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Design and Develop New Coupling System in Injection Molding Machine to Improve Screw Life: A Review

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Abstract

Injection molding machine is the most commonly used manufacturing process for the production of plastic parts. The plastic being melted in injection molding machine and then injected into the mould. The barrel contains reciprocating screw for injecting the material into the mould and the material is also melted into the barrel.This paper presents the solution of problem occurred for reciprocating screw of Injection molding machine. The problem occurred in the reciprocating screw of machine which is wearing of threads due to affect of temperature of mold materials (flow materials) i.e. Nylon, low density polypropylene, polystyrene, PVC etc.The main work was to model the components of machine with dimensions, and perform static and thermal analysis with parts of injection molding machine parts like reciprocating screw. The analysis of reciprocating screw provides the possible solution to reduce the wear or damage on reciprocating screw, hence avoiding the high cost and time lapse.

Keywords- Reciprocating Screw, Gear Box, Motor Capacity, rigid flange coupling, barrel heaters, Catia V5 and Ansys 14.

Introduction

1.1Injection Molding

1 Injection machine

The injection machine is machines that melt plasticize the molding material inside the heating cylinder and inject this into the mold tool to create the molded product by solidifying inside it. The injection machine is constructed of a mold clamping device that opens and closes the mold tool, and device that plasticize and inject the molding material. There are several types in the injection machine and the difference is made by how these two devices are arranged.

（1）Horizontal injection machine ： both mold clamping device and injection device Compounded horizontally.（2） Vertical injection machine ： both mold clamping device and injection device Compounded vertically（3）Two-color injection machine.（4）Rotary injection machine.（5）Low foam injection machine.（6）Multi material injection machine.（7）Sandwich injection machine.

1.2 Selection of injection machine

1.2.1 Select by injection volume

As a guide, generally the injection machine should be selected so that molded product volume will become 30%to 80% of the machine's injection volume. When molding, the relation of the machine's injection volume Q (g) and one shot weight (sprue and runner weight included) W (g) should be in the range indicated below.

$$Q = (1.3 \sim 1.5) \times W$$

If the injection volume is too small, plasticization will not make it, and might lose its original physicality as a molded product because the resin will be sent without enough plasticization. On the other hand, if the injection volume is too big, residence time inside the cylinder will be longer and cause degradation by more chance.

1.2.2 Select by mold clamping pressure

Both toggle type and direct pressure type is suitable when molding NOVADURAN. The relation of molded product projected area A (cm2) and required mold clamping pressure P (ton) should be in the range indicated below.

$$P = (0.5 \sim 0.7) \times A$$

1.2.3 Nozzle structure

Open nozzle is common when molding NOVADURAN. The nozzle of commercially-supplied injection machine can be open nozzle or shut-off nozzle (Figure 1-1) but in any type, it is necessary to have a temperature control.

(A) Open nozzle (B) Shut-off nozzle

Figure 1-1 Types and structures of the nozzle

Molding condition

1.3.1 Resin temperature

When molding NOVADURAN, resin temperature should be generally about 240Cel.～265Cel. Liquidity will be better as the temperature rises, but extremely high temperature will accelerate heat degradation which will end up with physicality deterioration of the molded article.

1.3.2 Injection and pressure keeping

（1） Pressure Injection pressure can be considered as the fill pressure (primary pressure) and the hold pressure (secondary pressure). Generally the fill pressure will be set stronger than the hold pressure. When low-temperature solidification, crystalline resin like NOVADURAN will cause a big shrink, therefore the hold pressure is necessary for filling up and is closely related to the molding shrinkage. Increasing the hold pressure is effective to resolve sink and void problem, but if it increase too much, it might cause burr, so the attention is required.

（2） Injection speed

In the case of thin molded product or multi-cavity molded product which severe size precision is required, faster injection speed is better. In contrast, slower injection speed is better for thick molded product. Also, the program control of injection speed is effective to resolve the jetting and the flow mark.

（3） Injection time

Setting will differ by the molding machine, but basically should be considered as below. Injection time (filling time + pressure keeping time) > gate sealing time

Gate sealing time is the time when resin stops flowing by solidification at the gate part. If pressure keeping is put away before the gate is sealed, molten resin will backflow from the gate by the tool internal pressure, which will cause measurement and physicality variability, sink and

avoid problems, because of decrease in molded product's filling density (packing property). To estimate the gate sealing time, measure the weight of molded product by gradually increasing the injection time, and look for the injection time when the weight of molded became a certain amount and stop changing.

