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Recycling Trends in the Plastics Manufacturing and Recycling Companies in Malaysia

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Abstract: This study presents the findings from a study on the consumption of recycled materials and recycling practices in the plastics manufacturing industry and recycling companies in Malaysia. The findings were obtained from a survey conducted in twenty plastic manufacturing companies and detailed case studies in three recycling companies. The survey conducted in the plastic manufacturing companies' shows that the consumption rate for poly-olefins (PP and PE) is the highest among the resin types and the industrial sector that consumes the most plastic materials is the electrical and electronics sector. The consumption of recycled materials is high among the local manufacturing companies (80%) which are largely due to cost savings; about 20% of these companies conducted in-house recycling. The study has also shown that the medium scale industry consumes the most recycled materials as compared to the large and small scale industry. The rate of disposal for plastic materials in the local industry is approximately 5%. The detailed case studies conducted in the recycling companies have successfully identified the main processes involved in plastic recycling namely manual sorting, cleaning, drying, meshing/pelletising and packaging. These recycling companies obtained recycled materials from various sources including industrial scrap, dumping sites, local producers as well as imported sources. Pricing of recycled materials were based on classification according to grade and quality of the recycled materials. The study has reflected the extent of in-house recycling trends in the local plastic manufacturing companies and their dependency on the supply from the local recycling companies.

Key words: Plastics recycling, recycling process, in-house recycling, plastic waste management

INTRODUCTION

The rapid economic growth in Malaysia has generated 0.5-0.8 kg waste material/person/day and in rural areas the figure increased to 1.7 kg/person/day (Kathirvale *et al.*, 2003). The authors noted that plastics materials constitute the largest component of waste material by weight at 18.9%, apart from food and paper. The plastics waste materials comprised 3.2% rigid plastics, 14% plastics film and 1.65% foam plastics. Most plastics such as poly-olefins, a petroleum derivative, are not easily degradable. This means that the plastics materials cannot be decomposed by bacteria when buried or disposed at the dumping sites. Pocket Guide to Marine Debris (2003) predicted that plastic bottles would take approximately 450 years to decompose.

Biodegradable plastics materials such as polyactic acid and polyhydroxybutyrate however, are too expensive to compete with petroleum based plastics. The government has faced difficulties in finding suitable

dumping sites as well as outcry from the public whenever issues on the development of new dumping sites were raised (Jamlus, 2004).

The British Plastics Federation (2003) categorized recycled plastics as industrial scrap and post-use products. The former is derived from manufacturing scrap while the latter is plastic products that have undergone a full service life and later reclaimed for further use.

Plastics waste materials that are collected from industry sources that comes under the sorted plastics categories were claimed to be better in terms of quality than those collected from mixed material sources. It is relatively easier to identify and control the cleanliness of materials that are collected from the industry as compared to those from municipal waste. Better grade recyclable plastics will ensure better quality for the second grade plastics materials to be produced without the need for sorting and cleaning processes. Sorted plastics materials can be obtained from the industry or consumers that sort their own plastics waste materials.

The objective of this study is to determine the consumption and disposal rate of plastic materials in plastic manufacturing companies and to identify recycling trends in these companies as well as in recycling companies in Malaysia. Results from the study would provide some insights into issues related to the recycling pattern, supply and quality of recycled materials in Malaysia.

MATERIALS AND METHODS

The study was conducted in Malaysia from February-April 2005 using the survey method that was sent out to forty plastic manufacturing companies and detailed case studies involving interviews in three plastics recycling companies. The survey method was aimed at acquiring information related to the consumption of plastics and recycled materials, plastics recycling practices and issues in the plastics manufacturing companies while the detailed case studies were used to gather details on recycling practices in recycling companies. Respondents for the study were identified from the directory of companies registered with the Malaysian Plastics Manufacturers Association (MPMA Directory 2001/2002). Twenty plastics manufacturers responded to the survey. Findings from the survey and detailed case studies are reported in the following section.

RESULTS AND DISCUSSION

Recycling of plastics in plastics manufacturing companies

Consumption rate of plastics according to resin types: With regard to the type of resins consumed by the plastics manufacturers, results from the survey (Fig. 1) indicated that ABS-28%, PP-27%, PS-20%, other materials such nylon and acrylic 11%, PE-10% and PC-4% were the main resins used. The results clearly indicated that polyolefin such as polyethylene (10%) and polypropylene (27%) monopolised the plastics industry in Malaysia. This finding is in line with the study by the Malaysian Plastics Manufacturers Association (MPMA) that reports the consumption of poly olefins as the highest, at 67.7%.

The consumption of the ABS resin is high (28%) since most of the respondents are from the electrical and electronics sector, producing telephones, computer casings and domestic appliances such as casings for food processors and hand-held electrical items. PS is third in terms of consumption and this finding conforms to the study conducted by MPMA (2004).

