Mold Flow Analysis on Fan Part using Plastic advisor

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Abstract**—** *Injection molding is the most widely used method for the production of intricate shape plastic parts with good dimensional accuracy. For plastic components manufacturing process used is Injection molding. While doing this manufacturing process we have to face some problems in filling process, clamping, cooling, and amount of material to inject into the cavity area. Due to the above problems there is wastage of material, time, poor component quality. Optimization of cycle time in injection molding plays a vital role in manufacturing of plastic parts to improve the productivity of the process. At the same time it should not affect the quality of the final product. The process parameters like cooling time, filling time are optimized in which it contributes more in the cycle time by changing the mold temperature, melt temperature and injection pressure. We can optimize Injection molding manufacturing process.*

Keywords— Mold Flow, Injection Molding, Melt Temperature, Mold Temperature, Injection Pressure

I. INTRODUCTION

Thermoplastic injection molding is a well known process for manufacturing effortless and complex shaped products in short time and at low cost. Nowadays there is a need for optimizing the processing parameters to increase productivity. In the cycle time the cooling time can represent more than 70% of the injection cycle. Cutting down the cycle time for each part is a major concern in injection molding machine.

Problems found after tooling development are always expensive and frustrating. For plastic part design and manufacture, there is a better way. By simulating the plastic-filling process for injection-molded parts, Pro/ENGINEER Plastic Advisor enables engineers to design for manufacturability, uncover problems, and propose remedies, reducing development time and expensive. Pro/ENGINEER Plastic Advisor simulates mold filling for injection molded plastic parts. Advanced features provide valuable manufacturability insight - insight that can significantly reduce late-cycle design changes and mold reengineering costs.

By changing the mold temperature, melt temperature and injection pressure. We can optimize Injection molding manufacturing process.

II. EXPERIMENTAL PROCEDURE

In this project i have selected the fan part and then designed using the pro-e software as shown in the fig.1.

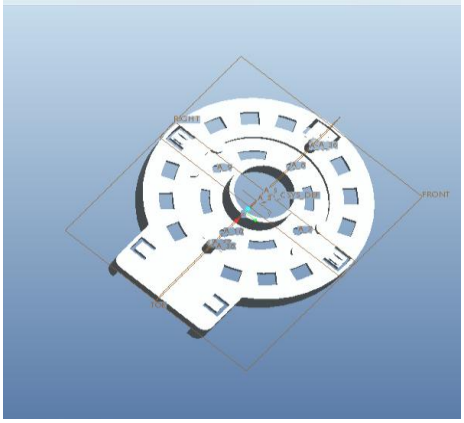

FIGURE 1. FAN PART

Ones the part is designed in pro-e then that part is opened in the plastic advisor software for the mold flow analysis as shown in the fig. 2

