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Improving Plastic Management-Tentative Results of a Mysore Study

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Abstract

Although principally favorable from a life cycle environmental impact perspective, recycling of plastics from Waste Electrical and Electronic Equipment (WEEE) is not uncontested because of the potential dissipation of hazardous substances into new products. Considering the results of the survey, actual mass flows of the Mysore WEEE recycling systems and rough estimations of the value added of recycled plastics appear to be the WEEE categories with the highest theoretical recycling potential. However, these results are to be considered as tentative due to remaining data gaps and -uncertainties. A more robust and differentiated picture of the recycling potential of plastics from WEEE product categories will be available as soon as the planned sampling campaign will have been performed.

Keywords: Flame retardants, Plastics, Recycling, RoHS, WEEE

1. Introduction

Plastics have made significant contribution in almost every field of human activity today – agriculture, medical, transportation, piping, electrical and heat insulation, packaging, manufacturing of household and electronic goods, furniture and other items of daily or specific use. Plastics in medical products like disposable syringes, blister packing of tablets and capsules, joint replacement prostheses, inter venous (IV) fluid bottles, blood bags, catheters, heart valves, etc., have significantly helped supporting the human life. Medical devices made of plastics are implanted into the human body. Packaging is one of the most important applications of plastics. In fact, about 40% of plastic materials worldwide are used in packaging applications. Plastics have contributed in creating a sustainable, hygienic, energy efficient, cost effective and environmental friendly packaging system. Versatility of plastics has allowed creating an efficient pilfer proof, hygienic and cost effective packaging of food products like milk, spices, edible oil, bread, confectioneries, rice, wheat flour, snack foods and various types of medicines. Plastics are used for packaging of toiletries, cosmetics and host of other consumer products of daily and special purpose use required all – rich or poor in urban cities or in the villages. This has been possible due to the following attributes of plastic materials:

i. Safe and hygienic – inert and chemical resistance,
ii. Light weight and non-breakability,
iii. Excellent barrier properties - enhancing shelf-life,
iv. Superior impact resistance,
v. Sterilizable and resistance to bacterial and other microbial growth,
vi. Transparency as well as opacity,
vii. Lower fuel consumption and product loss during transportation

Contribution of plastics to human health is difficult to ignore. Plastic based packaging with the above-mentioned properties ensures reaching the best, hygienic and unadulterated product to the masses. Despite all these benefits, plastics packaging in general, and plastic bags / carry bags – which are a part of the packaging system, are under the scanner. Plastics are blamed for series of health, safety and environmental problems. Non biodegradability of plastics is attributed towards causing waste management problems and choking of the drains in urban cities. The solution to waste management problem lies in segregation of dry and wet solid waste at the source for which an effective mass awareness campaign is very important. Creation of efficient solid waste management infrastructure coupled with encouraging establishment of recycling centres would help address the MSW problem. Plastics can be recycled to produce articles for mass use augmenting the concept of resource management. Many useful products have been developed with recycled plastics and large number of people is employed in these activities in small, micro and informal sectors. An informal industry estimate put the recycling figure of India at around 1.5 Million Tons – close to 50% of plastics used for packaging applications. This is a very high recycling ratio. Recycling ensures that the unwanted and discarded plastics waste does not remain in road side nor it is carried to the landfill.

Other plastics extensively used in our daily lives are as follow:

- High Impact Polystyrene (HIPS) – used in fridge liners, food packaging, vending cups. Acrylonitrile butadiene styrene (ABS) – used in electronic equipment cases (e.g., computer monitors, printers, keyboards), drainage pipe.
- Polyester (PES) – used in fibers, textiles.
- Polyamides (PA) (Nylons) - used in fibers, toothbrush bristles, fishing line, under-the-hood car engine mouldings.
- Polyurethanes (PU) - used in cushioning foams, thermal insulation foams, surface coatings, printing rollers.
- Polycarbonates (PC) - used in CDs, eyeglasses, riot shields, security windows, traffic lights, lenses.
- Polycarbonate/Acrylonitrile Butadiene Styrene (PC/ABS) - A blend of PC and ABS that

creates a stronger plastic. Used in car interior and exterior parts and mobile phone bodies.

