been studied, where the segregation at source has been ensured**.

Most of the States are now proceeding towards imposing fine/Ban on plastics carry bags instead of finding disposal methodology by recycling. All the consumer plastics waste (mostly carry bags, plastic wrappings, thermocole packing, plastic plates, cups, spoons, glass etc) becomes part of municipal solid waste (MSW). Then it is collected through the ragpickers and sold to the *kawadiwala.* And rest of consumer plastic waste like milk pouches, quality plastic bags, used plastics bottles, jerry can, broken plastic parts etc. come directly to scrap vendors through *kawadiwala*.

It is also found that some cities have imposed regulations on registered Housing societies that no plastics should be dumped in the house hold disposals. Plastics

waste to be collected separately during the collection of house hold disposals. In some cities like Ahmedabad, Mumbai, Delhi it is becoming a practice. Also in the region like Mumbai the plastics waste in separate waste bin is being collected.

XII POPULAR RECYCLING TECHNOLOGIES FOR FUTURE

The work which is done by manually can be automatic by the use of on-line machines where all the recycling process starting from segregation to grinding, dry & wet cleaning, drying and preheating and then pelletising performed by a series of machineries.

One of the recent developments is the recycling of PET water bottles which is widely used in all parts of the country. Mostly fibers, tapes / straps, sheets are manufactured from used PET Bottles by either import or by Indian machineries.

Fibers

- In staple form for fillings e.g., anoraks, bedding, cushions and furnishings.
- Industrial fibres for belting, webbing, scouring/cleaning pads, filters, cleaning cloths and geotextiles.
- Other textiles like carpets, upholstery fabrics, interlinings, protective clothing and other garments.

Straps

- Binding and strapping tapes, mainly for securing bales or bulky articles on pallets.

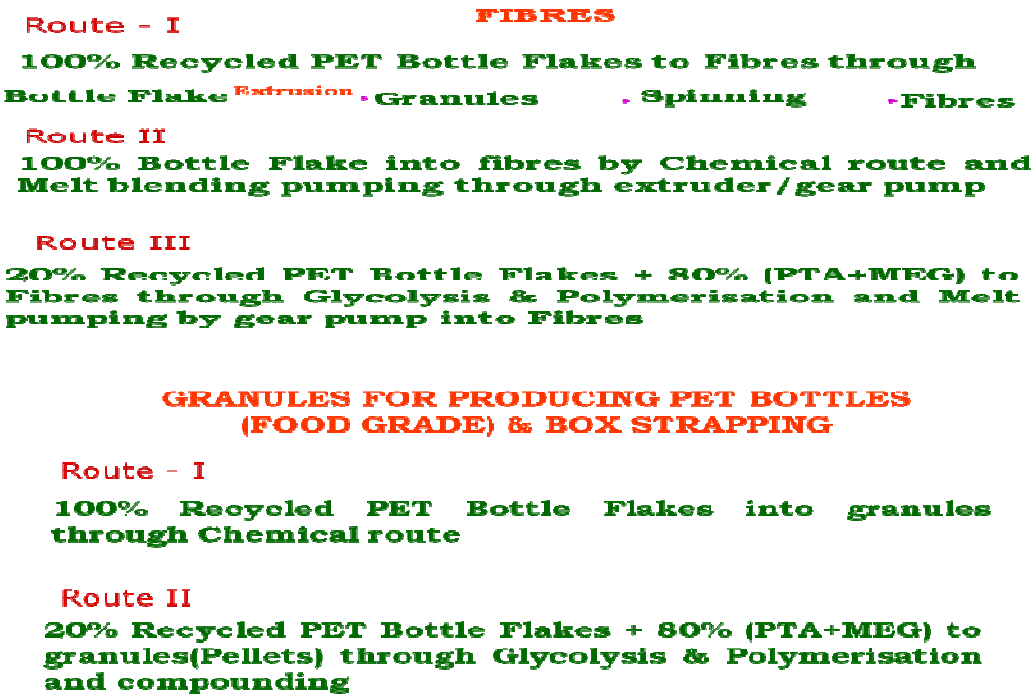
Sheet

- Recycled PET granules can be extruded as sheet for thermoforming applications
- Blister packaging,
- Boxes and Trays,
- Shallow pots and cups.

Blow moulding

- Primarily into bottles for non-food applications

Applications through different routes of recycling PET

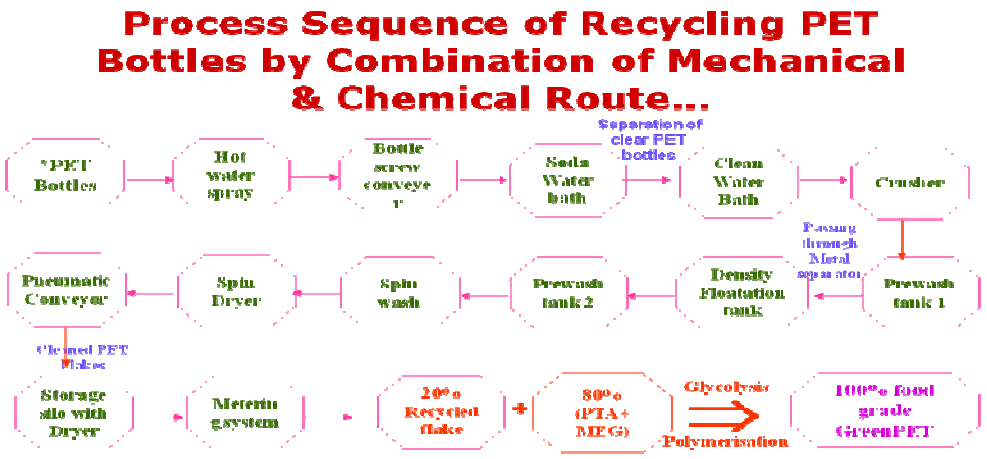


Successful Innovation of an Indian Company in PET Recycling

Unique process developed to produce resin with 80% PTA - MEG and 20% PCR bottles on Chemical Recycling Route, named as GreenPET.

- Combination of Glycolysis and Polymerization with Virgin Raw Materials.
- Final Polymer quality is as good as Virgin Polymer.
- Superior to “Salt and Pepper” approach.
- Process under Patent.

GreenPET has been certified by US FDA & Suitable for High Blow Moulding applications



* *In the developed system labels (paper or PVC), caps, Aluminium based closures, etc., are manually separated.*

Successful Innovation of an Indian Company in Commingled Plastics Waste Recycling

- Unique process developed to produce environmentally Wood substitute *(Chipboard)* for numerous furniture applications, pallets, interior decoration, doors, signages, etc.

