Quarterly news bulletin – December 2019

Discarded plastic – waste to worth

As in other parts of the world, the Indian demand for plastics increased over time. Depending on the commodity, plastics replaced earthenware, rubber, glass, wood, and several metals. Since the first production of polystyrene in the 1950s', India's output of various types of plastic grew tremendously, stimulated by demand, and facilitated by the growth of the petrochemical industry that supplied raw material and the plastic-processing machinery sub-sector.

In particular, plastic packaging and containers came to be used everywhere. Such containers were usually discarded at or near the places where they ceased to be of use to the consumer, accumulating in garbage-dumps and in water-bodies that became clogged with them, adding to health hazards. Further, the pollutants present in some plastics and even tiny fragments (micro-plastics) had adverse impacts on human life, and also on birds and animals who ingest plastic along with the food they locate. Large amounts of plastic waste even reached the oceans, eventually killing marine creatures who get physically entangled, or mistake micro-plastics for food and ingest them.

In the interest of health and environmental protection and necessitated by the problems of safe disposal, laws and rules regarding the use and disposal of single-use and other plastics have now been promulgated in many parts of the world. Total bans on the use of plastics have not been imposed in India because adequate alternatives have not been developed, particularly for essential items like milk sachets; further, most of the production is at small-scale enterprises so that livelihood would be adversely effected. Developing alternatives to plastic is therefore essential. In our last newsletter, we had described the conversion of biomass to mouldable pulp that could be fashioned into containers that could replace similar items made of plastic (http://www.iei-asia.org/IEI-AsianewsletterSep19.pdf).

But what about the tonnes of existing plastic waste that need to be disposed of? Compared with the materials they have replaced, plastics are relatively inefficient to re-use, due to significant processing difficulties, such as a low melting point which prevents contaminants from being eliminated during heating and reprocessing. For years, waste was sorted chiefly by waste-pickers who sold the little that could be re-cycled, leaving the rest to be burnt or dumped in landfills. But burning results in toxic gases being released, while during degradation in landfills, and some pollutants can leach into the ground, adversely impacting soil and groundwater.

However, plastic "waste" is now being more carefully collected and sorted, and re-used or converted for re-use. In this newsletter, we look at cases where plastic waste is being collected sustainably in rural, semi-rural and small urban locations through local effort, the use of plastic waste for surfacing roads (when mixed with bitumen) and construction, and for making tiles and surfacing pathways, as well as the use of domestic and industrial plastic waste (along with other fuel) to fire kilns of cement–making factories.

Sustainable waste collection in rural and semi-rural locations

While cities/towns can undertake garbage collection and disposal through their corporations/ municipalities, rural locations that are visited by tourists also face problems of garbage

accumulation, but usually without the resources to handle it. However, a project in some small towns and villages in Leh district of Ladakh - one of the northern-most territories of India[1] - celebrates two years of sustainable local waste management this month.

The *Tsangda*[2] project was initiated by the Leh district administration under Deputy Commissioner Avny Lavasa, in collaboration with the local Rural Development Department (RDD), and with support from the Leh Autonomous Hill Development Council. The system consists of waste segregation in homes and shops at each location, followed by collection and sale for re-use. The first centre was developed in Choglamsar, the second most populous town. Later, independent centres were developed in the Nubra valley (earlier for just the village of Diskit, but expanded to the Hunder sand dunes)[3], and at Nimo and Khaltsi.

The primary step consist of keeping bins of two colours - one for dry waste and other for wet waste. The collection vehicle goes to each locality on a specific day to collect the bins from homes/shops, while the market waste is collected daily. The dry waste is then delivered to collection/segregation centres, where it is further separated, as required.

Much of the segregated waste is re-used, thereby earning revenue. Some types of cardboard and plant waste are used to make bio-fuel bricks. Paper and cloth waste are used for making decorative items, cushions, and so on. Broken glass is used in construction activities by agencies like the Public Works Department and the General Reserve Engineer Force of the Border Roads Organisation. Shredded plastic is being sold for road-surfacing, to the *Pradhan Mantri Gram Sadak Yojana* (PMGSY)[4].

The RDD has taken the main responsibility - running awareness campaigns, building infrastructure, supervising operation, collecting user fees, and arranging for waste re-use. But the people's interest and involvement has been the main reason for the continuance[5]; they have valued the activities enough to pay Rs 50 per month per household, and Rs 200 per shop. The fuel costs for the collection vehicles and the work at the segregation centres are paid for by these local user' fees. The Tsangda project thus demonstrates that local involvement and smart governance practices jointly lead to success. It is intended that the management of the systems be later handed over entirely to the local committees.

Waste plastic for surfacing pathways/roads

Road surfacing and construction: Professor Rajagopalan Vasudevan and his team at the Thiagarajar College of Engineering, Madurai (Tamil Nadu state) experimented with mixing shredded single-use[6] plastic waste and hot bitumen; the mixture after heating could be used to cover a stone base. Such a road was successfully laid within the college, and a patent obtained.

