

Improving Performance and Life of Screw in Plastic Injection Moulding Machine – A Review

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Abstract— Injection moulding machine is the most commonly used manufacturing process for the fabrication of plastic parts. The plastic being melted in injection molding machine and then injected into the mould. The barrel contains rotating screw for injecting the material into the mould and the material is also melted into the barrel. This project deals with, the solution of problem occurred for rotating screw of Injection molding machine. It identifies and solves the problem by using the modeling and analysis techniques. The problem occurred in the rotating screw of machine which is wearing of threads due to affect of temperature of mold materials and using 30% glass filled material(flow materials) i.e. Nylon, low density polypropylene, polystyrene, PVC etc.

Key words: Rotating Screw, Barrel, and mould, wear, Injection moulding machine

I. INTRODUCTION

Injection molding machine, also known as an injection press, is a machine for manufacturing plastic products by the injection moulding process. It consists of two main parts, an injection unit and a clamping unit. Injection molding is the most commonly used manufacturing process for the fabrication of plastic parts. A wide variety of products are manufactured using Injection molding machine, such as plastics housings, consumer electronics, and medical devices Including valves & syringes which vary greatly in their size, complexity and application. The injection molding process requires the use of an injection molding machine, raw plastic material, and a mould.

The plastic is melted in the injection molding machine and then injected into the mold, where it cools and solidifies into the final part. The barrel contains the mechanism for heating and injecting the material into the mould. This mechanism is usually a rotating screw. A rotating screw advance the material forward by either a hydraulic or electric motor. During this process the material is melted by heat & pressure. The material enters the grooves of the screw. The screw completes the shot volume & returns to reverse position.

A. Machine Components:

1) Injection System:

The injection system consists of a hopper, a rotating screw and barrel assembly, and an injection nozzle,. This system confines and transports the plastic as it progresses through the feeding, compressing, degassing, melting, injection, and packing stages.

2) The 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.

3) The Barrel:

The barrel of the injection molding machine supports the rotating plasticizing screw. It is heated by the electric heater bands.

4) The Rotating Screw:

The rotating screw is used to compress, melt, and convey the material. The rotating screw consists of three zones (illustrated below):

- the feeding zone
- the compressing (or transition) zone
- the metering zone

5) The Nozzle:

The nozzle connects the barrel to the sprue bushing of the mold and forms a seal between the barrel and the mold. The temperature of the nozzle should be set to the material's melt temperature or just below it, depending on the recommendation of the material supplier.

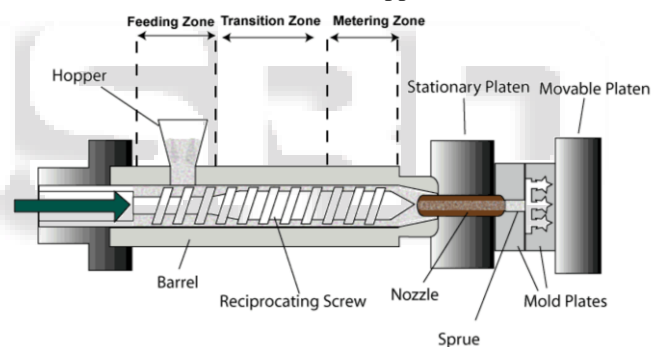


Fig. 1: Injection Moulding Machine

B. Parameters Affecting Life of Screw:

1) Factors in Machine Wear:

There are four main factors in machine wear:-

- Alignment of the screw and the barrel.
- Process condition such as pressure, temperature and screw geometry.
- Material characteristics such as the resin's lubricity in the melt state as well as the presence and nature of any additives, fillers and contaminants.
- Metals used to make the barrel and screw.
- In considering the four main wear factors, there are three main types of barrel and screw – adhesive, abrasive and corrosive.

C. Types of Wear:

1) Adhesive Wear:

Adhesive wear is the result of metal-to-metal contact between the screw and the barrel wall. To the naked eye, a new screw and barrel appear to have eye, a new screw and barrel appear to have very smooth, shiny surfaces.

2) *Abrasive Wear:*

There are two types of abrasive wear occur in the machine:

- One is two body effects resulting from axial movement of hard filler particles or glass fiber through the extruder.
- Abrasive particles become trapped in space between the screw flight and the barrel wall, this is the three-body wear.

3) *Corrosive Wear:*

Corrosive wear is material degradation wherein both wear and corrosion wear mechanisms are present.

This is the another parameters also affecting the life of screw

- 1) *Alignment:-* Good alignment is required to minimize the metal-to-metal contact. The ideal is a perfectly straight screw , a perfectly straight barrel and perfect alignment of two.
- 2) *Buckling:-* Another source of metal-to-metal contact is buckling of screw cause by discharge pressure at its front end.
- 3) *Deflection:-* The laws of physics also produce a third potential source of contact between the screw and barrel under its own weight.

D. *Barrel Temperature Override:*

If a screw designed for neat or unfilled resin is used to process a filled resin. It may appear to be processing the material in an acceptable manner. But inside the barrel other things are happening.

Normally, the first sign of problems will be temperature overrides in the barrel zones. This is due to the non-compressibility of the filler. The cause of the temperature override is typically due to the fact that viscous heating is taking place in a particular area the screw. Typically whenever a barrel zone temperature Override due to viscous heating. Normally, the first processing technique that should be used is to increase all of the barrel zones prior to zone that is Overriding. This should help raise the temperature of the resin .lower its viscosity and in turn allow it to flow more easily through the portion of the screw where the temperature Override was happening. This is only a temporary fix, and a term solution needs to implement with a properly designed screw.

