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Waste Management: Inspire Today for A Better Tomorrow

Pradeep Kumar Singh[1], Jignesh N. Vidani[2] and Veerendra Singh Nagoria[3]

[1,2,3]Rai University, Saroda-Dholka Road, Ahmadabad – 382260
E-mail: [1]pradeepsingh.171@rediffmail.com, [2]jigneshvidani@live.com, [3]veerendra.nagoria@gmail.com

Abstract—*The plastics waste constitutes two major categories of plastics; (I) Thermoplastics and (ii) Thermo set plastics. India has witnessed a substantial growth in the consumption of plastics and increased production of plastic waste. The hazards plastics pose are numerous. India has witnessed a substantial growth in the consumption of plastics and an increased production of plastic waste. When compared to a plastic manufacturing firm, a plastic recycling firm can employ approx 7 times more people. There are over 22,000 plastic processing units and over 150 plastic processing machinery manufactures in India.*

India recycles 60% of its plastic waste which is highest in the world; these plastics are recycled into non-critical items of daily use. The waste plastic generates fuel i.e. 1 MT of waste plastic generates approximately 1 tone fuel.

The Recycled Plastic Factory manufactures 100% recycled plastic lumber made from post-consumer and post-industrial recycled plastics, such as milk jugs and laundry detergent bottles, plastic bags and floater pots. The industry also consumes recycled plastic, which constitutes about 30% of total consumption.

"Living without plastics is impossible today. India ranks highest in the recycling of plastics, with 60% of plastics recycled, compared with a world average of 20%. There are three types of recycling that plastics can be subjected to: mechanical recycling, mixed waste recycling and feed stock recycling.

The paper focuses on the recycling of a plastic waste and how products can be made out of it. An attempt has been made in this paper to show what kinds of products can be made and how they can be used.

Keywords*: Plastic Recycling, Thermoplastic, Recycled Plastic, Plastic Waste, Mechanical Recycling.*

1. A PROLOGUE

There are a recorded 60000 farms operating within the Province of India. Close to 50% of these farms (30000) run farming operations which depend upon the use of balers to package forage crops, hay and straw into bales which are collected and stored until ready for use. Automated balers, of which there are over 39,000 in use within the province, are used to gather straw and feed crops into a condensed bundle that is secured by agricultural baler sheet. There are two types of baler sheet used today: Sisal fibber sheet, which is made from natural fibers grown in Brazil; and plastic sheet made from Polypropylene.

Sisal, which was once the industry standard is 100% biodegradable, is harmless to livestock and, when treated, is resilient to fungus, mould and rodents. From an environmental perspective, it still remains the choice of many farmers although it is known to break down quicker and thus not perform as well as its plastic sheet counterpart. Sisal is also more expensive than poly-sheet. For example a 7200 ft. role of poly-sheet costs Rs.1000 while the same role of sisal will cost Rs.2000 (UFI pricing as at March 9, 2012).

Polypropylene sheet has gained popularity over the last twenty-year period. It is said to perform longer than Sisal and its use is far more prevalent with over 3,500 tonnes sold to the agricultural industry in India each year. “Poly-sheet”, as recorded from one sheet distributor, outsells Sisal by approximately nine to one. The down side in using poly-sheet is that it is not biodegradable. Left uncollected, it causes entanglement and ingestion by livestock and causes costly repairs to farm machinery when it wraps around axles and moving parts. As a result, farm operators take care in removing the waste sheet, store it in piles and, ultimately, burn it or take it to landfills. Because of toxic emissions, it is illegal to burn anything coated with rubber or plastic including plastic baler sheet and plastic pesticide containers. When taken to dry landfills, it also causes problems with landfill machinery such as packers and loaders.

Herein lays the problem. While polypropylene sheet is an ever-present commodity in Indian agricultural industry (with over 3,500 tonnes sold and wasted on an annual basis), no safe environmentally sound and economical solutions to disposal, re-use or recycling have been developed to date.