Environmental issues on disposal of Plastic Waste: Indiscriminate littering of unskilled recycling/reprocessing and non-biodegradability of plastic waste raises the following environmental issues:

• During polymerization process fugitive emissions are released.
• During product manufacturing various types of gases are released.
• Indiscriminate dumping of plastic waste on land makes the land infertile due to its barrier properties.
• Burning of plastics generates toxic emissions such as Carbon Monoxide, Chlorine, Hydrochloric Acid, Dioxin, Furans, Amines, Nitrides, Styrene, Benzene, 1, 3- butadiene, CCl4, and Acetaldehyde.
• Lead and Cadmium pigments, commonly used in LDPE, HDPE and PP as additives are toxic and are known to leach out.
• Non-recyclable plastic wastes such as multilayer, metalised pouches and other thermoset plastic poses disposal problems.
• Sub-standard plastic carry bags, packaging films etc. pose problem in collection and recycling. • Littered plastics give unaesthetic look in the city, choke the drain and may cause flood during monsoon .
• Garbage mixed with plastics interferes in waste processing facilities and also cause problems in landfill operations.
• Recycling industries operating in non-conforming areas are posing threat to environment to unsound recycling practices.

1.1 Heavy Metals in plastics

Heavy metals in plastics, notably cadmium, have been highlighted as a concern.

Cadmium

Cadmium sulphide and cadmium sulphoselenide are utilized as bright yellow to deep red pigments in plastics. Both compounds are well known for their ability to withstand high temperature and high pressure without chalking or fading, and therefore are used in applications, where high temperature or high pressure processing is required, such as ABS, PA, PC or HDPE (International Cadmium Association,2010). Another possibility for an import of cadmium into plastics, especially PVC, is the use of mixed barium- and cadmium carboxylates as stabilizing agents.

Chromium (VI)

In EEE, chromium (VI) is applied as a pigment in the form of lead chromate as well as in metal coatings protecting from corrosion and abrasion. Elementary chromium (Cr(0)) is applied in metalized plastics, which are used in the electronics -, the automotive - or the sanitary sectors.

Mercury

In EEE mercury is applied, amongst others, in batteries, thermostats, sensors, relays in switches, and discharge lamps. The application of mercury in electrical switches is no longer considered state of the art. The use as a pigmenting plastics was stopped many years ago; an application in plastics in the last few years is not known.

Lead

In EEE lead has been applied as a solder in printed circuit boards, in glass from cathode ray tubes (CRT), light bulbsor in electrical ceramics. Infrared remote control unit scan contain LED with lead selenide. In plastics, lead compounds are applied as pigments and, as carboxylates,stabilizing agents. In an earlier study, for EEE, the share of lead containing plastics was exceptionally high with 30%,which was caused by the use of lead additives in the PVC isolation of cables. Lead was not only found in yellow, orange and red plastics, which can contain lead pigments, but also inplastics of (all) other colors.

1.2 Plastic in WEEE

The rapid rate of urbanization throughout the world has led to increasing amounts of waste and this in turn poses greater challenges for disposal. The problem is more acute in developing countries like India, where economic growth as well as urbanization is quite rapid. Management of e-waste is one such critical challenge faced by India in recent times. In the absence of a proper management system, around 95% of the e-waste recycled in the country is processed by the informal sector. Various reports have highlighted the hazardous recycling processes carried out by the informal sector, which includes open burning and acid baths. These backyard operations have no measures in place for controlling toxic emissions or effluents, thereby posing a risk to health as well as environment.

Plastic, which is a major component of WEEE, has become a major threat due to its non-biodegradability and high visibility in the waste stream. Its presence in the waste stream poses a serious problem when there is lack of efficient end of life management of plastic waste. Though there have been some focus on widespread littering of plastic bags, packaging and its impacts on the landscape, there has been little focus on plastic recycling in the informal sector, the possible threats and environmental impacts. The issue of WEEE plastic recycling also assumes a greater challenge due to the presence of additives and chemicals like flame retardants.

Flame retardants are applied in plastics contained in telecommunication devices, computers, monitors, television sets and other consumer equipment as well as – to a lesser extent – in office equipment. The share of flame-protected plastics in WEEE over all categories has been estimated to amount to about 25% (by (Huisman et al., 2008).The subsets of these flame-retardants, called "Brominated Flame Retardants" (BFRs), are now the subject of intense scrutiny and various studies undertaken. There is enough evidence available to predict that some of the BFRs are likely to persist in our environment, bio accumulate in the food chain and in our bodies, and cause adverse health problems. In the past decade, scientists have detected BFRs both in human and wildlife tissues as well as in house dust, sediments, sewage sludge, air, soil, and water samples.

