Analysis of Optimized Process Parameters in Plastics Molded Part using Plastics Advisor

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***Abstract*: Plastics injection moulding has been challenging process for many manufacturer and researchers to produce optimum process parameters with low cost and good quality. Obtaining optimized process parameters are difficult and hence needed computer analysis for part to be produced. But the process parameter manipulation during real time production creates a very intensive effort to maintain the optimized parameter from software and reduce quality problems. The aim of this research is to find out the difference between the optimization parameters obtained from plastics advisor, a mold flow software and real parameter actually extracted from injection moulding machine. The examination of processing parameters of injection molded part which is running at machine is compared with the optimized parameters received from plastic advisor, application software from Pro Engineer. The two parameters are compared and plotted for the difference.**

***Keywords*: Injection moulding, pro engineer, plastic advisor**

I. INTRODUCTION

Injection molding represents the most important process for manufacturing plastic parts. It is suitable for mass producing articles, since raw material can be converted into a molding by a single procedure. In most cases finishing operations are not necessary. An important advantage of injection molding is that with it we can make complex geometries in one production step in an automated process. The injection molding technique has to meet the ever increasing demand for a high quality product (in terms of both consumption properties and geometry) that is still economically priced.

This is feasible only if the molder can adequately control the molding process, if the configuration of the part is adapted to the characteristics of the molding material and the respective conversion technique, and a mold is available which satisfies the requirements for reproducible dimensional accuracy and surface quality.

Optimization of injection molding process serves for finding ideal conditions during production of plastic parts and observing their dimensions, shapes and properties. It is possible to determine the appropriate injection pressure, velocity, value and time of packing pressure, etc. by optimization.

Determining optimal process parameter settings are critically influences productivity, quality, and cost of production in the plastic injection molding (PIM) industry. Previously, production engineers used either trial-and-error method or Taguchi's parameter design method to determine optimal process parameter settings for PIM. However, these methods are unsuitable in present injection moulding machine because the increasing complexity of product design and the requirement of multi-response quality characteristics.

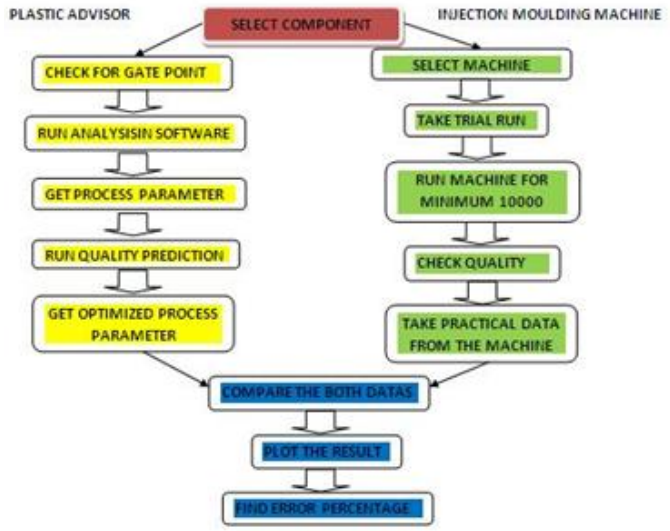
The use of innovative mold flow analysis has made it possible to drastically reduce the time required for finding out optimum process parameters. A new simulation tool for optimization of thermoplastic components has recently become available, and can be used for three-dimensional computation of the mould filling, cooling and internal stress buildup on a monitor. The proposed approach integrates all the processing parameters quality prediction to find out the optimized setting for the given product.

. We have pro-engineer to analyses the mold flow of the product. It is application software from pro engineer. Also the parameter which affects the production is manipulated in the software. This software has an advantage of all the process parameter important to the completion of quality product. But it is questionable that the parameters setting from the software is really applicable while running practical productions. To support this question we have conducted this research paper with respect to the software as well as the effect of setting in the machine.

