

Energy Conservation of Plastic Injection Molding Industry in India

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Abstract - Plastic Industry is one of the fastest developing and energy consuming sectors in India. On the basis of value added share plastic industries in India acquires 0.5 percent of India's GDP and the export of plastic products yields up to one percent of country's exports.

There are mainly four processes in any plastic industry they are, Molding, Calendaring, Extrusion, and Coating. Considering over 90 percent of plastics volume, energy saving potential in the plastic sector is very high and around 40 percent of energy can be conserved and utilized by implementing necessary corrective measures.

The outcome of the study shows that massive energy can be conserved and utilized efficiently during the whole process in the industry thereby curbing the energy losses to a greater extent.

Key Words: Plastic Industry, Molding, Calendaring, Extrusion, Coating, etc.

1. INTRODUCTION

Plastics are organic compounds that are malleable in nature that can be molded into solid objects. Due to its low cost, ease of manufacture, versatility, plastics are used in multitude of products of different scale. Many applications such as packaging, automobiles, furniture's, toys, medical field, etc make use of plastics as their primary source.

The Indian Plastic Industries consists around 25000 companies that employ around 4 million people. Gujarat is the leading plastic manufacturing state of India comprising nearly 5000 plastic firms. The growth rate of plastic industry in India is the highest in the World.

1.1 CLASSIFICATION OF PLASTIC PRODUCTS BASED ON PROCESSES

Plastic products are classified into different categories based on the types of processes they are,

Table -1: Classification of Plastic products based on Processes

Extrusion	Films and Sheets, Fiber and Filament pipes, Conduits and Profiles, Miscellaneous Applications.
Injection Molding	Industrial injection molding, Household injection Molding, Molded luggage etc.
Blow Molding	Bottles, Containers, Toys, House wares.
Roto Molding	Large circular tanks such as Water tanks.

Extrusion process is the most common process in India and accounts for 60% of total consumption by downstream plastic processing industries. Injection molding is the other popular process accounting for 25% of consumption Blow molding is used for 5% while Roto molding accounts 1% while rest of the plastic is processed through other processes.

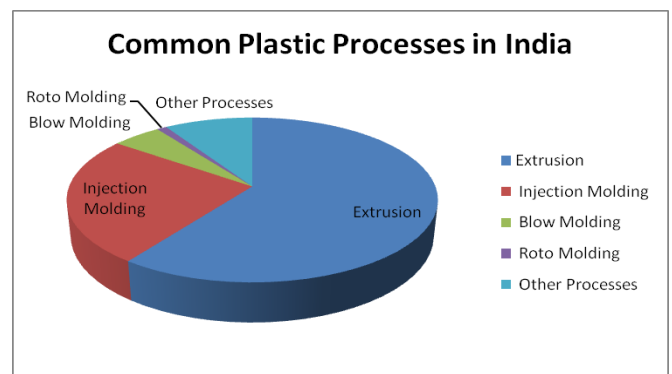


Chart: 1- Common plastic processes in India

2. PLASTICS AND ITS VARIETIES

Thermoplastic injection molding is the most popular way to manufacture parts, they are the polymers that can be repeatedly molten or softened by heating and solidified by cooling.

Below mentioned are the most common thermoplastics used in Injection molding process

1. ACRYLONITRILE BUTADIENE STYRENE

Acrylonitrile Butadiene Styrene (ABS) is an amorphous polymer and a thermoplastic flexible and light in weight that can be molded into many items used in our daily lives. The main advantage of this type of polymer is that number of modifications can be done into it to improve its impact resistance, toughness, and heat resistance. Molding ABS at high temperature improves the heat resistance and shine of the product whereas molding at low temperature improves the impact resistance and strength of the product. ABS is used in drain pipe systems, golf club heads, automotive parts and many other products.

2. POLYETHYLENE

Polyethylene is a thermoplastic polymer with an extreme wide range of applications depending on specific type. It is one of the most popular types of plastics in the world. There are two types of this plastic they are High Density Polyethylene (HDPE) and Low Density Polyethylene (LDPE). The main advantage of PE is high ductility, tensile strength, impact resistance, recyclability. The higher density of PE makes it more rigid, stronger, and more resistant to heat. Plastic bags, plastic films, containers, bottles, etc are some of its applications.

3. POLYPROPYLENE

This is a very common type of plastics that is known for its flexibility. PP has some characteristics which include high melting point, high resistance to stress, cracking, excellent impact strength, and does not break down easily from reactions with water, acid, detergents, etc. PP is safe for use as food containers because it does not percolate chemicals into food products, and hence it is commonly found in household products such as utensils and automotive parts such as car batteries.

4. CONSTRUCTION OF INJECTION MOLDING MACHINE

The main parts of injection molding machines are Hopper, Barrel, Injection Ram/ Rotating Screw type plunger, Heater, Movable pattern, Ejectors, and Mold inside mold cavity.

Generally injection mold machine works in horizontal manner. It consists of barrel to which hopper is located at the one end. A hydraulic ram, which runs by electric motor, is used to provide force is located inside barrel. A heater is attached to the barrel to melt the molding material coming down from the hopper. On the other side of the barrel mold cavity is attached inside which mold is located and movable horizontal pattern is used in whole manufacturing.