- Composition of the product
    - Proprietary process developed by Indian company using multi-layered paper waste polyethylene and aluminum foil to produce wood substitute “Eco” products

Properties of “Eco” *Chipboard*

- 100% termite and borer - resistant, denser than wood, maintenance free
- Excellent insulation and sound proofing quality & can be recycled
- It can be painted, laminated, Polished like other wooden material
- It can be sawn, moulded-cut, glued screwed, etc. like other Wood based board.(high compression strength)
- Thermoformable, Formaldehyde-free
- Resistance to acids, alkalies, solvents and other chemicals
- Cost effective

Comparison ("Eco"Chipboard Vs Conventional wood-based board)

S. No	Property	Plywood	Block Board	Particle Board	Natural Wood	MDF	Eco Chipboard
1	Acoustics	X	X	□	X	□	□
2	Water Resistance	X	X	X	X	X	□
3	Design Creativity	X	X	X	□	□	□
4	Economy	X	X	□	X	X	□
5	Machining	X	X	X	□	□	□
6	Physical Properties	Limited	Limited	Limited	Seasoned	Limited	High level
7	Attractive Surface	X	X	X	X	X	□
8	Termite/ Borer Resistance	X	X	X	X	X	□
9	Stability	Peels	Peels/ Warps	Warps	Contracts/ Expands	Contracts/ Expands	Stable
10	Thermo-formability	X	X	X	X	X	□
11	Compression Strength	Limited	Limited	Limited	Normal	Normal	High Level

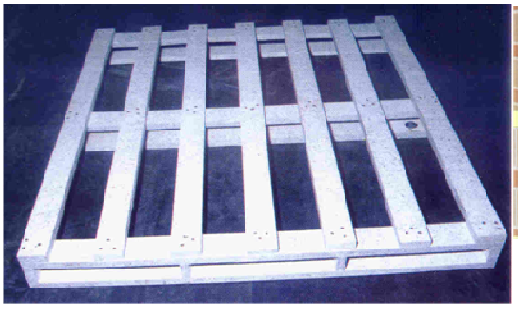
Few Furniture Applications

Interior for Showrooms

Temporary Structures, Such as Site Office, Mass Housing, Rehabilitation Houses, Post, Etc

Economy Doors(Water Resistant)

Highly Durable Poly Pallets



Value added Recycled products from Commingled Plastics Waste

Technology for Mixed Waste Recycling

There are many technologies available internationally which are discussed below.

- Swiss based technology available to convert mixed waste (except nuclear waste) into gas and refined into commercially useful by-products.
- Technologies for mixed waste plastics recycling commingled with non-plastics waste are available Worldwide.
- Proprietary technologies are available from developed countries for recycling a mixture of HDPE, LDPE, PVC, PS, PET (unsorted) and newspapers in the ratio of upto 50%.
- Post Consumer waste(PCW) into plastics wood/ lumber is popular world over with variations in technology.
- Plastics wood lasts more than 25 years and costs 30% less than redwood.
- Recycling of blends is one of the most technologically significant area.

  Few examples are -

- Recyclable blends of either PS or HIPS with 2-30wt% PP, and 5-20 wt% Styrene Ethylene Butadiene Styrene (SEBS), have good impact and flexural strength.
- Blends of PS and Polyolefins (PE or PP) and Styrene Butadiene Rubber(SBR) or block copolymer, were reported recyclable.
- Polystyrene, 10-90% wt% PS, was blended with 10-90wt% Polyolefins (e.g. LLDPE), and 5-40% SEBS (Comprising atleast 50% styrene). The system showed good resistance to impact and yellowing.

Equipment based Sorting Techniques

There are several simple tests that can be used to distinguish between the common types of polymers so that they may be separated for processing. The Technology for automatic separation of plastics-bottles & containers has been very well developed and bottles can now be identified and sorted at rates of over one ton per hour in some cases. In the most typical approaches, the system scans each bottle multiple times, and sometimes with multiple types of radiation (visible light, infrared light, X-ray) as it passes on a rapidly moving conveyor belt. The multiple scans ensure that the plastic has been measured independently from the labels or other non-plastic items, while the multiple types of radiation are used to pinpoint the plastic's chemical make-up. This type of approach requires an identification speed of hundreds of measurements per second. There are over 350 automated bottle-sorting lines in commercial operation in 2004 worldwide. Advanced systems can identify all of the commercially used packaging resins and can sort by colour. Other systems are in place which sort flakes by color and resin type (PVC and PET only today) at rates of over two tons per hour.

Sorting and separation techniques are usually based on chemical, optical, electrical or physical property differences between the various plastics to be sorted. An array of methods are available for sorting post-consumer plastics since no one method can satisfy all the criteria required (i.e. the different polymers to be sorted, purity of the separated streams, production rates, equipment costs etc.). For instance, optical sorting can sort on the basis of colour or transparency but gives no information regarding the chemical identity of the polymer. While, X-ray fluorescence methods

can only sort PVC from other plastics streams. Most physical separation processes for commingled waste plastics rely on exploiting a unique property which the polymer possesses (i.e. density, hydrophobicity, the presence of chlorine) or a specific polymer property which varies with temperature (e.g. melting point, solubility). A successful commercial method for sorting of plastics needs to be fast, reliable, economical and also flexible enough to cope with various forms of contamination as well as colour variation.

In the recent times, NEAR-INFRA-RED (NIR) SPECTROSCOPY has become the most suited technique for sorting. NIR absorption or reflectance spectroscopy is very fast and well suited to analysing transparent or lightly coloured polymers. NIR spectra of common polymers found in the post consumer and post-industrial waste stream are quite distinct (Figure 9).

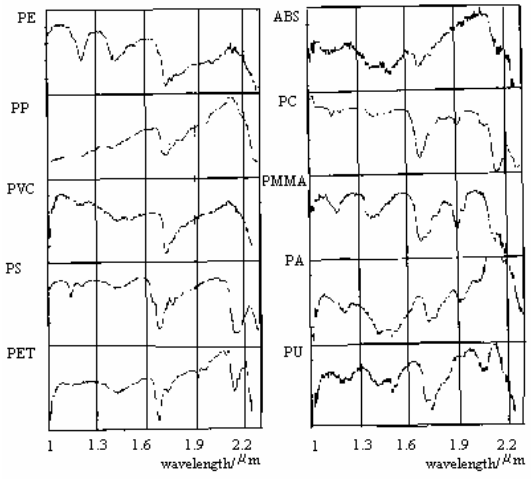


Figure 9: NIR Spectra of common polymers found in the post-consumer and post-industrial waste stream. The spectra were recorded at a scan speed of 150nm/ms. (Courtesy, Fraunhofer Institut Chemische Technologie, Germany).

For this reason, it is ideal for plastic bottle identification and sorting. NIR spectroscopy offers many advantages for sorting waste plastics. It enables rapid reliable identification (within milliseconds) and is sufficiently robust to operate in dirty and vibration-prone industrial environments which are typical of sorting facilities. NIR however, is not well suited to analysis of dark coloured plastics such as automotive components. A processing line based on NIR methodology for sorting of bottles is shown figure 10.

Figure 10: A processing line of the NIR-based plastic bottles sorting system developed by Sydel (France) (Courtesy of Sydel Ensemblier Industriel, France)

The Advantages and Disadvantages NIR-based sorting systems are:

Advantages

- It is possible to use conventional fibre-optics allowing easy and inexpensive remote sampling.
- Portable and robust units are available.
- NIR penetrates deeper into the polymer than Mid InfraRed Spectroscopy (MIR).
- Measurements can be performed in reflectance without sample contact.
- Instruments have no moving parts and can operate in vibration-prone environments.

Disadvantages

- Nature of peaks is not always clear since they are due to overtones and not fundamental peaks.
- Carbon black strongly absorbs and scatters at NIR frequencies making it difficult to probe dark plastics.

An overview of the NIR plastic sorting system developed by the Fraunhofer-Institute for Chemical Technology is shown in Figure 11.

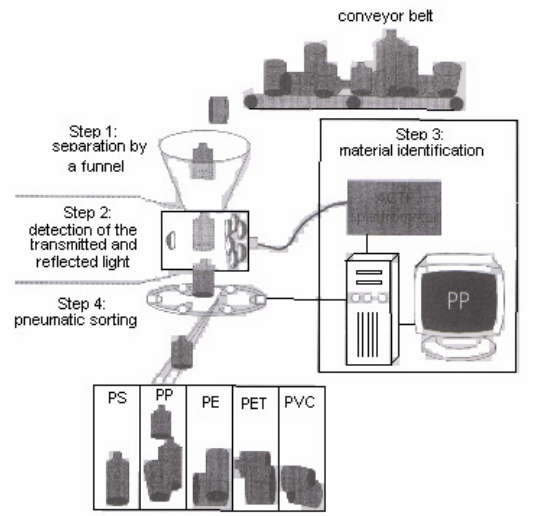


Figure 11: Overview of the NIR plastic sorting system developed by the Fraunhofer-Institute for Chemical Technology, (Courtesy of T. Rohe, Fraunhofer Institut Chemische Technologie, Germany)

Laminate separation by size reduction:

Size reduction processes can be used to separate polymer laminates such as multilayer barrier films, blister packs for pharmaceuticals, tube laminates for toothpaste and printed circuit boards.

