

ELIMINATION OF PLASTIC MATERIAL POROSITY

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ABSTRACT

Current contribution describes the problem of plastic material porosity after injection molding process, its reasons and effects. Exactly it describes influences of injection parameters and mold design on the porosity extend. Porosity of material has negative influence on mechanical properties of the plastic parts. Experimental part shows the elimination of porosity on example of automotive plastic part. Semi crystalline material with 30% of glass fibers was used for this part. The results are evaluated with usage of microtome cuttings. Microtome cutting method ensures detail observing of structural defects of plastic parts and is very useful to detecting of them.

Key words: *Material porosity, Plastic materials*

1. INTRODUCTION

Porosity of material has various reasons, the main reason use to be the shrinkage of material. We call this porosity shrinkage holes. The shrinkage holes appear in the place of the part, where not a proper wall thickness is. The cold wall of the mold causes that the surface of the melt becomes solid and the shrinkage inside the melted plastic creates a vacuum cavities. Originally vacuum cavities are after some time filled by air which comes in by diffusion process. The other reason of gaps in material can be a residual stress after injection molding process. These gaps create a mesh or a string and are positioned near the gate or in places where two different wall thicknesses are connected. They can be observed in edges of the part as well. This is caused by different direction of melt flow and than different direction of shrinkage. These gaps can cause the damage of the part in the case when it is strained. The gaps become into a crack. The other places where the gaps can appear are round holes. The reason for them in this place is a pin of the mould which creates a hole and defends to free shrinkage of plastic material. Another possibility is closed air in places where two or more streams of plastic melt are connecting and the air has no possibility to exit the

tool. This problem should be discovered during a part design by mould flow analyze. Additional effect of that closed air can be diesel effect as well. Particularly it can be removed by proper venting of the tool.

The porosity of material belongs to internal defects of plastic parts. This is a reason it is not easy to be discovered. Porosity in transparent part is possible to be seen by human eyes, but porosity of non-transparent parts can be seen only after cutting of part. It is very danger because the defect can be detected after a damage of the part when it is in serial production and it is very often too late.

2. PROBLEMATIC PART

During our research we worked with a part dedicated to automotive industry which is called housing and is used as a holder of car PC. The part is made from HAIPLEN H30 G6 BA, which is polypropylene homopolymer glass fiber reinforced 30% chemical coupled (black color). Glass fibers give to the polypropylene better mechanical properties. The part is shown on Figure 1.

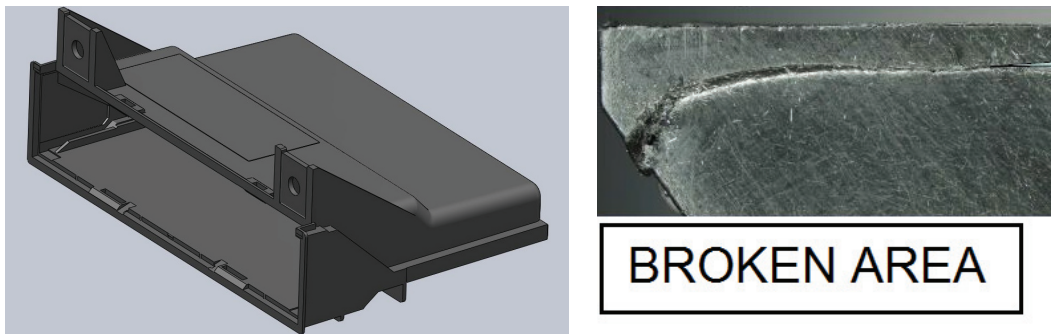


Figure 1 - Housing and detail of damage

A function of part is to hold an electronic device. During the life-time the part is exposed to cyclic straining. After tests the part was found to be broken in assembling area, near the screws which hold it. After that finding the parts were observed under loop to find a reason of the damage.

3. MICROTOME CUTTINGS

Microtome cuttings were used for this purpose. The microtome cutting technology is the way how to observe internal defects of plastic parts. Usually with a special knife the worker makes a strip of problematic area in tens of micrometer put it between two glasses and make snaps under microscope. The picture 2 captures a direction of cutting through part rib and mark able porosity of the part in this area. This porosity causes a damage of the part during a validation test. Gaps are in the area where two walls of part are in interaction. Wall thickness is here relatively similar and its value is 2 mm what is under recommended thickness. Material shrinkage has very different values in direction parallel to flow and across the flow. The glass fibers cause that fact. Cavities

appear along the edges where the glass fibers change their orientation for 90 degrees. Probably cause is then different shrinkage in this edge, residual stress and cavities creation. In combination with following cyclic dynamic load in car it has to lead to damage. In the next two captures we will look for possible solution.