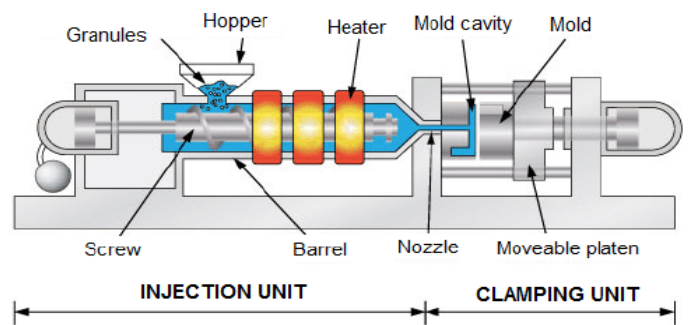


Fig: 1- Construction of Injection Mold machine

5. WORKING OF INJECTION MOLDING INDUSTRY

As the name indicates it works like an injection. Molding material is fed into the hopper by feeding device, which goes down into the cylinder. A heater located on the barrel is used to melt the material, where it starts melting and hydraulic ram pushes the material forward into the mould by applying some pressure. Molten plastic is injected into closed mould located on the other side of the barrel. After the whole process is done the parts manufactured is allowed to cool sufficiently, then mold is opened without damage using ejectors. Using these process complex shapes can be easily manufactured. In one cycle of the process around 12-15 thousand parts can be easily manufactured.

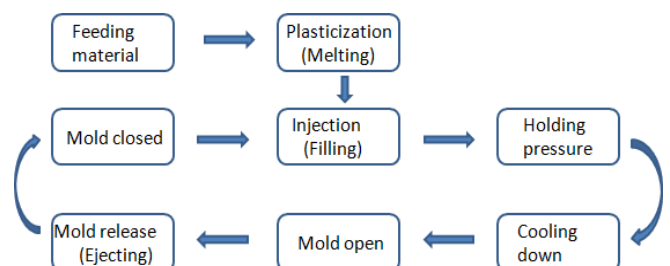


Fig: 2 - Process Flow diagram of Plastic Industry

6. NEED OF ENERGY CONSERVATION IN A PLASTIC INJECTION MOLDING INDUSTRY

Plastic injection molding is an energy intensive process, as energy carries both environmental and financial cost, it does not make any sense wasting it.

It has been estimated that plastic processing industry consumes around 4% of global energy. So any attempts made by this industry to save energy are likely to lead the significant advantages.

There are simple rules, which on implementing, can help in Conserving the Energy in Plastic Industry;

1. **Implementing Proper Energy policy of a Company.**
2. **Appointing responsible person for energy management**
3. **Implement a method of monitoring short term and long term performance.**
4. **Identifying the cost and approving Energy saving projects.**
5. **Reporting system must be implemented to track the status of the project.**
6. **Auditing system to drive actions and improvements.**

7. ENERGY EFFICIENT TECHNOLOGIES IN PLASTIC INDUSTRY

In any plastic injection molding plant, services such as Compressed air, Chilled water and other machines play vital role and accounts up to 30-35% of energy used.

7.1 COMPRESSED AIR

Compressed air is a convenient but expensive utility that consumes around 10% of total energy in an injection molding plant. An effective management of this air can save energy up to 50%.

Leakages: In a badly maintained system, leaks can account for as much as 40% of compressed air and around 20-40% of total energy in injection molding plant.

Efficient Use: Compressed air costs around 70-80rs/kwh at the point of use which is equivalent to Ten times the equivalent quantity of electrical power so it must be used only when essential.

Reduce Generation Cost: Set the pressure system of compressor to the minimum which can reduce the cost by three quarters.

7.2 CHILLED WATER IN THE UNIT

Providing chilled water for molds and cooling water for machines consumes around 10-15% of total energy in injection molding machine plant.

Free/Natural cooling generated from cool outdoor conditions can be used to cool the mold and reject the heat generated during the processing, which reduces the unnecessary load generated on Cooling Tower.

7.3 REPLACEMENT OF HYDRAULIC MACHINES BY ELECTRIC MACHINES

Replace all the hydraulic machines by electric machines which can reduce the energy usage between 30-60% because there power is directly provided by the electrical drive. The major benefit is that drives require lower power consumption at startup.

7.4 BARREL INSULATION

Use of Barrel insulation jacket reflects the heat radiated from the barrel thereby reducing its energy consumption by 50% it also reduces the operating costs and provides consistent operating temperature.

7.5 OTHER FACTORS

- A) Set the parameters and cycle times of the machines to actually needed using appropriate calculations.
- B) Provision must be given to the Maintenance of the unit especially on heat exchangers and cooling channels
- C) Appropriate startup and shutdown sequence must be planned to reduce the 'idling' time of machines.

8. CONCLUSIONS

The above mentioned recommendations could be easily adapted and replicated throughout the plastics industry to save energy. Optimize operating costs, enhance productivity, and reduce environmental emissions.

Implementing all the recommended measures would reduce 17% of energy costs of the company. Energy efficient practices are proven ways for plastics industry to tackle with rising energy costs and to maintain its competitiveness in global markets

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