ISSN (Online): 2231 –5268
www.ijcsms.com

CENTRAL CONVEYING & AUTO FEEDING SYSTEMS FOR AN INJECTION MOLDING SHOP

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Abstract

Nowadays injection molding is probably the most important method of Processing of consumer and industrial goods, and is performed everywhere in the world. The developing of injection molding becomes a competition from day to day. This Process now integrated with computer control make the production better in quality and Better quantity.

The trends of producing a plastics product in injection molding industries are recently changing from traditional method to using the FEA analysis. For injection molding industries, time and cost is very important aspects to consider because these two aspects will directly related to the profits at a company. The next issue to consider, to get the best parameter for the injection molding process, plastics has been waste. Through the experiment, operator will use large amount of plastics material to get the possibly parameters to setup the machine.

To produce the parts with better quality and quantity these molding defects are the major obstacles in achieving the targets with quality & quantity. Various defects like Short shot, colour streaks and low productivity rates are associated with the material mixing and feeding as molded plastics are often a blend of two or more materials. Colors (master batch) and other additives are often mixed (blended) with the raw plastic material prior to the molding process in molding plants. So it is very necessary to work out auto blending and auto feeding of plastic granules to the machine hopper. This paper will cover the study of automatic blending unit & central conveying system for plastic granule feeding to machine & will help in optimizing the injection molding process.

Keywords: *Injection modeling, colour loss, Productivity, Blending accuracy.*

Introduction

Injection molding is a manufacturing process for producing part from both thermoplastic & thermosetting plastic materials. Material is fed into a heated barrel, mixed, and forced into a mold cavity where it cools and hardens to the configuration of the mold cavity. After a product is designed, usually by an industrial designer or an engineer, molds are made by a mold maker (or toolmaker) from metal, usually either steel or aluminum, and precision-machined to form the features of the desired part. Injection molding is widely used for manufacturing a variety of parts, from the smallest component to entire body panels of cars. Injection molding is a complex technology with possible production problems. They can be caused either by defects in the molds or more often by part processing (molding). The most common molding defects are like flashes, shrinkage, short filling, weld line, silver streaks, jetting, blisters, burn marks etc.

These all defects results in poor molded components and lesser productivity also. Some out of these defects are because of material mixing. Various defects like Short shot, colour streaks and low productivity rates are associated with the material mixing and feeding as molded plastics are often a blend of two or more materials. Colors (master batch) and other additives are often mixed (blended) with the raw plastic material prior to the molding process in molding plants. So it is very necessary to work out auto blending and auto feeding of plastic granules to the machine hopper.

Manual blending and feeding leads to lots of issues which are mentioned below:

1. Colour loss (master batch) due to improper mixing
2. Molding defects like color streaks or shade variation
3. Increased process rejections
4. Machine stoppage resulting in lesser productivity

IJCSMS International Journal of Computer Science & Management Studies, Vol. 11, Issue 02, August 2011
ISSN (Online): 2231 –5268
www.ijcsms.com

5. Operator fatigue
6. High man power cost associated with material mixing

Plastic Blending

Molded plastics are often a blend of two or more materials. Colors (master batch) and other additives are often mixed (blended) with the raw plastic material prior to the molding process in molding plants. The accuracy of blending materials in specific ratios and the blend homogeneity are the main two factors to consider.

Blending Accuracy

Scrap is molded but undesired parts of a molded plastic product that are normally trimmed off and separated from the product after the molding process. Scrap is very often produced in the majority of plastics molding processes. Depending on the molding process, the mold construction and the shape of the product, scrap may weigh more than the finished product. Scrap is often recycled by being collected, reground and blended (mixed) with virgin resin in certain percentages to reduce material cost and to help save the environment. The mixing ratio of recycled plastics and virgin resins varies, depending on the type of material and the desired product quality. High accuracy in the mixing ratio is normally not required. Simple proportional vacuum loaders with marginal accuracy are often used to blend virgin resins with regrind and feed it to the process. Reasonably priced volumetric blenders are also applied in blending both virgin and regrind materials when more accuracy is required and the more sophisticated gravimetric blenders are applied only when high accuracy is necessary. It is often necessary to blend two or more different types of plastics in order to manufacture certain products with specific mechanical properties. More accuracy is normally required and, therefore, volumetric or gravimetric blenders are used to supply the processing machine with the specified material blend . Chemicals and other additives are often blended in smaller quantities with virgin resin or with a blend of virgin resin and regrind material in volumetric or gravimetric batch-blenders prior to the molding process. A major share of plastic products is manufactured in different colors. When high production volumes in a specific color are required, the molder may elect to purchase the main virgin material in the desired color from the resin supplier. It is more economical to blend colors (color dosing) with main materials in molding plants prior to the molding process when low production volumes are required or low production volumes in different colors are desired. Solid color grains (master batch) are the most common materials used in the plastics industry — pumping liquid dies (ink or color) is a messy and rarely used method. Master batch is blended in very small amounts (usually lower than 4% and often below 1%) with virgin resins in blending units prior to the molding process. A higher ratio of master batch normally does not show negative effects in the product quality but master batch is expensive. Higher ratios of master batch are wasteful and therefore more and more blending accuracy is required. Only the gravimetric blending (dosing) system is applicable when blending master batch with the main material prior to the molding process in molding plants.