Table 1: Consumption rate for different types of plastics resin per day of the respondent companies

Plastic resin	kg day ⁻¹
Polyethylene (PE)	4588
Polypropylene (PP)	12827
Polystyrene (PS)	9413
Polycarbonate	1825
Acrylonitrile butadiene styrene (ABS)	13218
Others	4966
Total consumption per day	46837

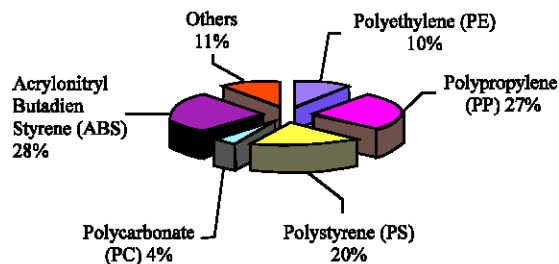


Fig. 1: Consumption rate of plastics according to resin types

In terms of unit weight, the total amount of solid resins consumed per day by the respondent companies is 46.8 ton day⁻¹. The total consumption of polyolefin resins can be as high as 17.4 ton day⁻¹, which includes the use of recycled resins. Table 1 shows the amount of resins consumed per day by the respondent companies according to resin types.

Consumers of plastics according to industrial sectors:

With regard to the consumption of materials according to industrial sectors (Fig. 2) the electrical and electronics sectors lead at 39%, followed by automotive 26%, domestic 19%, packaging 10%, building and construction and agricultural sectors, each contributing 3%. MPMA has identified the packaging sector as the largest consumer of plastics material. The packaging sector manufactures product using the extrusion method such as film extrusion to produce plastic bags and blow moulding to produce bottles etc. A majority of the respondents in this study use the injection moulding process for their products.

The injection moulding process uses less material as compared to the extrusion method since the extrusion method is a continuous process (Abidin, 2005). In the UK, packaging represents the largest single sector in plastics use; that accounts for 35% of UK plastics consumption (Waste online, 2006).

Consumption of virgin resin versus recycled resin: All the respondents use thermoplastic materials, enabling

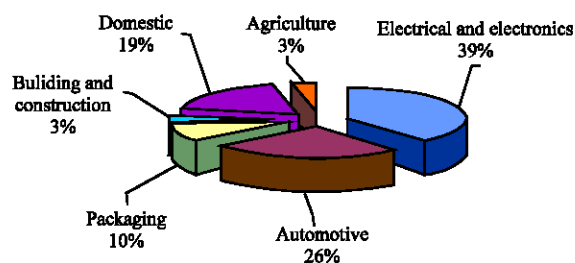


Fig. 2: Consumption (in %) of plastics according to industrial sectors

them to reprocess or recycle the materials. Injection moulding is the main process in most of the respondents. From the total of 46.8 ton day⁻¹ plastics materials consumed by the respondents, 19% are of the second grade material or recycled materials that have been mixed with virgin resin. The other 81% used virgin resin. Some manufacturers mixed less than 10% of the recycled materials into the virgin resin. According to the British Plastics Federation (2003) almost all moulding companies recycle their own plastic waste in-house. From the survey, it was found that 7 companies emphasised quality in their end products while saving on cost. 3 out of the 7 companies do not use recycled materials at all due to the need to produce high precision products as specified by the customer. Some companies use more than 50% of mixed recycled material in most cases for the manufacture of domestic products that do not require high quality or accuracy.

According to MPMA (2004) the total consumption of virgin plastics increases from 1.42 million metric tonne in 2003 to 1.53 million metric tonne in 2004. About 40% of the virgin plastic is imported due to the absence of the required grade and type in the local market.

Sources of plastics materials in the industry: Out of the 20 respondents, 80% used recycled materials. Many companies recycled their own materials in view of cost savings. Twenty percent of the companies that used recycled materials recycle their products in-house as well getting the supply from external recycling companies that are appointed on a contract basis. The recycled products are generally defects or those that do not comply with the specified quality standards. The British Plastics Federation (2003) refers to these scrap materials as industrial scrap that results from the start up and shut down periods of the processing machinery, from out of specification products and from quality control samples.

Outsourcing of the recycled materials is necessary when its capacity to support production requirements is

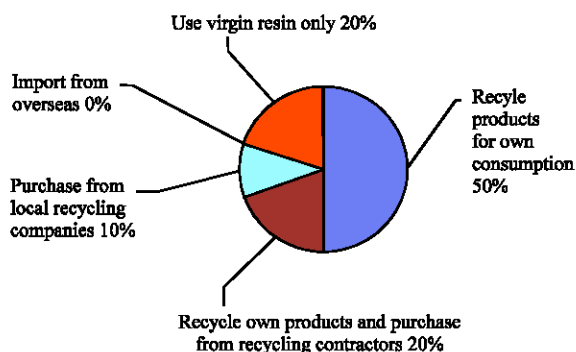


Fig. 3: Sources of plastics materials for the plastics manufacturers

low. Ten percent of the companies that use recycled material do not recycle their waste materials, instead they outsourced from recycling companies. None of the recycled materials are imported perhaps due to the availability of supply from the local recycling companies.

