PLASTICS RECYCLING: CHALLENGES AND OPPORTUNITIES

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ABSTRACT:

Plastics are low-cost, lightweight, and long-lasting materials that can be easily moulded into a wide range of products used in a variety of applications. As a result, plastics production has increased dramatically over the last 60 years. However, current levels of usage and disposal cause a number of environmental issues. Around 4% of global oil and gas production, a non-renewable resource, is used as feedstock for plastics, with an additional 3–4% expended to provide energy for their production. A significant portion of the plastic produced each year is used to create disposable packaging or other short-lived products that are discarded within a year of manufacture. These two observations alone indicate that our current plastic usage is unsustainable. Furthermore, due to the durability of the polymers involved, large amounts of discarded end-of-life plastics are accumulating as debris in landfills and natural habitats around the world.

Recycling is one of the most important actions available to reduce these impacts right now, and it is also one of the most dynamic areas of the plastics industry today. Recycling provides opportunities to reduce oil consumption, carbon dioxide emissions, and waste disposal volumes. In this section, we briefly compare recycling to other waste-reduction strategies, such as material reduction through downgauging or product reuse, the use of alternative biodegradable materials, and energy recovery as fuel.

Keywords: *Plastics, plastics recycling, plastic packaging, environmental impacts, waste management, chemical recycling, energy recovery*

INTRODUCTION:

Plastic, an invention of extraordinary material with a variety of characteristics and capacities, has evolved into a symbol of human inventiveness as well as folly. Recycling, upscaling, or reprocessing of PW has become an urgent necessity in order to curb plastic mismanagement and mitigate the negative environmental impacts of plastic consumption and utilisation. However, after post-consumer use, this resource has not received the attention it deserves. As shown in Figure 1, recycling or reprocessing of PW typically involves five types of processes based on the quality of the product produced by recycling the waste, namely upgrading, recycling (open or closed loop), downgrading, waste-to-energy plants, and dumpsites or landfilling.

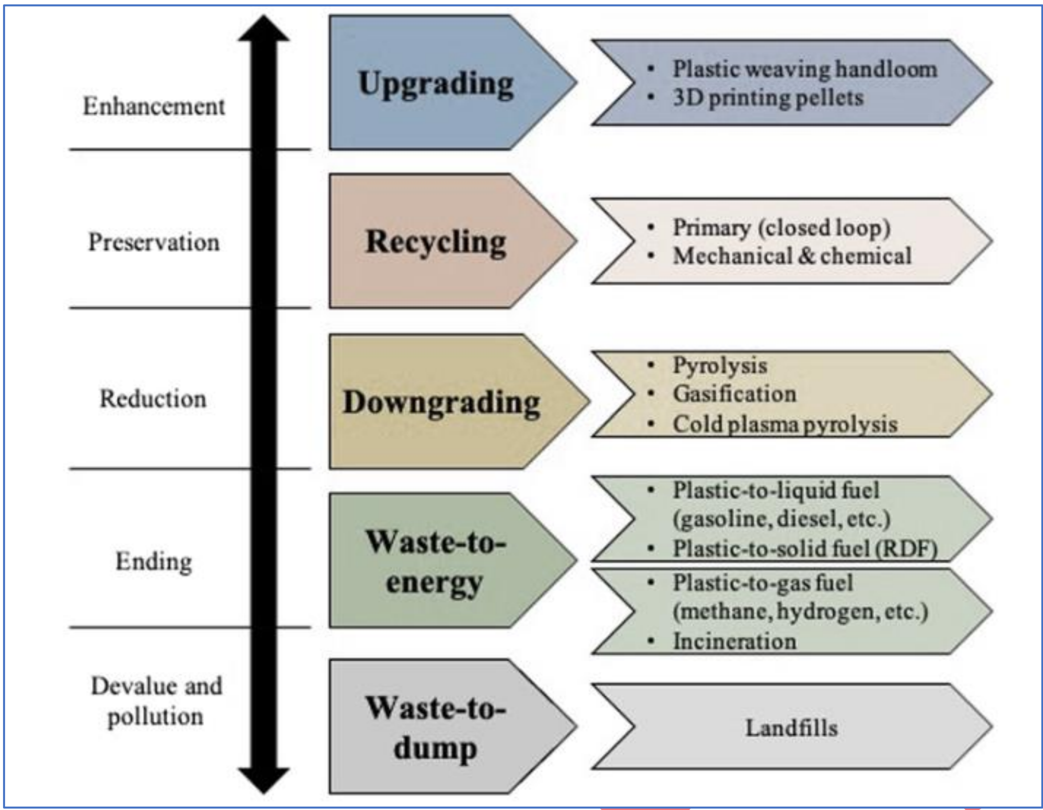

Figure 1: Different processing pathways for plastic waste

WASTE MANAGEMENT:

