PRODUCTION OF RIGID POLYURETHANE FOAMS FROM SOY-BASED POLYOLS

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Abstract— **The production of rigid polyurethane foams is made varying the soy-based polyol percentage between 20 and 30% into the formulation. Four blocks of foam are obtained using two oleochemicals polyols from ethanol and ethylenglycol (with funcionalities of 2 and 6, respectively). The foams were characterized by thermal and mechanic tests finding a conductivity value between 0.022-0.026 W/mK and a compressive strength of 15-20 psi, comparables with the commercial specifications and showing the obtained product as appropriate PU foam for industrial applications.**

Keywords— **Polyurethane, rigid foams, oleochemical polyester polyols, soy-based polyols, ethylene glycol.**

I. INTRODUCTION

Polyurethane (PU) is widely used in various applications as bulk plastics, elastomers, fibers, surface coatings, adhesives, sealants and foams (Latere *et al.,* 2005). PUs are present in different commercial applications such as seating, packaging, footwear, appliances, construction and furniture. Plus, these rank fifth in the production volume of plastics in the world and their consumption is increasing rapidly throughout the world (Tu *et al.,* 2007). PU is currently considered to be one of the most effective materials for insulation, reducing thickness and costs, with a very low conductivity (0,022 W/mK) and a very high ecoeficiency index to save energy (ANPE, 2008). Thus rigid PU foams are used especially in engineering applications such as insulation materials, automotive parts, and structural materials (Narine *et al.,* 2007).

The monomers used to form polyurethanes foams are organic isocyanates and polyols (including polyether and polyester polyols), which are mostly derived from petrochemical refining of crude oil and coals. For rigid PU foam, besides of the common basic component of MDI (polymeric diphenyl methane diisocyanate) other components like chain extender, blowing agent and surfactants are employed to regulate the morphology of the cells.

Polyols can be extracted or synthesized from natural materials such as plants, oils or wood. In the polymer industry, many types of oils (e.g. castor, soybean or rapeseed) have been used as feedstock due to their abundance and economy (Narine *et al.,* 2007). Polyols made from vegetable oils seem to be a good alternative in rigid foam technology in replacement of starting materials for renewable resources. The benefits of this new class of biopolyols are compatibility with hydrocarbon blowing agents, higher hydrofobicity and improved hydrolytic properties of PU foams obtained with a good oxidative stability (Petrović, 2005).

A 100% biobased PUs with acceptable properties are not available because of the lack of satisfactory results on isocyanate synthesis. So far researchers have developed materials containing more than 50% biobased components with thermomechanical properties comparable to petrobased polyurethanes (Latere *et al.,* 2005).

Nonetheless PUs have limited degradability when discarded after use therefore can be an environmental problem. Along with the increasing of % biopolyol in the foam formulation, it could be spliced hydrophilic chains into the backbone of the triglycerides compounds (due the inner hydrophobicity of PU foams, even those based on vegetable oils). The use of hydrophilic polyols (such as ethylene glycol) lends to increase the degradation rate of the foam, because it entails a rise in polymer permeability, and it has been demonstrated successfully by some authors (Yeganeh and Hojati-Talemi*e,* 2007).

Besides, the use of ethylene glycol in PU foam has a good economic advantage (667 USD/ton) compared to other alternative raw materials like propylenglycol (1000 USD/ton) or pentaeritritol (1278 USD/ton) (Bozell*.,* 2004).

II. METHODS

A. Materials

Polymeric MDI (PAPI 27 from Dow Chemical) was used as isocyanate. For the B side, it was made a mix of polyols that constitutes 100 parts (pph) for the formulation of the rest of compounds: catalysts (Polycat 8, Niax A-1 and Curithane 206), surfactant (Tegostab B-8427) and HCHC-141B as a foaming agent, all provided by Dow Chemical. The polyol mix included Voranol 446, Voranol 640 and soy-based polyols (hydroxyl numbers of 120 from ethanol and 331 mg KOH/g from ethylene glycol). These oleochemical polyols were prepared through an *in situ* epoxidation of the soybean oil with per acetic acid using a homogeneous catalyst (Boyacá and Beltrán, 2009).