A novel process has been devised for separating polymer laminates by mechanical separation of the components in a dry process in which simple grinding of laminates gives only an intimately mixed product that is very difficult to separate into its constituents, high-speed rotation of the laminate material on the other hand, gives a bimodal composition distribution. A system developed by Result Technology AG (Austria) is based on the different behaviour of the laminate materials (say polyethylene and aluminium) when subject to acceleration and vortices in a specially designed unit. The different components adopt varying morphologies after treatment in the accelerator (Figure 12).

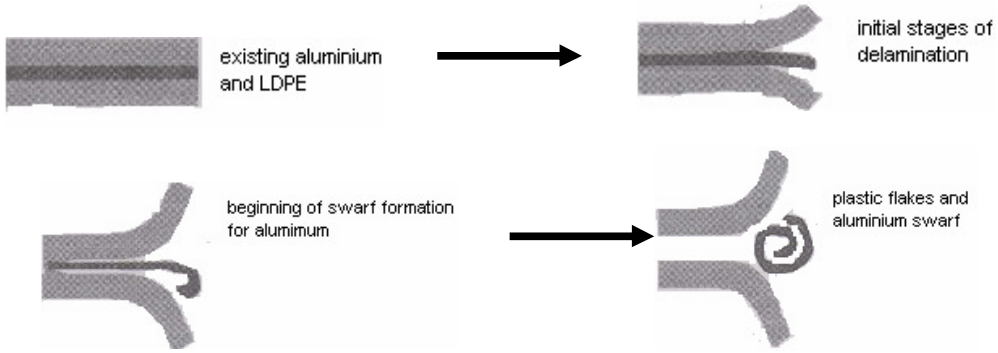


Figure 12: Laminate separation by High-speed rotation in an accelerator (Courtesy Result technology, Austria.)

There are essentially three principle means by which plastic waste can be agglomerated; namely by densifying discs, by compression and by agitation.

Separation of other materials

Melt filtration

Recycled polymers by their very nature are often contaminated with such foreign materials as paper, metal fragments, fibres, glass and incompatible polymers. In view of this, melt filtration systems which can remove such particulate contamination from the polymer, thereby upgrading its value and scope for application. Melt filtration is essential for recycled resins. In blow moulding since contaminants cause frequent `blow-outs' in bottle walls. In injection mouldings they can cause problems by blocking nozzles and also result in surface imperfections in films.

Melt filters can be classified as discontinuous or continuous. Due to the high level of contamination in recycled polymers compared with virgin polymers, continuous filters, capable of uninterrupted operation, are the preferred option. For very highly contaminated materials, continuous operation screen changers with an automatic backflush function have been developed. Latest developments in the area of melt filtration include the so-called laser filters, which comprise hardened steel discs in which laser-drilled holes are made. Such filters can continuously screen contamination from even the most heavily contaminated recycle streams (Figure 13).

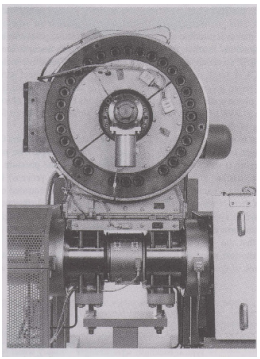


Figure 13: Melt filtration system known as "Laser filter" (Courtesy – Erema, Austria)

XIII FEW STATISTICS ABOUT PLASTICS RECYCLING INDUSTRIES IN INDIA

Central Pollution Control Board (CPCB) and State Pollution Control Boards have been approached to collect the registered information on status of Recycling Industries in the country. Accordingly, Data from Central Pollution Control Board (CPCB) was obtained on the State-wise status of Plastics Waste Management in the country, which is enclosed as Annexure - I. The source of CPCB Report is as on December 2006 and as per the CPCB data, the total number of Recycled Units is 2079.

Apart from the CPCB and industry department data, based on the field survey, the study team arrived at the following statistics for recycling industries in the country:

- Numbers of Organised Recycling Units: **3500**
- Numbers of Unorganised Recycling Units: **4000**
- Major Types of Plastics Recycled: **PE, PP, PVC, PET, PS, ABS,PMMA**
- Manpower directly involved in Plastics Recycling: **around 6,00,000**
- Manpower indirectly involved in Plastics Recycling: **around 10,00,000**
- Quantum of Plastics Recycled per annum: **36,00,000 Tons (3.6 Million Tons)**
- Estimated Investment in Ingenious Plant & Machinery for Recycling Industries (Mostly Tier – I): **about Rs. 150.00 Crores.**
- Future growth Trends in Recycling Technology for Plastics:

  i. PET Bottle Recycling (Conversion in Flake, Pellets and products like box strapping, Fibre, injection moulded products, Extruded sheets, etc.

  ii. Recycling of Automotive parts and reuse as blend with virgin material.

iii. Recycling of E-Waste (Electrical / Electronic / Computers parts.

iv Recycling route for Plastics Waste to Fuel.

v. Energy recovery route from plastics waste (incineration).

vi. Mixed waste recycling.

vii Use of PE&PP waste for Road construction(Concept of bitumen modification by Polymer)

XIV PROPOSED SHORT TERM, MEDIUM TERM AND LONG TERMS OBJECTIVES AND THE TARGETED DELIVERABLES BASED ON WHICH THE RECYCLING TECHNOLOGIES REQUIRED TO BE PROMOTED.

A. Short Term Objectives (Setting up of recycling Plants at major Metros)

As a short term objective, it is proposed that initially 4 Metros & their local bodies (**New Delhi, Mumbai, Chennai & Kolkata**) may be chosen for implementing a model for Plastics waste management by creating facility for Plastics waste segregation, cleaning & conversion into granules by mechanical recycling.

The proposed Intervention could be:

- Training of Metro Corporation Staff in Plastics waste Management, Awareness programmes, publicity campaign in these cities to educate public. The estimated budget would be around Rs 3 crore per Metro. *The awareness & training is essential during the preparatory phase before installation of Recycling plant at Metros.*
- Online plastics waste dry cleaner and separators
- Online plastics wet cleaner
- Plastics dryer
- Agglomerator
- Plastics granulators etc

Technology: Indian

Investment in Plant & Machinery:	Rs. 5.0 crore in each Metro Corporation (20 crores for 4 Metros)
Budget Required for Training, Awareness & Media campaign:	- Rs 3 crores in each Metro (Rs 12 Crores)
Total Duration:	12 month

Numbers of beneficiary: 4 Metro Corporations

Deliverables:

- Effective Waste management of plastics waste at Metros & building up of Public awareness about "Waste into Wealth" concept.
- Quality of Scrap will be improved due the proper cleaning, washing & drying process
- Quality of the second grade material will be improved
- High value from the material may be obtained

B) Medium Term Objectives (Taking up a Recycling Cluster as Model Recycling)

During the study, it was discovered that there are existence of major Recycling Clusters in the country at Dhoraji (Gujarat), Malegaon (Maharashtra), Indore (M.P), Mangolpuri, Babna (NCR, New Delhi), Kanpur (U.P), Dharavi (Mumbai, Maharashtra), Coochbehar / Kolkata (West Bengal).