Types of Blending Process

Plastics can be blended in many ways, the most common blending techniques are mentioned below:

1. Manual blending
2. Proportional loader blending
3. Volumetric blending
4. Gravimetric blending

Manual Blending

The simplest blending method is manually purging measured amounts of different components in a container (a barrel or a drum), closing the container and rolling it on the floor to homogenously mix the components. The blend is then fed to the processing machine through a holding hopper on the feed throat. Manual blending is enhanced by using a type of concrete mixer to blend the manually fed components instead of rolling a container on the floor. It is a batch blending method that is rarely used in the plastics industry today.

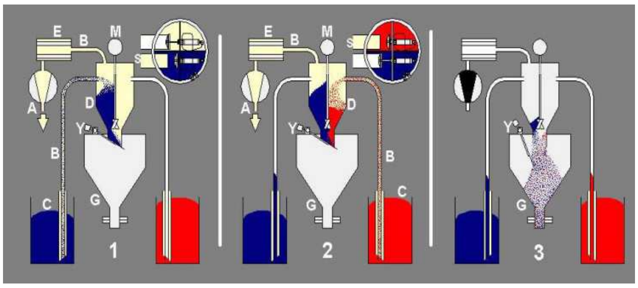
Advantages

• No initial investment and no installation cost

Disadvantages

• Manual operation with high labor cost

• Inhomogeneous blending on the feed throat



Proportional Vacuum Loader Blending

Vacuum loaders are widely used in the plastics industry to transfer virgin resins, regrind or master batch from storage sources to processing machines. A blower {A} sucks large amounts of air through the loading system at high speed creating a low pressure. The pipe {B} is immersed in a storage bin {C} containing the material to be transferred to the processing machine and the material is sucked into the pipe du e to the vacuum. A material-separating hopper {D} with and a filter {E} are installed at the end of the pipe. The filter allows the air to continue flowing to the blower but the material stays in the hopper and falls by gravity to the bottom of the hopper. The amount of material transferred depends on the size and shape of the pellets (bulk density), the amount of air sucked through the pipe and the vacuum level inside the system. One suction blower and one filter can suck two different materials from two storage bins through two pipes into a single separating hopper. Different amounts can be transferred into two chambers inside the separating hopper. Proportional loaders load one material at a time using a timer to control the suction time through each suction pipe {S}. Some proportional vacuum loaders include an auger {M} for better blending when the flapper {Y} is opened and the blend is dumped into the holding hopper {G}.

Advantages

• Simple and inexpensive system
• Loading and blending in one unit

Disadvantages

• Low blending accuracy
• Inhomogeneous blending

Volumetric Blenders

Volumetric blenders are more accurate than the previous described proportional vacuum loaders. They appear in many different forms in the plastics industry. One of the common methods of volumetric blending is to feed the additive {B} to the main material {A} through a feeding screw {D} driven by motor and drive {C}. The main material falls by gravity from a receiver through a mixing chamber {E} to the feed throat of the machine. The mixing chamber is designed to blend the main material and the additive homogeneously. The rotation speed of the screw is fixed based on the desired mixing ratio, the groove size of the screw and the size of the additive pellets. When applied on a cycling machine the screw is stopped at the end of every cycle and starts to rotate again when a signal is received from the processing machine. The machine operator must choose the right screw size for the blending range, observe the blending ratio and adjust the rotation speed of the screw to achieve the desired results.
Vibrations transmitted from the processing machine to the blender have a big influence on the blending accuracy. The sloping screw is meant to decrease the negative vibration effect. Changing the production rate or the cycle time is accompanied by resetting the blending ratio of the unit, and changing the type of material may require a different screw. Rotating discs with cavities in different sizes and adjustable rotation speed instead of the screw described above is another way of blending specific volumes of the additives with the main materials. Some volumetric units use feed screws or rotating discs for both main material and additive. Some units blend more than one additive with the main material, but the main idea is very similar in all volumetric blenders. Volumetric blenders are also applicable in a batch system. The blend is dumped into storage bins and then sucked by one or more vacuum loaders from the storage bins and supplied to one or more processing machines. The accuracy of all volumetric blenders depends on the size and shape of the pellets or the bulk density of the powder blended. The level of the material in the hopper above the feed screw makes a difference in the amount of material transferred through the screw. A vibration transmitted from the processing machine to the blender is a factor as well.
As these factors are always changing, the accuracy of the volumetric blender is limited.

