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Waste Minimization in Plastics Industry

By:
A. K. MEHTA

In the recession ridden current scenario, cost reduction seems to be the mantra for survival. Every customer is putting pressure on his small scale vendor to reduce his price. Easy availability of raw materials and easy flow of information has removed whatever small gap that used to exist earlier in the purchase price for individual small scale manufacturers. Then, how does one cut his costs and become competitive? By minimizing waste generation in his process and utilizing the waste effectively.

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Reprocessability of thermoplastics has always been a great attraction for processors. For a long time it was considered that processing of thermoplastics did not generate any waste since all rejected parts could be reprocessed. Manufacturers of technical products are now too aware about limitation of this possibility. The appropriate approach therefore, is to observe ways of minimising waste in the first place and be able to utilise, whatever waste is necessarily generated in an effective manner. Today I would like to share with you some of our practical experiences gathered in the course of our consultancy assignments and manufacturing activities.

1. **Material Handling and storage:** Thermoplastics are non perishable in the conventional sense. But proper care at this stage can certainly reduce a processor's costs in the following ways:

   1.1 **Preventing loss due to spillage** – A contaminated virgin raw material becomes a down graded material which has a lower value. This can be prevented by :
   - taking care that no bags are torn/damaged
   - changing and sealing damaged bags
   - making a clear cut on top to open the bag so as to prevent spillage during transfer of material to machine hopper etc.

   1.2 **Preventing dust accumulation on the bags** - This dust can get into the raw material process stream, leading to defects. This is particularly critical in film making, causing spots, excessive haze and in extreme cases, breaks in the film bubble or web.

   1.3 **Minimizing space required for storage**: That storage space is a cost, is overlooked by most entrepreneurs. Raw material bags are uniform in size /shape and can therefore be stacked properly. Partly consumed bags and in-process material storage is where improvement can be brought about by filling in uniform quantity and **stitching the bags instead of tying the top**. This not only ensures that more quantity is stored per unit floor area but also prevents spillage. In process scrap in the form of lumps, rejected parts, sprue and runners etc, can be ground to reduce in size and facilitate filling in bags. An appropriate tag can also be stitched to help identify and segregate materials. This eliminates chances of mix up and also saves time in locating and controlling inventory.

   1.4 **Preserving material for reprocessing**: Percentage regrind in the virgin material stream can be increased by preserving the quality of once processed material by preventing moisture and dust pick up during storage. To do so, the rejected components and sprue and runners can be neatly collected and ground without losing much time. For this scrap grinder(s) of appropriate sizes can be dedicated to individual machines or for a set of machines. The scrap is ground as and when generated and kept sealed in LDPE bags. This prevents pickup of moisture and dust and the stored scrap can be straight away used as and when its is required. This means the scrap does not carry any foreign material with it and can be processed the same way as virgin material.

2. **Processing**: Each processor is an expert in his field and would know ways and means of keeping waste in check in his domain. I will only mention some general aspects common to all plastics processes.

   2.1 **Production start up**: Sometimes there can be a large time lag between the machine start up and it being ready for production. This is also the time when a large energy input is being provided to the machine in order to heat it up to the desired temperatures.

   During this period all the associated systems like :
   - cooling water pipelines pumps and valves.
   - mould heating systems (for injection moulding) and
   - down stream equipments like water spray nozzles vacuum system for pipe and profile sizing; extrudate conveying and cutting systems; winding systems; trim cutting systems in films and sheets; corona treatment units etc.

   Need to be checked that they are working properly. The idea is to ensure that there is no prolonged heating of the machine due to faults in any of the associated systems which can hold up production. The prolonged heating not only causes an energy loss but can cause unnecessary degradation of residual material inside the machine. All this is best done by having a **check list** and going through its each item one by one. Certain zones in the machine get heated faster than the others like die. It is advisable to switch the heaters or first in the zones where temperature increase is slower, together with those in immediate vicinity. Other heaters can be switched on subsequently to ensure that the desired temperatures in all zones are reached around the same time.

   2.2 **Production shut down**: A properly shut down machine will ensure that there is minimal material and production loss at the time of next start up.

   2.2.1 While shutting down, the **machine should**

be purged with a suitable polymer to clean the material containing colourants and other additives which has a greater chance of degradation. Finally, thermally stable virgin polymer with extra dose of antioxidant should be left in the machine. Some processors believe in leaving the barrels of their extruders and injection moulding machines empty for shutdown. This is a good thing to do if all traces of polymer and additives could be removed. In actual practice however, this is not so and the degradation is faster when during the next start up the material is heated up in presence of air. Keeping the machine **barrel filled with virgin stabilized polymer** ensures that the air is excluded and the degradation is minimized.

Material in the hopper also ensures that nothing accidentally goes into the machine throat and causes damage.

2.2.2 After switching off the heaters, hopper cooling system should be kept on for sufficiently long to prevent material in feed section getting molten due to heat conducted from other zones at higher temperature. This will prevent problems during next start up.

