International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 01, January-2019

EXPERIMENTAL ANALYSIS OF EFFECT OF SHEAR FORCE IN DIFFERENT GATE LOCATION OF POLYACETAL

Mr.S.T.Saravanan[1], Mr.R.Saravanakumar[2], Mr.N.Murugan[3],
J.Lingaraj[4], Mr.M.Shanmugaraj[5]

[1]*Senior lecturer in plastic technology, V.S.V.N Polytechnic College, Virudhunagar, India.*
[2]*Lecturer in plastic technology, V.S.V.N Polytechnic College, Virudhunagar, India.*
[3]*Senior lecturer in plastic technology, V.S.V.N Polytechnic College, Virudhunagar, India.*
[4]*Senior lecturer in plastic technology, V.S.V.N Polytechnic College, Virudhunagar, India.*
[5]*Lecturer in Civil Engineering, V.S.V.N Polytechnic College, Virudhunagar, India.*

Abstract: ***Injection moulding process is very intellectual one due to its high precision and repeated production. The Quality products from the injection moulding process are complicated because of more process parameters to be controlled simultaneously. Gate is an important part of the mould where molten melt is entered through it. Small design changes in gate location will affect quality of products. So Computer aided design and simulation software are normally used before positioning gates in real mould. Also the shear force at gate area is important one for moulders to maintain quality. The shear stresses formed in the gate area are creating quality problems like weld line, sink mark and jetting. But calculating shear force in gates are difficult to predict during processing. This problem occur more in crystalline polymers like Polyacetal. So we have made a simulation analysis of shear force in different gate location to find out the lowest shear force arrived gate location by using analysis software moldex. We made this analysis for 'O' ring made by polyacetal.***

Keywords: Polyacetal, Simulation, Shear stress, Gate location

I. INTRODUCTION

An injection molding process has been used popularly in plastic processing technologies. It has high productive, automatic process and highly précised for repeated production and making complex geometry. The production cycle of the injection moulding can be divided into mould clamping, melt filling, packing, cooling, mould opening and product ejecting. The mould is the heart of the injection moulding process which can be made with respect to the product drawing. Reducing quality problems in moulding process are the major area to be study. Depending upon the product design, a mould design is done with all geometrical details of product. Once mould is made it is difficult to modify.

The location of the gate position in a mould is an important one to predict quality problems.

Location of gates in the mould plays a vital role in processing of injection moulding machine. With different gate location the quality criteria may change and also the auesthetic appearance of the product affected. To overcome this, mold flow simulation software is used to find out the best suitable gate type and its location.

Most of the moulders facing quality problems in engineering materials like Acetal, nylon etc. Shrinkage, Warpage, jetting mark and sink mark are the major problems in quality of the product. The causes of this quality issues are mainly depending on the gate location and the shear rate at gate. The shear stress at the gate area is unpredictable and causes all the quality problems. To find out the shear stress in gate area during processing in polyacetal is difficult and time consuming process.

To achieve this, shear stress of the gate point has to be studied and this cannot be done by any flow analysis during production process. Actually the process of molding polyacetal requires more shearing the resin to make it as melt and to get it to flow into the mold. Shearing occurs throughout the moulding process and, done correctly, makes for quality products. Done incorrectly, it can lead to polymer degradation, part failure, poor cosmetics, and excessive mold corrosion, among other things. A great number of molding problems can be easily avoided with a basic knowledge of plastic resin shear. The gate is generally the highest-shear area and many quality problems rises if not properly designed. From selecting gates to selecting proper location, a little understanding and a analysis can save you a lot of grief. But the processors are not aware about the shear rates in gate area and its affect on quality. So we have done a CAE research on the "o" ring made by polyacetal. Different gate locations are selected in moldex software for analysis. With respect to this gate location, the shear stress at the start of the gate point is studied. Its pressure variant and filling stages are plotted and compared.

II.EXPERIMENTAL DESIGN

2.1. SHEAR AND SHEAR FORCE

Shear in injection molding occurs when layers of molten polymer flow relative to each other. It is well known that during processing the path line of melt is from sprue to gate to product. Gate is the main area where the melt enters into the impression. It is like a fountain flow and hence the material moves through the flow channels at center and then outward to the walls of the mould. The time for fast shear occurs is referred to as the shear rate. The force acting on the gate area is shear force which are important to the design and molding of plastic products. As shear forces rise, the molecular chains that make up the polymer are stressed more. Since polyacetal is having high shear rate, the molecular chains or the glass fibers they might contains can be torn apart. This can reduce the mechanical properties of a product.