The study team found that in most of the Clusters, cleaning, washing & drying were performed in unhygienic condition. Although in some cases mechanized cleaning of plastics waste were done still heavy amount of contaminations in the form of mud, sands are left over. **The tank used to wash is maintained in a very unhealthy condition, where people used to clean manually by hand inside the tanks. The water was highly contaminated and no effluent treatment was followed.**

Drying was also done in a huge open field where there is chance of further contamination.

The lumps were made out of these materials by local fabricated machines without proper temperature control, results in degradation due to overheating.

These lumps again travel through a series of machineries all of them are local fabricated machines where no process control involved. *This leads to further degradation and the quality produced are of inferior quality.*

Also the study team came across the following common difficulties, faced by cluster units:

- Shorting is done manually in unhygienic condition
- Cleaning is in very dirty conditions
- Washing is done in a very poor & bad condition.
- Working condition inside the Unit is very bad in terms of hygiene, safety or industrial regulation is concerned.
- Child Labours are employed.
- Inadequate Space for Waste handling, storage.
- Need for Waste Depot at Cluster locations.

A **Common Facility Centre (CFC)** may be setup within an existing cluster, where **Cleaning, Washing, Lumping, Grinding & Drying** can be performed by automatic machines to maintain the quality of the basic scraps. And also by common **effluent water treatment plant** the water can be treated.

It is proposed that Dhoraji (Gujarat) may be selected as the Cluster for Intervention by Government to develop it as a Model Recycling Cluster, which can be subsequently replicated in the other parts of the Country. It will be an eye opener for other industries to adopt similar technology to maintain & retain quality of plastics waste and finished products.

Technology: German / USA / Japan / Italy

Investment: Rs. 25.0 crore.

Total Duration: 2 Years

Numbers of beneficiary: 150-200

Deliverables:

- Water Pollution can be avoided by effluent plant.
- Air Pollution can be avoided
- Industrial health & safety policy can be maintain
- Quality of the recycled plastics granules can be improved.

c) Long Term Objectives (Create Plastics Recycling Park/Zone by allocation of Land alike any Special economic Zones)

With the increase of Plastics Consumption in different end use sectors like Automotives, Electronics, Information Technology (IT) etc, it is foreseen that India has to gear up to tackle the Plastics Waste menace in an effective and organised manner by creating Plastics Recycling Park /Zone in different states of the country. These recycling parks can be developed alike Special Economic Zones (SEZs) by participation of Central & State Government agencies, Local Municipal bodies, Urban Development Authorities, Plastics Industries in Public private Partnership (PPP) mode.

Few of these models exist in the developed countries like Canada, USA, UK, Japan etc. These models can be studied by Government of India delegation. In Japan & China, there are number of Incinerators working for generation of Electricity. These incinerators need to be studied by India & possibility of developing similar models in India could be part of Long term Interventions to promote Recycling Technologies in the Country.

These Recycling Parks can be developed to include all kinds of Recycling technology including Incinerators to generate Electricity. A networking Mechanism of all Recycling Park can be developed and these recycling parks could be administered under a Centralised framework or institutional arrangement. During the study, the stakeholders informed that though the data of plastics waste generation has been reported as very high in different Cities and States of India, however, for high volume plants, the adequate waste cannot be sourced easily by recyclers.

The practical reality of plastics waste generation vis-à-vis available data across the country has mismatch and hence, the massive level recycling plants are not established in the country. One of the suggestions received from the stakeholders is about **creating a national network for plastics waste collection and transportation to the recycling zone or clusters.** It is proposed that the Centralised mechanism created for Plastics Recycling Zone or Park would also be responsible for sourcing the plastics waste from the respective regions / states and a proper warehouse / depot for plastics waste should be available in each Plastics recycling zone or park.

The total investment for creating such Recycling park / zone can be to the tune of Rs.50 – 100 Crores in Plant & Machinery, depending upon the capacity & type of recycling units to be established in the recycling park / zone.

Technology: Germany / USA / Japan / Italy / Poland / Canada
Investment: Rs. 50 - 100 Crores.
Total Duration: 3 Year

XV PROPOSED PRACTICES / GUIDELINES TO BE FOLLOWED IN INDIA

The Indian Plastic Industry has helped formulate standards and specifications for plastics recycling in the country. There are two BIS standards introducing the coding system recycling practices and standards for the manufactures & usage of recycled plastics. The spirit of Municipal Solid Waste rule "MSW 2000" and guidelines for plastics waste recycling need to be enforced in the country to improve the waste management for plastics and to create an effective supply chain to convert plastics waste into useful value added products.

a. Recycled Plastics for the manufacturing of products designation IS:14535

Scope

1. This standard is intended to be used for the identifications of the recycled plastics material on the basis properties and applications.
2. This standard applies to recycled plastics material ready for normal use without any further modifications.
3. Though some modification and methods have been provided in the standard any specific applications shall have to be agreed upon between the purchaser and the supplier.
4. Though this designation system is only indicative of a broad classification of the recycled material, the absolute value of the low results may be provided which shall be agreed to between the purchaser and the supplier.

This standard prescribes guidelines to the manufacturers of plastic products with regard to the marking to be used on the finished product in order to facilitate identification of the basic raw material. It will also help in identifying whether the material used on the end product is virgin recyclate or a blend of virgin and recyclate.

Terminology

End Products

Products made out of virgin, recycled/reprocessed plastics. Typical suggested and products along with use of appropriate types of plastics waste/scrap as per 4 are given in Annex A. A process by which plastics waste is collected, segregated, processed and returned for use.

Classification of Recycling

Plastics recycling technologies have been historically divided into four general types – primary, secondary, tertiary and quaternary. (Discussed in the preceding sections)

- IS : 14534/14535-1998 Introducing Coding System/recycling practices
- Packaging guidelines of Ministry of Environment & Forests (MOEF), Government of India
- MOEF notification "Recycled Plastics Manufacturers & Usage rule" 1999

Recycled Plastics in Packaging – Global View

Introduction – Use of recycled Plastics for specific end uses has been introduced in US as per FDA directives.

A variety of plastics materials are used for food packaging applications. The low molecular weight components such as monomers and additives in the form o f antioxidants, stabilizers, plasticisers, etc. which are used during processing may migrate from the packaging material into the product packed inside and may cause contamination which could be dangerous.
Recycling of plastics may cause further problems of contamination. In view of the seriousness problem which is consistent with its mandate to protect public health.

The legal considerations, recycling procedures, potential problems and the testing methods are as follows:

Legal consideration for use of recycled materials

- Food, Drug and Cosmetic Act
- Food Additive Regulations

Potential problems with recycled Plastics

- Permeability – contamination
- Variety of types/grades of plastics
- Variety of additives.

Need for use of codes for proper segregation of Plastics Waste

The Resin Identification Code System was introduced in 1998 by the Society of Plastics industry, Inc. (SPI) at the request of recyclers around the world. The SPI code was developed to meet recycler's needs while providing manufacturers a consistent, uniform system that could apply across the globe. The codes for different plastics are indicated below

Polymer Type	Polymer Identification Code	Some common examples
Polyethylene Terephthalate		Fizzy drink bottles, water bottles, mouthwash bottles, shampoo and conditioner bottles
High Density Polyethylene		Detergent bottles, bleach bottles, milk bottles
Polyvinyl Chloride		Pipes and fittings, tubing, credit cards, cable sheathing
Low Density Polyethylene		Refuse sacks, bubble wrap
Polypropylene		Bottle tops, syrup bottles, yoghurt and margarine containers, drinking straws, ice-cream containers, flower pots
Polystyrene		Fast food trays, plastic egg containers, hot drink cups, insulation
Unallocated references		Used on items that are made from unallocated polymer blends. Although a 'recycling triangle' is shown, the symbol is used here as a material identification code and does not mean that it can be recycled.

