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SRI SUSTAINABLE RECYCLING INDUSTRIES

Burning of plastic wastes in brick kiln in India

November 2016

1. About SRI Project

Incorporating a flame retardant in plastics is a common procedure in preventive fire safety measures, and is applied to reduce the risk of fires. FRs reduce the flammability of plastics. FRs are active during the starting phase of a fire wherein they prevent spread of an inner source or exterior source of ignition, hence prevent, delay, or inhibit the spread of a fire.

Brominated Flame Retardants are persistent in the environment and are liable to contaminate the food chain, animals, and people. Some of them like polybrominated diphenyl ethers (PBDEs) are toxic with considerable health effects on the nervous system. To develop environmentally sound management system for BFR contaminated plastics SRI (Sustainable Recycling industries) program was launched.

Sustainable Recycling Industries (SRI) program is funded by Swiss State Secretariat of Economic Affairs (SECO) and is implemented by the Institute for Material Science & Technology (EMPA) and World Resource Forum Association (WRFA). Confederation of Indian Industry has been selected as Country Leader for implementation of this project.

The SRI project in India aims to identify an alternative mechanism for handling BFR plastics and to develop technical standards for handling, transport and destruction of BFR plastics. The project also intends to set up a pilot take back mechanism to segregate & prevent BFR plastics from entering the secondary value chain. The project involves evaluation of management options for BFR plastic e.g. Co-processing in cement kilns, Waste to Oil, Waste to energy and recycling. As a part of this evaluation, desktop review for current practice of burning of plastic wastes as a fuel in brick kiln has also been conducted to understand its environmental impact.

2. Plastic waste management in India

2.1 Plastic waste generation

Each year, about 5.6 million tons of plastic waste is generated in India, and that amount is growing rapidly (Mahapatra 2013). Besides that, increasing amounts of plastic scrap are received from developed countries, looking for inexpensive ways to dispose of their plastic wastes. In India, an estimated 50-60% of this plastic waste is recycled (Mutha and colleagues 2006). It is estimated that, out of 15,342 tons of plastic waste generated daily in India, about 60% are collected and recycled, while the remaining fraction ends up in the environment.

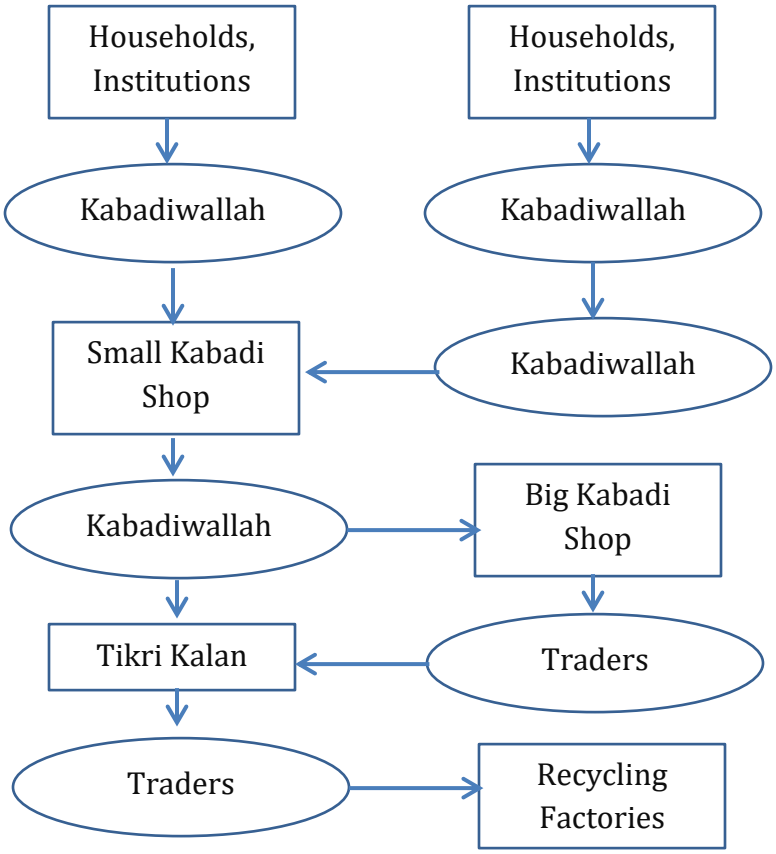
Further out of two main types of plastic polymers, thermoplastics constitute 80% and thermoset constitutes to 20% of total post-consumer plastics waste generated in India. Most of these plastics are recycled in a crude manner in informal set up.