II. EXPERIMENTAL DESIGN

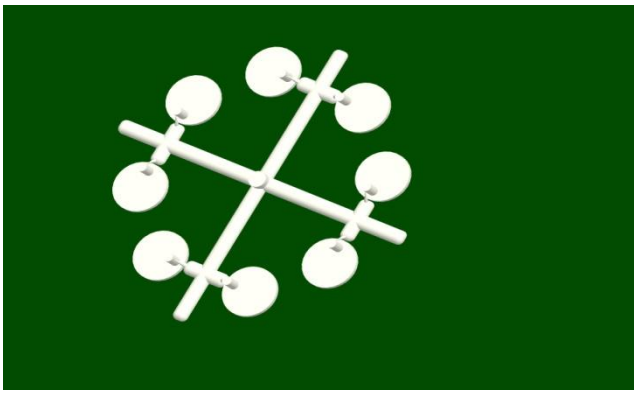
To support the concept an experiment is conducted with respect to software and machine. A product is selected and it is analyzed. Finally the optimum process parameters are arrived from the software. While running in machine, the parameters setting for the same product are retrieved from machine control panel. These two parameters are checked and variations of results are discussed. This finally defines the real process problem faced during production and also the difference between real data with software data.

The following flow chart explained the way we conducted the research work.



III. SELECTION OF PLASTICS COMPONENT

The component selected must be very simple to analyze and produce. So we have selected a part which is used for printing of company logo on the water tap assembly. It is made by ABS plastics. The component weight is around 0.98 grams. It is made as 12 cavity injection mould. That is 12 components can be made for each cycle time. The cycle time is approximately 12seconds.



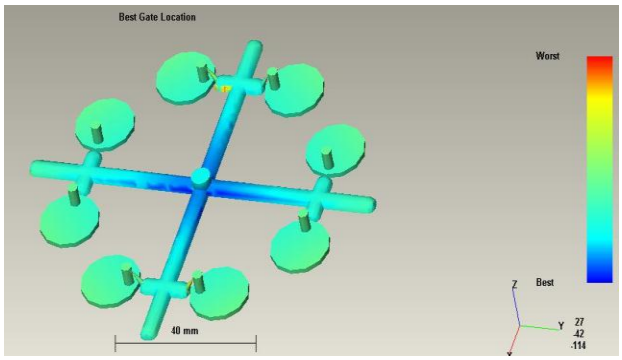
This is designed by Pro-Engineer (component courtesy: M/s Sri Balaji Plastics, Coimbatore

IV. PLASTICS ADVISOR

Plastics Advisor is mold flow software that interfaces directly with part model. Advisor combines process setup, real-time process optimization, and quality prediction according to set process parameters in one system. This is the application software from pro engineer. The following optimizing techniques are describing complete details about the required processing parameters.

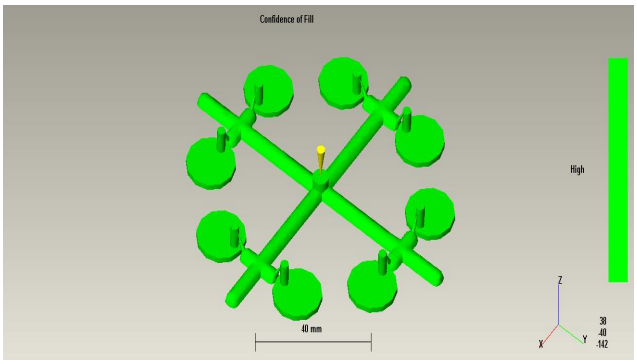
4.1 Finding gate point:

During the first step analysis, the plastics advisor is giving the suitable gate point where the component will fill completely with good quality. The following results obtained about the efficient gate point. The best position recommended by the software is at the centre of the runner.



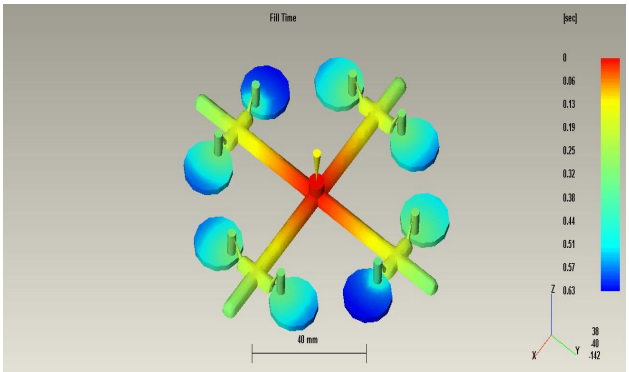
4.2. Confidence of fill:

It is giving the possibility of cavity filling in the mould. If the confidence is more, the component will fill easily. In our analysis it is found that the confidence of fill is good.