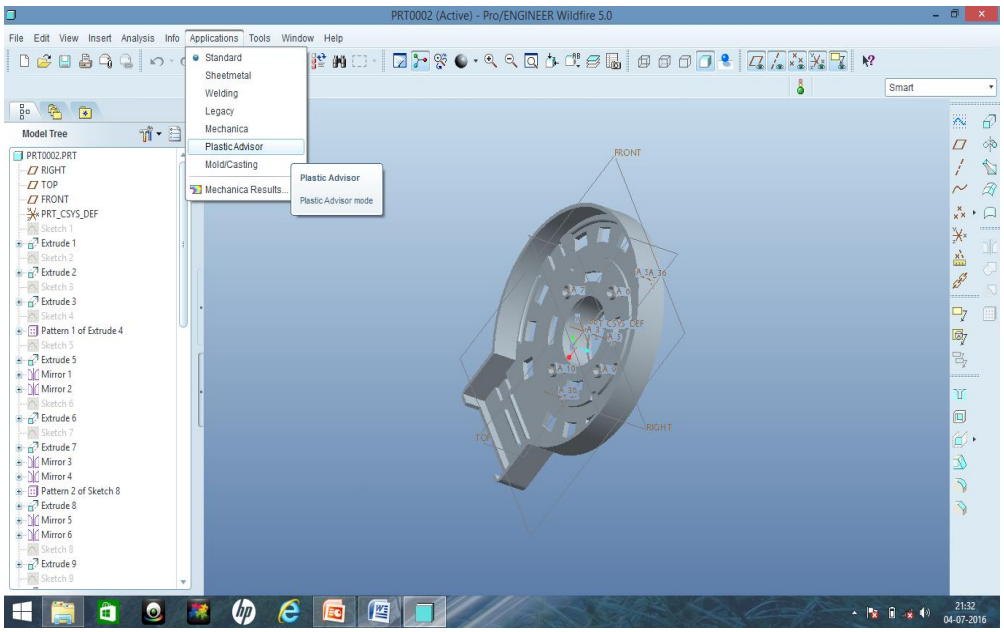

FIGURE 2. PART OPENED IN PLASTIC ADVISOR

Now the selection of the material that is generic pp is selected in this project for analysis. Then by changing the mold temperature, melt temperature and injection pressure we can optimize the cycle time.

I have considered six cases to optimize the cycle time.

From the Table3, we can observe that the case four has got lest cycle time when compared to the other cases. And in this case the confidence is high, quality is good and cooling quality is also better when compared with other cases.

Case 4

TABLE 1

INITIAL VALUES TAKEN IN CASE 4

Material used	Generic pp
Melt Density	0.82021g/cm^3
Solid Density	0.96221g/cm^3
Young's modulus	1340Mpa
Poisson ratio	0.3918
Mould Surface temperature	40 deg. C
Melt Temperature	240.00 deg.C
Maximum machine injection pressure	160 Mpa
Automatic Injection time	3sec
Machine clamp/open time	3sec

Case 4 Summary report for Generic PP

TABLE 2
FINAL RESULT IN CASE 4

Part Name	Fan part
Material Supplier	Kumho Chemicals Inc
Material Grade	Pp
Max Injection Pressure	160 Mpa
Mold Temperature	40 degC
Melt Temperature	240.00 degC
Model Suitability	Part model was highly suitable for analysis.
Filling Analysis	Fan part
Moldability	Your part has completed filling
Confidence	high
Fill Time	0.85 sec
Injection Pressure	17.18 Mpa
Weld Lines	Yes
Air Traps	Yes
Shot Volume	44.07 cu.cm
Filling Clamp Force	14.48 tonne
Surface Temperature Variance Range	-1.03 deg C to 8.72 deg C
Freeze TimeVarianceRange	-5.09 sec to 20.35 sec
Cycle Time	12.68 sec
Cooling quality	Low
Quality predication	medium
Warnings	Cooling quality is un acceptable.

TABLE 3
MOLD FLOW ANALYSIS OPTIMUM PARAMETERS FOR MAXIMUM PRODUCTION

	Cases					
	1	**2**	**3**	**4**	**5**	**6**
Mould Surface Temperature(Deg.C)	40.00	40.00	40.00	40.00	40.00	40.00
Melt Temperature(Deg.C)	210.0	220.00	230.0	240.0	250.0	255.0
Maximum Machine Injection Pressure(Mpa)	160.0	180.00	160.0	160.0	180.0	180.0
Fill Time(Sec)	0.51	0.47	0.13	0.11	0.22	0.19
Cycle Time(Sec)	1.36	1.36	1.09	0.85	0.97	0.97