2.2. SELECTION OF MATERIALS AND PRODUCT

An "O" ring made up of polyacetal is selected as sample. The dimensions and product are designed in Creo software version3.0 (Fig-1). The details of the material is shown in table-1

Polymer type	**POM**
Grade name	DELRIN 100 AF
Producer	DuPont
Melt flow index	MFI(190,1.05) =0.5 g/10min
Fiber percent	0.00 %
Melt temperature range	200 ~ 220 °C
Mold temperature range	80 ~ 100 °C
Ejection temperature	130 °C
Freeze temperature	145 °C

Table-1

Also the product with dimensions is designed. The three dimensional shapes has been plotted for the mold flow analysis.It is shown in Fig-1.

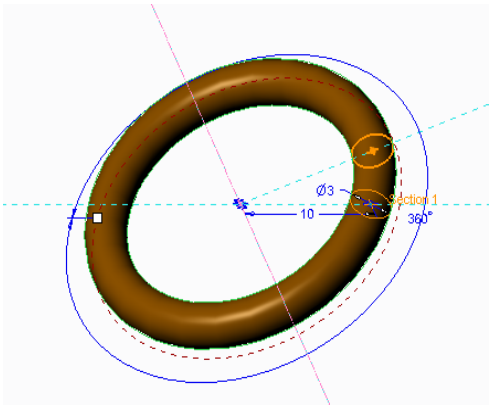


Fig-1

2.3. LOCATION OF GATE

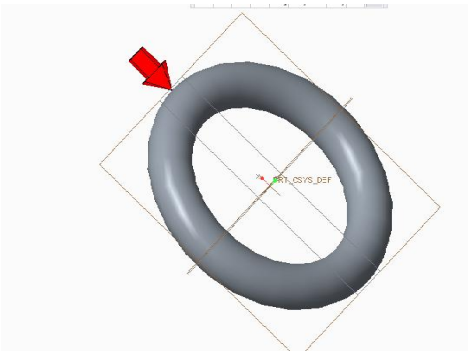
By considering the design it is possible to locate three types of gates in the product.

1. Edge gate
2. Rectangular two point edge gate
3. Rectangular four point edge gate

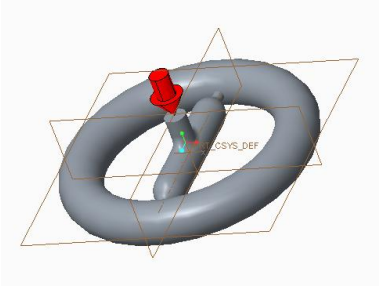
The edge gate is normal appearance for the circular product whereas the other two gated are different in filling phase. The Fig-2 shows different gates.

For different location the gatepoint to the impression is designed. Fist case having single entry point which is called edge gate. The second gate location have two material entry polint whereas the third one have four different entries to the mould cavity.