Annexure - I

Status of Units as per CPCB Report

Central Pollution Control Board (CPCB) is co-ordinating with State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) with regard to implementation of Plastics Manufacture and Usage (Amendment) Rules, 2003. The Prescribed Authorities for manufacturing and recycling of plastics are SPCBs/PCCs whereas; Prescribed Authorities for use, segregation, transport and disposal of plastics waste are District Collectors/Deputy Commissioners. CPCB has compiled information relating to implementation of the said Rules and prepared status report on plastics waste management (PWM).

State wise Status of Plastics Manufacturing / Recycling Units (As on December, 2006)

S. No.	SPCBs / UTs	No of Units	No. of Registration Granted	*Comments / Suggestions*
1	Andhra Pradesh	177	177	The Plastics Manufacture & Usage Rules, 1999/2003 are being implemented. Levy of penalties against the violators of recycling Norms are stipulated vide Notification No 25 dated 30.3.2001. The Board is encouraging urban local bodies to segregate waste at source so as to promote recycling. The Andhra Pradesh Pollution Control Board imposed a fine of Rs. 25,000/- each on 16 defaulting units and issued closure orders to 2 units during April 2006 to September 2006.
2	Andaman & Nicobar Islands	Nil	Nil	Plastics Manufacture & Usage Rules re-published by the Administration vide Notification No. 121 dated 5.5.2000. A committee was formed for effective implementations of the rules vide order No. 623 dated 23.7.2004. Administration is organizing regular awareness programmes.
3	Assam	10	Nil	Environmental Awareness programs are being conducted regularly. Bi-lingual publications are brought out by the board regularly. The board is developing Criteria for other plastics products such as ropes, sheets, soap case etc.
4	Arunachal Pradesh	Nil	Nil	The Notification of the Ministry has been circulated to the concerned Department and Deputy Commissioner of the State for compliance by the State Government.
5	Bihar	-	-	Advertisements in local daily newspapers for compliance of plastic rules were

				issued. Inventory is being done. Offices of the State Board have been identified and notified to assist the District Administration for effective implementation of the rules.
6	Chandigarh	9	9	The UT administration has notified the plastic rules vide Notification no. DC/MA/2001/187/dated 14.9.2001. Vide notification No. ED/2003/543 dated 16th September, 2003 the Government has restricted the thickness of plastic carry bags to be not below 30 microns and size not less than 8x12 inches.
7	Chhatisgarh	32	11	Inventorisation of plastic bag manufacturing units has been done. A committee has been formed to monitor the implementation of compliance. Awareness programmes are being organized from time to time by regional offices of the SPCB through media / eco-clubs and NGOs etc.
8	Delhi	147	147	The Delhi Plastic bags (Manufacture, Sale and Usage and Non-bio-degradable Garbage Control Act, 2001 has been brought out vide DOE/2001 /Rules/451 dated 2-11-2001 to manage plastics waste. Vide notifications No. F.B (86)/EA/Env. /2005(ii)/485,486 dated 2.6.2005 & F.8 (86)/EA/Env./2005(ii)/450 on 25th May, 2006, the Government of Delhi has made the degradable plastic carry bags compulsory in all four and five star hotels, hospitals having bed strength of 100 beds and more and restaurants having sitting capacity of more than 50 seats, all fruits and vegetables outlets of mother diary, all liquor vends and all shopping malls. Public notices in Hindi and English newspapers about the plastic rules as well as management of the plastic wastes issued.
9	Daman&Diu	-	-	The Notification of the Ministry republished on official gazette
10	Dadara & Nagar Haveli	-	-	The Notification of the Ministry republished on official gazette
11	Gujarat	200	94	Published public notices in Gujarati and English regarding RPMU rules, 1999 and its amendment in 2003. Gujarat Board has

				organized meetings at various levels to create awareness on plastics and the awareness programmes are organized periodically. The Board has completed the inventorisation. Government of Gujarat has banned the use of plastic carry bags at religious places i.e. at Ambaji, Dakor, Somnath and Dwarka.
12	Goa	125	17	The State of Goa has notified Goa Non-biodegradable Garbage (Control) Act, 1996. In this Act, the major implementer of this Rule is local authority, which has to provide various places/types of receptacles for deposit of "Non-biodegradable, Biodegradable and Biomedical" garbage/waste and also ensure that owners/occupiers of all lands and buildings abide by the regulations under the above-said Act. Notification has been brought out and thickness of plastics carry bags for selling has been raised to 40 microns. Inventory on the units manufacturing carry bags / containers is in progress.
13	Haryana			Plastics Manufacture & Usage Rules re-published by the State. The SPCB has prepared inventory of 106 units so far and it has been reported that all these units are complying with the rules and they are manufacturing carry bags with more than 20 microns thickness.
14	Himachal Pradesh	50	15(12)	The State has notified the Himachal Pradesh Non-biodegradable Garbage (Control) Act, 1995. Under this Act, the Government prohibits using colored polythene carry bags manufactured from Recycled Plastics for packaging goods from 1st January 1999. Subsequently, in 2004, vide notification No. STE-A (3)-2/2003 dated 4.6.2004 the Government imposed a ban on use of plastic carry bags of thickness below 70 microns and size less than 12x18 inches
15	Jharkhand	-	-	The compliance to the rules is being periodically monitored by the State Pollution Control Board. Rules disseminated through Public Notices
16	J & K Kashmir	-	-	Plastics Manufacture & Usage Rules re-

				published by the State Government.
17	Karnataka	302	Nil	Public Notice issued 30.3.2000 & 7.12.2000. Municipalities are also involved in implementation of plastic rules. Reuse of plastics wastes are used in laying of Roads. Inter-state movement of substandard carry bags/ material etc. is restricted.
18	Kerala	193	10	Wide publicity has been given on the restrictions imposed as per Plastics manufacture and usage rules, 1999. State Government notified vide G.O. (P) No. 264/2003/LSGD dated 1.9.2003 prohibiting the plastic carry bags which are less than 40 microns in the State. Also the Govt. of Kerala has formulated an action plan for plastics waste management within the state.
19	Lakshadweep	Nil	Nil	The administration imposed ban on packing and carrying of plastic bags for carrying consumer goods. Notification on "Lakshadweep Sanitation Conservancy Bye-laws, 1998" was issued vide No. 17/2/96-ST&E dated 17.7.1998 to prohibit the use of non-biodegradable materials for packing and carrying consumer goods. Hoardings are displayed at prominent places indicating, "prohibiting littering of plastic waste". Awareness programmes are periodically conducted for phasing out plastic wastes. .
20	Madhya Pradesh	179	83	The State Government has issued orders dated 4.6.2003 declaring authorities for the implementation of the plastic rules as per the original notification. Board has organized wide publicity campaign regarding the provisions of the rules through various means like Articles in newspapers, workshops, leaflets, pamphlets, rallies exhibitions, TV and radio talks. Inventorisation is complete.
21	Maharashtra	-	-	Maharashtra plastic carry bags (Manufacture & Usage) Rules 2006 notified under Maharashtra Non-biodegradable Garbage Control Ordinance 2006 published. Under these, the Govt. of Maharashtra has banned manufacturing of plastic bags below 50-micron thickness

				and size of 8X 12 inches. Maharashtra State Pollution Control Board (MPCB) has taken actions against units, which are non compliant and also issued show-cause notices, directions and subsequent closures, if required.
22	Mizoram	Nil	Nil	Mass awareness campaign organized through publication, distribution of leaflets / pamphlets, by organizing radio, TV talks, seminars and discussions with NGOs and public.
23	Meghalaya	1	Nil	The Meghalaya Prohibition of Manufacture, Sale, Use and Throwing of low-density plastic bags Act 2001 notified. As per this Act manufacture, sale, use and throwing of plastic bags less than 40 micron has been prohibited in the State. Authorities are designated by the Government for the proper implementation of the Rules.
24	Manipur	-	-	Plastics Manufacture & Usage Rules re-published by the State Government during June 2004. Monitoring on the compliance of the rules is being carried out by the State Pollution Control Board.
25	Nagaland	4	4	Plastics Manufacture & Usage Rules re-published by the State Government vide notification no. GAB-9/26/2003 dated 12.11.2003 through which less than 20-micron poly carry bags are prohibited. The Board is also creating awareness on the eco friendly use of plastics through pamphlets etc.
26	Orissa	14	2	Plastics Manufacture & Usage Rules re-published by the State Government. Advertisement are given in the local newspapers to draw attention of the concerned for compliance of these rules. State level awareness programmes are being carried out regularly. Inventorisation of industries has been completed. In the State of Orissa, the use of plastic carry bags has been banned in the municipality area of Puri and Konark with effect from 01/04/2002.
27	Pondicherry	42	8	Pondicherry administration has republished the plastic rules vide G.O. Ms. No. 16/2003/Envt. Dated 1st December,

