ASSESMENT OF SHRINKAGE AND EJECTION FORCES OF THERMOPLASTICS REINFORCED WITH GLASS FIBER AND NANOCLAYS

Mauro César Rabuski Garcia e Aurélio da Costa Sabino Neto
Instituto Federal de Educação Ciência e Tecnologia Sul-Riograndense – Brasil
mauro@sapucaia.ifsul.edu.br e asabino@sapucaia.ifsul.edu.br

António José Pontes
Universidade do Minho - Portugal
pontes@dep.uminho.pt

KEYWORDS

Shrinkage, glass fiber, nanoclay, ejection force, injection molding

ABSTRACT

This work presents results of shrinkage and ejection force in glass fiber reinforced thermoplastics and nanoclays in injection molding. The part is a tubular deep geometry. The part surface temperature, cavity pressure and ejection force were measured. In general, the glass fiber decreases the shrinkage and increases the ejection forces and the nanoclays decrease the shrinkage and the ejection forces.

INTRODUCTION

The reinforced thermoplastics have gained more market due to improved mechanical properties compared to unreinforced thermoplastics. The modulus of the material is significantly increased providing greater mechanical strength. The glass fibers are widely used as reinforcement because of its low cost. The use of reinforced materials becomes more versatile when molded by the injection process.

The shrinkage of the part depends of many variables such as processing conditions, the polymer type and part geometry (Jansen et al. 1995 and Jansen et al. 1998a). The glass fiber has anisotropic shrinkage the difficult to obtain dimensions e shape of the final part.

The force required to eject the part is a fundamental design variable, because it defines the design of the ejection system (Pontes, 2002).

The ejection force depends of shrinkage of polymer, the surface roughness of the mold and the friction coefficient between the steel mold and molded part at the time of ejection (Burke, 1991).

MATERIALS AND PROCESSING

This mold has sensors with the possibility of monitor cycles injection parts since its injection until its ejection. The sensors attached to the injection molding are thermocouples, pressure sensors and force sensors.

The materials used: PP Domolen 1100L, PP Domolen P1-013-V10-N with 10% of glass fiber, PP Domolen P1-102-V30-N with 30% of glass fiber and Nanoclay Nanomax P-802.

The parts were molded with PP, PP with 10% glass fiber, PP with 30% glass fiber, PP with 2% nanoclay, PP with 6% nanoclay, PP with 10% nanoclay, and still, PP with 10% glass fiber and 2% nanoclay and PP with 30% glass fiber with 2% nanoclay.

The processing temperature of the material was 220 ° C and several mold temperatures were used such as 30 ° C, 50 ° C and 75 ° C.

After the moldings of the parts, the diametrical shrinkage was measured on a three-dimensional measuring machine.

RESULTS AND DISCUSSIONS

After an analysis of the results was observed that shrinkage decreases when it increases the percentage of glass fiber, due to the increased elastic modulus. The nanoclays also decrease the shrinkage of the material, but its effect is less pronounced than glass fiber (figure 1). In relation the gate location, the pure PP shrink more far of the gate than near of the gate. It is happen because the gate is last zone to freeze and, consequently, the second press has bigger effect to compact the material, this behavior hold for nanoclays. The glass fiber reinforced PP shrinks less far of the gate than near of the gate. The higher temperature of the mold was observed that the shrinkage of the part also increased.

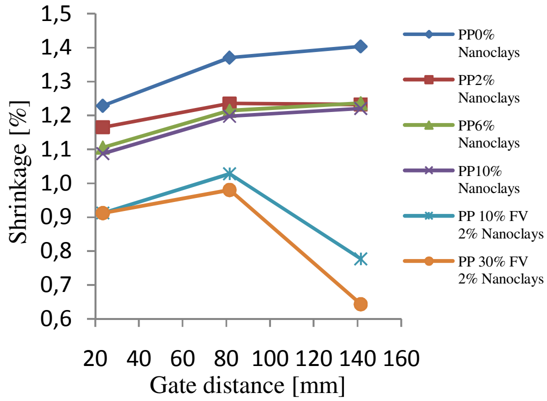

Figure 1 – Diametrical shrinkage internal in relation to material in the mold temperature of 30°C

The ejection forces were compared for the materials mentioned and for different mold temperatures. The ejection force decreases with increasing temperature of the mold, due the part may deform at the time of ejection. Moreover, the lower temperature of the mold is required greater ejection force. The ejection force also increases with increasing content of glass fibers in the material, because this is tougher, higher elastic modulus, which hinders the ejection of part of the mold. The nanoclays decrease the ejection force when compared with glass fiber and pure PP (figure 2).

CONCLUSIONS

In this study, glass fiber reinforced thermoplastics in matrix PP decreases shrinkage and increases the ejection forces when compared with pure PP. The nanoclays decrease the shrinkage and the ejection forces when compared with pure PP. This work will give support to develop an analytical model for predicting the shrinkage and ejection forces for materials reinforced with glass fiber and nanoclays. This model will be based in the Jansen's model, that provides shrinkage and residual stresses for materials reinforced with glass fibers in two dimensions, and the Pontes's model that to predict the shrinkage and ejection forces for deep tubular geometry parts (Jansen et al. 1998b, Pontes 2002 and Pontes et al. 2005).

REFERENCES

Burke,C. and R. Malloy, 1991. "An experimental study of the ejection forces encountered during injection moulding" Proceedings of 49th annual meeting of the Society of plastics Engineers, p.1781-1787.

Jansen, K. M. B, D.J. Van Dijk, M.H. Husselman, 1995 "Effect of processing conditions on shrinkage in injection molding", Polym. Eng. Science, Vol.38, No.5, p.838-846.

Jansen, K.M.B., R. Pantani, and G. Titomanlio,1998a "As-molded shrinkage measurements on Polystyrene injection molded products". Polymer Eng. Science, Vol. 38, No.2.

Jansen, K. M. B., D. J. Van Dijk and M. J. A. Freriksen 1998b "Shrinkage anisotropy in fiber reinforced injection molded products". Polymer Composites, Vol. 19, nº 4.

Pontes, A. J. 2002 "Shrinkage and ejection forces in injection moulded products". Phd Thesis, Universidade do Minho, Portugal.

Pontes, A. J., Pantani, R, Titomanlio, G., Pouzada, A. S. 2005. "Ejection force of tubular injection moldings Part II: A prediction model. Polymer Engeneering and Science, vol. 45; p. 325-332.

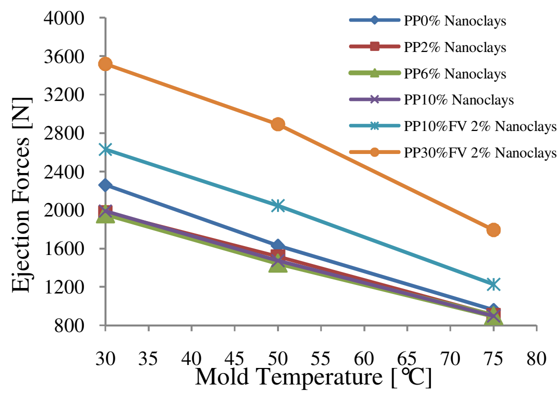

Figure 2 – Ejection forces in relation the mold temperature

AUTHOR BIOGRAPHY

MAURO CÉSAR RABUSKI GARCIA was born in Rio Pardo, Brasil. He is mechanical engineering and master in the area of Transport Phenomena, this degree was obtained in the Federal University of Rio Grande do Sul. He is Professor of Federal Institute of Education, Science and Technology Sul-Riograndense. Actually, He is doing Phd in the Polymer Engineering Department of University of Minho in Portugal.