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[1] Ladakh was a part of India's northern-most state of Jammu and Kashmir, but is an independent Union Territory since 31st October 2019.

[2] "Tsangda" or "stangda" means cleanliness in Bothi, the local Ladakhi language.

[3] Tourists take rides there on the unique Bactrian camels.

[4] This translates to Prime Minister's Village Road Plan.

[5] The inspiration for this project came from the resource management centre in Bishnah, Jammu district; but that centre is no longer functioning as planned.

[6] These include carry-bags, cups, packaging for snacks, and so on.

Using waste plastics for road construction has many advantages: it enables a use for single-use plastic, it can be carried out without new machinery, the bitumen required is reduced by a tenth (lowering costs), and the binding of the surface improves, resulting in better resistance towards rain and water flow. The large amount of plastic waste used per unit length of road ensures a reduction in accumulating plastic waste.

Stretches of roadway have now been surfaced with bitumen mixed with non-recyclable plastics, in many regions of India, even in the small hilly states in the north-east. For example, in Meghalaya (just north of Bangladesh), the state government completed such a road in Nongkynjang village in Nongstoin in West Khasi Hills, last year, and this August, in the Tetengkol locality of Tura town in the West Garo hills[7].

Large organizations have begun using waste plastics for road surfacing, to reduce the cost of bitumen while increasing durability with respect to moisture and also utilizing waste plastic.

Bangalore International Airport Limited (BIAL) has a project to build polymerized roads of 50 km within its campus, by 2021, for which they are asking citizens in the locality to donate waste plastic. An access road was completed in September this year. (Workers inserting shredded plastic, the plastic-bitumen-mixing plant within the airport campus, and the completed road are shown above).

Indian Oil Corporation Limited (IOCL), India's largest Public Sector petroleum undertaking, has recently built 850m of plastic-infused bitumen roadway outside its R&D facility in Faridabad (Haryana state), on an experimental basis. According to the Central Road Research Institute, the allowable percentage of waste plastic in bitumen is 0.8%, but this road has been constructed with sections of 1%, 2%, and 3%, to assess the condition with increased proportions of plastic waste.

Construction blocks: Made from a mixture of waste plastic and granite, "plastones" were also developed at Thiagaraja College. These are cheaper substitutes for concrete blocks. As they are more resistant to water than the latter and can prevent water seepage, they are

[7] The technique pioneered by Prof Rajagopalan Vasudevan has been used in these cases, too.

suitable for outdoor flooring and compound walls, and particularly for lining canals and other water bodies. There are a couple of disadvantages: Pure plastic road requires using compatible plastics because, when melted, plastics of different types may phase-separate and cause structural weaknesses. Wear could create harmful plastic particulates that could worsen the current micro-plastic pollution problem. In order to facilitate the laying of Plastic Waste Roads, the National Rural Roads Development Agency, Ministry of Rural Development (Government of India) has issued standard Guidelines, including the methods of road laying, the mix ratios, and other pertinent information.

Paving tiles: Scientists at CSIR - National Physical Laboratory (NPL) [8] had developed a way to use plastic waste for the making of tiles for use indoors and outdoors. To ensure usability in varied circumstances, tests were carried out -- checking tensile strength, flammability, thermal stability, glass transition, temperature, permeability, environmental stability, and resistance against strong acids and strong bases.

The technology has recently been licensed to companies to manufacture the products on a commercial scale – last year to Visakhapatnam-based Vyzag Bio-energy Fuel Private Limited[9], and this year to Kolkata-based Bengal One Enviro Infra LLP. Production of tiles, pavement blocks, panels, etc. from discarded plastic containers (like bags and bottles) would not only provide use for waste, but improve the wages for those subsisting on collecting such items from garbage, and avoid the harmful impacts of the earlier methods of disposal. As with concrete pavers, the shape of the tiles enables interlocking, so that adhesives are not essential and installation is quicker and less expensive.

A Bangalore organization called Swachha is now producing tiles like these that they call "Re-tiles". They collect source-segregated wet and dry waste in separate bins, storing them at a designated centralised yard. The dry waste is then transported in to Swachha-operated dry waste centres, where it undergoes secondary segregation into plastic, paper, metal, rubber, and other categories. This tertiary segregated plastic is then sent to Swachha Eco Solutions waste processing centres for further segregation, to get the desired quality for recycling. The plastic waste is broken down using a grinding machine, and the flakes are loaded into a plastic extruder to obtain granules. It is expected that such homogeneous tiles could later be recycled.

Plastic-waste co-processing in cement kilns

India's Hazardous wastes (Management and Handling & Transboundary movement) Rules, 2008, provide rules and norms for the utilization of wastes, including the use of hazardous waste as a supplementary resource for energy through co-processing.