When waste plastics are diverted from landfills or littering, they are recovered. Because of the lightweight nature of both flexible and rigid plastics, plastic packaging stands out as litter. In the first instance, the amount of material entering the waste-management system can be reduced by actions that reduce the use of materials in products (e.g. substitution of heavy packaging formats with lighter ones, or downgauging of packaging). Designing products that can be reused, repaired, or remanufactured means fewer products end up in the waste stream. [2]

Recycling is the process of using recovered material to manufacture a new product after it has entered the waste stream. For organic materials such as plastics, the concept of recovery can also be expanded to include energy recovery, in which the calorific value of the material is used as a fuel by controlled combustion, though this has a lower overall environmental performance than material recovery because it does not reduce the demand for new (virgin) material. This is the thinking behind the 4Rs strategy in waste management, which stands for reduce, reuse, recycle (materials), and recover (energy), with landfill being the least desirable management strategy. [3]

CHALLENGES AND OPPORTUNITIES FOR IMPROVING PLASTIC RECYCLING:

The next major challenge for the plastics recycling industry is the effective recycling of mixed plastics waste. The advantage is the ability to recycle a greater proportion of the plastic waste stream by expanding post-consumer plastic packaging collection to include a broader range of materials and pack types. Product design for recycling has the potential to significantly aid in such recycling efforts. A study conducted in the United Kingdom discovered that the amount of packaging in a typical shopping basket that, even if collected, cannot be effectively recycled ranged from 21 to 40%. As a result, broader implementation of policies encouraging industry to use environmental design principles could have a significant impact on recycling performance, increasing the proportion of packaging that can be economically collected and diverted from landfill. The same logic applies to durable consumer goods, where designing for disassembly, recycling, and specifications for the use of recycled resins are important steps toward increasing recycling. [4]

Most post-consumer collection schemes are for rigid packaging because flexible packaging is difficult to collect and sort. Because of the different handling characteristics of rigid packaging, most current material recovery facilities have difficulty handling flexible plastic packaging. Because of the low weight-to-volume ratio of films and plastic bags, it is also less economical to invest in the necessary collection and sorting facilities. However, plastic films are currently recycled from sources such as secondary packaging such as shrink-wrapping of pallets and boxes, as well as some agricultural films, indicating that this is feasible under the right conditions. Separate collection or investment in additional sorting and processing facilities at recovery facilities for handling mixed plastic wastes could be approaches to increasing the recycling of films and flexible packaging. To achieve successful recycling of mixed plastics, high-performance sorting of the input materials is required to ensure that plastic types are separated to high levels of purity; however, further development of end markets for each polymer recyclize stream is required. [5]

If the diversity of materials were reduced to a subset of current usage, the effectiveness of post-consumer packaging recycling could be dramatically increased. For example, if rigid plastic containers such as bottles, jars, and trays were all PET, HDPE, and PP, rather than clear PVC or PS, which are difficult to separate from co-mingled recyclables, then all rigid plastic packaging could be collected and sorted to produce recycled resins with minimal cross-contamination. The value of recycled resins and the losses of rejected material would be increased. Furthermore, labels and adhesive materials should be chosen carefully to maximise recycling performance. Improvements in sorting/separation within recycling plants provide additional potential for higher recycling volumes as well as improved eco-efficiency by reducing waste fractions, energy, and water use. The objectives should be to maximise both the quantity and the quality of recycled resins.