Poly-sheet recycling has been identified by the Capital Region Waste Management Advisory Committee as a major initiative of the India Postconsumer Recycling Strategy. In January 1999 the India Plastics Recycling Association (A.P.R.A.) was asked by the Committee to undertake a feasibility study to recycle polypropylene sheet. The project is designed to explore recycling options and/or post market use of plastic baler sheet and includes its potential use in making shingles,molded or extruded plastic products, concrete or

asphalt reinforcing additives, stuffing for furniture or live stock mattresses, geo-textile fabricant waste to energy options

2. LITERATURE REVIEW

Hongping Yuan & Liyin Shen *(2011):* Research interests in addressing construction and demolition (C&D) waste management issues have resulted in a large amount of publications during the last decade. There study demonstrates that there is no systematic examination on the research development in literature in the discipline of C&D waste management. The findings from there study also indicate that survey and case study are major methods for data collection, and the data are mostly processed through descriptive analysis. It is anticipated that more future studies on C&D waste management will be led by researchers from developing economies, where construction works will remain their major economic activities. On the other hand, more sophisticated modeling and simulating techniques have been used effectively in a number of studies on C&D waste management research, and this is considered a major methodology for future research in the discipline. C&D waste management will continue to be a hot research topic in the future, in particularly, the importance of human factors in C&D waste management has emerged as a new challenging topic.

Jukka A. Rintala and Jaakko A Puhakka *(1994)*: The pulp- and paper-industry generates large volumes of highly heterogenous wastewaters containing compounds from wood or other raw material, process chemicals and compounds formed during processing. The wastewaters from mechanical pulp and secondary fiber pulping as well as the condensates from chemical and semi-chemical pulping are typically non-toxic to methanogenic degradation and contain easily degradable organic compounds. Consequently, anaerobic digestion is an attractive treatment alternative for these effluents. In addition, both primary and secondary sludges from pulp- and paper-industry wastewater treatment-plants are amenable to anaerobic digestion. In contrast, the bleaching effluents from chemical pulping, the debarking effluents as well as the CTMP effluents are likely to be inhibitory to methanogenic degradation; also their biodegrability is relatively low. Dilution with other wastewater streams or detoxification by various pretreatments have been used to facilitate anaerobic treatment of these inhibitory wastewaters. the potential of the anaerobic systems for reductive dechlorination and sulfur recovery is unique and of great interest. In almost all pulp- and paper-industry full-scale applications, anaerobic treatment is followed by aerobic post-treatment. The suitability and the cost of the anaerobic-aerobic and aerobic treatment-systems are largely affected by a variety of mill-specific factors.

Table 1: Research Design

Research Problem	**:**	How we can recycle waste plastic into various useful Products and reduce the pollution made by it in all manners?
Period of Research	**:**	2 month
Type of analysis	**:**	Secondary
Data Collection Method	**:**	Internet, Newspapers, Magazines and Videos
Type of Research	**:**	Descriptive Research

3. PERFORMA OF OUR STUDY

Phase 1: Market Options Identification and Market

Feasibility Study including:

- Feedstock supply inventory.
- Market acceptance to identified options.
- Volume pricing of markets for recycled poly-fiber or flake.
- Product and manufacturing specifications.
- Essential pre-requisites to sustainability for recycling re-use or waste to energy.
- Identification of previous research.

Phase 2: Collection Feasibility Analysis:

- Options for at-source handling.
- Current disposal methods.
- Cost of status quo disposal.
- Identification and cost impacts of alternative handling methods for collection and transportation.
- Identification of and impacts surrounding province-wide collection and strategic development.
- Develop and examine selected collection pilots.

Phase 3: Re-processing Feasibility Analysis including:

- Reviews of current reprocessing methods and handling costs.
- Identify alternative forms of reprocessing for further study.