IJCSMS International Journal of Computer Science & Management Studies, Vol. 11, Issue 02, August 2011
ISSN (Online): 2231 –5268
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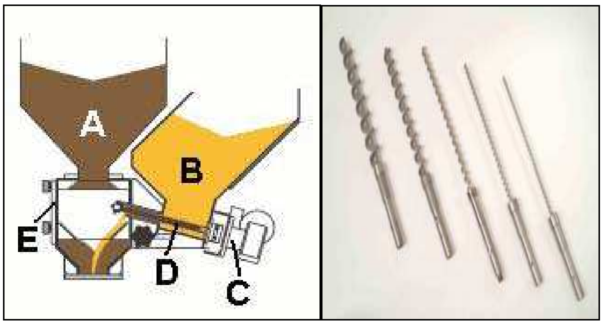

Fig. volumetric blending

Advantages

• Simple and inexpensive blender
• Higher accuracy than proportional loaders

Disadvantages

• Inconsistent blending
• Operator skill and observation are required
• Frequent adjustments are necessary

Gravimetric Blending

Gravimetric blenders are usually much more accurate than volumetric blenders. The additives are blended with the main material based on the mass of the additive and the mass of the main material. The volume of a specific mass varies based on the bulk density of the material, but the mass (weight) is constant. The accuracy of gravimetric blenders is dependent on the accuracy of the load cell (weighing device), the mechanical design of the blender, and the units operating software. Load cells are usually very sensitive to vibrations and external forces (top or side loads). They are therefore more applicable in a remote system. It is important that the mechanical
Design not only protects the load cell but also includes a solution for a homogenous blend. A good mechanical design is o ne that solves the problem with fewer moving parts. The control system and the software are also an essential part of the gravimetric blender. The control system must be designed so that when changes in the production rates are automatically detected, the blending parameters are automatically readjusted in order to maintain high accuracy and eliminate the need for constant monitoring.

It includes 4 hoppers containing different materials to be blended a mixing camber {E} attached to load cells and a control cabinet built on a floor standing frame. The hoppers {A} and {B} include pneumatically operated gates at the bottom. The hoppers {C} and {D} include feed screws at the bottom. The gate at the bottom of the hopper {A} containing the main material is opened and the main material falls b y gravity to the mixing chamber {E}. The load cells detect the weight of the material falling into the mixing chamber. The gate is then closed when the desired amount of the material is reached. The same procedure is repeated with recycled material in hopper {B}. The feed screw in hopper {C} is then started and a certain amount of the additive falls into the mixing chamber before the screw is stopped. The same procedure is repeated with master batch contained in hopper {D}. The mixer is started at last to mix the materials in the mixing chamber and the blend is then ready for loading to the processing machines. The vibration caused by the feed screws is very limited and the mixer is stopped during the weighing process. The accuracy of the load cells is very good and the desired ratios of the blend can be easily achieved. The design of the mixer is normally sufficient to achieve almost a homogeneous blend in the mixing chamber, but the key is to maintain homogeneity until the blend reaches the feed throat of the processing machine. The material flow and the remote batch blending process are shown in the molding plant layout in the illustration above. The central loading system transfers different types of materials and additives from storage bins {M} as well as recycled materials from the grinders {N} to the remote batch blenders W. After blending, the blend is transferred to the vacuum receivers {R} and then to the individual processing machines {P} via individual loaders {X}. The filter units {F} are to protect the vacuum blowers {V} from dust in the suction lines. It is very clear that material separation will take place after the blending process on the way to the individual processing machines.

