TRENDS IN PLASTICS PACKAGING: THE ECOLOGICAL ASPECTS

Packaging is one major field of application for plastic materials. Packaging may be defined as "a means of ensuring the **safe delivery** of a product to the **end consumer** in **sound condition** at the **minimum overall cost**".

Why Plastic Packaging?

Plastics, being synthetic materials, can be **tailor-made** to meet specific or combination of performance requirements of packages.

From packaging point of view, some of the distinct advantages that the plastic materials offer are:

- They are very **light in weight.**
- They are **non-toxic** and absolutely safe to use even in direct contact with food products, medicines, etc.
- They have **excellent barrier properties** towards oxygen, moisture and gases to achieve the anticipated shelf-life for products to be packed and also protect their flavours or aromas from loss through permeation.
- They are **resistant to most chemicals**.
- They **can be sterilized** by all the conventional methods.
- They can be processed to **any desired shapes and forms**, like
  - Flexible – film/pouch
  - Semi rigid – tube
  - Rigid – sheet/bottle/crate, etc.
- They **can be transparent and clear as glass**, e.g. PET, Polystyrene and Polycarbonate containers.
- They are sturdy and safe-in-use, because they **do not break easily** and even if they break, the broken pieces are not harmful as those of glass and metal.
- They **do not corrode** in humidity.
- They **do not promote any bacterial growth.**
- They result in effective **cost saving in the storage and transportation**, because of lower volume and lesser secondary packaging.
- **Various methods for closures and dispensing** are available.
- Even the **smallest unit packs such as sachets** are possible, thereby providing an economical and safe pack to weaker sections of the society.
- They **can be made pilfer-proof**, tamper-evident and child resistant.
- They **require the lowest energy for conversion.**

Thus, **plastics definitely score over all other packaging materials**. It is needless to mention that if they are used sensibly and judiciously, they should not pose any disposal and ecological problem.

Table 1 below gives the consumption of packaging materials.

TABLE 1

Consumption of Major Packaging Materials (in metric tonnes)

	1999-2000	2004-2005 (Estimated)
Paper & Paperboard	16,00,000 (34%)	24,87,000 (40%)
Jute/Hessian	15,00,000 (32%)	15,00,000 (24%)
Glass	8,00,000 (17%)	10,20,000 (16%)
Plastics	5,92,062 (12%)	9,24,806 (15%)
Metals	2,48,000 (05%)	2,88,000 (05%)
	47,40,062 (100%)	62,19,806 (100%)
Wood (in million cu.m)	7.8	7.8

At present, plastics account for about 12% of the total quantity of major packaging materials, which includes paper and paperboard, jute/hessian, glass, metals (Tinplate Steel & Aluminium), besides plastics. It is estimated that **by the year 2004-2005, plastics will account for about 15%** of the total packaging materials and obviously, expected to take some market share or applications of other conventional packaging materials, like glass and metals.

With the Government's liberalization policy and emphasis on exports, the demand for plastics packaging is bound to grow further. There is no doubt that plastic packaging is going to play a very significant role in the years to come. As a result**, India's per capita consumption which is around 4 kgs** at present, **compared to world average of about 20 kgs,** is expected to reach a per capita consumption level of **6 kgs by the year 2005-2006.**

Environment Related Issues

Important environmental issues, which directly impinge on packaging to varying degrees are:

- **Solid Waste Disposal**
- Ozone Depletion
- Air Pollution
- Water Pollution (in particular, ground water)
- Sea & Ocean Pollution
- Litter
- Depletion of Non-renewable Resources

According to the OECD (Organization for Economic Co-operation & Development) statistics, packaging accounts for

- 20.8% **of all waste**
- 2.0% **of gaseous emission**
- 1.5% **of water consumption**
- 3.7% **of energy consumption**

However, in India, following are considered to be the major problems related to packaging, particularly, plastics packaging.

Indiscriminate Littering

Packaging in general and plastics packaging in particular, has become a matter of concern because of its **high-visibility** all around and **eye-catching** colours, which attract attention of the people.

As a result, by promulgating some r**ules**, number of Municipal Corporations or States in the country have tried **to curb the use of thin plastic carry-bags,** which is identified as the main culprit for all our civic problems. Although most of the places it has not been effectively implemented, the Central Government has now issued a notification banning the use of plastic carry-bags which have a thickness of less than 20 microns.

