A Review: Design Analysis and Optimization of Screw Feeder of Injection Molding Machine

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Abstract— In this paper, the design and analysis of the rotating screw of injection molding machine has been presented. The flow of melted material is controlled by the reciprocating screw inside the barrel, where the raw material of the product is melted. The proper flow of melted material is required to obtain better quality of the product. Thus, the rotating screw can be considered as a critical component of injection molding machine and its size varies model to model. The work presented is based on parametric modelling of reciprocating screw. Using developed parametric model of rotating screw, three parameters (radius of screw, feed flight depth and metering flight depth) are required to generate the three-dimensional (3D) model for further analysis. The ease of present approach is very useful for the development of the different types of rotating screw in terms of variation in the said dimensions. The static structural and steady-state thermal analysis has been considered to analyse stresses, total deformation, total heat flux and directional heat flux. The obtained result depicts that has higher yield strength and has low total heat flux value. Thus, can be considered where higher strength is required and for higher wear resistance is preferred for reciprocating screw. During injection molding process, the heater temperature is one of the most important influences on the product quality. In this paper, the temperature of the heater will be examined for different product sizes. The temperature values and distribution will be collected and compared. Results show that when the product size changes, the heating and cooling steps have a slight variation. The simulation results were verified by an experiment. Polymeric matrix composites are the most commonly used matrix materials.[2].

Keywords: Injection molding machine, rotating screw, heater, plastic molding, barrel

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.

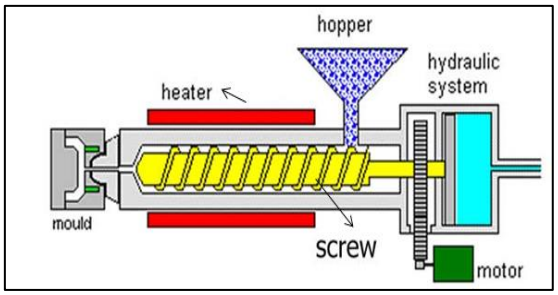

Fig. 1: Injection molding machine

II. MACHINE COMPONENTS

A. 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.

B. 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.

C. The Barrel:

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

D. 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–

E. 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

III. 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.

IV. VARIOUS TYPES OF SCREW

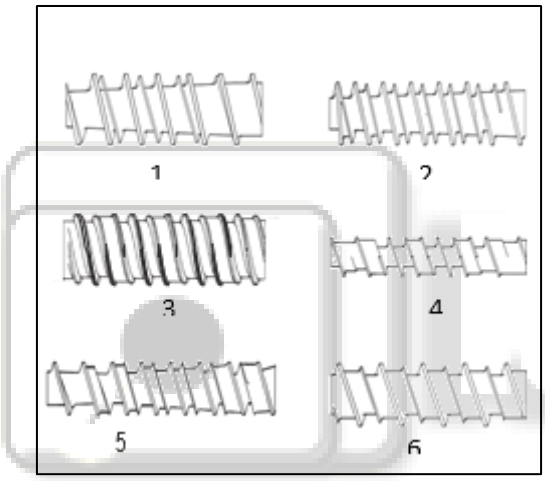

Fig. 2: Types of screw

The Double Wave design features repetitively spaced alternating wave peaks in each screw channel forcing the resin alternatively to either cross the narrow-undercut center barrier or squeeze over the peaks of the waves. This design and the E.T. illustrate the use of repetitive solids/melt redistribution to promote melting as contrasted with the restriction of the solids bed breakup concept utilized by the other barrier designs.

The DM2™, manufactured by Glycon, features a thermal "cross-over zone" positioned along the screw at a point where 70 - 80% of the polymer is melted. This allows theme lt, as well asthepellets, to interact without excessive pressure buildup.

The next section of the Handbook discusses screw *designs for extrusion applications*. Extrusion screws require greater shear capability than injection molding screws, which suggests the use of barrier designs in most cases. Because the clearance between the barrier land of a barrier screw and the inside diameter of the barrel wall can be minimized, barrier screws can achieve great shear capability so necessary to extrusion processing.

V. LITERATURE REVIEW

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]

A. Mayur D. Jagtap A Review on Development and Testing of Hybrid Fiber Composite Material (2018) JournalNX- A Multidisciplinary Peer Reviewed Journal 147-149.

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]

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