4. MARKET OPTIONS AND FEASIBILITY

Prerequisites to Sustainability "The Challenge"

In order to achieve sustainability within the context of this B-plan, identified solutions (or programs) must be:

- Ongoing.
- Affordable in the context of full cost accounting taking into consideration the environmental costs associated with the present problem.
- Technologically feasible with the hope that technological advancement will improve sustainability over time.
- Acceptable to all stakeholders from a social, political and economic perspective.

This means that the accepted solution or combination of solutions, if found, must recover and/or find acceptable disposal solutions for a major portion of the 3,500 plus tonnes of all plastic waste.

A target of 2,000 tonnes per year, or just over one half of the scrap sheet produced, has been set as an acceptable target rate and thus the challenge for us. Because of the characteristics of Plastic, its state in a sheet form and its condition after use, there are both obstacles and opportunities that must be considered before any potential alternatives are assessed. The following sections provide this overview and a basis of understanding from which potential programs can be compared and evaluated.

Product Constituents of Poly-Sheet

Plastic baler sheet is almost 100% pure virgin polypropylene. Colouring agents containing some chemicals are added to better enable collection and to distinguish between sheet sizes that can vary depending upon strength required. Polypropylene is part of the Polyolefin resin family, which includes low density, linear low density and high-density polyethylene. They have high molecular weight hydrocarbons and Are the only family of resins that float? Polypropylene is break resistant, non-toxic and non-contaminating on its own (without paint additives). It is more susceptible than polyethylene to strong oxidizing agents and offers the best stress/crack resistance of all polyolefins. Pound for pound it is stronger than steel and continually wears through steel pins and cutting shears/blades.

Products made from polypropylene include concrete fiber reinforcing additives (i.e., Fibre mesh) plastic bottle caps, battery casings, automobile parts, microchips and electronic equipment casings. Such products are brittle and may crack at temperatures below 0o C if dropped from bench top height. Prolonged exposure to UV light can damage this polymer.

Physical Properties:
Tensile Strength 97 ski average

Melting Point 330o F (165oC)

Ignition Point 1094oF (590oC)

5. POLY-SHEET MARKET OVERVIEW

Volumes and Distribution

- The sheet that will be distributed in India is likely manufactured in Spain, Portugal, Czech Republic or the United States (Houston, Texas).
- Predominate distributors include Hoyle Sheet in Millarville,AB and Bridon Pacific in Saskatoon, SK.

Obstacles to Sustainable Program Development

Poly-sheet use is widespread throughout all agricultural regions of the Province, thus the collection of post consumer sheet would have to occur on a Province-wide basis if targeted volumes were to be achieved.

At source, post consumer poly-waste is usually contaminated with soils, cattle manure and straw particles, thus it must undergo a cleaning process if it is to be used for recycling purposes.

Various samples of poly-waste from large commercial feedlots forage exporters and farms have been taken to plastic recyclers and brokers for value assessments. One broker currently bales and broker's industrial waste ends (waste from the manufacturing process). It was concluded that the marketability of post consumer bales with even a slight occurrence of straw particles is negligible to non-existent. Post consumer waste mixed with farmyard dirt and manure is a non-starter.

Post consumer poly-waste can vary in size and colour, thus some recycling applications and end market uses may require separation by colour and, in some cases, by size. Poly-sheet is manufactured in varying thickness (strengths) according to the number of strands (polypropylene microfilaments) incorporated in the sheet. Colouring agents are added to distinguish between grades and as well to improve the visibility of the Plastic waste for collection purposes.

The properties that make polypropylene an excellent choice for strength and durability are diminished with ultra-violet light thus re-use for applications that require tensile strength arena-starters.

Poly-sheet that is left outside in sunlight will deteriorate over time. Since forage and straw bales are often stored outside and since used waste (after the bale is broken down) is normally stockpiled outside, the tensile strength of the polypropylene is diminished. The longer the exposure the weaker the tensile strength.