				2003. Proposing to declare plastic free zone in the town. Also proposed a draft Pondicherry Non-bio degradable Garbage Control Act, 2003. Regular awareness drive is being created.
28	Punjab	-	-	Usages of poly carry bags for foodstuff banned vide Order 8/21/STE (1)/2221 dated 2.11.2000. Inventory of the plastic-manufacturing units completed. Punjab State Council for Science & Technology has introduced a Bill 'Punjab Plastic Carry Bags (Manufacture, Use & Disposal Control) Bill, 2004' which has been cleared by the State Government. This Bill prohibits plastic carry bags below 30 microns & size less than 8x12 inches and has got penalty provisions incorporated in it. Released public notices highlighting the salient features of the Rules in local newspapers for proper compliance. Board has organised several awareness meetings in various districts in the state.
29	Rajasthan	-	-	Vide Circular No. 8(1) PLG/99 1.6.2000 usage of poly carry bags for foodstuff banned.
30	Sikkim	-	-	Usage of poly carry bags for foodstuff banned vide Sikkim Government Notification GOS/UD & HD/97-2000/6 (83)/93 dated 30th March 2001. Regular awareness programmes are being conducted.
31	Tamil Nadu	588	45	Massive awareness drive initiated through publications in newspapers, programmes in TV and Radio, hoardings in prominent places and buses. Also a mobile awareness creations van is in operation. Inventory of manufacturing units completed.
32	Tripura	6	6	The manufacture, sale, distribution and use of virgin and recycled plastic bags and containers are prohibited vide Direction issued by Tripura SPCB dated 1.9.2003. Board has issued number of advertisements in local newspapers to generate public awareness.
33	Uttar Pradesh	-	-	Usage of polythene carry bags for foodstuff banned. Non biodegradable garbage control act notified vide No 2448

				(2)/XVII-V-I dated 1-11-2000
34	Uttranchal	Nil	Nil	A draft of the Uttaranchal plastic bags (Manufacture, Sale and Usage) and non-biodegradable garbage (control) act, 2004 has been prepared by the Board and has been sent to Government for notification. A task force has been created to organize mass awareness programmes. Published advertisements in the newspapers on plastic rules. Efficient collection of plastic waste for recycling is being organized.
35	West Bengal	-	-	West Bengal Government is proposing a non-biodegradable garbage control bill. Plastics Rules Notified. The Board has issued ban orders on the entry, use sale of plastic carry bags in several heritage / tourist places. The West Bengal Plastic Carry Bags and Garbage Control Bill introduced in the State prohibit manufacture, storage, transport and use of plastics made of recycled plastics. Thickness of plastic carry bags should not be less than 20 microns and for cups and tumblers are to be with 40 microns thickness. Board has published advertisements in the newspapers & organised awareness campaigns.

Strategy for Plastics Waste Management

Commonly littered plastic wastes include; polythene carry bags, ,plastic wrappings, thermocole packings, plastic plates, cups, spoons, glass, melamine crockery and other non-recyclable plastics waste such as gutkha pouches, multilayerpackaging, laminated packagings etc. Estimated quantity of plastic waste is 5-10% of total Municipal Solid Waste (1.2 lakh TPD) generation i.e. 6000 tons per day (TPD). It has been observed that in the present Rules, there are no provisions for the disposal of post consumer plastics waste. With the result, plastics waste is littered as road. The waste often chokes open drains as well as make the land infertile. Considering the ill effects and seriousness on the issue, following strategies are suggested to tackle the menace.

Issues of Concern	Strategy
Production of sub- standard plastic products	Regulation of sub- standard plastic products
Multilayer, laminated and thermoset plastic wastes are not recyclable	Banning or alternate to non-recyclable plastic packaging
Improper recycling without environmental consideration	Improvement in recycling mechanism
Improper regulatory mechanism	Stringent action against defaulting units
Inadequate and unsustainable plastic waste collection and disposal mechanism. (Only 50-60%	Promotion of alternate options for collection and disposal of plastic waste such as use in road construction, conversion into fuel oil, use in blast

thermoplastics plastic waste is recycled)	furnace/cement kilns, densification, baling e

ANNEXURE - II

QUESTIONNAIRE ON RECYCLING OF PLASTICS WASTE (TYPE OF TECHNOLOGY ADOPTED)

1) Name of the Industry (with complete postal address, telephone and fax nos., Email and Website details) _____

2. Name of the Chief Executive (with designation) _____

3. Type of recycling technology being adopted _____

   a. Conventional Mechanical Recycling _____

   b. Modern Mechanical Recycling with Die face cutter _____

   c. Name of Material being recycled _____

   d. Applications / End use of recyclates _____

4. Name of machine/plant manufacturer _____

5. Plant production capacity (maximum) _____

6. Percentage utilization of plant capacity (efficiency) _____

7. Foreign collaborator, if any (Name and address) _____

8. Give product range and end user details _____

9. Total investment in plant and machinery (in US $ / in Rupees) _____

10. Type of Chemical recycling, if used. _____

    a. Chemolysis, Methanolysis, Glycolysis (for PET) _____

    b. Feed stock recycling (Pyrolysis, Hydro- _____

generation, gasification) for conversion of polymer into basic raw materials / monomers _____

c. Commercial viability _____

11. Incineration – Energy Recovery, if used _____

a. Type of Incinerator and capacity _____

b. Type of emission controls used _____

c. Total energy generated _____

d. Energy Consumption _____

e. Commercial viability _____

f. Environmental norms/clearance details _____

g. Name of foreign collaborator, if any _____

12. Type of assistance immediately required by the industry in recycling and plastics waste management areas (please describe in details) _____

Annexure - III

Minutes of the Eastern Regional Stakeholder Meeting held on June11, 2008 at IPF Conference Hall, Kolkata under the Chairmanship of Mrs. Asha Rani Rungata Dy. Secretary (Finance), DCPC, Govt. of India

List of participants attended the meeting is enclosed as Appendix A.

CIPET is carrying out three Feasibility studies at National level under the New Schemes on Petrochemicals as a follow up of National Policy on Petrochemicals. As part of consultations in different regions of the country, Stake Holder meetings are being organized by CIPET to get the feedback /suggestions/views.

The Eastern region meeting was held at Conference Hall of Indian Plastics Federation (IPF) Kolkata on June 11,2008. The meeting commenced with Welcome address by Shri Seksaria, President, IPF, Kolkata. R.K. Dwivedi, coordinating the studies from CIPET made a presentation on the following three Feasibility Studies awarded to CIPET and the activities undertaken by CIPET so far:

i) Promotion of Recycling Technology for Post Consumer Plastic Waste.
ii) Fixation of Quality Standards for Plastic Products.
iii) Testing Centres as certifying Agency for Testing of Plastic Products and raw material – Augmentation and Promotion.