2. Exploratory Research Findings

This chapter focuses on the findings from the field visit conducted in Mysore. The information was collected mainly through observation in the field survey and through unstructured interviews.

2.1 Study Area

Mysore city occupies an important location in the larger context of southern part of the Karnataka State at 12'18 N latitude and 76'12' E longitude. Mysore city lies in a saucer shaped basin flaked by Chamundi Hills on the south east. It is in the interfluent between two rivers Cauvery and Kabini. The city of Mysore is next only to Bangalore in importance as a growing urban centre in Karnataka. It is described as a "Garden city "and "City of Palaces". The city is spread over an area of 87 sq km and it is situated in an undulating surface. The present study has been carried out in the urban environment of Mysore in the year 2009 to understand the problems and perspective associated with solid waste management in the city.

Figure 1: Study Location of Mysore

3. WEEE Plastic in Mysore

Mysore, the capital and one of the largest cities in India, does not have any proper e-waste assessment and there are no figures/data available on the quantity of e-waste generated in the city. Hence it becomes difficult to estimate the amount of WEEE plastic generated in Mysore. But we have tried to arrive at some rough estimate by looking at the total waste generation in the city.

According to Karnataka Pollution Control Committee, around 7310 Tons per day (TPD) of municipal solid waste is generated in Karnataka. For India the estimate stands at around 136996 TPD [22]. Global estimation and studies have indicated that around 1-2% of municipal solid waste is E-waste. If we take this estimate, then the total generation of e-waste in the city would be around 73-146 TPD, meaning around 26000-53000 tonnes of e-waste generation annually.

The amount of plastic in EEE differs. The plastic content in e-waste, as an average, is assumed to be around 30% [3]. That would mean approximately 8000- 16000 tonnes of WEEE plastic generated in the city, that is around 22-44 TPD of WEEE plastic.

Since the obsolescence rate in India is assumed to be lower than the developed countries, we can assume that the total WEEE plastic generated in the city will be closer to 22 TPD (which is the lower estimate-Table 5). Given that the city generates 1000 TPD of plastic, this would mean that the WEEE plastic is around 2.2% of the total quantity

Table 1: Minimum and Maximum of WEEE plastic generated in Mysore

Location	MSW (TPD)		E-waste (TPD) (1%)		E-waste (annually) in tonnes		WEEE Plastic (TPD)		WEEE Plastic (annually) in tonnes	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Mysore	8421	9542	73	148	26700	58964	22	65	8000	18520
India	136996	146875	1370	1588	500000	154860	410	612	150000	180250

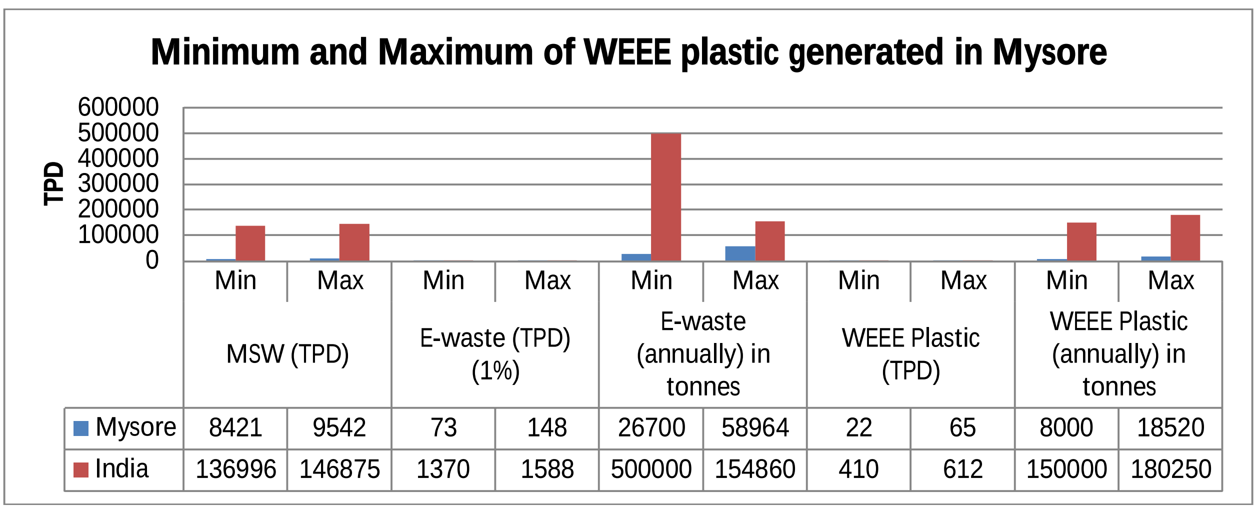

Figure 2: Minimum and Maximum of WEEE plastic generated in Mysore

The expected quantity of solid waste generated in Karnataka will be about 12,750 TPD by 2015