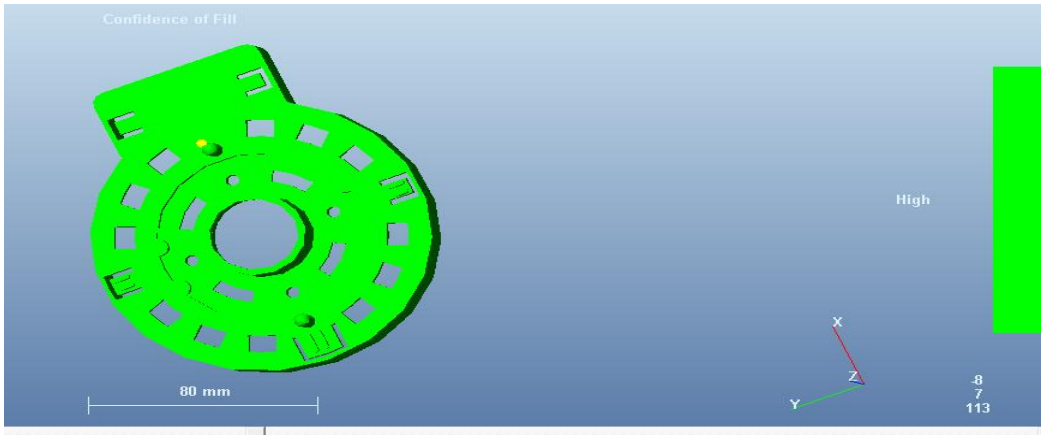

FIGURE 3. CONFIDENCE OF FILL

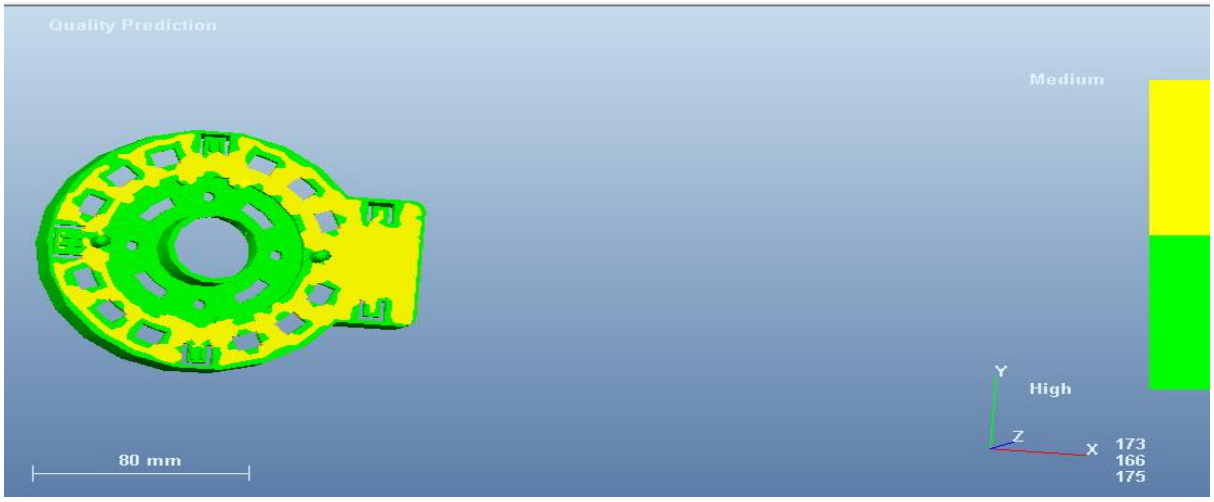

FIGURE 4. QUALITY PREDICTION

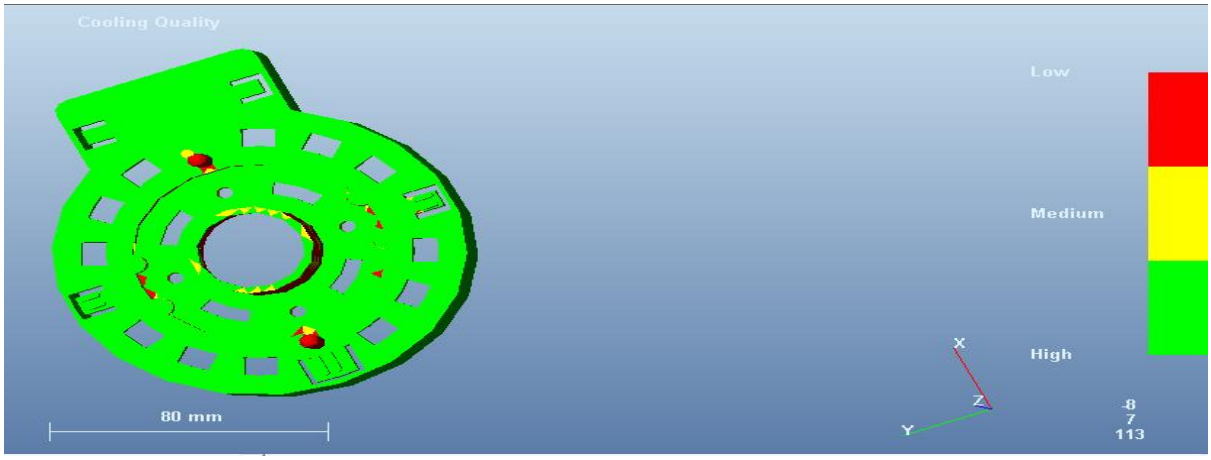

FIGURE 5. COOLING QUALITY

III. RESULTS AND DISCUSSION

In this study, the simulation have performed by changing injection molding process parameters in the application software Plastic Advisor. According to the experiment and simulation analysis, the melt temperature, mold temperature and injection time are considered as the main factors to optimize cycle time. The experimental result explains the minimum time required to fill the mold cavity.

