ANALYSE OF THE INJECTION PARAMETER IN IMPACT PROPERTIES OF THE POLYPROPYLENE – PP

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Abstract. The consumption of polymer materials has increased in last years. Among many process the injection molding has been in focus. During the injection process, many parameters must be adjusted to correct processes, such as injection pressure,temperature and speed. The aim of this work is with Design of Experiments - DOE study the influence of injection parameters in the impact properties of Polypropylene - PP.

Keywords: Polymer materials, Design of Experiments, Impact properties.

1. Introduction

The injection molding of thermoplastics is the most important process used in plastics industries. (Dym, 1987), (Beaumont, Nagel and Sherman, 2002)

Many studies have been made to find a higher productivity and quality product. Like in a cooling time that results in an excessive molded-in stresses as well as an uneconomical cycle time. (Fischer, 2003)

Some quality methods are allocated to make the process better. One of these methods is the *Design of Experiment*s – DOE, that has been a very useful tool to design and analyze industrial problems. (Park and Ahn, 2004). This technique provides large amounts of information on the process results in quality improvements, variation reduction, and lower costs. (Launsby at al, 1999), (Viana, Kearney and Cunha, 1999)

The DOE procedure consists of planning with the definition of the problem, screening, i.e, reduction of the number of variables, optimization through the determination of the optimal values for various experimental factors and verification. The DOE approach can be divided into a full factorial experiment and a fractional factorial experiment. (Montgomery, 1983)

This work uses the DOE full factorial to determine which injection molding parameters influence the izod impact strength of Polypropylene - PP.

2. Experimental

This experiment used steel mold with four cavities and one injection machine Sandretto Micro 65. The material used was Polypropylene – PP (XM 6150K) from Polibrasil Company to make samples to be studied. The izod impact strength tests were performed on the impact machine according to ISO 180.

The parameters analyzed during the injection molding were: injection pressure, temperature and speed, screw rotation and cooling time. The other injection parameters such as mold temperature and clamp force were maintained constant during the test. (Tab.1)

The interactions were determined by setting the maximum and minimum parameters in the software and making a 2^5 = 32 the full factorial experiment. Later all the process parameters were set in the injection machine as shown in Tab. 2.

Each experiment run was repeated 3 times; i. e. the total number of runs in the experiment was 96 with 384 samples.

After the injection the samples were tested to obtain the results of izod impact test and the software Minitab was used. The experiment was constructed a 95% confidence interval.

Table 1. Fixed Parameters.

Fixed Parameters	
Clamping force	450 KN
Mold temperature	30° C
Ejection time	1 s
Mold open time	1 s
Mold close time	1 s
Advance stroke	65 mm
Advance speed	160 mm/s
Ejection back stroke	0,1 mm
Ejection speed back stroke	150 mm/s
Ejection force	10 KN

Table 2. Parameters used.

Run	Injection			Screw Rotation (rmp)	Cooling Time (s)
	Pressure (bar)	Temperature (°C)	Speed (cm³/s)		
1	200	190	38	90	10
2	800	190	38	90	10
3	200	190	38	200	10
4	800	190	38	200	10
5	200	190	70	90	10
6	800	190	70	90	10
7	200	190	70	200	10
8	800	190	70	200	10
9	200	210	38	90	10
10	800	210	38	90	10
11	200	210	38	200	10
12	800	210	38	200	10
13	200	210	70	90	10
14	800	210	70	90	10
15	200	210	70	200	10
16	800	210	70	200	10
17	200	190	38	90	20
18	800	190	38	90	20
19	200	190	38	200	20
20	800	190	38	200	20
21	200	190	70	90	20
22	800	190	70	90	20
23	200	190	70	200	20
24	800	190	70	200	20
25	200	210	38	90	20
26	800	210	38	90	20
27	200	210	38	200	20
28	800	210	38	200	20
29	200	210	70	90	20
30	800	210	70	90	20
31	200	210	70	200	20
32	800	210	70	200	20

3. Results and Discussion

The means of the results of Izod impact strength are shown in Tab 3. The cooling time is the parameter that most influences the impact strength as shown in Fig. 1. One other parameter, injection temperature also influences this property. The screw rotation combined with injection speed also contributed with change in this mechanical property.

Table 3. Results of impact strength.