It has been noted that in developing countries, the scope for plastics recycling is growing as the amount of plastics being consumed increases (Recycling of Plastics, 2006). Figure 3 depicts the various sources of plastics materials. The other 20% of the respondents who did not use recycled materials did so due to requirements for high quality products. Waste materials from these companies are sold as scrap through quotations or to contractual buyers.

Consumption of recycled plastics according to industry size: In Malaysia, the industry is classified according to sizes based on the following category: small sized- full time employee less than 50, annual sales less than RM10 million; medium size-full time employee 50-150 and annual sales between RM10 million-RM25 million; large size-employee more than 150 and annual sales more than RM25 million. Findings from the study indicated that the medium-sized industry consumed the most recycled material, at 4 ton day⁻¹ (43%) compared to the large industry at 2.9 tonne/day (40%) and small industry at 1.9 ton day⁻¹ (17%).

Rate of disposal of plastics materials: Findings from the study indicated that plastics materials are disposed at a rate of 2.943 kg day⁻¹, an approximation of 5% from the daily consumption of plastics material. This finding is in agreement with the results obtained by Rossbach (1979) at 5.3%.

Recycling of plastics materials in plastics recycling companies: The findings discussed in this section were

obtained from detailed case studies conducted in three plastics recycling companies (industrial partners). These companies are Bumiputera-owned companies that are categorized as small scale industries (full time employees <50 and annual sales <RM10 million).

Recycling process: The main processes involved in recycling in the industrial partners are presented as follows:

Step 1: Acquisition of plastics waste material

Step 2: Manual sorting by trained operators. Sorting can be based on:

- Resin type: PE, PP, PS, ABS etc.
- Material grade: blow moulding grade, film grade, injection moulding grade
- Colour of material: material is of the original colour or has been mixed with other colours
- Cleanliness level of the materials: clean materials or materials that are mixed with dirt and impurities.

Step 3: Cleaning of materials depending on the level of cleanliness. Cleaning is normally done by spraying or soaking in liquid detergent.

Step 4: Drying using a spin dryer of high speed and a tumble dryer.

Step 5: Meshing of materials by grinding

Step 6: Pelletising by melting meshed material using extruder. The molten plastic will be pushed out via a moulding the form of continuous strips. These strips will be passed through a cooling tank prior to drawing into a cutting machine forming granules known as pellets.

Step 7: Weighing and packaging. The weight of each packaging is 25 kilogram.

Not all materials that are obtained from the industry will undergo the pelletising process especially materials from the injection moulding process (Abidin, 2005).

Materials that are purchased directly from local producers of resin will be cleansed, packaged and eventually marketed. Generally, materials that are obtained from the local suppliers do not require classification since the material specification can be obtained directly from the suppliers. The process flow for plastic recycling in the industrial partners is presented in Fig. 4.

Sources of recycled plastics: From the case studies, it was observed that recycled materials might be obtained from several sources as outlined in the following:

- Waste material from the plastics manufacturing industry i.e., products that are disposed due to defects or other quality reasons. These materials are obtained directly from the industry based on contracts or from traders of recycled materials.
- Waste materials that are imported from countries such as Germany
- Waste materials collected from dumping sites that can be purchased from traders of recycled materials. These materials have undergone the selection and classification process.
- Materials from local producers such as Petlin, Titan and Polyethylene Malaysia, which do not comply with specifications. These materials can be obtained through contracts.

Material grade and quality: The price of the recycled material is generally classified according to the grade and quality of the recycled materials as follows:

- Colour-materials that are produced from their original colour will be priced higher compared to those of mixed colours. Materials of a single colour will be priced higher than those that have been mixed with other colours. Materials of mixed colours will be produced in black colour.
- Shape-Materials that underwent pelletising will be priced higher compared to materials that are meshed. With regard to quality, products that are developed from pellet recycled materials will give products of better quality. This is supported by the results of Baltz (1992).
- Processing type grade-materials from the blowing grade has a higher price compared to materials from the injection moulding grade.
- Level of material cleanliness- the cleanliness of materials obtained from dumping sites is lower compared to materials from the industry. Hence a higher price for materials from the industry is bid.
- Price of virgin resin in the market- the price of virgin resin is dependent upon type. The increase in price of virgin resins has led to the high demand for recycled materials.
- Nature of the material- materials that are obtained directly from the producers of plastics resins are of a higher value since the materials are virgin resins that was earlier rejected due to failure in complying with specifications.