2.2 Waste Collection

In India, waste collection and transport is carried by two entities, the formal and the informal sector. Most of the plastic recycling takes place in the so-called informal sector, providing livelihood to many, but being done with little or no regard for worker safety and environmental protection, and without much control or monitoring by the government.

Based on the report on Plastic Trading in India; there are two kinds of informal collectors, the Chugnewallah or scavenger and the Kabadiwallah or itinerant buyer. Chugnewallahs are people who take wastes from open spaces such as streets or parks and Kabadiwallahs are people who purchase waste from households and private or public institutions.

According to experts, along the transport chain, wastes collected by Chugnewallahs or Kabadiwallahs get more and more segregated. This transport is really driven by small trading operations. Chugnewallahs sell their waste to panni dealers and the Kabadiwallahs to kabadi shop. This waste is sold to a bigger Kabadiwallah, who sell it further to traders



A study conducted in Asia's biggest plastic scrap market, Tikri Kalan in New Delhi which revealed some astonishing facts. There exist three distinct areas of plastic trading e.g. PVC market, Badi Tikri and Choti Tikri. Details of these areas are as mentioned:

Area	Size (Km^2)	Number of units	People employed
PVC market	0.94	1380	7000
Badi Tikri	0.07	408	2000
Choti Tikri	0.38	80	

In these three areas, the main players are traders which import plastic scraps from Kabadiwallahs and export plastic scraps to recycling industries or brick-kilns. PVC market is the biggest trading area by Choti Tikri and finally Badi Tikri.

PVC market and Choti Tikri get their plastic scraps from Kabadiwallahs located inside or outside Delhi. Badi Tikri gets its plastic scraps only from PVC market. Plastic scraps that are leaving the system are sold based on their quality. Good quality plastic scraps are sold to plastic recycling factories, and plastics of lower quality finds its way to brick-kilns. Traders can also sell their commodity within traders of Tikri Kalan.

PVC market mainly focuses on trading and sorting activities. Some traders employ people to sort, others trade directly. In this area, plastic wastes are sorted according to resin and colour of the plastic scrap. Sometimes low quality plastics are sold to Badi Tikri.

Badi Tikri deals in dismantling and sorting processes. Plastics are broken apart into pieces such as toys or automotive part. Plastic scrap is sorted according to the use, colour, hardness and resin type. In this area, each trader specializes in 2 to 3 different resins or qualities. Internally plastic scraps are sold and bought based on the requirements.

The main activity in Choti Tikri is trading. Some units in Choti Tikri are also involved in sorting and grinding activities. In this area, there are both general and specialized traders. General traders sell scraps to specialized traders or grinding units.

All plastic scraps after sorting is sent for recycling. Approximately 97% of the plastic scraps are sent for the recycling while balance 3% is sent to brick kilns. In cases, plastic scrap is sold at very low prices or given free of cost to brick kiln.

Approximate daily inflow and outflow of plastics in these areas is as mentioned below:

Area	Inflow (ton/day)	Outflow – Recyclers (ton/day)	Outflow – Brick Kilns (ton/day)
PVC Market	1367 $\pm$ 502	1351 $\pm$ 497	17 $\pm$ 6
Badi Tikri	132 $\pm$ 47	113 $\pm$ 47	20 $\pm$ 12
Choti Tikri	375 $\pm$ 175	354 $\pm$ 176	21 $\pm$ 19
Total	1875 $\pm$ 530	1818 $\pm$ 375	57 $\pm$ 24