1.Edge Gate



2.Rectangular two point edge gate



3.Rectangular four point edge gate

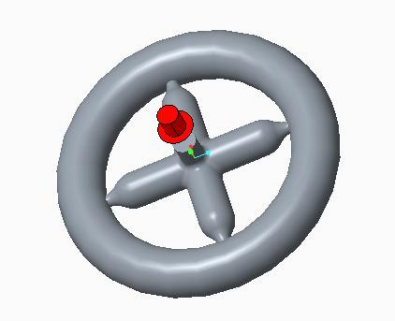


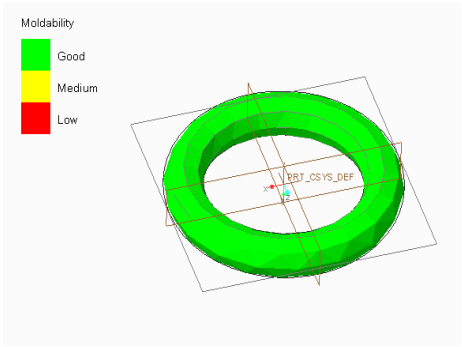
Fig-2

III.ANALYSIS

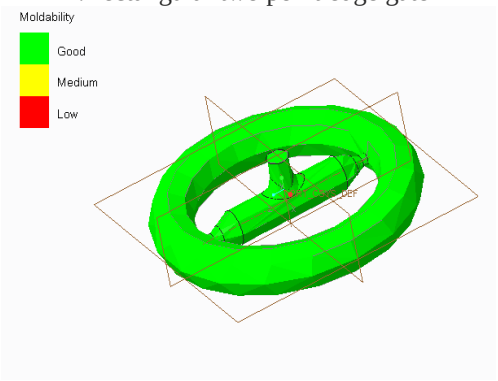
3.1. ANALYSIS FOR MOLDABILITY

Moldability is the well known factor that the possibility of moulding to fill in the mould. In this Yellow or Red regions show the areas where the melt filled with difficulty, which could result in quality related problems. In green indicates well mouldable. Compare with the above all three gate system having good moldability. This analysis first done to confirm that the mould fills properly without any difficult. Our three types of locations gives good result about its filling, so no need of changing gate location and position(Fig-3).

1.Edge Gate



2.Rectangular two point edge gate



3.Rectangular four point edge gate

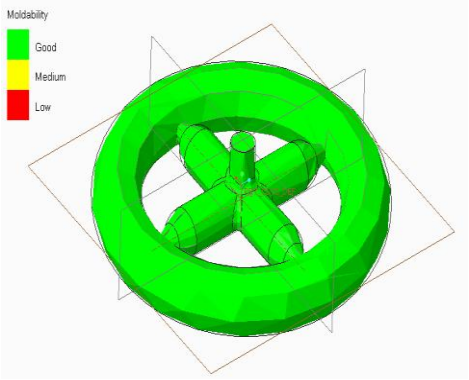
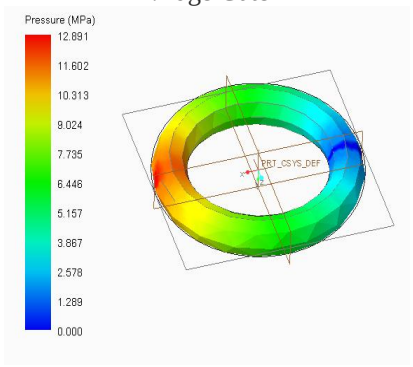


Fig-3

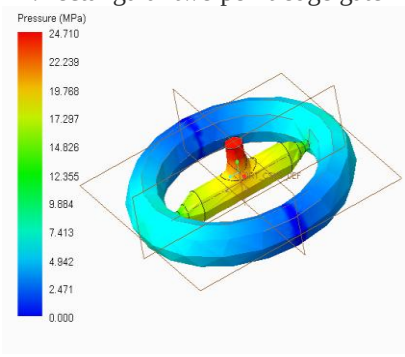
3.2. ANALYSIS FOR PRESSURE DISTRIBUTION

Pressure analysis result shows that the pressure distribution of the plastic materials at the end of filling. The condition to be followed to control the pressure distributed among the product are pressure transmission conditions, drop in pressure in the gate system. The pressure drops are compared for three gates for different flow length of polyaceteal (Fig-4).The lower the pressure distribution will result higher stress free products. So lowest value among three gate locations are studied well. Comparing three locations thick blue color in the analysis shows the formations of weld line where two polymers melt front are formed.

1.Edge Gate



2.Rectangular two point edge gate



3.Rectangular four point edge gate

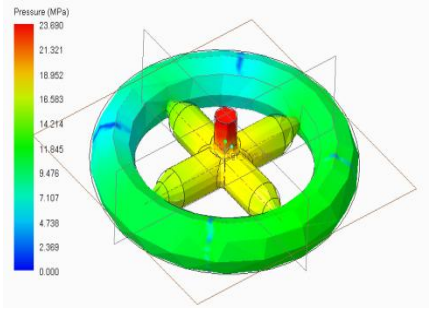
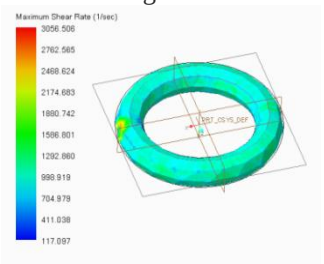


Fig-4

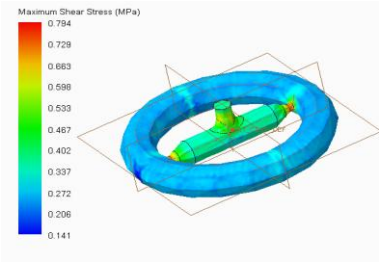
3.3. SHEAR PRESSURE ANALYSIS

Maximum shear pressure result shows the peak value of shear pressure at each product during the filling stage. All the three gates are compared for its higher shear rates. Three gate locations with respect to form lower shear stress are analyzed (Fig-5). The shear forces at the gate locations are plotted in different colour.