4.3 Fill Time:

The fill time of the component is given here. This fill time is expected to match with real machine parameter.



The actual fill time is shown above. The time for filling all the cavities are 0.63 seconds. It is observed that no flow restriction in gate area. But in practical it is found that the fill time was more due to flow restriction in gate area.

4.4 Total cycle time:

This is an important parameter in which it decides the total production output per hour. This should not be adjusted to maintain uniform quality all over the production. The following process parameters are recommended by the plastic advisor.

Results Summary

General

Model Suitability :	Part model was highly suitable for analysis
Part Name :	part18

Material

Material Supplier :	Bayer ABS Limited
Material Trade Name :	Absolac 300

Processing Conditions

Mold Temperature :	60.00 deg.C
Melt Temperature :	235.00 deg.C
Max Injection Pressure Limit :	65.00 MPa

Filling Analysis

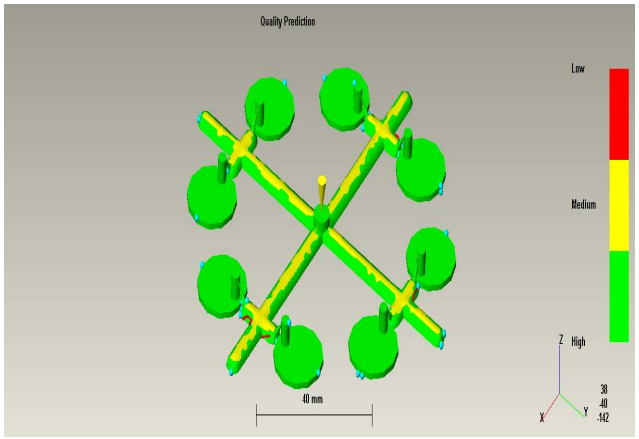
Actual Injection Time :	0.63 sec
Actual Injection Pressure :	34.74 MPa
Weld lines :	Yes
Air Traps :	Yes
Shot Volume :	4.47 cu.cm
Filling Clamp Force :	7.68 tonne
Estimated Cycle Time :	15.12 sec

Warnings

No problems were detected

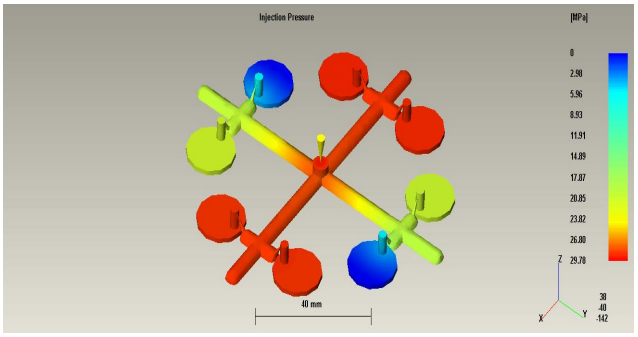
4.5 .Quality prediction:

It gives the quality of the product including sink mark, weld line and voids. In this analysis it is found that the overall quality of the product is good. But it is found slight shrinkage on the runner area.



4.6 Injection pressure:

In this analysis the profile of the injection pressure and the pressure drops are shown. For multicavity mould, with respect to the gate point, the diameter of the gate has to be modified.