2.3 Standard operating conditions (SOC): Each processor or operator has his sets of operating conditions for a given product. The need however is to have these standardized and put down in black and white. Everybody should follows these standard operating conditions to get a standard product output. These are time tested parameters and can be suitably and consciously amended when required. This prevents the need for frequent experimentation by individuals which may cause loss in production/product quality.

2.4 Maintenance: Maintenance is a cost; preventive maintenance appears more so. But the adage "A stitch in time saves nine" is most appropriate here. A preventive maintenance programme built in the production routine ensures 100% availability of the machine time for gainful production. Moreover, the maintenance costs are also effectively lower since a fault is more likely to be rectified at initial stages itself with lower cost and time component.

2.5 Standard quality motors and drives: It is our practical experience, corroborated by peers and other experts in the field, that motors and drives of a standard make and source may have initial cost higher than the "local" brands, but apart from higher degree of reliability, bring about around 2% of saving in energy costs. This is no small saving for a 24 hours a day 7 days a week production routine.

2.6 Instrumentation : Measuring instruments on processing machines help in the following ways :

1. Help in maintaining SOCs like temperatures, speeds, pressure, time periods etc.
2. Save energy e.g., PID temperature controllers provide for differential energy input as the actual temperatures nears the set temperatures. This facilitates faster start up of machine, prevents temperature shoot up and conserves energy in steady state operation.
3. Anticipate changes in process and forewarn about impending problems. For example change in melt temperature or motor load at SOC indicate a change in melt viscosity which has a bearing on mould filling in case of injection moulding or die swell in case of profile extrusion. Similarly, a change in melt pressure indicates screen choking in case of extrusion.

   All these aspects affect productivity and quality of the end product.

2.7 Part and Mould Design: This is the first and the most obvious means of reducing waste. The length of runner in injection moulding and the side trim width in film and sheet extrusion contribute the maximum to the waste generated in those processes and cannot be eliminated in spite of controlling all the other factors discussed here. This is a direct saving in material and energy.

2.8 Quality Assurance v/s Quality Control: We all know that product of a specified quality only can be sold. Here lies the importance of Quality Control. The issue however is the cost of producing that quality. This is where Quality Assurance comes in.

Quality control effectively removes off-specification material from the lot, which have a contribution to the product cost. **Quality assurance is a manufacturing system that entails producing product with low inherent rejection**. Some of the characteristics of such a system are:

2.8.1 Strict control on quality of input materials. For example MFI and MFR for polymeric raw materials in injection moulding and extrusion; film thickness and thickness variation in thermoforming.

2.8.2 Have **well defined quality parameters commensurate with the machine capability and testing capability**. For example in a film if thickness variation required is ±10% then the accuracies in die and machine speeds have to be of a corrosponding order. Moreover, the thickness variation device should have a least count of 1 micron.

2.8.3 Have in line checks wherever possible e.g. thickness variation in film and sheet plants.

2.8.4 Quality assurance to be entrusted to the operator on the machine rather than the Quality Control inspector. The operator himself identifies and segregates the off-specification material during process.

2.8.5 Strict monitoring of SOCs and look for tell tale indicators for process instability and take corrective actions.

3.0 Recycling: All said and done the rejects produced and scrap generated are available for recovery of some of the cost. Some aspects were covered under the material handling section earlier, where you can use a higher percentage of regrind in the same process. Alternatively scrap of one component can be used in some other application which demands lower aesthetics/mechanical properties. For example, film scrap can be used for injection moulding or small blow moulded containers.

I would like to share with you here **a classic case of reducing costs via recycling** in plastics industry which we helped develop. A large moulded luggage manufacture in India generated huge quantity of scrap nylon (around 20 tpm) at various locations. We helped them convert it into a nylon grade with slightly lower tensile strength but impact strength equivalent to the virgin nylon. This material was good enough to be used the same way as virgin for some of the components like luggage handles and wheel caps. This was achieved by

a) Grinding the scrap immediately after generation.
b) Packing and sealing the ground scrap in LDPE bags.
c) Hopper blending 5-7% OPTIM impact modifier and injection moulding directly.

This increases the ratio of conversion of raw material to finished product and thereby reduce component cost. They have made all their vendors adopt this practice and pass on benefit of the reduced cost.

Other possibilities of adding value to plastics waste are :

a. Compatibilising mixed plastics waste and using the same for thick section injection moulded / extruded articles.
b. Make wood composite using waste wood flour and scrap polyolefines.

In conclusion, I would like to point out that **waste minimisation is a need of the hour as much due to environmental issues as due to need to cut our costs. The success of this mission depends more on our attitude than on the technology.**

Pluss Polymers Pvt. Ltd.
610 A, Udyog Vihar, Phase V, Gurgaon -122016 Haryana (India.)
Tel: +91 124 4309490 / 91 / 92, Fax: +91 124 4309493, Email: info@pluss.co.in, Website: www.pluss.co.in