Polypropylene has a high glass transition temperature thus its use as a recycled resin is limited to products that are not exposed to low temperatures. Polypropylene becomes brittle aglow temperatures, thus the use of recycled poly sheet as

constituent of recycled products must be carefully examined. The handling of post consumer Plastic waste from a health standpoint would have to be considered into any collection and recycling program.

Hay bales often serve as winter homes for small vermin and mice. Post-consumer Plastic waste from bales that are broken down will contain particles that can become airborne with handling. The major concern for handlers is with the deadly Hanta Virus carried from droppings of deer mice. Workers who process large concentrated

Quantities of post consumer Plastic waste would have to conform to India Health Act regulations. The cost to landfill Plastic waste as a component of a mixed waste stream varies from region to region, thus areas with low cost (or no cost) disposal may not have an incentive to recycle. Some rural landfill operators do not impose a charge for landfilling Plastic waste; others charge a nominal fee of up to Rs.7500 / tonne. Large urban landfill operators can charge up to Rs.4000 / tonne in India; however, these locations are usually far removed from the actual generators of the waste, thus the cost of land filling will not be a major incentive to recycle for those who currently dispose of Plastic waste at rural landfills.

The at-source collection of large quantities of entreated piles requires specialized handling procedures and/or new methods of at-source collection, which eliminate entangled Plastic waste piles.

Mechanical recycling requires that post-consumer sheet is in a form which can be manually introduced into granulators or choppers. This means that entangled sheet must be straightened and/or size reduced to allow for the processing to commence. While this may not be necessary for larger scale waste to energy applications, it is a costly manpower intensive step in the recycling process. This step could be reduced or eliminated if at-source generators could be trained to collect the waste sheet in straight strands as opposed to piles.

The commodity pricing of recycled polypropylene (in flake form) has ranged between Rs.90/ lb. and Rs.200/ lb. over the last three year period. Thus, any options (programs) must operate with costs at the low end of this range to be sustainable. The brokering of post-consumer plastic (in any form) to overseas markets has proven in the past to be highly speculative since market demands change, there is no consistency regarding criteria (specifications) for acceptance and financial exchanges have not been honoured on a regular basis.

The above noted obstacles are not universal to all recycling /recovery alternatives nor are they totally insurmountable. However, where they do apply, they will affect financial viability.

Existing Opportunities

A conventional form of Plastic Recycling that exists today represents a known use for poly-plastic waste. Plastic resin recycling has been around for some time in India and the brokers, re-processors and recycle manufacturers have learned to manage volatile market pricing, fluctuating volumes, changes in quality and overall local competition. Many have survived because they have found their market niche by developing their re-processing equipment in line with their chosen resin market and in securing stable sources for supply of product.

While polypropylene is a constituent of many products (bottle caps, battery casings, car parts and other plastic waste), it represents a very small portion, as little as 1.3% of all plastics in the waste stream. As a result, few plastics re-processors have set up to recycle this resin.

This situation could change if a guaranteed supply of close to 2000tonnes per year of poly-plastic waste could be made available. Discounting collection, handling and re-processing costs, this amount represents between Rs.5M to Rs.10M depending upon market price.

While there are no known recycling applications which use post-consumer poly-plastic waste, recyclers do recycle other products which contain polypropylene resin. For example, recycled polypropylene is used in automobile parts, battery casings, carpets and textiles. Recent research efforts towards recycling poly-plastic waste into fiber additives for concrete have met with some success.

A local company has done some research aimed at recovering the polypropylene micro fibers from poly-plastic waste, chopping the fibers and re-marketing the product as concrete fiber additive.

This recycled product is suggested to compete with current manufactured concrete additives in both price and performance even though the fibre diameters and configurations are dissimilar to the family of polypropylene additives that are on the market. While this business plan proposal shows a great deal of promise in a laboratory environment, in-field pilots have not been undertaken. In addition, with a current market demand in India for virgin fiber mesh product at approximately 270 tonnes, even a 30% penetration of this market would, in effect, require approximately 80 tonnes of recycled plastic waste feedstock. This represents a demand in India for less than 4% of the targeted capture volume of 2,000 tonnes.