Undoubtedly, in India waste is littered, instead of being disposed properly, to facilitate collection and recycling. Littering is, in fact, an **attitudinal problem of the people** rather than any problem with the plastics material.

A Major Source of Municipal Solid Waste (MSW)

It is true that packaging contributes to Municipal Solid Waste, but definitely, plastic does not make up a very large part. As per a published report of Brihanmumbai Municipal Corporation (in 2000), which handles more than 6,500 metric tonne MSW per day, shows that **plastic waste is only 0.75%.**

Even in Europe and U.S.A. with per capita consumption of plastics at over 50 kgs per annum, plastic waste makes up only 8% of the total MSW. The rest is made up of organic materials (33%), paper & paperboard (30%), glass and metals (16%) and others (13%).

One must appreciate that plastics make a significant contribution by **reducing the weight and volume of materials** that are typically thrown away.

A study conducted by the "German Society for Research in the Packaging Market" shows that **if plastics packaging were replaced with other materials, the weight and volume of disposables would increase approximately by a factor of 4 and 2.5 respectively, along with twice the level of energy consumption and double the cost of packaging.**

Plastics are not Bio-degradable

In general, **all man-made products,** during manufacture, processing and disposal, **have an impact on the environment.** It is, therefore, necessary to understand, which of these products or packaging materials will impose the least burden on the environment.

Other materials, like tinplate, aluminium and glass are also not bio-degradable. The materials of composite containers, like plastic coated paper, cups also do not bio-degrade easily. Bio-degradability cannot be sole criterion for selecting a packaging material, e.g. wood is a natural and bio-degradable material, but its use for packaging application is discouraged, because cutting timber or deforestation would cause more harm to the environment.

Plastics Packaging: Should it be Replaced?

The wide spread belief that **substitution of plastics with paper** is more favourable to the environment needs to be **supported by facts and a Life Cycle Analysis**.

The **manufacture of paper bags requires two-and-half times the energy** as compared to plastic bags of the same size and for comparable performance.

A stack of, say, **2000 paper grocery bags** will have a height of about **7.5 ft. compared to 7.5 inch height** of equal number of **plastics grocery bags**, which means that transportation and storage of empty paper bags are also likely to be more.

It also **produces significantly higher air pollution**. There is a huge disparity in **waste water discharge** in manufacturing or recycling of paper.

As far as **bio-degradability** is concerned, the University of Arizona study shows that the newspapers buried in 1952 were legible. The same observation was made even with the telephone directories. In short, **bio-degradation in buried land-fills is a very slow process** (sometime more than 15 years).

Some may argue that **paper is manufactured from wood,** which comes from trees, and is **a renewable resource**; **while plastic is manufactured from mineral or petroleum oil**, which is **non-renewable**. Against this, the counter-argument would be that the **forests play an important role in protecting soil erosion** and more importantly, maintaining the right proportion of gases or **the gaseous balance in our atmosphere**, by absorbing carbon-dioxide and releasing oxygen.

From the available statistics, it is observed that **for making 1 metric tonne of paper, 17 trees are required** as raw material and in our hunger for wood, **44 million hectares of forests have already been felled** since our independence, making this country a land with **one of the lowest areas under forest cover**, i.e. area under forest to total land area. Therefore, under these circumstances, it may not be a wise decision to substitute all plastics packaging with paper-based packaging.

Even compared with glass, for many applications, plastics packaging may be considered as more economical. A classic example is the light weight **stretched blow moulded PET bottles** for soft drinks or mineral water. A **truck can carry 60% more water with 80% less packaging,** as compared to glass bottles. This also results in fuel savings of almost 40%.

The ratio of product weight packed to the weight of package is the highest for plastics packaging, e.g. for packaging 500 grams coffee powder, the average weight of a

Glass Jar	= 500 grams
Tinplate Container	= 130 grams
Plastic Laminated Pouch	= 12 grams

One kg common salt is packed in a plastic pouch weighing only 5 grams where the ratio of product weight to package weight come to 200:1.