Figure 2 - Cutting through the part rib

4. PROCESS PARAMETER CHANGE

Before we started to change a tool we tried to change the process parameters. Generally the porosity should be removed by better filling of problematic areas. The shrinkage is then eliminated and the final effect inhibited. Basic injection parameter is injection pressure and hold pressure. The injection pressure has to ensure that the injection velocity will be fulfilled and has to be set about 10 MPa higher than real specific injection pressure. It is also necessary to fill the part during the filling step of the injection cycle for about 95 % of final weight. For this the filling analyzes and set of switch over point has to be done. Hold pressure should be set for about 80% of injection pressure and for semicrystalline plastic it should be constant or little decreasing for whole hold pressure time with rapid decreasing in the end. Semicrystalline plastic has very high shrinkage and it has to be compensated with hold pressure. The time necessary for hold pressure is given by a freezing of gate. It must be so long so the weight of plastic part is increasing. Regarding the temperatures due to elimination of shrinkage the temperature of plastic melt should be lower. On the other hand the tool temperature has to be set higher.

We have followed all these rules which should help with the porosity but not with total positive result. The porosity was still detected on 25 % of inspected parts. After these trials and measurements we started to modificate the tool.

5. TOOL MODIFICATION

Tool modification is very expensive doing so it is every time a last step during optimization. As the first thing what is generally recommended when the porosity of material appears is to make a better venting of tool. The air which is easily going out can't make bubbles inside a plastic staff. The other step was making of radius in problematic area to eliminate a notch. The notch elimination helps to hold proper rigidity of part and decreases the effect of different shrinkage which is given by different orientation of glass fibers in this place.

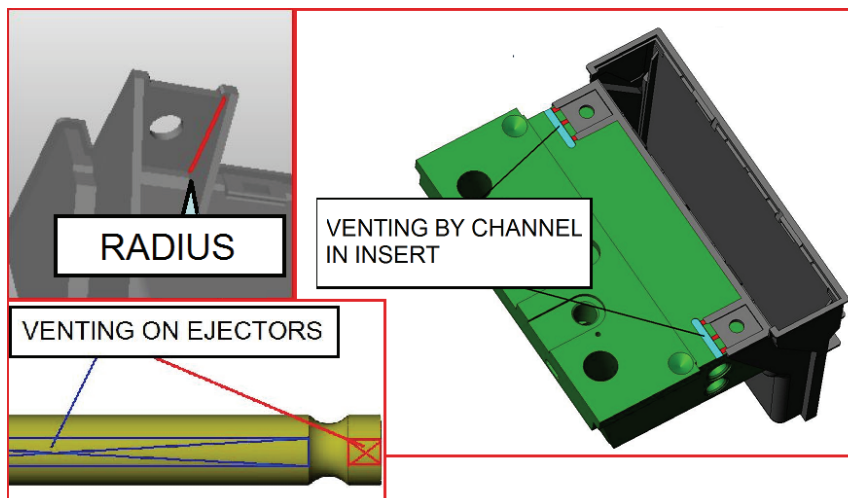


Figure 3 - Tool modification

After this modification the rate of parts which have mark able porosity decreases to 10 %. This is better than the situation in the beginning, but has doesn't ensure 100 % function of the part. Our recommendation is to add ribs to stiffen problematic area. This will ensure function of the part without difficulties with new part design.

6. CONCLUSION

The porosity in current case was caused by difficult orientation of glass fibers in the edge where two walls of the part are connected. Unfortunately the part purpose requires filled material. The technological parameters were set to eliminate the porosity together with tool adjustment. With these two standard possibilities we decrease the porosity to the level of 10% from all tested parts.

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ELIMINACIJA POROZNOSTI PLASTIČNIH MATERIJALA

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REZIME

U ovom radu opisani su problemi poroznosti plastičnih materijala nakon procesa ubrizgavanja, i navedeni razlozi i uticaji na pojavu poroznosti. Tačnije opisani su uticaji parametara procesa ubrizgavanja i konstrukcije kalupa na širenje poroznosti. Poroznost materijala ima negativan uticaj na mehaničke osobine plastičnih delova. Eksperimentalni deo rada pokazuje eliminaciju poroznosti na primeru automobilskog plastičnog dela. Polu kristalni material sa 30% staklenih vlakana je korišćen za izradu ovog dela. Rezultati su ocenjeni primenom mikronskih isečaka. Metoda mikronskog isečka osigurava detaljno posmatranje strukturnih defekata plastičnih delova i veoma je korisna za njihovo otkrivanje.

Ključne reči: Poroznost materijala, plastični materijali