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A Review on Foam Recycling

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ABSTRACT

Foam has large field of applications like packaging, automotive industry, sports and leisure. Polyethylene foam (PE) is most commonly used plastic polymer in the world with annual production of 60 million tonnes to cushion products in packaging applications. The need for recycling is due to the high consumption of foam across the globe. Foam is not bio-degradable in nature; its disposal is an issue. The best solution is recycling of foam. The major concern in recycling industry is due to its weight to volume ratio while transporting. The system is environmental friendly and it can gain carbon credits if recycling is done on a large scale. In this paper the attempt has been made to study and review the different foam recycling machine useful for the energy researchers.

Key Words: Polyethylene foam, Foam application, Foam Consumption, Recycling of Foam, Carbon Credits etc.

1. INTRODUCTION

Polyethylene foam (PE) is most commonly used plastic polymer in the world with annual production of 60 million tonnes to cushion products in packaging applications. PE foams are designed to provide maximum protection with a minimum use of material, reducing the amount of packaging required. Foam has large field of applications like packaging, architecture, automotive industry, electrical engineering, sports and leisure. [16] Prices for virgin polystyrene, polyethylene and polypropylene (PP) resins worldwide continue to increase. Prices have increased as much as 20% or more since the beginning of 2010. There has also been an increase in products made with recycled PE and PP content. These factors are helping to push up the prices for recycled PP and PE foam logs to very attractive levels. It is a good time to take a new look at your EPE, PE and PP foam wastes. The return on investment for a foam compactor may be significantly better than years ago. The demand for sustainability of all materials whether expanded foam plastics or any other materials are becoming the way of life. In recycling of foam materials such as expanded polyethylene and polypropylene, economic transportation becomes one of the major issues pertaining to the ability for a successful recycling program of these materials. Therefore, a plant with mobility is very good option to overcome the economic transportation problem [1] [12].

At present, the global Polyethylene (PE) foam recycling rate is generally very low. Recycling PE foam companies are also very few. Conventional recycling methods such as landfill and burning, in a certain extent, caused environmental pollution. [14] To solve this problem, PE foam compacting or hot melting is necessary. Expandable Polyethylene (EPE), also named PE foam, is an environmentally-safe foaming material that can be recycled. The versatile physical properties of foamed polyethylene open new possibilities in weight-saving and energy-saving. The need for recycling is due to the high consumption of foam across the globe. Foam is not bio-degradable in nature; its disposal is an issue. The best solution is recycling of foam. The major concern in recycling industry is due to its weight to volume ratio while transporting. The recycled foam pallets can be easily transported to the foam manufacturing unit. These pallets can be then used with 80% virgin plastic. [18]

The profiles of the plastics can be done by extrusion process. In practice, the plastic pallets are extruded through screw extruder. The various shapes of dies are used to extrude useful plastic articles and parts. The recycling machine works exactly opposite the practical thermoplastic profile extrusion. [2]

1.1 Polyethylene Foam

Polyethylene foam, also known as PE foam, is most commonly used to cushion products in packaging applications. PE foams are designed to provide maximum protection with a minimum use of material, reducing the amount of packaging required. [2]

Advantages of Foam:

- Cushioning

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- Flexibility
- Odorless
- Non-dusting, Non-abrasive
- CFC free and Ozone friendly
- Sound absorption
- Shatter proof
- Tear and Puncture Resistant
- Dimensional Stability and uniform cell structure
- Buoyancy
- Thermal conductivity

1.2 Consumption of Foam Worldwide

Prices for virgin polystyrene, polyethylene and polypropylene resins worldwide continue to increase. Prices have increased as much as 20% or more since the beginning of 2010. There has also been an increase in products made with recycled PE and PP content. These factors are helping to push up the prices for recycled PP and PE foam logs to very attractive levels. It is a good time to take a new look at your EPS, PE and PP foam wastes. [3]

The return on investment for a foam compactor may be significantly better than years ago.