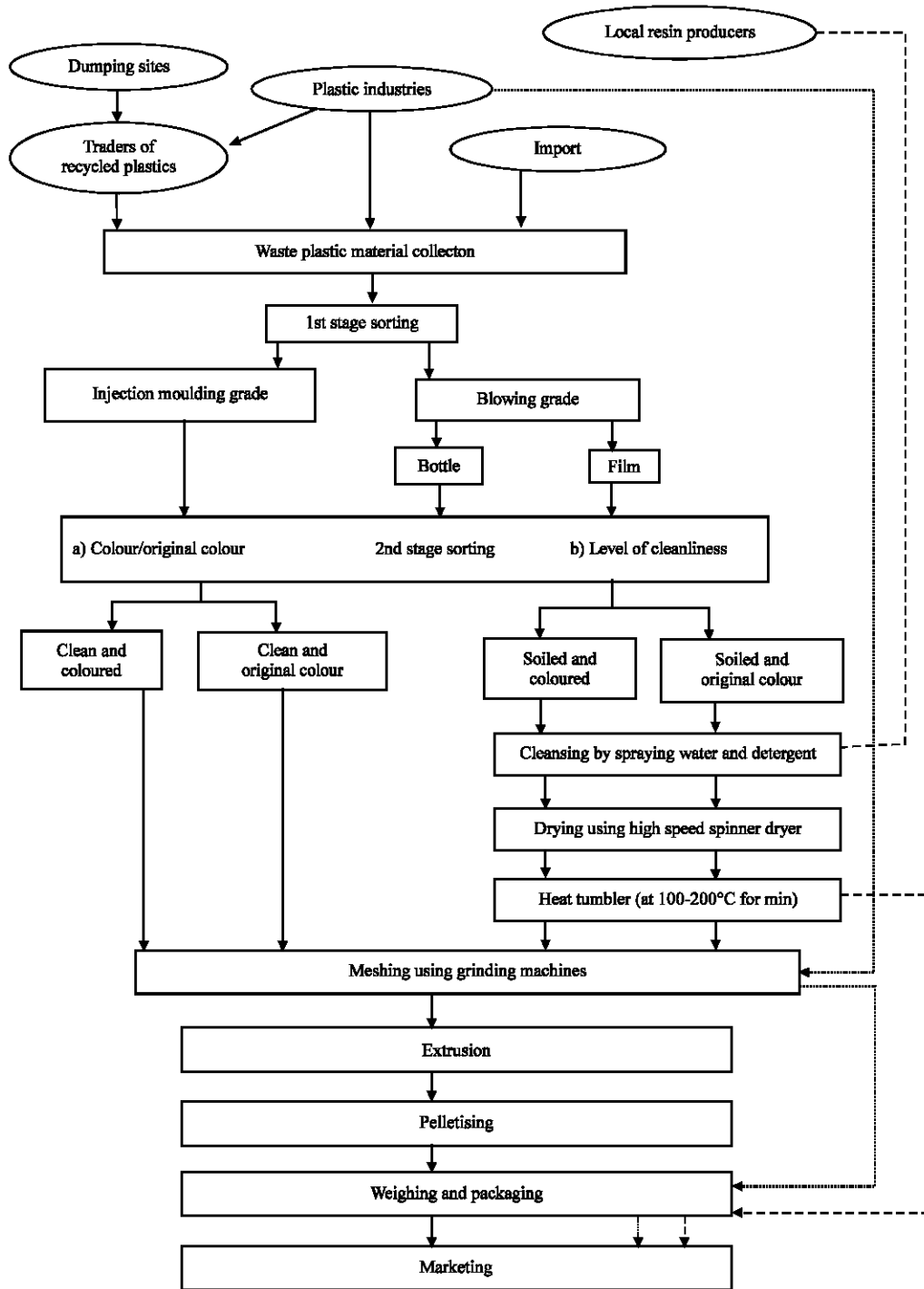


Fig. 4: Process flow for plastic recycling in the industrial partners

CONCLUSIONS

In Malaysia, one of the prime movers for the expansion of the plastics industry is the plastic recycling companies. Findings from the study indicated that 19%

of the plastics materials used are recycled materials and their supplies are either from in-house or local recycling companies. This study found that 20% of the manufacturing companies recycled their own materials as well as hiring external recycling companies to mesh their

products into flake-forms. The material flow pattern within the plastics manufacturing company enables the re-use of materials of the same grade. Ten percent of the manufacturing companies purchased second grade materials in the form of pellets or flakes. Three possible reasons were cited i) the lack of facilities for recycling, ii) high demand for recycled materials causing manufacturers to be incapable of recycling their own material, or iii) the need to develop products of a higher quality by using second grade materials that has been pelletized; pellets are deemed better than meshed materials.

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