(National Environmental Engineering Research Institute), which means around 46,000-93,000 tonnes/annum e-waste and around 14,000-28,000 tonnes/annum WEEE plastic by 2015.

It is also important to assess the quantity of WEEE plastic processed in the city. There is no information indicating that plastic waste or e-waste is flowing out of the city for processing, hence it is safe to assume that the 22 TPD of WEEE plastic generated in the city is mainly processed within the city. But it is important to find out if the quantity recycled in the units in Mysore every day is higher than these 22 tonnes.

Our sources in the field clearly mentioned that Mysore receives plastic wastes as well as e-waste for processing from all parts of the country, thus indicating that the quantity processed in the city is much higher than the generated quantity of 22 TPD. The attempt to arrive at the total quantity proved to be far more challenging as there are no records of the waste flows within the country. The field interviews suggest that the quantity coming in from outside is much more than the domestic generation, since WEEE is coming in the city from all parts of the country including large e-waste generation center s like Chennai, Mumbai etc.

We also tried to arrive at this quantity from visiting the recycling units and assessing the quantity of WEEE plastic processed in these units on an average. Almost all units in the informal sector mix plastic from different sources. For example, if there is ABS plastic in a mobile phone it is segregated as ABS and then mixed with other ABS which may be sourced from car accessories or some other products. Similarly for the other resins used in EEE. There are no separate process lines for the WEEE plastic and hence no records maintained. The units visited during the study were unable to specify the quantity of WEEE plastic they received. Therefore it is not possible to quantify the total quantity.

3.1 Material & Methods

3.1.1 Plastic Sampling

The samples were randomly collected from the different areas of Mysore; from the recycling and plastic sorting units, pellet making and moulding units of M/s. Ameena Enterprises, C-199, KSSIDC Industrial Estate, Hebbal Mysore- 570 017 (560 MTA) , M/s. Shobith Industry –Unit II, Survey No. B-4/1, KSSIDC Industrial Area, Nanjangud – 571302, Mysore District (300 MTA) , M/s. Retone E-Waste Management, Plot No. 95 B &96 A, Belagola Indl Area, Mysore- 570017 (1080 MTA).

4. FINANCIAL ANALYSIS, CASE STUDIES

4.1 Waste Picker

A typical analysis of the quantity and type of waste collected by waste pickers is presented bellow. The results are based on sample of 55 respondents, mainly women, from Kuntigrama slum and 61 respondents, mainly men, from Bharatmata slum. Generally, a waste picker goes for waste picking on an average 17 to 20 days a month.

Table 2: Quantity and Type of Material Collected

Type	Amount Kg/day	Price Rs./kg	Total Rs./day
Road Waste	55	8.00	440.00
Pugga and Milk Covers	6	16.00	96.00
Kadak	5	12.00	60.00
	66		596.00

