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INFLUENCE OF MOLD CAVITY SURFACE ON FLUIDITY OF ELASTOMERS

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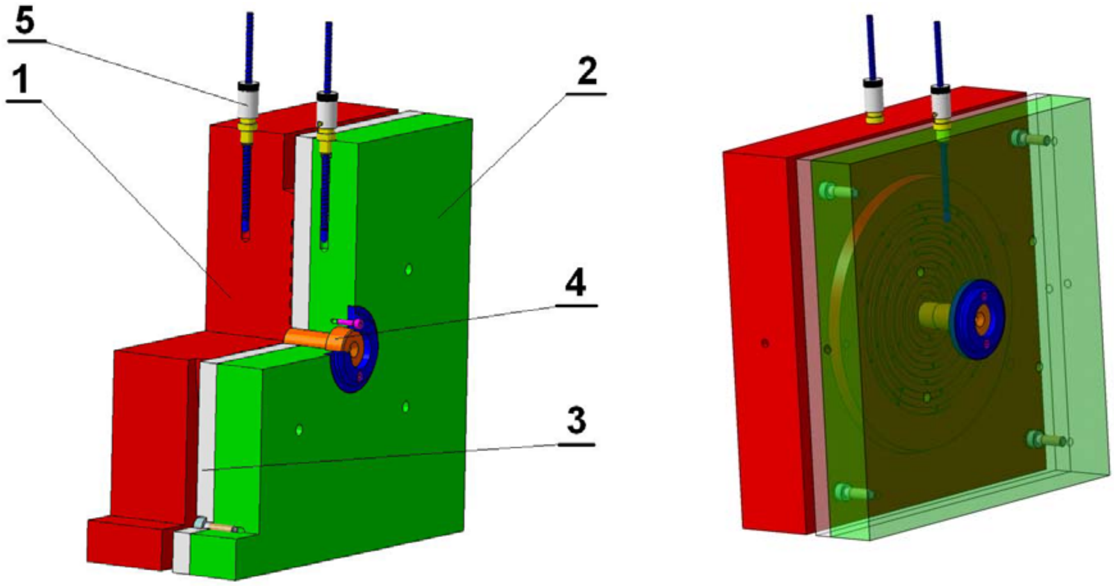
ABSTRACT
Injection molding reduces the time required for curing; eliminates the need to preform the rubber prior to molding; reduces the amount of mold handling and scrap in comparison with compression molding. This paper shows influence of technological parameters on the flow length into mold cavity. The fluidity of elastomers is affected by many parameters (mold design, melt temperature, injection rate, pressure and curing process).
Keywords: injection molding, surface roughness, plastics, rubber, runners, elastomer

1. INTRODUCTION
Injection molding is now a well-established fabrication process in the rubber industry. Injection molding has more advantages than compression or transfer molding. These advantages comprise reduced labor costs, shorter cure times, better dimensional control, and more consistent mechanical properties of the product. During injection molding, rubber compounds are subjected to more severe processing conditions than during compression or transfer molding. Temperatures, pressures, and shear stresses are higher, though cure times are shorter. Control over process variables can be more precise. The cycle time can be minimized by independently controlling barrel temperature, screw speed, mold temperature, cure time, and injection pressure. Compounds with widely differing flow and cure characteristics can be molded into a variety of complex shapes.

2. EXPERIMENT
The main aim of our experiment is to describe influence of surface roughness of mold cavity (runners) on fluidity rubber compounds. To be able to study this behaviour special injection mold has been designed and machined. Then have been chosen rubber compounds with different properties which are commonly use in industry.

2.1. Injection mold
Obviously, the major design consideration with a mold is the shape and size of the required molding. However, within this restriction, there are a number of points that have to be considered in determining the optimum mold design for a particular product.To be able to study the influence of surface quality of runners and cavities on the flow of elastomers, a special injection mold has been designed and machined. Injection mold is assembled from these (1) cavity plate, (2) clamping plate, (3) testing plate, (4) sprue bushing, (5) temperature sensor. (Figure 1)



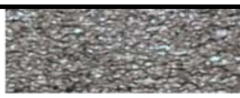
a) **b)**

Figure 1. Injection mold

2.2. Testing plate

The surface of the plates (bottom of spiral) is machined using various types of working technologies: milling, grinding, polishing and electro-spark cutting. Values of surface quality of testing plates are given in the Table 1.