1.3.3 Back pressure

The measurement might become instable by the gas and the air generated from molten resin when plasticization. To stabilize the measurement and improve the kneading effect, put the screw back pressure （5～10kg/cm2） on. However, if the back pressure is too strong, it might degrade the plasticization ability.

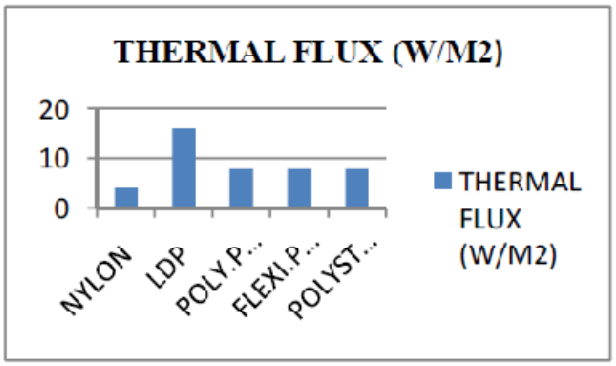
1.3.4 Mold temperature

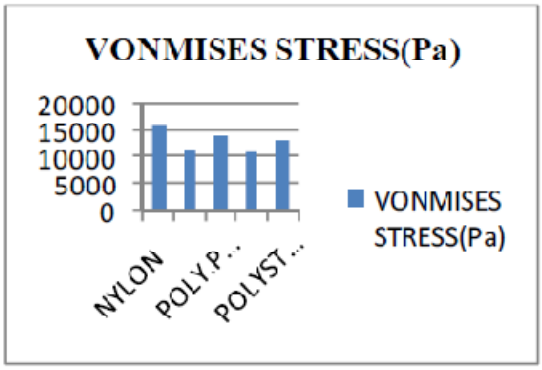
Generally, 60Cel. to 80Cel. is suitable for mold temperature of NOVADURAN, and this is the most important point in the molding condition. If high cycle molding is intended, molding in temperature of about 20Cel. to 30Ce. is possible by using chiller temperature controller, but require attention because it might cause deformation by the residual strain inside the molded product, and dimension change by after contraction might be bigger depending on the usage environment (high temperature atmosphere). It is effective to raise the mold temperature to about 120℃, when dimension stability is required since assumed to use under a high temperature atmosphere, or high level of surface gloss is necessary.

LITERATURE SURVEY

Finite Element Analysis of Reciprocating Screw for Injection Molding Machine

For reciprocating screw of injection molding machine, Steady state Thermal analysis & Static structural analysis performed on screw using finite element analysis applying temp. At various points & and fixed support. The reciprocating screw material is EN41B, EN9, EN8 & EN 24.The flowing mould material is Nylon, Low density roly-poly prop, Flexible PVC & Polystyrene. The results obtained are plotted on charts.





FINITE ELEMENT ANALYSIS OF RECIPROCATING SCREW FOR INJECTION MOULDING MACHINE

Among all the steel Grades SAE 4040 (EN 8) is the most suitable material for processing of the mould materials as it exhibits the minimum heat flux generated while processing. Also the values of heat flux for SAE 4340 and SAE 4040 are approximately very close but the yield tensile strength values are:

FOR SAE 4340: 470×10^6 Pa.
FOR SAE 4040: 350×10^6 Pa.

Clearly SAE 4340 will resist more to pressure compared to SAE4040 so the Steel grade suggested for Injection molding machine is SAE 4340.

Conclusion

The Literature review presents reciprocating screw of material EN24 (SAE4340).of injection molding machine Static structural analysis performed on screw using ANSYS R14.5 software analysis applying torque at the end on motor side and keeping whole surface of screw as fixed support side, it is found that reciprocating screw has more chances of failure. In the same way For reciprocating screw of material EN-41B (SAE 52100) of injection molding machine Steady state Thermal analysis & Static structural analysis performed on screw using ANSYS R14.5 software analysis applying torque at the end on motor side and keeping whole surface of screw as fixed support side, it is found that this reciprocating screw also has more chances of failure. For reciprocating screw of material EN-41B (SAE 52100) also has done thermal analysis and it has shown variation of temperature along the full reciprocating screw length and it also can give temperature of material at different point.

Also the review presents that to avoid failure of reciprocating screw ,the focus will be on design a coupling . Design a coupling as before fail of screw ,first fail the coupling as high stress come on screw.

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