PACKAGING OF DRINKING WATER

Water is a key to social equity to environmental stability and to cultural diversity. If one goes back to the culture of ancient times, with all the great religions of the world, it will be seen that water is much more than an economic issue. Water is directly linked with spiritual values, with respect to mankind towards nature. Water is also firmly linked with health. According to the estimate of World Health Organisation (WHO), 80% of all diseases — approximately 25 million deaths per year — in the developing countries are caused by contaminated water.

PET Bottles in the Global Market

Pure and safe drinking water has always been a necessity. Traditionally, pipe water distributed by the municipalities has been the trusted water supply for drinking purposes. In the earlier days, water available from the wells and springs used to be considered safe and was stored in earthen pots or brass containers. This water was considered safe for drinking and serving to guests and visitors. The tradition and style of serving drinking water, in India, has however changed quite dramatically during the last decade. Almost a decade ago, the introduction of bottled water or "packaged mineral water" has changed the tradition of serving and consuming drinking water. This has ushered in very strongly, the use of polymers or plastics as materials for water storage and distribution.

Today, packaged drinking water is an industry in India, which is estimated at Rs.700 crores with over 200 brands floating in the market, most of which have restricted territorial distribution. This is a growing market in India as quality consciousness among the consumers is on the rise.

Every year an estimated 800 million litres of bottled water are marketed in plastics and the demand continues to grow. Besides bottled water, there is also a large market for plastic pouches, especially in the states of Tamilnadu and Gujarat.

At the global level, packed water (containers up to 10 litres) industry is considered as a significant contributor in the beverage industry and accounts for over 80 billion litres per

annum. It is the fastest growing beverage industry worth Rs. 990 billion a year. Volume growth for the year 2001 stood at 8%, making it the best performing of all soft drinks on the world stage. Among several other factors, general trend towards a healthier lifestyle is the key attribute. Concerns over the quality of public water supplies in various countries around the globe have also added significant support.

PET Bottles in the Indian Market

Processing of Water for Bottling

In India, the quality of drinking water is very poor in comparison to other countries. Treatment of water is required for purification. To produce high quality drinking water as prescribed by the World Health Organisation (WHO), conventional processing methods like coagulation, flocculation, sedimentation, ion exchange, filtration and oxidation etc. are not sufficient. Membrane processes have advantages over other treatment processes. Micro-filtration and ultra-filtration are said to be very useful in removing micro-organisms. Reverse osmosis membranes are used to remove various contaminants found in drinking water. A combination of reverse osmosis and de-ionisation can be used to produce high quality water.

Bottle Filling

Before filling, freshly manufactured plastic bottles are rinsed and inverted from where they go for filling on a rotary bottle filler. The water flows from the filler bowl into the bottles via ventra flow valves. These valves use an airlock method for accurate filling. The variation is no more than 5mm. When liquid reaches the end of the valve sleeve, air cannot escape. Pressure is created at the top of the bottle, and no more liquid can enter. The airlock method provides consistent, repetitive filling and reduced product loss. The fillers are available in a wide range of configurations and are adaptable to a variety of capping systems.

IS : 14543 - 1998 (Specification for Packaged Drinking Water) prescribes the hygienic practices to be followed in respect of collecting water, its treatment, bottling, storage, packaging, transport, distribution and sale for direct consumption , so as to guarantee a safe, hygienic and wholesome product.

The bottles are generally capped using roll-on type plastic caps, with pilfer proof rings.

Bottle Labeling

The last step is the labeling of bottles. In the earlier days, gummed paper labels were used which satisfied only the legal requirements of declaration. When these labels came in contact with moist surface, they lost their identity. Later shrink film plastic labels came into use for this application. Auto-sleeve system for labeling then became a commercial success. **Auto-sleeve labels are used both for one way and refillable-multi-trip plastic bottles. It is a stretchable label made of low density polyethylene of special grade.**

The Department of Health, Ministry of Health and Family Welfare has notified to carry the following declaration on the label of the disposable bottle of mineral water or packaged drinking water.

["Crush the bottle after use"]

The notification will be published in the Gazette of India and the rule will come into force from 01/04/2004.

Other labeling requirements should be as per PFA Rules and Packaged Commodities Rules as prescribed in IS: 14543 – 1998 (Specification for Packaged Drinking Water).