Therefore, **plastics packaging enables to get 'more out of less'.**

Making Packaging Eco-friendly

It is not only product itself **but packaging too, which is required to be environment-friendly or eco-friendly.** However, environment-friendliness is **not in absolute terms, but in relative terms.** It means that among the alternative packages, the **one, which makes least harm to the environment**, will be considered as 'eco-friendly package'.

Present endeavour all over the world is to **use packaging media generating minimum solid waste, more easily reprocessable, recyclable or bio-degradable.** The aim is to :

- **Use more "Non-waste Technology", i.e. the technology which reduces waste to the barest minimum,** e.g. solvent-less lamination, and
- **"Manage" the packaging waste and not just dispose it off.** The proper and **effective waste management system** is expected to help in not only **improving our environment and eco-system**, but also in **helping resource and energy conservation. The long-term goal of the global waste management is to keep the land-fill amount within 10%.**

In this respect, the industrialised countries have already taken a number of initiatives. Germany had introduced an **Ordinance on the Avoidance of Packaging Waste** in 1991, by which manufacturers and distributors had been obliged to take back used or post-consumer packages and adopted **"polluter pays"** principle. **European Union (EU)** had also issued **2 major directives** to its member countries in 1994 related to packaging, namely **General Packaging Directive and Plastics Directive**. In all these, **major thrust is on 3 R's, i.e. Reduce, Reuse and Recycle.**

It is worth noting that no country in the world has yet completely banned plastics for packaging applications. Of course, some countries have restricted the use of particular type or some kinds of plastics packaging; but that is done purely on the basis of non-availability of local recycling facilities.

In the advanced countries, though bio-degradable plastics are available for decades, considering economy and long-term degradation process, its use has neither been made mandatory nor become very attractive. Other kinds of degradable plastics packaging materials including **Water Soluble Films**, which are available in India too, are also being **used in a very limited manner.**

For minimizing packaging solid waste, the present trend is to follow the priorities given below.

Avoidance or No Packaging

It means elimination of package or packaging materials, wherever possible. For example, a secondary pack made of EPS, i.e. expanded polystyrene used for packing a glass bottle (primary pack) is either eliminated by using a plastic bottle as primary pack or substituted by paper-based honey-comb board, where there is a restriction to use plastic foams.

Consumable Packaging

The idea is to eliminate completely the possibility of generating packaging waste, if not the package itself, e.g. instead of using the conventional metal drum, if suitable plastic bags are

used for packaging of tar or asphalt, these can be consumed 100% at the time of using the product. In fact, it may improve bonding character of the product.

Reduction or Optimum Packaging

It means reducing or optimising packaging materials at source. This is achieved **in terms of weight or volume** of packaging materials through an alternative material or improved design, but without sacrificing product quality. For example, the weight of a 200 litre drum can be drastically reduced by changing its packaging material from steel (weighing 20-22 kg) to HDPE (weighing 8.5-9.2 kg).

It is worth noting that, of late, product packers have moved to plastics in order to achieve a decrease in packaging weight. This trend is likely to continue. One should appreciate that **'weight is cost'.**

Even without changing packaging material, improvements in resins/technology have enabled down-gauging to achieve source reduction in number of cases (Refer Table).

Plastic Packaging	Original Weight/Thickness	Current Weight/ Thickness	% Source Reduction
• PET Bottles			
1.5 litre	66 gram	42 gram	36%
2 litre	68 gram	51 gram	25%
• HM-HDPE Bag	47µ	25µ	47%
• Yogurt Cup	12 gram	5 gram	58%

Change over from **rigid to flexible packaging** also ensures reduction at source. In general, **flexible packaging generates 60-90% less waste** than rigid containers.

Some of the **common approaches followed to reduce package weight** are :

- Changing design and construction/designing light-weight shapes
- Using materials with higher performance
- Marketing refill/recharge units
- Introducing product concentrates or re-designing/re-engineering
- Choosing a package type considering weight/volume ratio and total volume
- Limiting production tolerances
- Choosing processes that allow less material
- Light-weight packages without changing appearance

Reusable, Returnable or Refillable Packaging

Some type of packages are being returned for reuse or to refill the products number of times, e.g. plastic crates, containers (like large milk cans), pallets, etc. This is done primarily to avoid generation of solid waste.