OBJECTIVES:

1. Exploring household plastics recycling practices.

2. Identifying socio-economic and technological barriers and drivers to creating a competitive market.

3. Proposing policy recommendations to overcome those barriers in promoting end markets for recycled plastics.

REVIEW OF LITERATURE:

Since the invention of various routes for the production of polymers from petrochemical sources, the plastics industry has grown significantly. Plastics have significant advantages over many other material types in terms of weight, durability, and cost (Andrady & Neal 2009; Thompson et al. 2009). In 2007, total polymer production was estimated to be 260 million metric tonnes per year, including thermoplastics, thermoset plastics, adhesives, and coatings, but not synthetic fibres (Plastics Europe 2008). This corresponds to a historical growth rate of about 9% per year. Thermoplastic resins account for roughly two-thirds of this production, and their use is increasing at a rate of about 5% per year globally (Andrady 2003). [6-9]

Recycling is obviously a waste-management strategy, but it can also be viewed as one current example of implementing the concept of industrial ecology, whereas in a natural ecosystem there are no wastes, only products (Frosch & Gallopoulos 1989; McDonough & Braungart 2002). Plastic recycling is one method of reducing environmental impact and resource depletion. Fundamentally, high levels of recycling, along with reduced use, reuse, and repair or re-manufacturing, can allow for a given level of product service to be provided with fewer material inputs than would otherwise be required. Recycling can thus reduce energy and material consumption per unit of output, resulting in improved eco-efficiency (WBCSD 2000). However, it should be noted that the ability to maintain whatever residual level of material input, plus energy inputs and the effects of external impacts on ecosystems, will determine the overall system's ultimate sustainability. [10-12]

Plastics are now almost entirely derived from petrochemicals derived from fossil oil and gas. Approximately 4% of annual petroleum production is directly converted into plastics from petrochemical feedstock (British Plastics Federation 2008). Because the production of plastics requires energy, it is responsible for the consumption of a similar amount of fossil fuels. However, it can be argued that the use of lightweight plastics can help to reduce the use of fossil fuels, such as in transportation applications where plastics replace heavier conventional materials like steel (Andrady & Neal 2009; Thompson et al. 2009b). [13-14]

RESEARCH METHODOLOGY:

Plastic samples were collected from a variety of sources. Waste plastics were collected from a Danish municipality and represent both source-segregated fractions and manually sorted fractions.

Waste plastic samples collected from Danish household waste, on the other hand, had to be pre-treated in order to be separated from residual waste.

Books, educational and development journals, government papers, and print and online reference resources were just a few of the secondary sources we used to learn about the composition, use, and consequences of plastic recycling

RESULT AND DISCUSSION:

1.plastic waste generation is increasing at a rate of about 3% per year, roughly in line with long-term economic growth, whereas mechanical recycling is increasing at a rate of about 7% per year.

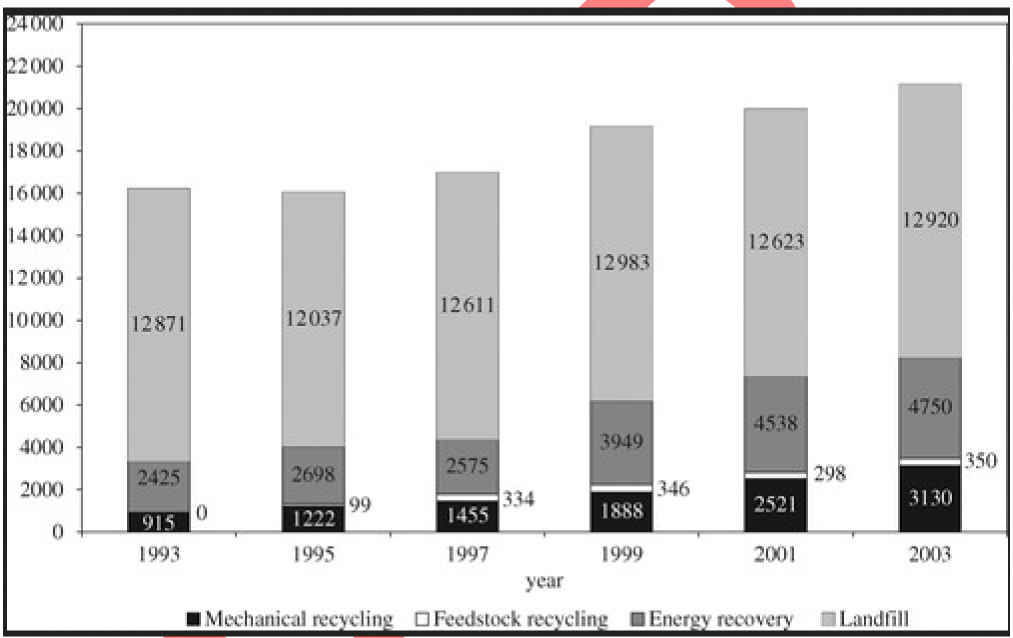

Figure 2. Volumes of plastic waste disposed to landfill, and recovered by various methods

