

Modeling and Analysis of screw in plastic injection moulding machine for improving life and performance

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Abstract

Injection moulding machine is used in the industries for manufacturing or fabrication of the plastic parts. The screw is subjected to different temperature zones. It is the most critical components of the injection moulding machine. The raw granules of plastic is melted in the injection moulding machine and injected into the mould. The material is feed into the hopper in the granules form. The barrel contains reciprocating screw for infusing the material into the mould and material is additionally liquefied into the barrel. The issue happen in the screw of machine which is wearing of screw because of influence of mould temperature and utilizing 30% glass field material i. e. Nylon, low thickness polypropylene, polystyrene ,PVC etc. The industries are having temporary solutions but it is not so effective in improving life of the screw, because the stresses will be more in machined screw on lathe machine as compared to normal screw. Hence, the modeling and analysis technique is used to solve the problem.

Keywords- Reciprocating Screw, Barrel, and mould, wear, Plastic Injection moulding machine

I. INTRODUCTION

Plastic injection moulding machine is consist of mainly two components, injection unit and clamping unit. Raw material in the plastic granules is fed into the injection mould and softened with the help of heating arrangement around the screw enclosed in the barrel. Then the softened plastic material is pushed into the mould cavity by the reciprocating screw. Then it is allowed to settle down for some period where in cooling is done. After this the part is separated from the mould.

Reciprocating screw propels the material forwarded by electric engine. screw finish the shot volume and come back to the invert position.

screw will have the same issue. The injection machine experienced different issue while its operation. Wear on barrels and screw of infusion machine. A couple of modal tests simulating tribological condition in the infusion machine have been created by finding the proper coatings treatments to minimize the wear.[Vikas. R. Rajoria , P. K. Jadhao].

It is generally seen that the glass-filled polymers produce a considerable wear on the components of injection moulding machine (barrel and screw). With the tester, the minute wearing of the screw was tested and the methods to overcome the difficulties associated with the screw and barrel had been delivered. To minimize the wear of threats they have been finding some coatings, treatments and some hardening or screw plating's to minimize the wear. In processing corrosive material such as fluropolymers plating are also used to provide corrosion resistance.. [P. Boey]

II LITERATURE SURVEY

Suggestive solutions performance of screw

The problem occurred in the screw of injection molding machine which was the wearing of the threads because of influence of temperature of molds materials(stream materials) i.e., nylon, low thickness poly-propylene, PVC and screw finished the short volume and come back to switch the position. The issue happened in the screw is wearing of threads because of influence of high dissolving temperature and weight of mold materials. The industries are having temporary solution to make repair of threads on lathe machine. This reduces weight and quality of screw coming-out misalignment together. [Nagsen B. Nagrale]

The screw is most crucial part of machine. After the failure of screw new screw is available in the market. The cost of screw is much more i.e. 4 – 5 Lac. This

III PROBLEM DEFINITION

There are four main factors in screw 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(steel material) used to make the barrel and screw

Wear due to the high temperature and exposed to glass materials. The modeling and analysis is carried out in the Cero 5.0 and

ANSYS respectively to find out actual Stresses. Apart from this analysis some other alternatives one suggested for wear reduction such as surface coating , hardening , material change etc. since the cost of the screw is very high and very critical components.

IV DESCRIPTION OF MACHINE

The components used in the machine are as follows:-

Injection system

This system transports the plastic. The injection system are having hopper, barrel, reciprocating screw and injection nozzle assembly. It progress through melting compressing, degassing, injection, feeding and packing stages

a)The hopper

In the form of small pellets the thermoplastic material is supplied to molders. The hopper hold the pellets. The barrel and screw assembly pellets are gravity –fed from hopper through the hopper throat.

c) The barrel

The rotating plastizing screw is supported by barrel in the injection moulding machine. The electric heater bands are used for the heating purpose.

d) The rotating screw

For compress, melt, and convey the material the rotating screw is used. There are three zones in rotating screw (illustrated below):

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

e)The nozzle

It is forms seal between barrel and the mold because the nozzle is connects the barrel to spure bushing of 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.