He apprised about the information collected by CIPET through the Field Survey/work by a dedicated study team of CIPET, particularly on the present status of recycling Industries in different regions of the Country. It was informed that the Field study revealed about the existence of Major recycling Clusters already operating in Dhoraji (Gujrat), Indore (M.P), Malegaon (Maharashtra) etc. from where the Study team collected useful data on the status of Technology as well as operating mode of these Units.

In the presentation, information about the Terms of reference (ToR) of the Studies on Testing Centre and Fixation of Quality Standards was shared and Mr. S.K.Choudhary, DDG (Retd from BIS) was introduced who has been assisting CIPET on these Studies.

The observations made by NABL on the Plastics Testing methodology by different Labs was also indicated in the Presentation. A list of products identified by CIPET team for Fixation of Quality standard was also presented for further deliberation by the Stakeholders.

As per the agenda for the meeting, Chairman asked Mr. R.A.Lohia, IPF to give presentation on the Recycling Industry status in Eastern region. Mr. Lohia gave a presentation with input given on the work done by IPF and Jadavpur University in developing Pollution free recycling technology, as part of Project from CPCB. The statistics on Recycling industries was presented by Mr. Lohia and a video film on Source segregation of Waste by Cooch Behar Municipality was screened for the participants.

After the presentations, Mrs Asha Rani Rungta, Chairman requested stakeholders to put forth their valuable views as part of the Agenda of the meeting. She stressed the need for a frank and free flow of information from Industry, so that a realistic view & finding of all studies can be presented by CIPET in the Final reporting.

On deliberation, the following views/suggestions expressed by the Stakeholders:

1. *Technology Levels of most of the recycling clusters are low end, needs to be improved by up gradation and skill training of employed workers.*

2. *Implementation of MSW 2000 rules in true spirit.*
3. *Allocation of dedicated Land by Govt. for "Plastics recycling" zone.*
4. *A widespread PR campaign for popularizing concept of "Plastics Waste into Wealth "approach.*
5. *Mr. Tibrewal from IPF mentioned, in particular, the need for an Institutionalized framework for Plastics waste collection across the country by a Central monitoring agency. This is an emergent need because though we talk about volumes of waste littering in the country, but reality is for a world class Recycling operation with huge volumes are not successful in India because of non availability of Waste, due to improper collection system. It was also discussed that due to littering, around Railway Track across the country, a large chunk of plastics waste is not being collected, becomes eyesore.*
6. *Need for evaluation of alternative technology such as Waste to Fuel or use of waste in road construction.*
7. *Need for providing better Working environment in the available Clusters and create Hygiene in these Recycling Centres.*
8. *Economic support to recycling Industries like exemption of Excise duty.*
9. *For testing & quality standards, Mr. S.K.Choudhary informed that we need to look at TBT issues under WTO. He further, suggested that for non standard item, CIPET can act as certifying body based on validated test methods. Mr Choudhary outlined the significance of NABL certification for Testing laboratories.*
10. *It was suggested that there is a need to change the Indian Philosophy of discarding recycled items as inferior quality products. If the recycled products meet the end property requirement as per the desired specification/standard for a particular Product, then issue of Virgin vs Non virgin recycled material should be considered insignificant.*
11. *Over the past few years, PET recycling has emerged as an organized Industry with better quality output and helped in clearing littered PET bottles waste across the country. The stakeholder from PET recycling Industry , Mr. Saurabh Khemani desired that if their output meets the criteria of Performance and properties as per BIS or any other International Standard, then the Testing Labs should not have hesitation in certifying their products, merely due to its production route being "recycling".*
12. *Mr. Choudhary stated 4 parameters- Performance, Health / safety, Environment & Security are the basic parameters for any product certification.*
13. *The examples of Coochbehar district in West Bengal, Suryapet in A.P, in some parts of Mumbai, Chennai, etc for source segregation required to be propagated.*
14. *A nationwide campaign to popularize 'Zero Waste by recycling" to be launched by Govt & Industry jointly.*
15. *An important issue raised during the deliberation was pertaining to User Industry of Plastics packages in different Industry, & consumer segment. These User segments to be pursued for proper disposal of Plastics waste and to bring into proper recycling route.*
16. *The Municipalities/Metro corporations have responsibilities to provide Land, Water & power to recycling Industries as their mandate to do Waste management.*
17. *The recycling Industries should be Recognized and efforts to be taken to bring in them at par with normal Industry recognition.*
18. *On PET recycling, the stakeholders expressed views that these Units are involved in the organized manner and they find difficulty in getting the PET bottle waste and go for imports of waste. These Units represented for Concession on CVD, VAT etc as encouragement for the Recyclers.*

Chairman expressed satisfaction on the exchange of views and suggestions from all participants. She desired that CIPET should consider the suggestions/views of the stakeholders, which should form part of the Study reports. On compilation of draft Report, the same can be circulated amongst all Members and comments may be invited before finalization.

While summing up, Chairman requested that all members present in the meeting may send their comments, suggestions, and inputs to CIPET as soon as possible.

Mr. Seksaria, President, IPF, thanked Chairman for giving the opportunity for expressing their views and involved IPF in the consultation process of all studies carried out by CIPET.

Mr Rajesh Motha, Secretary, IPF proposed vote of thanks to Chair and all invitees.

Appendix A

LIST OF PARTICIPANTS

1.	**Smt. Asha Rani Rungta**	**-**	**Dy. Secretary (Finance). DCPC, Govt. of India**
2.	Shri A. K. Agarwal	-	Dy. Indl. Advisor, DCPC, Govt. of India
3.	Shri S. K. Chaudhuri	-	Former DDG, BIS, New Delhi
4.	Shri K. K. Seksaria	-	President- IPF, M/s Uma Plastics Ltd.
5.	Shri Amar Seth	-	Vice President – Plastindia Foundation - M/s Rajda Sales (Cal) Pvt. Ltd.
6.	Shri S. K. De	-	Dy. Director, CIPET, Haldia
7.	Shri R. K. Dwivedi	-	Chief Manager (TBD), CIPET Corporate, Chennai
8.	Shri Rajesh Mohta	-	M/s Mahabir Plastic Industries
9.	Shri R. A. Lohia	-	M/s Neha Impex Pvt. Ltd.
10.	Shri Sourabh Khemani	-	M/s National Moulding Co. Ltd.
11.	Shri K. M. Tibrewala	-	M/s Tib Creations Pvt. Ltd.
12.	Dr. S. N. Yadav	-	Manager (P/T), CIPET Bhubaneswar
13.	Shri U. Mukherjee	-	Manager, CIPET, Haldia
14.	Shri Jayant Goenka	-	M/s Polyplastics & Industries
15.	Shri K. K. Mohasathan	-	IPF, Kolkata
16.	Shri J. Pain	-	General Manager, Reliance Indus. Ltd.
17.	Shri T. K. Das	-	General Manager, Reliance Industries Ltd.
18.	Shri P. V. V. Prasad Rao	-	CTTC, Kolkata
19.	Shri Kanakendu Das	-	CTTC, Kolkata
20.	Shri M. C. George	-	Indian Oil Corpn. Ltd., Kolkata
21.	Shri R. V. Prabhu	-	Indian Oil Corpn. Ltd., Delhi
22.	Shri D. Khastagir	-	Indian Oil Corpn. Ltd., Kolkata
23.	Shri Santanu Das	-	Haldia Petrochemicals Ltd.

Minutes of the Southern Regional Stakeholder Meeting held on 13th May, 2008 at Hyderabad under the Chairmanship of Shri. Yashvir Singh, Dy. Secretary (PC), Govt. of India

List of participants attended the meeting is enclosed as Appendix – A.