Packaging Requirements

It is well known that drinking water should be packed in clean, colourless, odourless, clear, tamperproof containers, which are hygienically safe. Much of the water is packaged in similar bottles as carbonated soft drinks, and would, therefore, carry many of the same requirements.

Strength

Unlike carbonated drinks, the bottles filled with still water need only enough strength to hold water and to survive impact.

Colour and Clarity

Clarity is one of the most important requirements and is the main reason why clear bottles of plastics are used. A resin with higher levels of co-polymer adds to the clarity. As regards the light blue colour in the bottles, this is permissible for one time use bottles. However in India, the BIS (Bureau of India Standards) has prescribed colourless bottles for multi trip/reusable containers.

Since currently almost all the bottlers use blue coloured containers, studies have commenced at IIP to establish whether blue colour helps to reduce the UV effect and the percentage of blue colour that could be considered to be added without affecting the clarity of the bottle.

Purity

Because water is a flavourless product, using a plastic that remains tasteless and odourless is imperative.

Mandatory Certification

To prevent adulteration, the quality of the bottle and its sealing drew great attention and concern. The standardisation of the quality of the water and the bottles was not thought of earlier. There was a concern whether mushrooming brands in packaged drinking water would really ensure quality and safety. The provisions of mandatory BIS certification and that of Prevention of Food Adulteration Act (PFA) have brought in assurance to the consumers that packaged drinking water is trustworthy.

The Indian Standard IS: 14543 – 1998 prescribes the quality and safety requirements of packaged drinking water.

25-litre HDPE Container

Plastic Package Types

As the market has evolved, so too has its packaging mix. Bottles may be the favourite container for packaging water, but glass rarely features as the first choice today. Glass together with cans and cartons have a diminished share. Glass retains a high profile in outlets where the water is for consumption on the premises (hotels, restaurants, cafes) remaining particularly strong in Central and South America and Europe, especially Germany.

Plastics are versatile materials and are in many cases capable of matching or surpassing the characteristics of other types of packages. They do not corrode, are hygienic, lightweight and often provide opportunities for reducing the weight of the packages used.

A variety of polymers are available which can be used for packaging of drinking water.

Polyethylene

Low-density polyethylene film is the most important group of plastics used in packaging drinking water. Polyolefins also have the highest calorific value of all constituents in the packaging waste stream and are, therefore, prime candidates for disposal through incineration with energy recovery.

Polyethylene Terephthalate (PET)

PET is the most extensively recycled plastic of the present time. It is easier to collect than other plastics. It has a high intrinsic value, is economic to recycle even with existing collection systems and there are well-developed markets for its recycling, such as carpet fibres and fibre film. The important feature of used PET is its ability to be converted

20 litre PET Container

chemically to the monomer from which it was produced using hydrolysis or methonolysis. The US Food & Drug Administration for food-packaging applications have approved PET produced by chemical recovery of this sort. For packaged drinking water PET bottles are used in 50ml to 20 litres capacity.

Perrier has developed a new container that incorporates a layer of nylon sandwiched between layers of PET to comply with the requirement for a standard 12 months shelf-life mineral water.

20-litre Polycarbonate Container

Polypropylene (PP)

Polypropylene (random clarified co-polymer) is widely used for food contact applications throughout the world and enjoys favourable status with food and regulatory agencies. PP containers/cups with peelable lids are used for packaging of drinking water in 100, 200ml. capacities with suitable lids for closures.

Poly Vinyl Chloride (PVC)

Earlier, the most commonly used package for mineral water was stretch blow moulded bottle of PVC, as PVC is rigid, clear and has adequate impact strength. Compared to other polymers, PVC requires lower amount of energy to produce. If collected separately, it can be readily recycled. The recycled PVC is sandwiched between inner & outer layers of virgin polymer in co-extruded PVC pipes. The major concern for safe use of PVC for non-toxic and food contact applications is the residual monomer level in the resin. The FDA in USA and regulatory agencies have specified the monomer levels at 5ppm in PVC resin. PVC containers in capacities of 100, 200, 250 and 1000ml are used for packaged drinking water.

Polycarbonate (PC)

Polycarbonate can be processed into useful end products by any of the usual processing techniques like extrusion, blow moulding, injection moulding etc. Polycarbonate containers are popularly used for muti-trip application for mineral water containers of 15-20 litres.