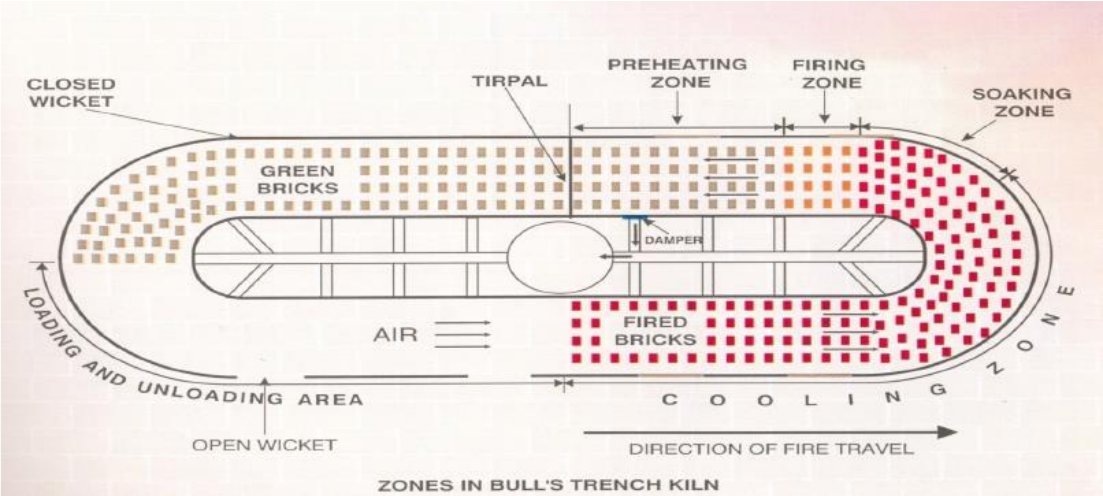
Some of the key findings of the study in Tikri Kalan, New Delhi are as below:

- Tikri Kalan site receives almost all types of plastic waste from all parts of the country. The plastic waste that is received is segregated based on :
    - Profitability
    - Kind of plastic (depending on number of times plastic has been recycled – primary, secondary, tertiary and non-recyclable)
    - Physical appearance and texture of the material
- There exists approximately 350 sheds which handles 189,000 tons of plastic waste annually.
- The recyclable plastic from these sites is sent to recyclers for further recycling and non-recyclable plastics and plastic wastes with lowest profitability are sold for burning in brick kilns at the rate of around Rs 0.7 - 1 per kg.
- Exact quantity of waste sent from these sites to brick kiln manufacturers could not be estimated as the traders and workers are not hesitant and not willing to share any of the information due to several reasons.
- Burning of plastics in brick manufacturing as a fuel, economically more attractive as plastic available at such a low rate and is easily available.
- Study indicated that approximately 60 tons of plastic each day is sent to brick kiln that equivalents to more than 21,000 tons of plastic scraps every year.

3. Brick manufacturing in India

India's brick manufacturing industry which is second largest producer after China, is expected to grow by 5-10% every year. Annual brick production is as high as 240-260 billion, out of which 74% of production is by BTKs (Bulls Trench Kiln) technology. Mostly coal and biomass are used as fuel (35-40 million) and in cases plastics and other wastes are also sometimes used.

In BTK, bricks are stacked in an oval surrounding a central chimney. The air flows from the completed bricks, through the firing zone and up the central stack. The firing zone is slowly shifted around the kiln towards green bricks (work in progress) bricks.



ZONES IN BULL'S TRENCH KILN

Burning of coal or biomass or plastic in brick kiln is equivalent to open burning of these fuel/wastes as brick kiln operations does not have any pollution control equipment that are deployed before emitting flue gas through chimney over 30 meters height.