The three Feasibility Studies have been awarded to CIPET under the New Schemes on Petrochemicals as a follow up of National Policy on Petrochemicals. Shri R.K. Dwivedi, CIPET made a presentation on the following three Feasibility Studies awarded to them and the activities undertaken by CIPET so far:

iv) Promotion of Recycling Technology for Post Consumer Plastic Waste.
v) Fixation of Quality Standards for Plastic Products.
vi) Testing Centres as certifying Agency for Testing of Plastic Products and raw material – Augmentation and Promotion.

He introduced the Study team members drawn from CIPET centres for carrying out Field Survey/work for collection of Primary data for all the three studies.

2. In the promotion of recycling technology for post consumer plastic waste CIPET has initiated the nation-wide survey on status of existing recycling industry. A Questionnaire has been formulated and circulated to various plastic manufacturers associations namely AIPMA, ICPE, GSPMA, IPF, PLASTINDIA Foundation and also to various regional associations through the Internal Study Team of CIPET.

3. The questionnaire focused on the technology adopted, plant capacity etc. The members of the study team have collected information from the major recycling centres in the country. As per the preliminary data collected, the following technologies are being used / adopted in India, which can be broadly classified into 3 different categories:

1) Low end mechanical recycling of Plastics waste (Consumer waste of all type of commodity plastics products mainly of PE, PP, PVC)- Crude methodology and improper system of Cleaning, Washing.
2) Technologically well developed PET bottle recycling by mechanical route to convert into Flakes, Pellets, Fibres, etc., Mechanical recycling of Engineering Plastics particularly used for automotive products, Recycling of E-waste (Plastics components), Mixed waste recycling (Lumbers, Wood-substitute products)
3) Technology for Plastics Waste to fuel –Under commercialization & validation stage from Imported & indigenously developed process, Use of PP & PE waste(mostly Film/packaging waste) for road construction (on the concept of "Polymer modified bitumen")

Technically major options for recycling of plastic waste are Mechanical recycling, Mixed waste recycling, Chemical recycling and Incineration to generate energy, out of which in India most commonly used option is Mechanical recycling, which is nothing but a Plastics Extrusion Process to produce strands, which are cut into pellets/granules. A combination of Chemical & mechanical route is used by a company for PET waste, based in Chennai.

4. During the survey CIPET encountered difficulty in convincing the Recyclers for filling up the Questionnaire for collection of data, as they are operating in an informal or

unorganized sector. It was understood that many of the Units are not registered as well. As per the preliminary assessment, there are about 4,000 units engaged in recycling (data based on CPCB, State PCBs, Field survey and Association information in the respective regions), and have provided employment to about 5 lakhs persons. Most of recycling industries are of Low end (As indicated above at Sr No. 1) with technology gaps, Labour intensive and poor hygienic condition during Waste handling from Scrap yard to washing, cleaning, drying stages.

5. During the deliberations, suggestions were made to make the existing BIS guidelines on recycling compulsory throughout the India and facilitate compliances of the regulations. Mr. Vijay Merchant, Chairman, Plastindia Foundation Environment and Plastic Image Committee informed that example of China to be an eye-opener for India, wherein, Recycling Industries have been developed alike Plastics Processing Industries.

6. He was of the opinion that there may be more than 10,000 recycling units across the country including unregistered Units with no records as per Governmental census. Chairman requested Mr. Vijay Merchant to give his input for the study with an Approach paper/note.

7. Mr. Swaminathan from Tamilnadu Plastics Mfrs. Association (TAPMA) expressed that terminology of "Post Consumer Waste" related to a particular segment. It was clarified that the term used covers all Plastics waste, which comes into waste stream from consumers as well as from Industry. He suggested that ToR of the study may include social issues as well.

8. Mr. Anil Reddy, President, Andhra Pradesh Plastics Mfrs. Association (APPMA) & Mr. Anil Kumar from a local recycling unit remarked that Government may consider supporting the sector by providing few incentives, promotional measures for export promotion etc.

9. One of the suggestions from participants was to create Common Facility Centre (CFC) for cleaning, washing, drying in the identified Cluster of recycling Industries. A video on the Recycling Cluster in Dhoraji region (Gujarat) was screened, wherein the Recycling Industries started way back in 1975 by recycling of PVC scrap .In this region alone, about 200 recycling units are working with total capacity of about 60 KTA ,employing direct labour of 5600 persons and indirect workforce of about 35,000.

10. It was decided that as per Terms of Reference (ToR), a roadmap with potential areas of intervention by Govt. of India may be proposed with authentic data and status based on the field survey.

11. In the study on fixation of quality standards, CIPET is interacting with its centres engaged in testing for identifying the existing standards, amendments needed and new products for which BIS standards needs to be put in place. As CIPET's officials are in different Sectional Committees of BIS, they are compiling the status of the standards of plastics products (BIS) as well as on the international level.(ISO,ASTM etc.) They have identified till now few products for which there are no quality standards from BIS. They have also planned a meeting with BIS in the first week of June to get the feedback on these products.

12. On the augmentation of promotion of testing centre for plastic products and raw material CIPET has formulated a questionnaire for identification of status of various plastic testing centres, NABL accredited laboratories and the testing activities, facilities available. Review meetings were held by CIPET with Sriram Institute, CPRI, IIP, etc. for assessing different tests under use for testing and the status of private testing centres, who are operating in the area of testing of plastic products. They will be identifying various testing requirements and the facilities needed for upgradation, internationally reputed best practices etc.

13 During the discussion the suggestion was to explore the possibility to have setting up of Central Facility with high and testing. This could be in one or two places in India with State of Art testing equipments. The samples could be sent there for facilitating the diverse requirement of the entrepreneurs both in the finished product as well as raw material testing. It was also noted that such testing facility should have the minimum required time for testing so that the industry utilizes the facilities. In the evaluation of existing testing laboratories they should take into account regional testing centres under the Ministry of Micro, Small and Medium Enterprises (MSME) and the testing labs available for plastics in agriculture.

14. While summing up the deliberations, Chairman desired that all members present in the meeting may send their comments, suggestions, inputs to CIPET on all the three studies as per the ToR and their scope, which will facilitate in preparation of realistic Study report with facts and figures and a defined roadmap.

Meeting ended with a vote of thanks to the Chair.

Appendix - A

List of participants attended to Regional Stakeholder Meeting held on 13th May, 2008 at Hyderabad

1.	Mr. Yashvir Singh, Deputy Secretary to Govt. of India, DCPC	Chairman
2.	Dr. T K Chakravarthy, Joint Industrial Adviser, DCPC, Govt. of India	Member
3.	Dr. R K Pradhan, Sr. Research Officer, Planning Commission, Govt. of India	Member
4.	Mr. Vijay Merchant, Chairman, Plastindia Foundation Environment and Plastic Image Committee	Member
5.	Mr. B Swaminathan, Executive Secretary, TAPMA	Member
6.	Mr. Anil Reddy, President, APPMA	Member
7.	Mr. Anil Kumar, Proprietor, M/s. Ajay Pet, Hyderabad	Member
8.	Mr. P Poomalai, Deputy Director, CIPET Hyderabad	Member
9.	Mr. R K Dwivedi, Chief Manager (Technology & Business Development), CIPET Corporate	Member
10.	Mr. P K Sahoo, Chief Manager (TS), CIPET Ahmedabad	Member
11.	Mr. S N Yadav, Manager (P/T), CIPET Bhubaneswar	Member
12.	Mr. A S N Murthy, Sr. Technical Officer (P/T), CIPET Mysore	Member
13.	Mr. B Rajamalliah, Technical Officer (P/T), CIPET Hyderabad	Member
14.	Mr. Shamsuddin, Technical Officer (P/T), CIPET Hyderabad	Member