Effect of injection moulding parameters on fill time using moldflow simulation software

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ABSTRACT – This project studies the effect of injection moulding parameters that are melting temperature (MeT), mould temperature (MoT), injection time (It) and number of gate (Gate) on fill time response. Taguchi method with orthogonal array having L9 experiment runs is used to determine the most significant parameter. It is found that (It) is the most significant factor affected fill time followed by (Gate), (MoT) and (MeT). The levels of optimum parameters are (It) 0.2s, (MeT) 320°C, (MoT) 120°C and (Gate) 1. Injection time contribute 99.99% which number one ranking among the four factors. Validation result shows 11.66% improvement after optimization process.

1. INTRODUCTION

In injection moulding, the quality of the product depends on the choice of materials, the design of the mould, the process parameters which are considered to be of the utmost importance. Therefore, the quality of injection mouldings is dependent on optimizing the parameters of the injection moulding machine. Incorrect parameter settings such as cycle time, melt temperature, mould temperature, cooling temperature and rate of injection can all causes incorrect production parts to be created in terms of differing component weights, incomplete shots or overfilling [1].

However, by simulation flow analysis process, it has capability to determine potential part defects such as weld lines, air traps and sink mark. Simulation the flow filling of the injection moulding process helps to predict the flow of melted plastic, fill mould cavities uniformly and finally achieve higher quality manufacturing as a real world processing conditions [2].

In order to achieve the optimization of injection moulding parameters, a systematic method is needed to determine the relationship between process factors and the output of the responses. One of them is by using Taguchi method. In this study, four parameters are selected that are melting temperature, mould temperature, injection time and number of gate. According to Ali et al., [3] injection time was the most significant parameter affected the filling time. Meanwhile, volumetric shrinkage and deflection were affected by mould temperature and number of gate respectively.

Therefore, the aim of this study to find the most significant parameter that are melting temperature, mould temperature, injection time and number of gate on the response of fill time. Taguchi method and analysis of variance (ANOVA) were performed through moldflow plastic adviser simulation software based on parameters such as melting temperature, mould temperature, injection time and number of gate.

2. METHODOLOGY

Polypropylene having density between in range 0.895 and 0.92 g/cm was selected in this study. Simulation software moldflow adviser 2019 was used to find the fill time of the response. Dumbbell specimen was design using CATIA software. Then, the dumbbell specimen was imported in MPA software. Setting in MPA software including injection location, type of material of part and mould cavity, parting line, selection of gate was performed. Finally, analysis was done based on the parameter selected.

3. RESULT AND DISCUSSION

Table 1 shows the result of the simulation analysis. As in the table, it shows at run number 7 has the higher value of fill time than other experimental run. Value parameter that used for highest fill time is 320°C melt temperature (MeT), 60°C mould temperature (MoT), 4s injection time (It) and used 2 number of gate (Gate). But, run number 1 and number 8 has same value and it has the lowest fill time, even use different value of parameters.

Table 1 Experimental result for fill time

MeT	MoT	It	Gate	Fill time
280	60	0.2	1	0.206
280	90	2.1	2	2.214
280	120	4	3	4.239
300	60	2.1	3	2.214
300	90	4	1	4.261
300	120	0.2	2	0.207
320	60	4	2	4.284
320	90	0.2	3	0.206
320	120	2.1	1	2.182

Figure 1 shows the different colour of indicator

that shows the start and final of fill time measurement. Red colour was defined the final fill time and it has a higher value time taken. For blue it shows starting point of fill time measurement. From the figure, it shows that 4.284s is higher value for fill time.

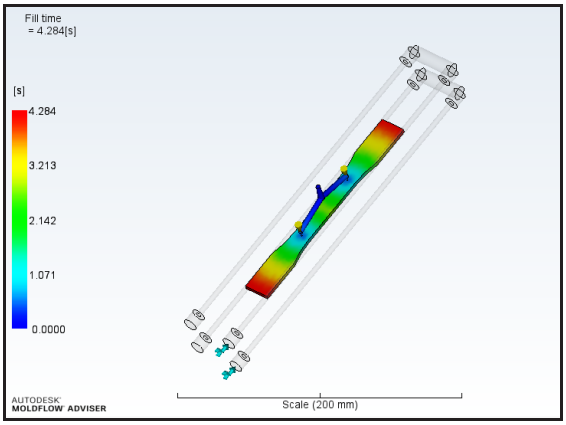

Figure 1 Measurement fill time at higher value

Table 2 shows the relationship parameters towards response and it analysed which parameters that most significant for fill time. Based on the table is proved that injection time is most factor that affect the fill time based on rank in the table. it shows injection time that achieved a highest delta with 26.308.

Table 2 Response table of S/N ratio for fill time

Level	MeT	MoT	It	Gate
1	-1.907	-1.938	13.717	-1.880
2	-1.932	-1.922	-6.861	-1.948
3	-1.896	-1.875	-12.591	-1.907
Delta	0.036	0.063	26.308	0.068
Rank	4	3	1	2

Also same as in Figure 2 that SN ratio graph shows only injection time has higher distance and most significant to fill time. The highest value for graph S/N ratio of It is 0.2s. For (MeT) is 320°C, (MoT) is 120°C and Gate is 1. However, MeT, MoT and Gate were not significant factor to fill time.

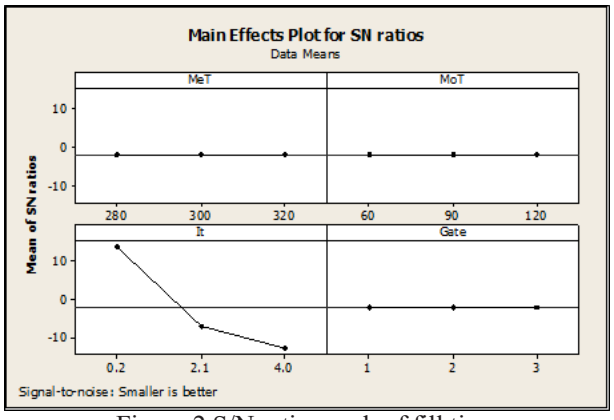

Figure 2 S/N ratio graph of fill time

Table 3 shows the analysis of variance (ANOVA) of fill time where injection time dominance the contribution. This result has shown the influence of the fill time as input parameter to the fill time of the response always parallel to its relationship [4,5].

Table 3 ANOVA of fill time

	DOF	SS	P	%
MeT	2	0.00	1.000	0.00
MoT	2	0.00	1.000	0.00
It	2	24.67	0.000	99.99
Gate	2	0.00	1.000	0.00
Error	0			
Total	8	24.67		99.99

Validation based the lowest the better of fill time by taking the highest level from Figure 2 shows that fill time reduces to 0.1844s which reduces the fill time 11.66%.

4. CONCLUSIONS

It can be concluded that fill time is the most significant factor affected the fill time followed by number of gate, mould temperature and melt temperature. Fill time contributes 99.99% out of four factors selected. After optimization, predicted value reduces 0.1844s as compared to the 0.2059 from actual value which decrease the fill time to 11.66%. Thus if selected change of injection time it affected the fill time immediately.

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