Advantages

- Consistent & homogeneous blending
- Higher accuracy
- Easy to operate No frequent adjustments required

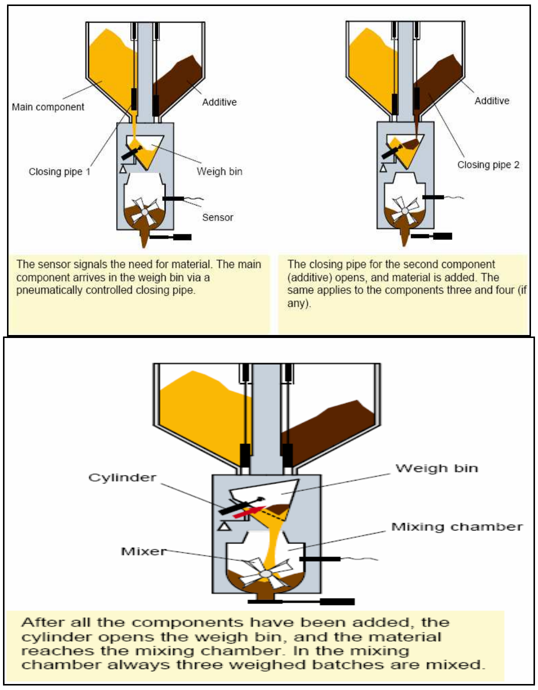

Fig General Operation of blending unit

Feeding Of Plastic Granuels To Molding Machine Hopper

Thermoplastic material is supplied to molders in the form of small pellets. The hopper on the injection molding machine holds these pellets. The pellets are gravity-fed from the hopper through the hopper throat into the barrel and screw assembly. Feeding of the plastic granules can be done by two ways

1. Manual feeding
2. Auto feeding

Manual feeding

Main material and the master batch are mixed in a container and then loaded manually with the help of a small bin. Manual feeding process is involving the fatigue of the operator and less productive, as the operator has to stop the machine every time for feeding the material resulting in less productivity. Because the hoppers are generally of small capacity of 2 to 5 Kg only and this much amount is consumed in every 2 to 3 hours so the operator has to stop the machine for feeding the material to the machine hopper. Sometimes there is no idea of emptying of the material in the hopper which result in short filling of the last produced piece resulting in increased production.

Disadvantages

- Operator fatigue
- Less productive
- Increases process rejections
- Requires high labor cost

Auto Feeding

Hopper Loaders are used for filling the machine hopper with the required raw material without human intervention. Hopper loaders work on the principle of vacuum. The hopper loader consists of a vacuum pump, receiver vessel and an inlet for the tube. One end of the tube is connected to the receiving vessel which generally fits on top of the hopper and the other end of the tube is connected to the source of the raw material (which could be an open gunny bag containing the material, a master tank containing the raw material, etc) . The hopper loaders depending on their make come with inbuilt timers for activating the vacuum pump. Depending on the shot weight, cycle time and the capacity of the hopper on which the hopper loader is fitted, the operator has to set the time on the hopper loader. At that designated time the hopper loader is activated and stays active for a set amount of time thus filling up the hopper with the material. This not only reduces cost of manpower but also prevents spillage and raw material losses. Typically, when multiple machines are running a standard product that use the same raw material and color, manufacturers attach hopper loaders to all their machine hoppers and connect them to a master tank containing the raw material and required master batch. Periodically the hopper loader sucks the raw material from the master tank thus simplifying the task of loading all the machines with same material. The hopper loader contains a self buzzer, level sensor, and a coil operated pneumatic cylinder. It has to pipes one is connected to vacuum blower and other one is connected to feed the material. Level sensor gives the signal of emptying the loader and the coil operates the cylinder to open the valve for vacuum suction and the material is sucked by the loader automatically the suction is cut off when the level sensor gives the signal when loader is full.

Advantages

- No human intervention
- No productivity loss
- Reduces process rejection

IJCSMS International Journal of Computer Science & Management Studies, Vol. 11, Issue 02, August 2011
ISSN (Online): 2231 –5268
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- No operator fatigue