In **case 1** the mold temperature initially set to 40^{o}C, Melt temperature set to 210 ^{o}C, injection pressure 160mpa, for generic PP material. The estimated cycle time is less i.e. 12.24 and the filling time are more i.e. 1.36 in this case when compared to case 4. if the filling time is more than the material gets solidified fastly without the total fill of cavity. So that the fill time should be minimized.

In **case 2** the mold temperature set to 40 ^{o}C, Melt temperature set to 220 ^{o}C, injection pressure 180mpa, for generic pp materials. In this case the estimated cycle time is less i.e. 11.88sec and the filling time is same 1.36 sec .when compared with case 4 and the air traps and weld lines are found.

In **case 3** the mold temperature set to 40 , Melt temperature set to 230 deg.c,injection pressure 160mpa, for generic pp materials. In this case the estimated cycle time less i.e. 12.28sec and the filling time is more i.e. 1.09 sec when compared with case 4 and the cooling quality is poor.

In **case 4** the mold temperature set to 40 ^{o}C, Melt temperature set to 240 ^{o}C, injection pressure 160mpa, for generic pp materials. The cycle time is more than the previous cases i.e. 12.68sec but the filling time is less than the other cases i.e. 0.85sec if the fill time is less than the weld lines and air traps not present and the confidence of fill is high in this case 4. And the part quality is good than other cases.

In **case 5** the mold temperature set to 40 ^{o}C, Melt temperature set to 250 ^{o}C, injection pressure 180mpa, for generic pp materials. In this case the estimated cycle time is more i.e. 13.18 sec and the filling time is more i.e. 0.97 sec when compared with case 4 and the air traps and weld lines are found with poor quality.

In **case 6** the mold temperature set to 40 ^{o}C, Melt temperature set to 255 ^{o}C, injection pressure 180mpa, for generic pp materials. In this case the estimated cycle time is more i.e. 13.07sec and the filling time is more i.e. 0.97sec when compared with case 4 and the air traps and weld lines are found and quality is affected.

1) In the above test cases Fourth Test case Machining Parameters are satisfying the part quality.
2) The given machining parameters can used in component production.
3) Mould Surface temperature = 40 ^{o}C
4) Melt Temperature = 240 ^{o}C
5) Maximum machine injection pressure = 160Mpa
6) Automatic Injection time = 3sec
7) Machine clamp/open time = 3 Sec
8) From above mould flow analysis we are getting following output results
    a) These results can feed to the Injection moulding machine
    b) Injection Pressure = 17.18MPa
    c) Shot Volume = 44.07 Cm^3
    d) Filling Clamp Force = 11.88 Ton
    e) Fill time = 0.85 sec
9) By using cycle time We can estimate Number of components can produce in some period of time
    a) Cycle Time = 12.68Sec
    b) In one hour we can produce 284 components.

IV. CONCLUSION

After the introduction and knowledge of all the details and concepts with mold flow simulation we can finally conclude that mold flow simulation is a very popular and important technology in the field of molding process.

1. In the production of components in injection moulding process by changing processing parameters by trail and error method, the company is incurring loss in material, time and power.
2. In this thesis, the above problem is rectified by taking software support of plastic advisor which is a module in Pro/Engineer. In this software, the component can be checked for filling by given processing parameters before going to manufacturing.
3. In this project fan part is analyzed for mould flow using material Generic PP. By changing processing parameters for six times, the production of the component is good. In the trial and error method nearly 20 components are wasted but by using this mould flow analysis only 5 components are wasted.
4. And also by using this analysis, the exact processing parameters for production can be determined. Number of components for one hour can be estimated by using cycle time. The numbers of components produced are 284.
5. In this project I have optimized the cycle time by changing the processing parameters like mold temperature, melt temperature and injection pressure.

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