THE MODELLING OF SHORT FIBRE REINFORCED POLYMER COMPOSITE AGEING – PREDICTION OF THE COMPONENT LIFETIME

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Summary. The presented paper deals with the numerical modelling of ageing of Short Fibre Reinforced Polymer Composites (SFRPC) based on the Polybutylene Terephthalate (PBT) matrix. The investigation is focused on the effects of accelerated humidity-temperature ageing and fibre alignment on material properties.

1 INTRODUCTION

Prediction of the component lifetime is one of the most important aspects in automotive products development. It is especially important for under the hood applications, where hot and wet operating conditions are changing material properties in time, leading to the destruction of the component. The polymer matrix and their composites, especially based on PBT matrix, are very sensitive to changing environmental conditions [1]. This implies a need to create tools to predict the durability of products including both the working conditions of the element and structure resulting from the production process. This is particularly important in the case of injection moulded polymer composites reinforced with short glass fibres, which in the production process induce anisotropic properties which in turn, affects the behaviour of the product during use.

2 EXPERIMENTAL AND MATERIAL MODELLING

The tensile, compression and shear tests for transverse and longitudinal fibre alignment, different strain rates and ageing times, were done to determine the influence of the ageing time on PBT GF20 composite properties. Accelerated composite ageing was done using
Humidity-Temperature cycling acc. USCAR rev.5 class 3 – with temperature of 95°C set under conditions of increased (controlled) relative humidity (95%). 40 and 80 cycles, each 8 hours’ long, were programmed. Test results showed a number of phenomena occurring during ageing of the material. The most important are: decrease of Young modulus in longitudinal fibre alignment and increase of Young modulus in transverse direction, loss of the viscoelastic properties after H-T cycling, drop in tensile, compressive and shear strength for both transverse and longitudinal direction in tension, increase of the shear modulus, decrease of shear strength and equalisation of shear properties for transverse and longitudinal fibre alignment, increase of the scattering of the strength properties. All these factors were used to create the transversely isotropic based, nonlinear rate and age dependent material model taking into account fibre alignment resulting from injection moulding process [2]. Presented model was validated on real component (snap fit) from automotive industry.

Figure 1: Force – Displacement curve with confidence interval bounds (95%) for specimen after 40 H-T cycling

Obtained results, in the form of the force confidence intervals – based on the material strength confidence intervals, enables a fairly accurate prediction of the durability of SFRPC parts in Finite Element Analysis. Using results from material tests and phenomenological material model which makes distinction between tension, compression and shear predominant stress state possible, complemented by material failure, produces very good results, close to laboratory tests.

REFERENCES