As waste plastic is commonly available, many brick manufacturers finds it cheaper substitute for coal which is commonly used as a fuel. Burning of plastic in open atmosphere gives rise to various health and environmental hazards. Some of them are as discussed below:

3.1 Emission from burning of plastic

Pollutants released from burning plastic waste in open are transported through the air either short or long distances, and are then deposited onto land or into bodies of water. A few of these pollutants such as mercury, polychlorinated biphenyls (PCBs), dioxins and furans persist for long periods of time in the environment and have a tendency to bio-accumulate which means they build up in predators at the top of the food web. Bioaccumulation of pollutants usually occurs indirectly through contaminated water and food rather than breathing the contaminated air directly. In wildlife, the range of effects associated with these pollutants includes cancer, deformed offspring, reproductive failure, immune diseases and subtle neurobehavioral effects. Humans can be exposed indirectly just like wildlife, especially through consumption of contaminated fish, meat and dairy products.

The byproducts of plastic combustion are airborne particulate emission (soot) and solid residue ash (black carbonaceous colour). Several studies have demonstrated that soot and solid residue ash possess a high potential of causing significant health and environmental concerns. The soot when generated is accompanied with volatile organic compounds (VOCs), semi-VOCs, smoke (particulate matter), particulate bound heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzofurans (PCDFs) and dioxins and has the

ability to travel thousands of kilometers, depending on prevailing atmospheric conditions, before it can drop back on earth and enter into the food chain.

The toxicity of combustion products generated from burning of plastics has been evaluated by various researchers under experimental conditions. Significant amount of pollutants of environmental and health concern including carcinogens such as PAHs, nitro-PAHs and dioxins have been identified in the airborne particulate emissions. Further, these particulates have been found to be highly mutagen. Researchers have also found high concentration of persistent free radicals (unstable and highly reactive molecules) both in the soot and the solid residual ash which are considered to be very important in the creation of adverse health effects especially to human lungs.

Heavy metals including lead, cadmium, chromium and copper have been measured in the smoke and the solid residue ash. DEHP (Diethylhexyl Pthalate) is one of the compounds among the plasticizers used in plastic manufacturing that has been described by USEPA as a probable human carcinogen, a potential endocrine disruptor and is believed to be harmful by inhalation, generating possible health risks and irreversible effects. This compound is also released during the combustion of plastic. Most of the pollutants discussed have the potential to cause health and environmental effect as discussed in the table below:

Potential pollutant generated from burning of plastics	Health Effects	Environmental Effects
Carbon Monoxide	Causes dizziness, headaches and Slowed reflexes. Affects mental function, visual acuity and alertness	Oxidized to carbon dioxide (which is a greenhouse gas) in the atmosphere
Dioxins and furans	May cause cancer; causes growth defects; affects DNA; affects immune and reproductive systems	Increased toxic loading on environment; leads to contaminated water/land, affects animal health
Polynuclear Aromatic Hydrocarbons (PAHs)	Cancer causing agent in most animal species including mammals, fish and birds	Increased toxic loading on environment, leads to contaminated water/land, affects animal health
Volatile Organic Compounds (VOCs)	Directly toxic including problems ranging from cancer risks to nervous disorders. Causes respiratory irritation/illness, chronic lung disease	Contributes to low level ozone (smog), causes vegetative damage. Leads to contaminated water/land, affects animal health

Particulate Matter	Irritation of respiratory tract, aggravated asthma, contributes to chronic obstructive pulmonary disease	Increased toxic loading on the environment; leads to contaminated water/land and affects animal health
Aldehydes	This is a animal carcinogen. Causes eye and respiratory illness and headaches	Increased toxic loading on environment, leads to contaminated water/land, affects animal health

4. Regulatory Framework

There exist several rules and regulations which countries have adopted to restrict usage of BFR plastics. Major frameworks are as mentioned below

Plastic Waste (Management and Handling) Rules, 2016

India's Ministry of Environment adopted new rules governing the management and disposal of plastic waste in 2016. The new rules include an extended producer responsibility system. These Rules do not lay down any standards or guidelines to recycle plastic and does not have any provisions mentioned for plastics with flame retardants or other hazardous chemicals.

Guidelines on recycling of plastic waste

The Bureau of Indian Standards (BIS), New Delhi has issued guidelines on recycling of plastics waste, including code of practices for collection. However, while formulating Indian standard specifications for various plastic products, used for critical applications like plastic piping system, water-storage tanks, packaging for food articles, a clause is included which reads "no recycled plastics waste shall be used". Again there is no specifi c mention of critical additives like BFRs.