Table 1. Surface of testing plates

Polished plate Ra[µm]	Ground plate Ra[µm]	Electroerosion machined plate ("fine") Ra[µm]	Milled plate Ra[µm]	Electroerosion machined plate ("fine") Ra[µm]
				
0,029	0,369	3,52	9,368	17,393

2.3. Injected samples

Shape of injected samples is spiral. Length of testing samples has been measured by measuring jig. The experimental dates have been statistical processed and evaluated. The maximum length of injected sample can be 2000 mm. Width of sample is 5,6 mm and thickness is 2 mm.

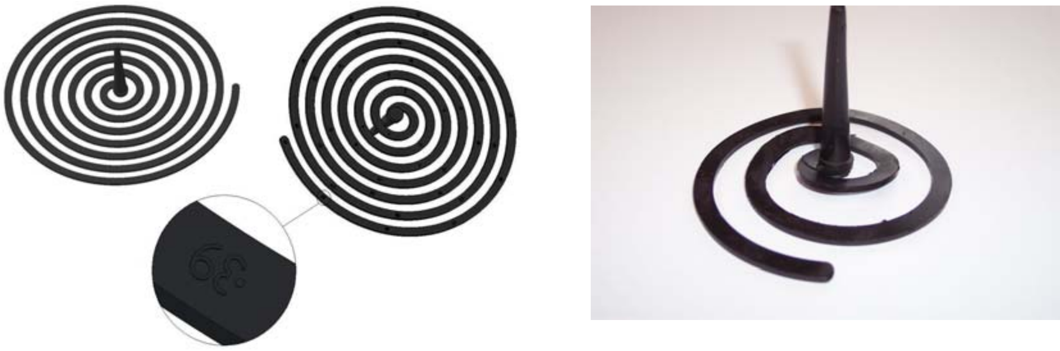


Figure 2. Injected sample

2.4. Injection molding of elastomers

The injection, or mold filling, time and temperature depend on the temperature of the mix, as determined by the above factors, the injection pressure, dimensions of nozzle, runners and gates, and the viscosity response of the compound. The cure time depends on the mold temperature and the temperature of the compound as it enters the mold. On Figure 3. is shown injection molding process of elastomers.

a) b) c)

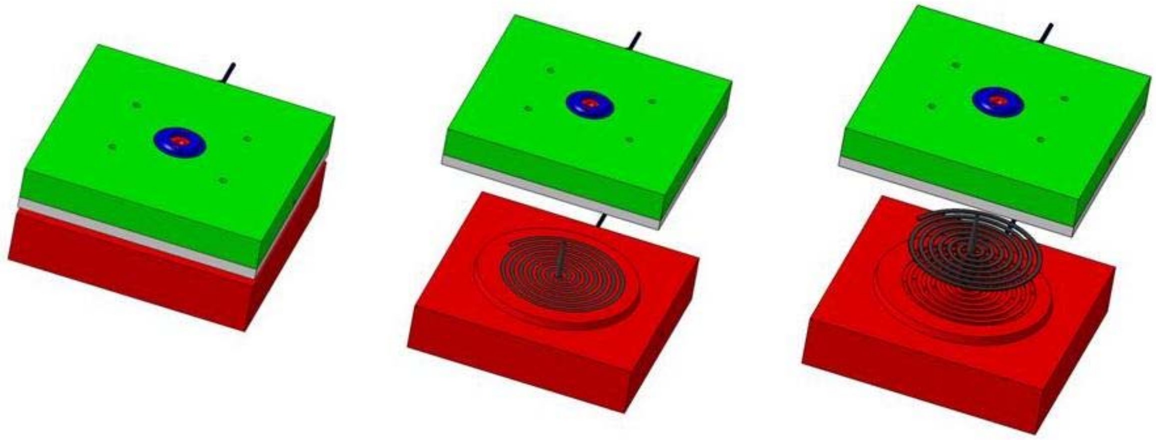


Figure 3. Injection molding process
a) closed mold, injection, cure, b) open mold, c) product ejection

2.5. Rubber compounds

For preparing of injected samples were chosen three rubber compounds with different flow properties. These compounds have to have sufficient processing safety (scorch safety) to flow through the nozzle, runners, and gates without scorching, but still cure rapidly in the mold.