To ensure return of the packages, if necessary, a 'deposit scheme' or any other suitable scheme may be introduced. Of course, at times, cost of collection, transportation back to the filling station, cleaning of used packages, etc. may not be economical.

Recycle Packaging

The **recyclability of a package** or the **use of recycled content** in the package is considered to be the most desirable alternative all over the world now from an environmental stand point.

In the first case, the package is designed or selected on the basis of **easy and economic recyclability character of the material,** e.g. mono-film or single packaging material (without lamination or coating) is preferred, compared to multi-layer or laminated/coated material, provided functional properties do not vary much. For the same reason, trend is to replace multilayer film like **10µ PET/10µ Met-PET/100-200 g LD by a 35µ heat sealable BOPP for biscuit wrapping,** wherever possible. Similarly, if the **bottle is made of PP, its closure is also made of PP,** so that **segregation is not needed for different components** of the same package and the whole package can be sent to one recycling plant.

In the case of using recycled packaging material/packages, the trend is to use the **recycled material in the middle of the multi-layer container** (3-layer). The HDPE recycled bottles have been successfully used for packaging of motor oil, detergents, softeners, pesticides, etc. Examples of such containers are :

- **Motor Oil (5 litre) Container**

Inner layer	- Virgin HD (10 %)
Centre layer	- Recycled HD (70% including 25% post-consumer waste recycle)
Outer layer	- Virgin HD (20%)

- **Detergent/Softener Bottle**

  Containing 25 to 30% recycled HD (Target – 50%)

In fact, for making its package (of window-cleaner) more eco-friendly, a company has changed original **one-shot container,** first by a **refill pack (stand-up pouch)** primarily to reduce weight, and then by a co-extruded **reusable bottle** with structure like **HD/LLD (20% PCR)/PE (reverse printed).**

Recoverable Packaging

If packages cannot be reused or recycled economically, one thinks of recovering it in some way or the other, otherwise it is considered as waste of raw material and energy.

Plastic wastes contribute to increasing calorific value of municipal solid waste for incineration, which is a useful source of energy, estimated to be from 8-9 GJ/T to 20 GJ/T. Moreover, compared to other common combustible materials, on an average plastics produce more heat energy, e.g.

Plastics	- 40 MJ/kg
Coal	- 30 MJ/kg
Wood	- 15 MJ/kg
Paper	- 15 MJ/kg
Textiles	- 13 MJ/kg

In Western Europe, plastic wastes provide 30% of energy generated in MSW recovery plants.

Other Ecological Considerations

If we consider reclaimable energy content of plastics, along with the energy required to process raw materials into finished goods or packages, it could be seen that the **energy (oil) consumption to make plastic bottles or plastic bags is much less** compared to that of glass bottles or paper bags for comparable use and performance levels. In other words, plastics help in resource saving, as highlighted here.

Package		Oil Consumption	Resource Saving
Number	Type		
1000	1 litre Glass Bottles	230 kgs	57%
1000	1 litre Plastic Bottles	100 kgs	
1000	Paper Bags	47 kgs	32%
1000	Plastic Bags	32 kgs	

From conservation of raw material resources point of view, it could also be seen that plastic packaging is better than other type of packaging i.e. with the same quantity of packaging raw material, more number of packages can be produced from plastics, e.g. **number of bottles (1 litre capacity) produced per kg raw material:**

1 kg. Raw Material	No. of Bottles
Glass	3
Tinplate	10
HDPE	11
PVC	25
PET	31

It has been observed that **to pack 1 tonne of foodstuffs in 1 kg package, we need only 32 kgs of PET, as compared to 350 kgs of glass, 100 kgs of tinplate, 90 kgs of HDPE and 40 kgs of PVC.**

Conclusion

Packaging represents one of the most significant material support to lifestyle, produced by the industrial society. It best expresses the way our society's material life is organized. Plastics being synthetic materials can be tailor-made to meet specific or performance requirements of packages.

Plastic have effectively replaced its other counterparts due to its lightweight, strength, moisture-resistance and durability. Plastic packaging also has storage, production and distribution advantages over other packaging mediums.

Due to increasing awareness, plastics have gained social importance as an environmental friendly material in terms of lesser energy consumption, low weight and volume of disposables, lesser pollution and conservation of natural resources.