Gamma-Irradiated Cross-linked LDPE foams: Characteristics and Properties

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ABSTRACT

Foamed polymers are future materials, as they are increasingly considered "green materials" due to its interesting properties at very low consumption of raw materials. They can be used to improve appearance of insulation structures, thermal and acoustic insulation, core materials for sandwich panels, fabrication of furniture and flotation materials or to reduce costs involving materials. Low-density polyethylene is widely used because of its excellent properties, such as softness, elasticity, processibility and insulation. In general, cross-linking is often applied to improve the thermal and mechanical properties of polyethylene products, due to the formation of a three-dimensional network. In particular for the production of PE foams, cross-linking is applied prior the expansion to control bubble formation, cell characteristics and final properties of the foam. However, the usual production process of PE foams is a process in which a gaseous blowing agent is injected into a melted thermoplastic polymer, under pressure, to form a solution between blowing agent and melted polymer. An extrusion system is provided for foaming the polymer, supplied to an extruder and moving through a rotating screw. The pressure must be high enough to keep the gas blowing agent (or foaming agent) in the solution with the melt. The foaming agent is then diffused and dissolved in the molten material to form a single-phase solution. In the present work it was used carbon dioxide as the bowing agent, a chemically stable and non-toxic gas, with good diffusion coefficient; gas pressure used varied within a 20 - 40 bar range. Some requirements for physical foaming are required, as low friction heat generation, homogeneous melt temperature distribution, melt temperature at die exit just above crystallization temperature (die) and high melt strength during expansion. This work studied foams properties gamma-irradiated within 0, 10, 15, 20 to 30 kGy, from a LDPE exhibiting 2.6 g/10 min Melt Index. Accomplished tests: DSC, Gel-fraction, Swelling ratio in various solvents, Rheological measurements, Infra-Red Spectroscopy and Melt Strength. It was verified that within a given radiation dose range; the material exhibited an optimization in viscoelastic properties, providing the desired Melt Strength range for obtaining foams.

Keywords: Low Density Polyethylene, gamma irradiation, physical foaming, melt strength