ROTOLINING POLYETHYLENE: A HOT-WATER TANK MADE OF MILD STEEL AND COATED INTERNALLY WITH PE USING ROTATIONAL MOULDING

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Abstract

In the presented research work, the rotolining process is used for the development of an innovative hot water tank, which will be used in a 'solar plus supplementary system' (see ISO 9459-2:1995). The first project stage included the material choice, which was based on a specific set of selection criteria: A zero shear viscosity is required to aid in the flow of the polymer within the mould[1]. The material flow characteristics are important with regards to the way the plastic powder distributes itself in the mould and to ensure a uniform wall thickness is achieved[2]. The Melt Flow Index (MFI) should be high enough for the polymer to be formed inside the mould but low enough for the impact strength to be appropiate for its enduse. Also, the materials should meet the requirements for storing potable water and they should also show chemical stability at high service temperatures. Based on the above, four Polyethylenes (PE) were choosen: i) crosslinked PE, ii) LLDPE iii) impact modified HDPE and iv) metallocene MDPE. The second project stage included a series of tests in order to validate the materials specifications, where aplicable: a) MFI measurements (EN ISO 1133:2005) b) Ultimate Tensile Strength and Elongation at Break (ASTM D638:2002), c) Vicat Softening Temperature (EN 727:1995), and d) dimensional change measurements.

The next project stage involved a series of rotolining experiments for each material, designed to reveal each resin's potential. It is well known that the mould Internal Air Temperature profile is linked to all the key stages in the rotomoulding process and it is an excellent quality control parameter, related to the morphology and the mechanical properties of the moulded articles[3]. Therefore, the TempLogger System was used for the monitoring and control of the process. The metallocene MDPE proved to be more than adequate for rotolining, which was confirmed during the final project stages.
Labaratory tests were conducted in parallel with rotolining experiments, and involved a) thickness uniformity and mechanical strength determination b) performance in operating conditions c) impermeability tests: a) Steel and polymer wall thickness was measured with an Insize Ultrasonic Thickness Gauge. The thickness measurements confirmed that rotolining allows for the production of products with thickness homogeneity, regardless of mould geometry. b) Rotolined products were also tested in controlled heating – cooling experiments. The LLDPE, the crosslinked PE and the metallocene MDPE products endured substantial temperature differences (maxT=90 ^{o}C, minT=31.6 ^{o}C inside the tank) and rapid temperature changes (max $\partial T/\partial t$ =55^{o}C/10min). However, the adhesive properties of the metallocene MDPE resin proved to be of crucial importance for this application.

The Hot-Water Tank is currently being tested according to ISO 9459-2:1995 for solar systems performance characterization. The authors would like to thank the Research Promotion Foundation of Cyprus for the funding of this work.

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