However, on a nation-wide or broader marketing basis, the business plan proposal has merit and if we assume that all feedstock came from India, it is conceivable that 50% of the available capture of post-consumer poly-plastic waste could be recycled for this purpose.

Emerging Opportunities

During the course of this research, a number of plastic industry contacts were made via virtual media i.e. internet. Through networking, many possibilities for the use of post-consumer plastic waste came forth. The following

opportunities are considered to be in their development stages and thus represent emerging opportunities for the use of the product. The next section contains "Ideas for Use" that are yet to reach their development stage.

Ideas for use of post-consumer poly-sheet

Broom Manufacturing

E mail was made with Fiber built Manufacturing Inc. in Calgary (Vincent Foong). This company buys polypropylene in fibre form from DuPont to manufacture bristle products like brooms, mud flaps, etc.

They report using a volume of 100,000 lbs (45 tonnes) of polypropylene each year and are one of three Western Canadian companies who are in this business. They would like to try a sample of post-consumer poly-plastic waste in strands in some applications, but admit that their volume demands would be too low to warrant a comprehensive collection program.

Oil Spills Clean up

This idea was received from a past recycler of plastic who was actually involved in early pilot studies to wash and grind postconsumer poly-plastic waste. He notes: "An interesting property of polypropylene is that it attracts hydrocarbons if ground, contained within a porous polypropylene pillow (or mat) and introduced into a liquid, the pillow would float and behave as a wick in attracting suspended hydrocarbons".

This principal is currently applied in various applications like diapers and sporting garments. In the case of diapers, the liquid passes through a polypropylene barrier and into an absorption layer. The poly-layer does not contain any moisture; it acts to keep the skin surface dry.

Similarly, sporting garments like cold weather jackets and socks will allow perspiration to "wick" or gravitate through the poly and away from the skin's surface, thus maintaining a dry condition where it counts. In the oil spill application, there may be some merit to floating large mats containing polypropylene filled pillows. These mats would "wick" the oil and would be winched back onto a large vessel that in turn would remove the oil and replace the large mats. If technologically feasible, this application would no doubt serve as a great alternative for the use of post consumer polypropylene, including poly-plastic waste.

Cattle Pillows

Champaign Editions Inc. is an Alberta based company that manufactures products from rubber crumb. One of their major products is rubber crumb filled pillows used as livestock bedding –an alternative to straw. The owner of the company was approached via email to consider the possibilities of replacing or augmenting rubber crumb with granulated poly-plastic waste. Their annual volume demands for rubber crumb far exceed the poly-plastic waste volumes targeted for province wide collection (2,000 tonnes).

Thus, on a volume basis, this alternative would be ideal. There was little interest shown to replace rubber crumb with ground poly-plastic waste, but it was suggested that they may be willing to try augmenting the rubber with percentages of poly-plastic waste material if it could be supplied in an uncontaminated state. Due to competition for processed rubber crumb in Alberta, the Company has purchased a large-scale grinder for grinding rubber and would be willing to do a pilot test to grind poly-plastic waste material.

The timing to do this pilot is, at present, undetermined pending the installation of the grinder. They may choose to move their grinding operation to the U.S. where access to rubber tires is less competitive and does not fall under the same regulatory framework as that found in Alberta.

6. CONCLUSION

There are a recorded 60000 farms operating within the Province of India. Close to 50% of these farms (30000) run farming operations which depend upon the use of balers to package forage crops, hay and straw into bales which are collected and stored until ready for use. Automated balers, of which there are over 39,000 in use within the province, are used to gather straw and feed crops into a condensed bundle that is secured by agricultural baler sheet. There are two types of baler sheet used today: Sisal fiber sheet, which is made from natural fibers grown in Brazil; and plastic sheet made from Polypropylene.

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