V. INJECTION MOULDING MACHINE

The plastic injection molding cycle consists of four phases: plastication, injection, packing, and cooling. Therefore, several process parameters which include the melt temperature, mold temperature, injection pressure, injection velocity, injection time, packing pressure, packing time, cooling temperature, and cooling time all potentially influence the quality of injection-molded plastic products

Courtesy: M/s Sri Balaji Plastics, Coimbatore

5.1. Real Practical Parameter:

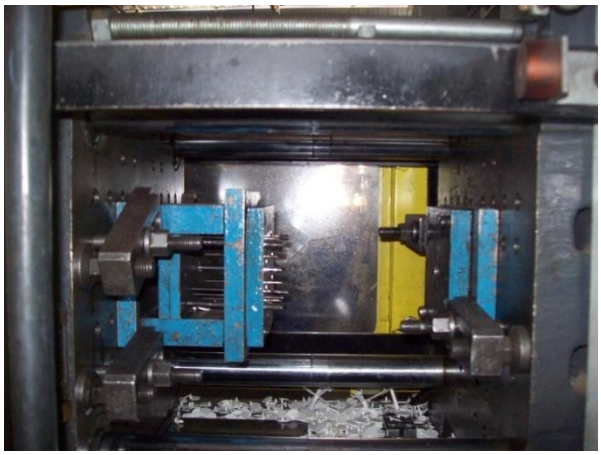
Nowadays, injection molding machine operators can consistently and systematically set up the process, perform an automated DOE (design of experiments) to determine a robust processing window, and automatically correct the process whether it should be drifted or go out of control during production.

Courtesy: M/s Sri Balaji Plastics, Coimbatore

Process optimization in the real machine allows users to determine a robust, "good parts" processing window that will compensate for normal process variation and ensure that acceptable quality parts are produced consistently. Process control is designed to maintain the optimized processing conditions determined with Process Optimization, resulting in reduced reject rates, higher part quality, and more efficient use of machine time.

5.2 Optimized parameter setting in machine:

Optimizing process parameter problems is routinely performed in the manufacturing industry, particularly in setting final optimal process parameters. Final optimal process parameter setting is recognized as one of the most important steps in injection molding for improving the quality of molded products. Previously, engineers used trial-and-error processes which depend on the engineers' experience and intuition to determine initial process parameter settings. Subsequently, numerous engineers applied Taguchi's parameter design method to determine the optimal process parameter settings. However, the trial-and-error process is used to find out optimum process parameters in advanced machines.



Courtesy: M/s Sri Balaji Plastics, Coimbatore

In the machine itself facilities are provided to find out the processing parameters in good manner. There is a question that the received parameters are optimized or not. The practical parameters can be derived as optimized one after the production run of around 10000 pieces. During this run, the problems raised in quality and others such as sink mark, warpage, silver streaks are avoided by altering the process parameters. So the parameters received during this continues run is assumed as the final optimum process parameter.

VI. RESULTS AND COMPARISON

This research presents an approach in a comparison and deviation of real optimized molding parameter with the optimized data received from plastic advisor. The research results indicate that the proposed approach can effectively help engineers determine optimal process parameter settings and achieve competitive advantages of product quality and costs. The following table ensures the difference between software(Advisor) and machine(Actual).

Comparison Table

Sl	Specification	Advisor	Actual
1	Material	**ABS**	**ABS**
2	Injection time(s)	**0.63**	**1.8**
3	Cooling time(s)	**10**	**10**
4	Total cycle time(s)	**13**	**11.8**
5	Temperature range(d.c)	**190-240**	**180-240**
6	Shot weight(grm)	**5.9**	**6**
7	Injection pressure	**60MPa**	**62 MPa**
8	Machine tonnage	**8 tons**	**20 tons**
9	Quality prediction	**Slight**	**Moderate**
10	Confidence of fill	**Good**	**Good**

In this comparison there is an indication of drastic change in injection time where the melt is filling into the cavity. This difference caused due to the restriction in gate area. The software assumes smooth and perfect diameter gates in the mould. Whereas during manufacturing there is a slight restriction to the flow of the material hence the injection time is increased practically.

In the machine tonnage also there is a prediction of giving more clamping tonnage than set tonnage. This extra tonnage given in the machine is to avoid parting line flash. While manufacturing mould plates, it is very difficult to make zero surface variation in the plates which are mate together. But these extra tonnages will not affect process parameter.

In the quality prediction side it is found that slight sink marks on the gate area. It is to be noted down that in the product also it is notified. This cannot be avoided and it is still in the finished component. But this is accepted in the quality of the part since it is not affect any end application

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