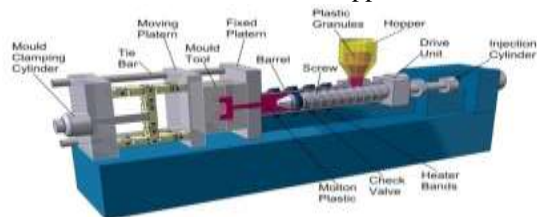


Fig 1 : Injection Moulding Machine

V FACTORS AFFECTING SCREW WEAR

There are four main factors in screw wear:-

- Alignment of the screw and the barrel.
- Process condition such as pressure, temperature and screw geometry.
- Metals used to make the barrel and screw.
- Material characteristics such as the resins lubricity in the melt state as well as presence and nature of any additives, fillers and contaminant

VI WEAR- DESCRIPTION AND PREVENTS

Fillers like mica and fiber glass will result in forceful wear in feed segment of the screw. Ordinarily, the wear is on the push side of the flight. the fundamental reasons that most of the wear happen in the territories specified is that the screw is in the pellets ,in this portion of the screw and the composite are turn then close to the external surface of the the pellets and are rubbing against the unprotected steel base of the screw. the other proof of improper screw outline for composite thermoplastic resin is in the zone of screw wear.

In the event that the volumetric pressure degree has not be improved for the composite wear will be clear in the root of the screw channel. Different filler cause the wear to happen in diverse area of the rough wear. Once the gum begins to dissolve, a film of dissolve material start to help lubricate up the range between pellets and base of the screw. Wear is erosion of material at whatever point two surfaces in contact experience relative sliding movement under the activity of contact power. Wear can be adhesive, abrasive.

Following are the ways and intends to prevent or less the wear

- Improve working conditions.
- The right decision of material, as per the fundamental type of wear.
- Improve the nature of repair.
- A surface treatment.



Fig 2: Wear of screw

VII. PROBLEM ANALYSIS

A] MATERIAL SELECTION:-The choice of material and the techniques utilized as a part of creation are fundamental parts of creation parts of the design of any machine segment. Material determination for machine segment is as follows identifying attributes of the applications.

- Identify part specification.
- Identify material properties.
- Select potential material applicant considering expense, accessibility.
- Fabrication of part.
- Verification testing or assessment and failure analysis of part.

Screw are made from several base materials such as low carbon steel, stainless steel, hastelloy and Dura nickel 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

Fig: - Different material of screw

B OVERRIDE BARREL TEMPERATURE

If screw design 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. Regularly the first indication of issue will be temperature override in the barrel zones this is because of the non-compressibility of the filler. The reason for the temperature override is commonly because of the way that viscous warming is occurring in a specific zone of the screw. A barrel zone temperature override because of gooey warming. Ordinarily, the first handling system that to be utilized is to build greater part of barrel zones before zone that is overriding. This should be help to the temperature of resin.

C. FAILURE CAN BE MINIMIZING BY FOLLOWING WAYS:-

- Changing the material of the screw having different properties fatigue failure and the brittle fracture and the ductile fracture is reduce.
- Working condition improves then wear can be decreased.
- Surface treatment can reduce wear.
- Proper lubrication of part wear can be minimize.

D FEA/FEM:-

Many complex problems arrive in the field of engineering design. The mathematical formulation of which is tedious and usually not possible by analytical methods. Here the finite element method (FEM) is very powerful tool for getting the numerical solution of getting the numerical solution of engineering problems. In this the structure or body is divided into the smaller elements is called "finite element". Assemble all this elements connected at a finite number of joints called as "Nodes". The properties of the elements are combined top obtain the properties of entire body. The necessary boundary condition is applied and the equations of equilibrium are solved to required optimum solution such as stress, strain, temperature distribution etc. FEM is now a day used as a powerful and an efficient tool for understanding the stress strain behavior of the structure.