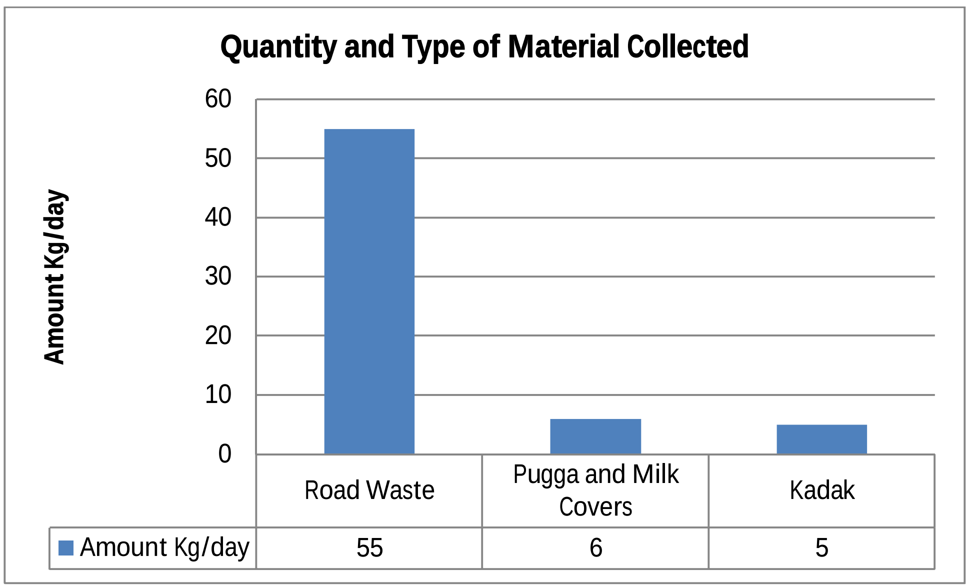

Figure 3: Quantity and Type of Material Collected

4.2 Economics of recycling

The plastic recycling business in Mysore is big, as this is the largest, both in terms of volume and in terms of economics, in India. Since the plastic usage and consequent disposal has increased many times in the last two decades, we can safely assume that this amount must have also increased substantially. Plastics' recycling is an attractive business in India due to availability of cheap labour. The cost of recycling one ton of HDPE plastics in is around Rs.6000 while the same would cost Rs.80 in Mysore.

The study of the plastic chain in the Delhi recycling market does not give too much insight into the real profit margins of each player since the informal sector is highly guarded on this and is not willing to share the economics at each level. But the important finding was that each player in this value chain works for at least 10-15% margin, though the traders at times work for higher margins. The table below indicates some costs.

Table 3: Economics of recycling trade (Purchase price-all figures in INR/kg)

Plastic Resin	Dismantler	Plastic Scrap Dealer	Grinding unit	Pellets Factory	Market
ABS	28-35	30-36	35-41	45-70	60-90
HIPS	20-35	35-50	45-60	50-65	50-90
PVC	20-25	20-45	25-80	30-75	
PP	25-40	25-35	40-60	50-75	50-80

5. Conclusion and Recommendations

The current study was carried out by Toxics Link in two parts, i.e. field research and lab analysis of the samples collected. The results indicate that, in formal as well as informal, plastic recycling units there are hardly any procedures to decontaminate the plastic or prevent cross contamination. Presence of BFRs like PBDEs and PBBs and heavy metals like lead and cadmium in lab analysis clearly point out towards the increasing risk of absence of such decontamination. Varying concentrations of PBDE and PBE found in the recycled plastic pellets point towards two major findings. Firstly, that though some of these chemicals have been phased out in developed countries, they are still being used in the products sold in India. Secondly, the entire plastic recycling chain is getting contaminated by these kinds of additives. Lab detection of the chemicals in the samples which were being sold in the plastic market as Flame retardant free is particularly alarming. The varying concentrations also probably indicate towards release of the chemicals during the recycling process, thereby raising the concern of occupational safely.

The study does have its limitations in terms of geographical area and sample size. But the findings clearly give us a basis to warrant a larger study to investigate the extent of cross contamination and also look at the repercussions of the same. The positive part is that there are new materials and product design techniques available in the market today that can replace the use of some of these harmful BFRs. The following recommendations will help spur the rapid adoption of currently available safer materials and catalyze the search for more environmentally friendly flame retardants. Also, it is important to note that BFRs are present in historical and current EEE. And hence we also need to come out with safer management practices and monitoring systems.

1. As a priority, we recommend a ban and phase-out in manufacture and use in products of PBB and Penta, Octa and Deca PBDE . Studies across the globe have indicated the risks associated with the usage of these chemicals and several countries have already banned their usage.
2. Some studies also indicate the toxic effects of other BFRs. Studies should be conducted on health and environmental impacts of these and if those studies indicate risks, regulatory agencies should take early action to phase them out.
3. There should be recycling guidelines for electronic products to ensure that BFRs are not continually put into new products and that workers are protected. Materials containing brominated compounds need to be separated from other materials to reduce contamination of those materials that can be recycled and reused in new products.

4. Products must contain information on materials and chemicals. This would help in separating contaminated plastic and keeping the recycling chain cleaner.
5. There is an urgent need for generating awareness among plastics recyclers on harmful impacts of toxics used in plastics.

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