E-Waste (Management and Handling) Rules, 2016

E-waste rules were notified in 2016 and looks at both upstream and downstream aspects of waste arising from EEE. The rules call for the reduction in the use of hazardous substances in the manufacture of EEE. Every producer of equipment listed in schedule 1 of the rule namely, information and telecommunications equipment and consumer electrical and electronics shall ensure that their products do not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, and polybrominateddiphenyl ethers above a specified threshold. The threshold for cadmium is 0.01% by weight; for all other substances, the threshold is 0.1% by weight. The list of concerned appliances is given in Annexure 1. The rules also apply to products imported into India.

The Stockholm Convention

The Stockholm Convention, which also has been ratified by India aims at reducing and eliminating production, use and release of persistent organic pollutants (POPs). In May 2009, certain congeners contained in commercial PentaBDE and OctaBDE were added to Annex A of the Stockholm Convention. As a consequence of this, these chemicals are now officially classified as POPs and may no longer be produced.

Tolerable Daily Intake (TDI) is a value calculated as an index of the effects on health, when daily intake continues throughout life. The international agencies including, WHO-FAO, Codex Alimentarius Commission have issued TDI limit for dioxins intake of a human being. Many countries have put regulation in place on the permissible intake of dioxins through their food.

Regulatory Body	TDI (pg/kg of body weight / day)
WHO	1-4
FDA EPA	0.7
European Union	1-4
Japan	4
Canada	2.3
Australia	2.3
Joint FDA/WHO expert committee on food additives	2.3
India	Does not have any standards

5. Conclusion

India has seen significant growth in plastic consumption in the last couple of decades. Though the per capita plastic consumption in India, which stands at around 9 kgs, is much lower than many developed countries, the >1 billion population means enormous amounts of plastic being used and eventually discarded or thrown. 'We are sitting on a plastic time bomb," the Supreme Court, the highest judiciary body of India, said 2015, as India generated 56 lakh tonnes of plastic waste annually. 60% of this waste plastic is recycled with some 3,500 recognized recycling units and unlimited number of units in the unorganized sector, spread all over India.

Plastic recycling and its burning through brick kiln to the tune of 21000 tons every year can be a concern, especially with the presence of contaminants and additives which are added for different purposes. Plastic from EEE have additives like Brominated flame retardants (BFRs) added to inhibit the fire catching ability. A lot of work and knowledge is available

internationally on the topic of BFRs and its environmental and health impacts. By including some BFRs in the Stockholm convention, the international community has signaled strongly that BFRs are global pollutant and the need for knowledge exchange between developed and developing economies can be extremely beneficial.

Open burning of plastics has severe health and environmental effects thus it is worth emphasizing that open uncontrolled burning or use of plastics in brick kiln is by no means an environmentally sound option to dispose of waste BFR plastics. Other environmentally sound options must be explored for their safe disposal like co-processing in which plastics is burnt as a fuel in cement kiln at around 1700 C to 1800 C which completely eliminates the formation of Dioxins and Furans. However, to have clear idea of this disposal options, trial run has to be conducted.

6. References

1) Report on 'Plastic scrap trading in India' by Daniel Kroiss
2) Brick Kilns in India by J S Kaymotra
3) Report on 'WEEE Plastic and Brominated Flame Retardants' by Toxics Link
4) http://www.online-sciences.com/health/dangers-and-bad-effects-of-burning-plastics-and-rubber-on-humans-and-global-warming/
5) http://www.ecobrick.in/resource_data/KBAS100083.pdf
6) http://plasticisrubbish.com/2008/06/02/dioxins-why-you-dont-want-to-be-burning-plastic/
7) http://www.wecf.eu/cms/download/2004-2005/homeburning_plastics.pdf
8) http://www.saskh2o.ca/PDF/epb433.pdf
9) http://toxicslink.org/docs/DIOXIN-Factsheet44.pdf