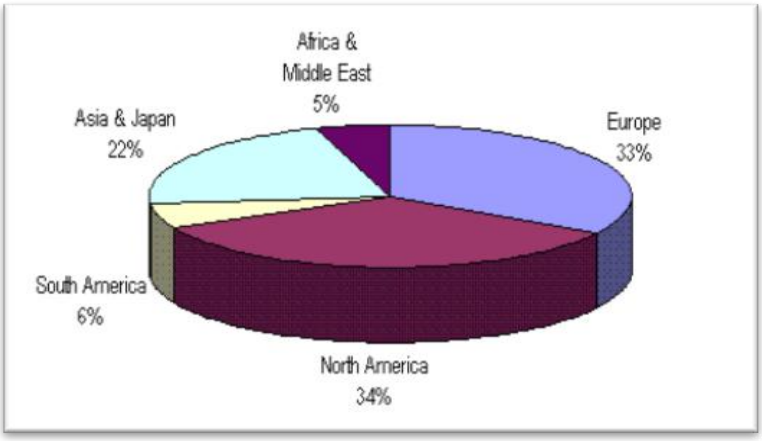

Figure 1.1 Consumption of Foam Worldwide [2]

The demand for sustainability of all materials whether expanded foam plastics or any other materials are becoming the way of life. In recycling of foam materials such as expanded polyethylene and polypropylene, economic transportation becomes one of the major issues pertaining to the ability for a successful recycling program of these materials. Therefore, a plant with mobility is very good option to overcome the economic transportation problem.

1.3 Sources of Waste Foam: Industrial waste (or primary waste) can often be obtained from the large packaging industries. Rejected or waste material usually has good characteristics for recycling and will be clean. Commercial waste is often available from workshops, craftsmen, Shops, supermarkets and wholesalers.

Municipal waste can be collected from residential areas (domestic or household waste), parks, collection depots and waste dumps. In Asian cities this type of waste is common and can either be collected from the streets or can be collected from households. The foam according to its type and no of recycles can be categorized. This foam is then further extruded from single screw extrusion process.

2. LITERATURE REVIEW

Baird, D.G. et al (2014) in his book explained polymer processing principles, design and process engineering for recycled and renewable polymers. [1]

Prof J.S Colton (2011) explained extrusion and injection molding analysis. Extrusion and injection molding machine is to make useful extruded parts. [2]

Andrew W Christie (2010) in his screw design basics book reviewed basic extruder components and discuss process elements. [3]

Florian Kamleitner et al (2017) concentrated upon waste management and presented long chain branching as an innovative up-cycling process of polypropylene post-consumer waste possibilities and limitations. Due to the highly

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improved melt properties, the possible application profile is extended and not only a ‘‘re-cycling" process, even a real up-cycling is presented. The used PP was collected from commingled household polyolefin waste, which contained different types of PP and macromolecular impurities such as 10% of polyethylene with high density (PE-HD). In addition, a single PP waste fraction from cleaned beverage and yoghurt cups was manually sorted. [4]

Kim Ragaert et al (2017) reviewed a comprehensive description of the current pathways for recycling of polymers, via both mechanical and chemical recycling. Additionally, this review discusses the main challenges (and some potential remedies) to these recycling strategies and ground them in the relevant polymer science, thus providing an academic angle as well as an applied one. [5]

Mbaocha Christian C et al (2016) dealed with the modeling and control of an overall plastic extrusion system. A suitable digital compensator or controller has been designed using the MATLAB software, to improve the screw speed and the pressure of single screw plastic extruder. [6]

Jonathan Grimard et al (2016) reviewed Dynamic Models of Hot-Melt Extrusion, presented a literature review of a range of existing models. A common case study is considered to illustrate the predictive capability of the main candidate models, programmed in a simulation environment (e.g., MATLAB). Finally, a comprehensive distributed parameter model capturing the main phenomena is proposed. [7]

Asith Abeysinghe et al (2016) developed numerically controlled hot wire foam cutting machine for wing mould construction. The results of this research aid to improve the hot wire foam cutting by solving the limitations and drawbacks to select best cutting parameters of the Computer Numerically Controlled machine which is in progress. [8]

Daniel E. Ramirez-Arreola et al (2015) studied partial or total replacement of natural aggregates by recycled polymeric foams was used to lighten cement mortars. The influence of foamed material in mortar compressive strength was studied. [9]

Daniel Raps et al (2014) reviewed the recent advances in the processing, sintering behavior and properties of bead foam products, which possess unique advantages such as excellent impact resistance, energy absorption, insulation, heat resistance, and flotation. The key features such as the mechanical properties of the commercially available bead foams, namely expanded polystyrene (EPS) and expanded polypropylene (EPP), are presented. [10]