E. *Wear:*

The other evidence of improper screw design for composite thermoplastic resin is in the area of screw wear. If the volumetric compression ratio has not been optimized for the composite thermoplastic, extreme wear will be evident in the root of the screw channel. Different filler cause the wear to occur in different areas of the is abrasive wear.

Fillers like mica and fiberglass will cause aggressive wear in feed section of the screw. Typically, the wear is on the push side of the flight. The main reason that the majority of the wear takes place in the areas mentioned is that the resin is in the pellet in this portion of the screw and the composite are in turn then near the outer surface of the pellets and are rubbing against the unprotected steel root of the screw. Once the resin starts to melt, a film of melted material begins to help lubricate the area between the pellets and root of the screw.



Fig. 2: Wear of screw

F. *Material Selection:*

Screws are made from several base materials.

The base material for most screws is low carbon steel, to which hard facing are welded to the tops of flights for additional wear resistance. Screws that are hardened by nitriding are often made of nitralloy. Its contains aluminums to aid in the nitriding process. Tool steel is commonly used for monolithic screws.

Other materials such as stainless steel, Hastelloy and Duranickel are used to achieve greater corrosion resistance.

SR NO	Name of different steel material	Hardness of different material
1	Latrobe LSS 01 Tool steel (ASTM 01) OHNS	62
2	AISI Type 07 Tool Steel	64
3	AISI Type 06 Tool Steel	65
4	Latrobe LSS D3 Tool steel (ASTM D3)	64.5
5	HSS 142 Tool steel	68

Table 1: Different materials for screw

II. LITERATURE SURVEY

A. *Suggestive Solutions Performance of Screw:*

In Injection molding machine The problem occurred in the rotating screw of machine which was wearing of threads due to affect of temperature of mold materials (flow materials) i.e. Nylon, low density polypropylene, polystyrene, PVC etc.. the screw completes the shot volume & returns to reverse position. The problem occurred in the rotating screw is of the wearing of threads due to affect of high melting temperature & pressure of mold materials. In accordance the present invention is directed to industries are having temporary solution to make repair of threads on Lathe machine. This reduces weight & strength of screw resulting misalignment in assembly. The screw is the most crucial part of a machine. Also if the screw will fail after some years of operation, the new screw available in the market will have the same problem. Also the cost associated with new screw and its mounting is much more as it is the main component of machine. This some result is found by this review paper.[Nagsen B. Nagrale]

At the same time literature review shows that the injection moulding machine encounters various problems

while its operations. wear on the barrels and screws of injection moulding machines. A few model tests simulating the tribological conditions in the injection moulding machine have been developed for finding the appropriate coatings and treatments to combat the wear. This paper presented a new wear tester that has been developed to simulate more closely the wear that occurs inside the barrel of an injection moulding machine. The concept of the tester is similar to that of the ASTM rubber wheel abrasion tester with some additions to ensure the requirements of closely simulating the condition of wear. This paper presented a tester to assess the wear of untreated, The wear rate of untreated steel and chrome-plated steel increases as the temperature rises but the wear rate of the nitrided steel is effectively constant .but some glass filled material having problem that is wear is takes place on screw barrel in plastic injection moulding machine.[Vikas. R. Rajoria, P. K. Jadhao].

The Glass-filled polymers are known to produce considerable wear on the barrels and screws of injection moulding machines. A few model tests simulating the tribological conditions in the injection moulding machine have been developed for finding the appropriate coatings and treatments to combat the wear. This paper presented a new wear tester that has been developed to simulate more closely the wear that occurs inside the barrel of an injection moulding machine. [P. Boey]

- TiAlCrSiN coatings based on two different layers (CrN+nanostructured TiAlCrSiN) present a very good adhesion to the AISI P20 steel substrate.
- The wear resistance was increased about 50% with the TiAlCrSiN coating, related with the uncoated substrate, attending to the micro-abrasion ball-cratering tests.
- Practical tests allow observing that only very small damages were provoked in the coated surface after 45 000 injection cycles of 30% glass fibre-reinforced polypropylene.

[A. Kassman, S. Jacobson, L. Erickson]

The another solution is modeling and analysis is takes place by using this software:-

- To model all the components using modeling software Pro-E 4.0.
- To assemble all the components of the machine in the software.
- To make the assembly run in Pro-E software.
- Analysis of screw of machine using Ansys 11.0 software.
- To identify the wearing of threads and to provide the possible solutions.

III. ACKNOWLEDGEMENT

Our thanks to the scholars who have worked on the problems related to injection moulding machine.

IV. CONCLUSIONS

Injection moulding is a very important process, the paper shows that temperatures and pressure parameters of an injection moulding machine plays a vital role in product configuration. In this way we can say that problems caused by these parameters has an effect on the life of rotating

screw for injection moulding machine and the problem occurred in the rotating screw of machine which is wearing of threads due to affect of temperature of mold materials and using 30% glass filled material (flow materials) i.e. Nylon, low density polypropylene, polystyrene, PVC etc. Directly affects the quality of the components manufactured by Injection moulding machine.

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