Polyethylene Naphlthate (PEN)

This is a high performance resin and the containers made out of this resin are used for refillable, returnable mineral water.

High Impact Polystyrene (HIPS)

HIPS (High Impact Polystyrene) containers cater to the 200ml mineral water market. These containers are provided with heat sealable peelable lids.

Conformity of Packaging Materials to Indian Standards

The Bureau of Indian Standards have formulated standards for packaging materials used in contact with drinking water. The plastic materials used should conform to the relevant Indian Standards. The list of the standards is given below:

IS : 10146 - 1982
Specification of Polyethylene for it safe use in contact with food stuff and drinking water.

IS : 10141 - 1982
Positive list of constitutes of Polyethylene for its safe use in contact with food stuff and drinking water.

IS : 12252 - 1987
PET (Polyethylene terephthalate)/PBT (Polybutadeine terephthalate) for safe use in contact with food stuff and drinking water.

IS : 12229 - 1987
Positive list of constituents of PET/PBT for its safe use in contact with food stuff and drinking water.

IS : 10910 - 1984
PP and its copolymer for its safe use in contact with food stuff and drinking water.

IS : 10909 - 1984
Positive list of constitutes of polypropylene in contact with food stuff, pharmaceuticals, and drinking water.

IS : 10148 – 1982
Poly Vinyl Chloride and its co-polymer for its safe use in contact with food stuff and drinking Water.

IS : 10151 - 1982
Poly vinyl chloride and its co-polymers in contact with foodstuffs, pharmaceuticals and drinking water.

IS : 10142 - 1989
Styrene polymers for its safe use in contact with food stuff, pharmaceuticals and drinking water.

IS : 10149 - 1982
Styrene polymers in contact with food stuff, pharmaceuticals and drinking water.

IS : 12248 – 1988
Positive list of constituents of Nylon 6 Polymers for its safe use in contact with food stuff and drinking water.

IS : 12247 - 1988
Specification for Nylon 6 for its safe use in contact with food stuff and drinking water.

IS : 11705 - 1986
EAA co-polymer, positive list of constituents for safe use with food stuff and drinking water.

IS : 9833 - 1981
List of pigments and colourants for use in plastic in contact with food stuff and drinking water.

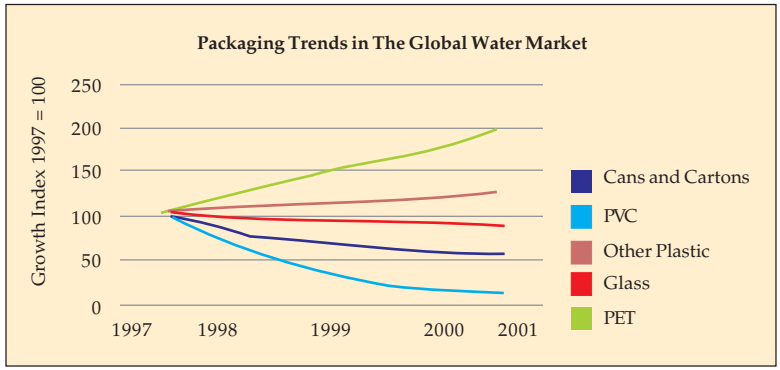
The standards basically specify requirements of the basic resin, colours and pigments, catalysts, emulsifying agents, residual monomers, antioxidants, other additives and the overall migration.