Figure 2 shows that in 2003, this still amounted to only 14.8% of the waste plastic generated (from all sources). With feedstock recycling (1.7%) and energy recovery (22.5%), this amounted to a total recovery rate of approximately 39% from the 21.1 million tonnes of plastic waste generated in 2003. The trend of increasing mechanical recycling and energy recovery rates is continuing, as is the trend of increasing waste generation. [15]

2. Figure 3 depicts the economic benefit of recycling stream I plastic waste and the application of pyrolytic technology to stream II plastic waste for energy generation. The cost benefits were calculated using the savings from recycling and the electricity generation potential of pyrolytic oil.

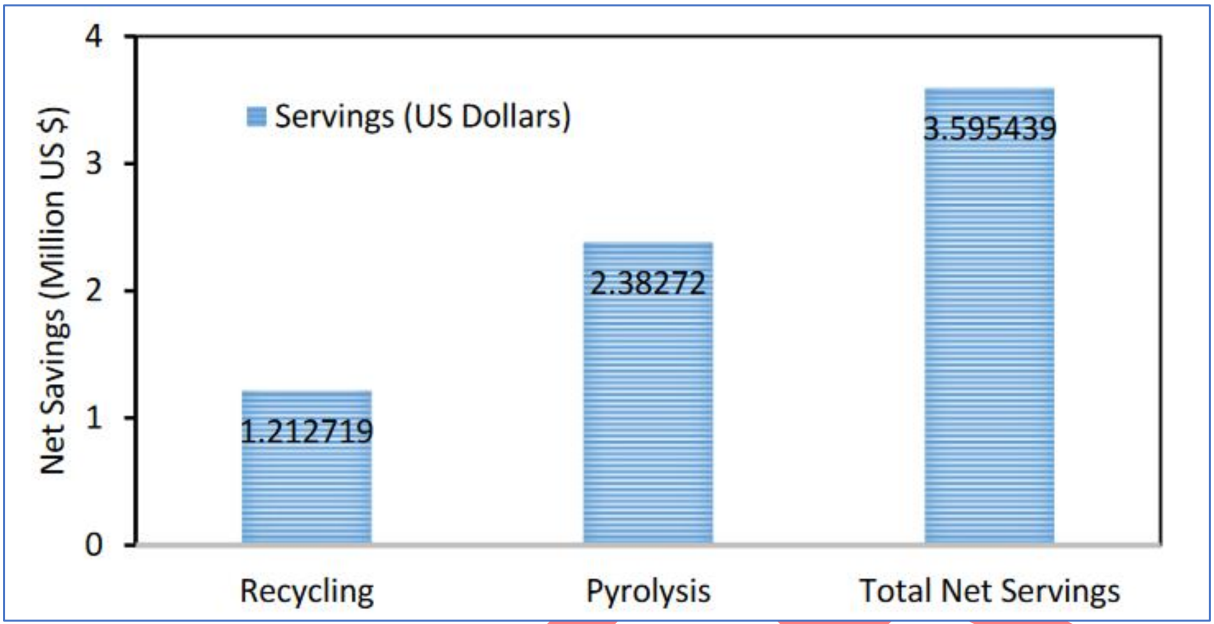

Figure 3: Economic benefits of adopting recycling and pyrolysis technology in treating plastic waste

Figure 3 shows that through recycling and the electricity generation potential of pyrolytic oil, net savings of US $1,212,719 and US $2,382,720 (total savings of US $3,595,439) can be generated from plastic waste. [16]

CONCLUSION:

To summarise, recycling is one strategy for managing end-of-life waste from plastic products. It makes increasing economic and environmental sense, and recent trends show a significant increase in the rate of recovery and recycling of plastic waste. These trends are likely to continue, but some significant challenges remain due to both technological factors and economic or social behaviour issues relating to recyclable waste collection and substitution for virgin material.

Recycling a broader range of post-consumer plastic packaging, as well as waste plastics from consumer goods and ELVs, will further improve plastic waste recovery rates and landfill diversion. Recycling waste plastics, when combined with efforts to increase the use and specification of recycled grades as replacements for virgin plastic, is an effective way to improve the environmental performance of the polymer industry.

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