Run	Impact Strength (KJ/m²)	Run	Impact Strength (KJ/m²)
1	2,61	16	2,66
2	3,55	17	2,10
3	2,75	18	2,62
4	3,61	19	3,30
5	4,26	20	2,34
6	2,73	21	2,03
7	2,69	22	2,50
8	3,11	23	1,98
9	2,36	24	2,75
10	2,20	25	2,09
11	3,02	26	1,84
12	2,84	27	2,56
13	2,59	28	2,07
14	4,00	29	2,34
15	2,26	30	2,11
16	2,66	31	2,09
17	2,10	32	1,87

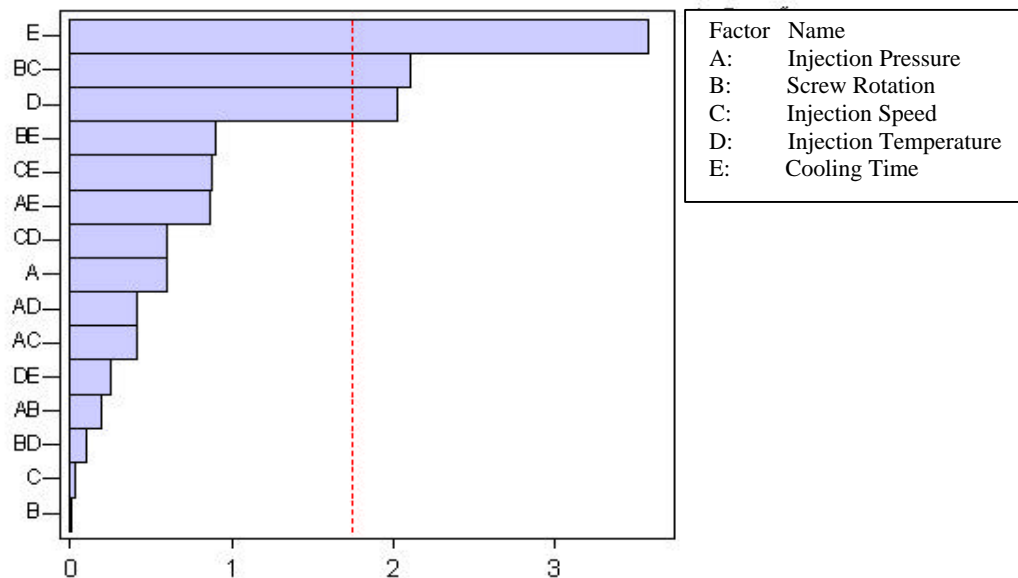| Factor	Name
A:	Injection Pressure
B:	Screw Rotation
C:	Injection Speed
D:	Injection Temperature
E:	Cooling Time

Figure 1. Results of DOE for izod impact strength.

Figure 2 shows the means of the impact strength versus the injections parameters. The injection pressure increased the impact strength, whereas the screw rotation and the speed injection did not influence the impact test. On Increasing, the injection temperature and the cooling time, the izod impact strength decreased, so this parameter must be controlled during the processes, because they are the most important parameters in a part that needs a higher impact strength.
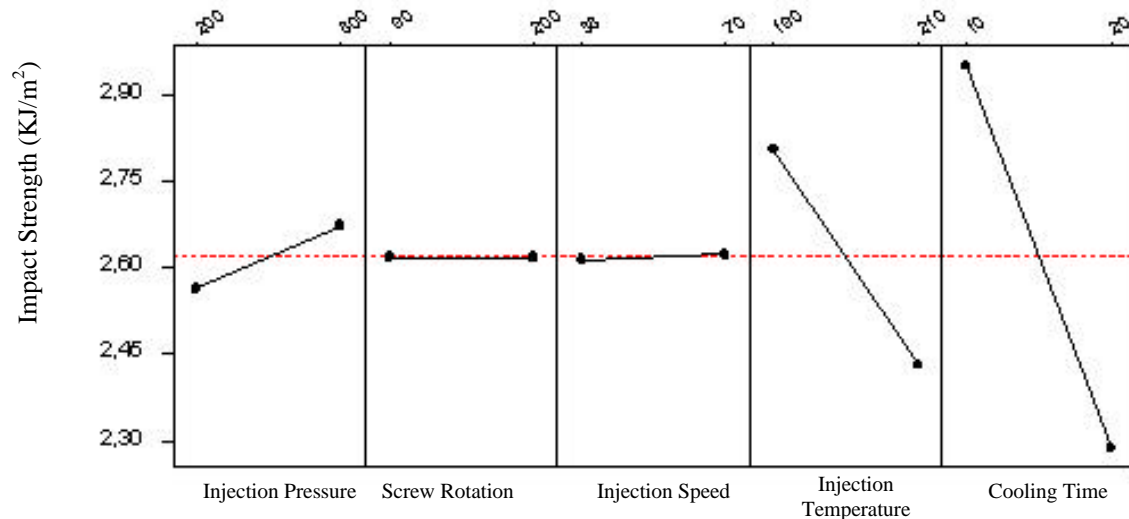

Figure 2. Effect results for the izod impact strength.

4. Conclusion

The performed tests have shown that through DOE it is possible to determine the influence of a variety of the processing parameters and their interactions in injection molding. This method can be used to increase the reliability and quality of this process.

The experiment with the full factorial shows that the cooling time is the parameter, which most influenced the izod impact strength for PP.

5. Acknowledgements

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