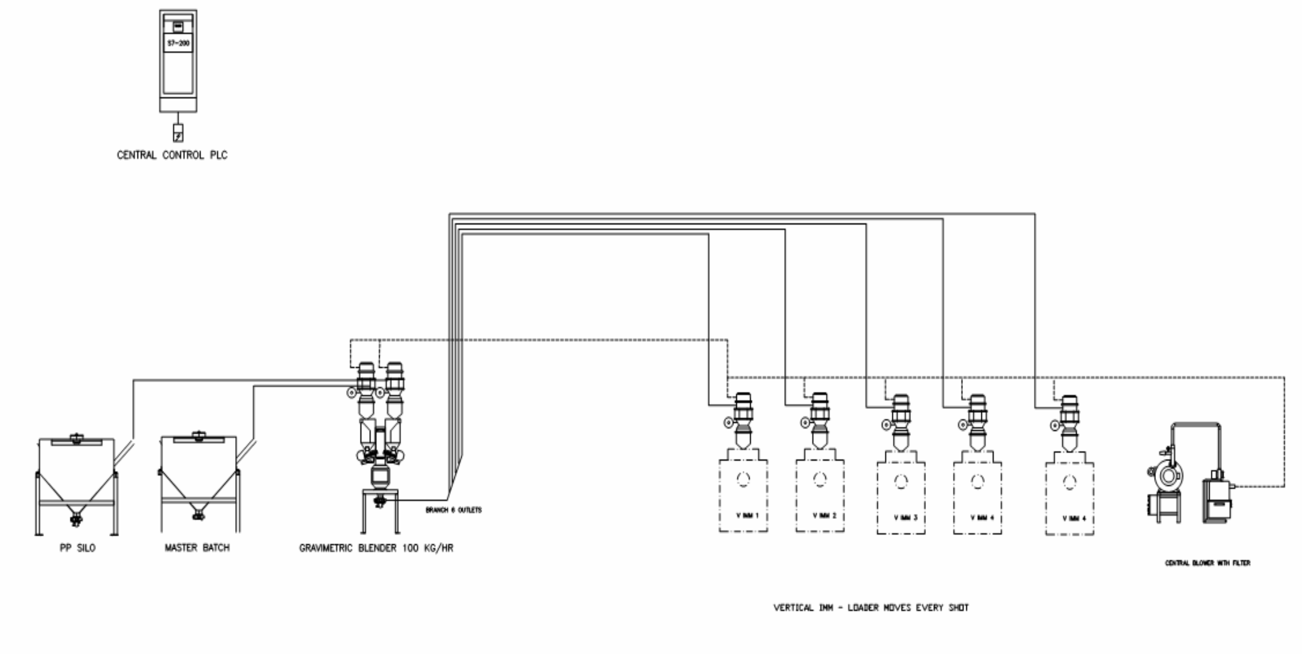

Fig. Example of central conveying system

Conclusion

In today's era of high completion need of robotics, automation, flexible manufacturing system and lean manufacturing concepts is very high to achieve of the production targets economically with quality & quantity associated with minimum cost. As discussed in the paper there is very lesser human intervention in the plastic blending and auto feeding by using these highly automated plastic blending unit and auto feeding system as an central conveying system so that plastic granules can be carried and mixed for the whole injection molding shop from a central place involving zero human intervention. These leads to the lean concepts straight away that minimum transportation is required as material is fed from a central place, no human fatigue associated, with increased productivity as every time no machine stoppage happens for plastic granule feeding. As a fact plastic molding is nowadays is probably the most important method of Processing of consumer and industrial goods, and is performed everywhere in the world. The developing of injection molding becomes a competition from day to day. This Process now integrated with computer control to make the production better in quality and Better quantity, as the rejection level in terms of plastic is very high in injection molding process so to achieve targets economically we have to optimize all the factors related to the process whether it is process parameters or process. So to avoid machine stoppages & to optimize the molding process with reduced rejection levels & to avoid high man power cost associated with non value aided activities & deploying it in value aided activities these plastic blending units & auto feeding systems are very much useful to achieve of quality quantity with minimum cost associated.

Manufacturers of HR systems, Consultation with specialists, the potential to check designs with the aid of computer techniques, assistance with start-up, etc., reduce the risk in building increasingly complex and expensive moulds.

References:-

[1] Bryce, Douglas M. Plastic Injection Molding: Manufacturing Process Fundamentals. SME, 1996.

[2] Brydson, J, Plastics Materials, Butterworths 9th Ed (1999).
[3] Callister, William D, Materials Science and Engineering: An Introduction, John Wiley and Sons
[4] HI *Whelan, Tony. Polymer Technology Dictionary Springer, 1994.
[5] Douglas M. Bryce. Plastic Injection Molding: Manufacturing Process Fundamentals. SME, 1996
[6] Rosato Dominick , Rosato Marlene, and Rosato Donald Injection Molding Handbook 3rd Ed. Kluwer Academic Publishers, 2000
[7] Tony Whelan. Polymer Technology Dictionary Springer, 1994
[8] Robert H. Todd, Dell K. Allen, Leo Alting. Manufacturing Processes Reference Guide Industrial Press Inc., 1994
[9] Todd, R. H., Allen, D. K., & Alting, L. (1994). Manufacturing Processes Reference Guide