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Techniques and parameters investigations on crosslinked rubber foam formations

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Abstract

Single Stage, Heat Transfer and Heat and Chill techniques were applied to determine suitable methods for crosslinked rubber foam formation. Various parameters such as expansion temperature and blowing agent concentration were also investigated. All samples were characterized to determine their curing time, foam density, gel content, cell size and compression strength. From the results obtained, it indicates that only Heat Transfer technique can produce crosslinked rubber foam. From this technique, it shows that increasing expansion temperature from 140 ^{0}C to 160 ^{0}C, no significant changes in gel content was observed. However, cell size decreased and foam density increased. Furthermore, increases blowing agent concentration from 4 phr to 8 phr, the foam density decreased follow by the increased in cell sizes with no changes in gel content. The compression properties found to be highly dependent on foam density.

Keywords: Rubber foam, Heat transfer, Crosslinked, Blowing agent and Gel content

Introduction

There are two major generic foam types that has been produced namely crosslinked and non-croslinked polymeric foams. However, crosslinked polymeric foam has gained wide acceptance and been extensively studied [1]. Crosslinking gives a considerably higher heat resistance and the material behaves as a thermoset compared with the base polymer (such as polyethylene, ethylene-vinyl acetate and polypropylene) which is thermoplastic in nature. The main areas of application of polymer foams depend upon density reduction. As the density decreases, improvements are seen in energy absorption, thermal conductivity and strength to weight ratio [2]. Another factor is that closed-cell foams exhibit buoyancy, which may be used in combination with other factors above to enable them to penetrate many markets [1]. The major application of polyolefin foams is in thermal insulation, packaging, construction and sports and leisure industries [3].

The most widely used crosslinked foam is based on crosslinked polyolefin and it is believed that its market will substantially increase due to further development and environmental concerns of physical blowing agents (PBAs) used in non-crosslinked polyethylene foam manufacture. Historically, chlorofluorocarbons (CFCs) were widely used as PBAs in non-crosslinked polyethylene foam manufacture [4]. The usage of CFCs has been dramatically reduced and they have been phased-out in the developed world following international legislation [5] designed to reduce the rate of destruction of the earth's ozone layer [6].

Most polymer can be crosslinked by chemical or irradiation methods, involving free radical generation, which can result in intermolecular covalent bonding and three-dimensional network formation [7]. However, different base polymers used in crosslinked polymeric foam manufacturing give different physical and mechanical properties and affect their processability [8].

Globally the majority of crosslinked polymeric foam sheet is produced by four processes developed by Furukawa Electric Co [9], Sekisui Chemical Co [10], Toray Industries Inc [11] and Hitachi Chemical Co [12]. The Sekisui and Toray processes rely on irradiation crosslinking while Hitachi and Furukawa processes employ chemical crosslinking. However, Furukawa Electric Company was one of the first companies which advanced the compression moulding