R. K. Roy et al (2013) presented tertiary recycling of poly (ethylene terephthalate) (PET) wastes to derive raw materials for production of polyurethane–polyisocyanurate foams. Experimental conditions like PET: DEG ratio and reaction time were optimized to maximize the extent of PET conversion. [11]

Gbasouzor Austine Ikechukwu et al (2013) studied Consequent on the environmental degradation caused by the littering of polythene materials in our cities, a polythene-recycling machine was designed and constructed. [12]

Mohammed Al Shrah et al (2013) described Fundamentally, there are two recycling methods for plastics: material recycling (including primary, secondary, andtertiary recycling, i.e. hydrolysis and glycolysis) and energy recycling or quaternary recycling. This work considers the material recycling of LDPE. LDPE represents nearly of 8-10% of the total MSW waste received at the landfill. Initially thermal analysis based on Simultaneous Thermal Analysis (STA) and Differential Scanning Calorimetry (DSC) is carried out to observe the plastic thermal behavior of two successively molded samples. [13]

Wenqing Yang et al (2012) described foam recycling methods, With the wide application of polyurethane foam materials, many polyurethane foam wastes need to be disposed. There are mainly three types of disposal technology, landfill, incineration and recycling in the world. In this paper, through comprehensive comparison, recycling is the most desirable way. [14]

Xueqin Liu et al (2012) studied Polymer extrusion is one of the final forming stages in the production of many polymeric products in a variety of applications. It is also an intermediate processing step in injection moulded, thermo-formed, and blow moulded products. [15]

Abdulkadir Kan et al (2008) described new technique of processing for waste-expanded polystyrene foams as aggregates. expanded polystyrene foams (EPS) are widely used as packaging material, construction material, and in household appliances as well as many others and new recycling process developed of the waste EPS foams by using heat treatment. [16]

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Djalma Batista Dias et al (2007) studied Cross-linking of low-density polyethylene by electron beam irradiation with the aim of foam production by thermal expansion. Mechanical and thermal properties of the obtained foams were studied. [17]

A. Greco et al (2005) studied the extrusion foaming of recycled polyethylene through different foaming agents. The results indicate that a higher polymer viscosity corresponds a lower density of the foamed product. [18]

J. Vlachopoulos et al (2003) overview concludes with a brief discussion of current trends and future challenges faced by the polymer industry. [19]

3. DISCUSSION

From the above literature, it has been observed that:

1. Fundamentally, there are two recycling methods for plastics: material recycling (including primary, secondary, and tertiary recycling, i.e. hydrolysis and glycolysis) and energy recycling or quaternary recycling. Since the former method replenishes material resources, it is favored where it is possible, i.e. for none polluted or mixed product. At some point after repeated use, the material may commence to degrade, by then it is destined to energy conversion or total breakdown subjected to incineration, gasification or pyrolysis. This work considers the material recycling of LDPE. LDPE represents nearly of 8-10% of the total MSW waste received at the landfill.

2. The foam injection molding machine is used for foam recycling. The purpose of this machine is to make useful extruded parts. The waste of various grades is converted to useful grades of plastic pallets. The recycling machine works exactly opposite to the extrusion machine.

The extrusion can be done by various methods-
a) Single Screw Extruder b) Continuous Extrusion
c) Ram Extrusion d) Intermittent Extrusion.

3. A Process Was developed and implemented for the recovery and recycling of Plastics from end-of-life (EOL) IBM Products into new IRM products. In general, the economics for this type of recycling, closed loop, has the greatest potential for achieving profitability. In addition to keeping the plastic out of the landfill, product material cost is reduced and there is no expense for plastics disposal. Factors affecting the recyclability and value of recovered plastics were identified and examined. These factors included the type and amount of plastic involved, type and degree of contamination, difficulty in removing contaminates, and the potential end-use application. Considerations from these studies supporting the technical and economic feasibility of establishing a plastic recovery process are discussed.

4. CONCLUSION

This review discusses the most of Foam is a non-biodegradable material, when burned causes air pollution hence its disposal is still a big problem, so it can gain carbon credits if recycling is done on a large scale. Current systems available in this category are of large scale and there are few small-scale plants. So, still there is opportunity to design foam recycling machine for small scale which can be used for small waste collection area. Type of waste foam and the capacity of heater used in the construction, decides the recycling of foam, because there are different types of foam which are having different properties and melting point. The volume to weight ratio of foam makes it difficult to transport it from the collection site to the manufacturing unit. Recycling of foam at the site and its conversion into granules makes it easier to transport.

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