[8] These are Dr S K Dhawan, Dr D.K. Aswal, Mr. Brijesh Sharma, and Ms Ridham Dhawan; NPL is a part of the Council for Scientific and Industrial Research, under the Ministry of Science and Technology and Earth Sciences, Government of India

[9] The firm is already involved with generating biogas from organic wet waste.

Waste from the packaging of products: Over a decade ago, ACC's Kymore (Madhya Pradesh state) cement plant experimented with co-processing, using waste from the packaging of Hindustan Unilever (HUL) products that were past expiration. The trial run was with 1.5 percent plastics waste[10] as supplementary fuel to coal. Rigorous assessments were made regarding chemical and thermal parameters of raw materials, clinker product, plastic wastes and coal and emission monitoring during and after feeding of plastic waste in the cement kiln. There were no abnormal emissions of dioxins or furans and no adverse impact on the quality of cement.

With the approval of the Central Pollution Control Board (CPCB), plastic waste is now considered advantageous as an Alternative Fuel and Raw Material (AFR) at cement kilns, for many reasons. High flame temperatures (around 2,000ºC), high material temperatures (up to 1,450ºC) and residence time (4-5 seconds) in oxygen-rich conditions ensure destruction of harmful pollutants. Scrubbing of exhaust gas with counter-current flow of raw material results in the trapping of heavy metals, sulphur and other pollutants (such as dioxins and furans) within the clinker crystal structure. (If the same wastes were burnt in incinerators, there would be emissions, and also residues that would have to be deposited somewhere). Kiln lines equipped with electro-static precipitators or bag filters ensure negligible particulate emission. By reducing the need for fossil fuels, the emissions from their combustion and the other environmental impacts associated with their mining are correspondingly reduced. However, the cement factories have to ensure that they meet the emissions standards prescribed by the relevant pollution control authorities. For specified pollutants, the co-processing emissions should not exceed the base-line (i.e. pre- co-processing) norms.

Waste from re-cycled paper production: There are around 40 small/medium paper and paper-board manufacturers in Vapi (Gujarat state). In order to avoid the use of fresh resources (particularly wood from trees), their production is based on re-cycled waste paper and board. The waste paper and board obtained are often plastic-laminated/coated. When these wastes are fed into pulping machines, the pulp usable for paper-making is separated from the plastic "waste". After water is squeezed out, the remaining plastic waste material is packed in bails. (Earlier, this material was sent to landfills, but as plastics are non-biodegradable and also prevent water percolation, groundwater re-charging was found to be adversely effected). Hence, in recent years, with the promotion of the Gujarat Pollution Control Board (GPCB), it is being co-processed in cement kilns[11], as AFR. For example, at the Kodinar unit of Ambuja Cement, plastic waste is regularly used, with a suitable system installed for efficiently and safely conveying the material from the storage shed to the feeding platform.

[10] Plastics co-processed during the trial were: ABS (acrylonitrile-butadiene-styrene), PBT (poly butylene terephthalate), PET (polyethylene terephthalate), PP (polypropylene), HDPE (high density polyethylene), and PS (polystyrene).

[11] The Central Pollution Control Board, under the Ministry of Environment, Forest, and Climate Change, Government of India had published guidelines in May 2017 (in accordance with the Plastic Waste Management Rules, 2016).

Waste from a township: Another cement factory – ACC's Madukkarai unit (in Tamil Nadu state) uses a part of the non-biodegradable domestic waste collected from the adjoining township. More than 50 women are employed as "Green Friends", to work among the 18 wards of Madukkarai. The GFs visit households daily, and collect garbage that is filled in different bins; there are eight categories of non-biodegradable waste (as shown in the pictures alongside).

The bins filled by the women are transferred to community bins, placed in every ward, from where they are shifted by vehicles to the Resource Recovery Park.

The wet garbage is converted into organic manure in vermi-compost pits; this is then sold to farmers at rates affordable to them.

The waste of single-use plastics, textiles, packaging material, leather, tyres, and liquid waste such as used oil and paint sludge (according to AFR norms) are added to the furnace at ACC's cement factory.

Thus Madukkarai, a small town with about 12,000 households and a population of around 35,000 people, currently holds a place in the Guinness Book of Records for the largest daily recycling.

Waste from a state: In Meghalaya state, plastic waste is being collected at designated locations on specific days, even from villages. For example, people gather every Saturday at 4pm in Urksew-Wahpathaw village in Pynursula block, and on the 30th of each month, in Pomlahier village in Mawrynkhneng block. Re-cyclers engaged by the *Swachh Bharat* (Clean India) Mission collect and transport the plastic waste from all these locations and are paid Rs 30 (US$ 0.43) per kilogram. This October, the Meghalaya government has signed an agreement with a cement factory to use plastic waste in its clinker production kilns.

"Waste" can thus be viewed as a resource that is merely at another place!

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