E. INTERFACE OF CAD/CAE SOFTWARE

i. CAD/CAE

Computer aided design is used in the different ways. It is utilized to produce drawing and document design. CAD software is the tool to needed to perform to our project and efficiently and time consuming task. It has provided the technological design of combination slide increase accuracy and uniformity. CAD has been acknowledged as key to improving the manufacturing productivity of combination slide. CAD (computer aided design) and CAE (computer aided engineering) is a technique in which the designer and computer works together as integrate team and utilizes best characteristics of each.

ii.PRO-ENGINEER WILDFIRE 5.0

Pro-E wildfire 5.0 has been develop by PTC(the product development company). This is CAD/CAM/CAE software we are using this for modeling (CAD) parts of project. This CAD includes.

- Sketcher
- Part modeling (part design)
- Assembly design
- Sheet metal design
- Drafting and detailing.

iii. ANSYS 11.0

ANSYS is complete FAE software package used by engineers worldwide in virtually all fields of engineering. ANSYS has robust tools to clean imported geometry contain surface with gaps, overlaps and misalignments which prevent auto meshing and high quality mesh generation. A partial list of industries in which ANSYS is used in Aerospace, Automotive, Biomedical, Bridges and Buildings etc.

VIII ACKNOWLEDGEMENT

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

IX. CONCLUSIONS

Process condition such as temperature and pressure of injectionmoulding machine plays a vital roll. These parameter effect life of screw on injection moulding machine. Further there is wear of screw due to processing of 30% glass field material(Nylon, low density polypropylene, polystyrene, PVC). It is directly affects quality of the parts manufactured by injection moulding machine.Wear due to the high temperature and exposed to glass materials. The modeling and analysis is carried out in the Cero 5.0 and ANSYS respectively to find out actual Stresses. Apart from this analysis some other alternatives one suggested for wear reduction such as surface coating , hardening , material change etc

References

1. Nagsen B. Nagrale, Dr.R.N.Baxi, —Finite Element Analysis of Reciprocating Screw for Injection Molding Machinel, Nagsen B.Nagrale et al. / International Journal of Engineering and TechnologyVol.3 (3), 2011
2. Vikas.R.Rajoria, Prof.P.K.Jadhao, —Finite Element Analysis of Reciprocating Screw for Injection Molding Machinel, InternationalJournal of Innovative Research in Science, Engineering andTechnology Vol. 2, Issue 7, July 2013
3. Akinci, I.D Yilmaz and M. Canakci, 2005. Failure of a rotary tiller spur gear. J. Eng. Failure Anal., 12:400-404
- 4 .Nanaware, G K. and M.J. Pable, 2003 Failure of rear axle shafts of 575 DT tractor. J. Eng Failure Anal., 10:719-724
- 5 Rahman, M.M., A.K. Arffin, N. Jamaludin, S. Abdullah and M.M. Noor, 2008. Finite element based fatigue life prediction of a new free piston engine mounting. J. Applied Sci.,
6. The effect of temperature on the abrasive wear of coatings and hybrid surface treatments for injection moulding machines -P. Boey, W. Ho, S.J. Bull, University of Newcastle, UK
7. Barrel temperature control during operation transition in injection molding. - Ke Yao , FurongGao , Frank Allgower ,The Hong Kong university of science and technology.
8. A simulation test for wear in injection moulding machines S.J. Bull a, Qiusha Zhou, University of Newcastle, Chongqing
9. Self-optimizing MPC of melt temperature in injection moulding -R. Dubay. The University of New Brunswick.
10. Ke Yao , FurongGao , Frank Allgower .Barrel temperature control during operation transition in injection molding ,The Hong Kong university of science and technology, Control Engineering Practice 16 (2008) p1259– 1264
11. -P. Boey, W. Ho, S.J. Bull -The effect of temperature on the abrasive wear of coatings and hybrid surface treatments for injection-moulding machines, University of Newcastle, UK
- 12.J. Primo Benitez-Rangel, A. Domínguez-González, G.Herrera-Ruiz & M. Delgado-Rosas -Filling Process in Injection Mold: A Review.(2007):Polymer-Plastics Technology and Engineering.