KN-15-192

Thursday, May 12, 2011, 10:30-11:10 am
Room: Reda 2

STUDY OF HEAT ABSORPTION IN THE THERMOFORMING PROCESS FOR OF TRANSPARENT AND FILLED POLYSTYRENE

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In the thermoforming process polymeric sheets are heated up to temperatures situated within the rubber elastic state. Radiation heating is widely used for that purpose in practical applications, whereby infrared radiation is emitted from a radiator and transferred to the polymeric semi-finished product. The heated two-dimensional sheet is reshaped into a three-dimensional part by vacuum or the application of pressure. A nearly even heat penetration is one of the key parameters for the satisfactory replication of the mould contours.
The transient heat conduction equation is used to calculate the temperature distribution in the polymeric sheet and the required heating time. Furthermore, it is crucial to describe the absorption process of the IR radiation in the polymer material using an appropriate model. Bouguer Beer Lambert's law can be applied to characterize the volume absorption of the heat radiation defined by an exponential decay of the radiation intensity by its depth. Two material parameters, the surface reflection and the penetration depth, determine this behaviour. These parameters can be measured by spectroscopy and further calculation.
This work investigates the validity of Bouguer Beer Lambert's law. The reflection and the transmission of both a transparent and a filled white-coloured polystyrene compound of different thicknesses were measured. The penetration depth was calculated and finally plotted as a function of film thickness.
Bouguer Beer Lambert's law is only valid when the penetration depth is independent of the film thickness. The results for the transparent polystyrene film showed a good agreement with this assumption. However, the results of experiments on the filled polystyrene films deviated more or less from those expected, depending on the wavelength interval. This abnormality can be explained by the scattering of the radiation that takes place due to filler particles, which give the compound its white colour. This scattering or deflection of the radiation rays reduces the radiation's intensity to a greater extent, than would be expected due to Bouguer Beer Lambert's law.