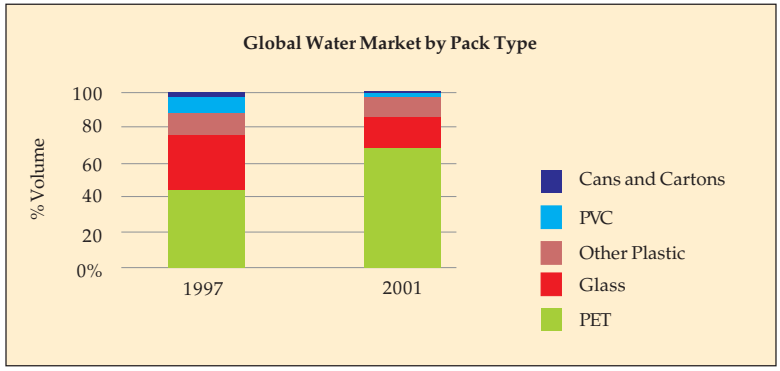
The Emerging Trend

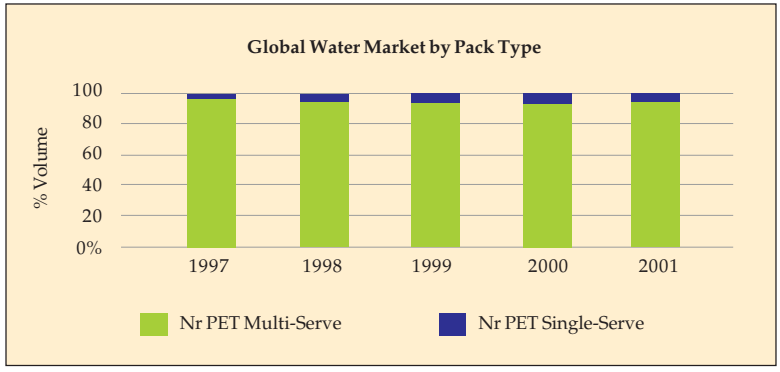
The packaging trends in the global water market are shown in Figure 1.

The trend indicates that lightweight, resilient and affordable PET is increasingly the packaging medium of choice. Almost 7 out of every 10 litres of water now appears in PET - a significant increase from 6 litres as of 1998, and it still continues to grow. The packaged water market is essentially a one-way street. Non-refillables account for four out of every five litres. Consequently non-refillable PET is very much the norm on a global scale.

Figure 1: Trends in Global Water Market







[Source: Canadean Ltd.]

It is estimated that worldwide, 1.5 million tonnes of plastics (mostly PET) are consumed for the manufacture of different sizes of drinking water bottles. In India, out of 54,000 tonnes of PET produced locally, 12,500 tonnes go in for the manufacture of bottles for the packaged water industry. The PET bottle market in India is also expected to grow.

The used PET bottles are disposable, their collection and recycling is a cause of concern to the industry, the consumers and the environment protection groups. However, in India, there is a PET recycling industry, with a capacity of 75,000 tonnes per annum. The PET waste is recycled into fibres. This is an effort to pre-empt a market situation that may arise a few years hence.

Studies Conducted at IIP on Drinking Water Packed in HIPS Cups

Studies were carried out on HIPS (High Impact Polystyrene) cups with respect to their suitability for packaging drinking water.

Extractability Migration Tests

200 ml cups as well as the flexible lidding material of plastic coated Aluminium foil were studied for migration / extractability as per IS : 1845. The simulant used for the study was distilled water.

The test results indicated that the values of extractability were within the safe limits prescribed as per IS:10142 - 1982 - Positive list of constituents of Styrene polymers in contact with food stuffs, pharmaceuticals and drinking water.

Odour Pick-up Test

The odour pick-up test as per IS:4006 Part II - 1987 was carried out on the HIPS cups and lidding material. The results of the test indicated that there was no odour or taste, which the product picked up from the plastic material.

Storage Studies

Filled and sealed cups were exposed to three different sets of conditions. The exposure conditions were:

- Accelerated conditions : 38°C ± 1°C, 90% ± 2% of R.H.
- Standard conditions : 27°C ± 2°C, 65% ± 2% of R.H.
- High Temperature conditions : 42°C ± 2°C.

The storage trials at all the three conditions were carried out for a period of 30 days. Samples were drawn from all the conditions on every alternate day and assessed organoleptically. The water was assessed for organoleptic characteristics to detect changes in odour or taste. A panel of five members carried out the assessment. The sensory/organoleptic evaluation was carried out by giving a known standard sample alongwith the drawn samples. The results of the tests indicate no odour or taste pick-up from the packaging materials.

It was concluded that the HIPS containers alongwith the peelable plastic coated flexible lidding material is suitable and safe for contact with drinking water.

Conclusion

Innovative packaging solutions have been developed for drinking water. Economic and social development is continuing to fuel demand for packaged water. In its 2001 Global Packaged Water Report, Canadean forecast that the global market will have exceeded 100 billion litres by the close of 2004, a gain of over 20% over current level. **It is confidently expected that PET will not only have added volume, but also a greater percentage share.**

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