1.Edge Gate



2.Rectangular two point edge gate



3.Rectangular four point edge gate

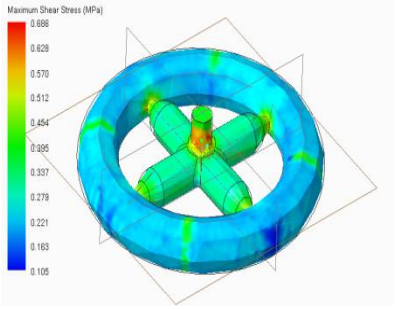


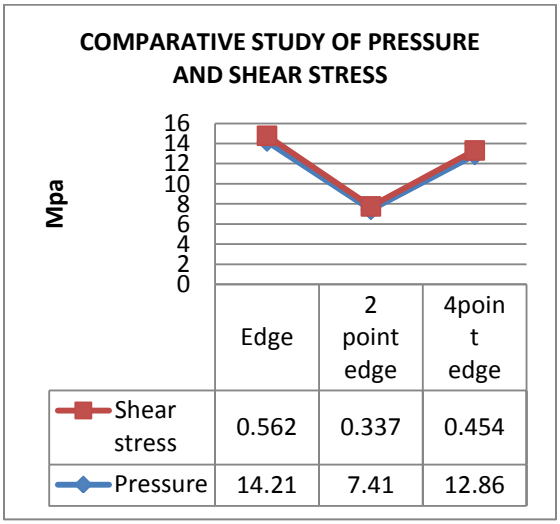
Fig-5

IV. RESULTS AND DISCUSSION

The three gate locations are compared for its shear stress. To support the efficient gate for lower shear stress its effect on filling also studied(Table-2).

Location of gate	Mold ability	Pressure (Mpa)	Shear rate (Mpa)
Edge	Good	14.21	0.562
2 point edge	Good	7.41	0.337
4point edge	Good	12.86	0.454

Table-2



The results are plotted in graph (Fig-6). The lowest shear force and pressure are achieved with two point edge gate location. The edge gate location is single point location. Melt requires more pressure to fill the cavity. So when the required pressure increases simultaneously the shear force increases in gate area. In four point gate, the pressure acting on four entry side and shear rate increases since the entry is more. But the filling time of this type of gate location is very less comparing other gates. But there are possibilities of four weld lines due to material flow. This will affect the quality of the product.

V.CONCLUSION

By considering above, the two entry gate point is the best suitable for quality products since the pressure and shear force are low in gate area. Also the weld lines formed are only two and the filling time is less compared with single edge gate. The graph shows lowest pressure and shear for two point gate. So it is recommended to avoid quality issues that two point edge gate can be selected as best option. The location of the gate position resulted in quality of the product. So the research shows that the forces acting on the gate area make frozen in stress formation. To avoid it, generally gate areas are smooth and radii. When comparing the three gates, all are well polished and gate shear is more in single and four point gate. The two point gate has less shear force at gate areas so it can produce high quality oriented parts.

VI.REFERENCES

1) Single gate optimization for plastic injection mold by CuiZhendong Wang Xicheng LiZhijie Dalian Univ. of Technol., Dalian This paper appears in: Network and Parallel Computing Workshops, 2007. NPC Workshops. IFIP International Conference on, issue Date:18-21Sept.2007Onpage(s):449-454Location:Liaoning Print ISBN: 978-0-7695-2943-1
2) Optimization of Gate, Runner and Sprue in Two-Plate Family Plastic Injection Mould By LIJi-quan (Department of Plasticity Technology, Shanghai Jiao Tong University, Shanghai 200030, China)E-mail: hutli@163.com
Received Nov. 22, 2006 revision accepted Mar. 19, 2007
3) Hand book of plastic materials and technology By Irvin.I.Rubin,wiley interscience
4) Injection mould design by R.G.W pye published East West Press Ltd
5) Modeling and simulation of weld line in injection moulding process by khaled mezghani released the 6th Saudi engineering conference, dec 2002
6) Delrin moulding manual by Dupont plastics.
7) Plastics processing hand book By dominic rosato, Chapman & hall