Table 2. Injected rubber compounds

compound	type	hardness [ShA]	density [g.cm^{-3}]	strength [MPa]	tensibility [%]	viscosity (1+4min/100°C) [°MU]
A	NBR	50±5	1,21±0,02	10	300	31
B	CR/NR/SBR	60±5	1,32±0,02	7	250	40
C	EPDM	65±5	1,06±0,02	16	300	73

3. RESULTS

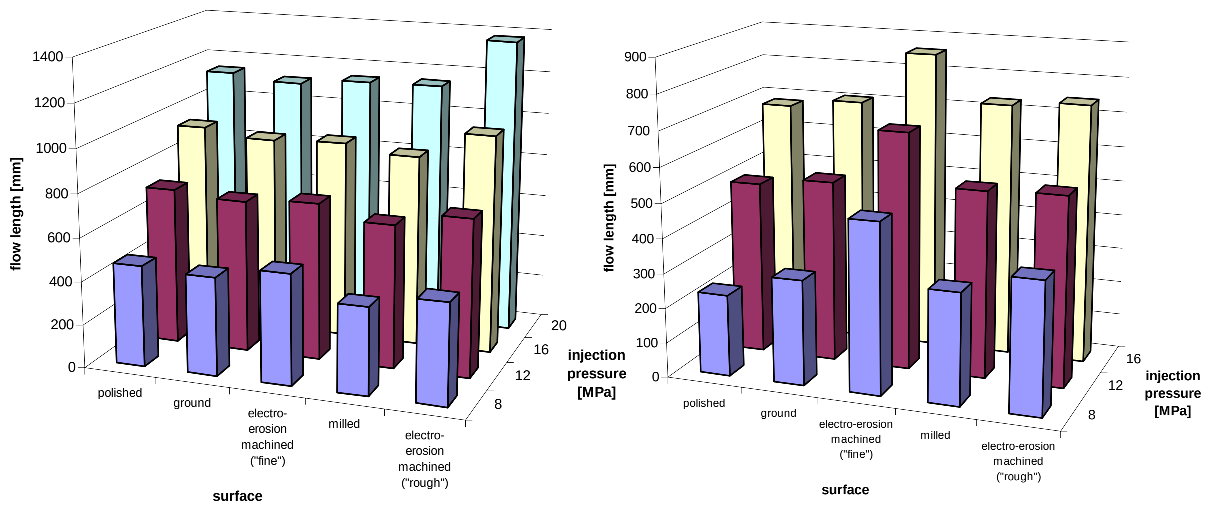


Figure 4. Dependence of flow length on surface quality and injection pressure (compound A, B)

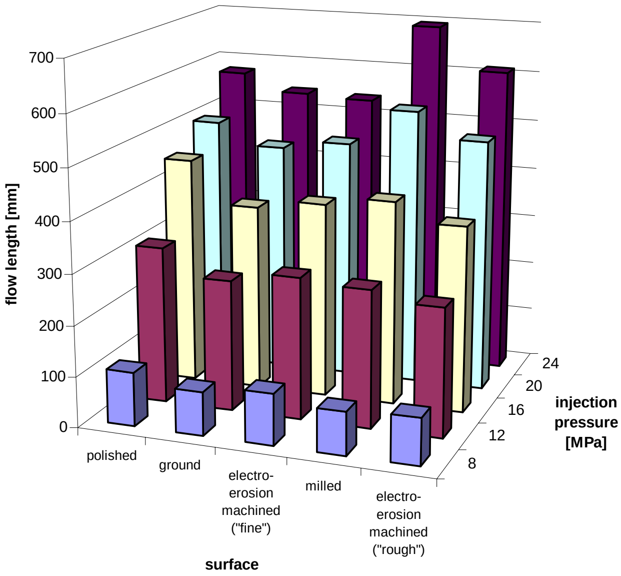


Figure 5. Dependence of flow length on surface quality and injection pressure (compound C)

4. CONCLUSION

Measurement shows that surface quality doesn´t have substantial influence on the length of flow. Samples which were injected into the spiral (cavity) with the worst surface quality have approximately same length of flow. These findings are very important from the point of view of use in production. For verification of these results further experiments have to be carried out using different rubber compounds.

5. ACKNOWLEDGEMENT

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