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Short communication

Systematic study on substituting petroleum-based polyols with soy-based polyol for developing renewable hybrid biofoam by self-catalyzing/rising process

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ABSTRACT

The future depletion of petroleum resources is driving development of sustainable alternatives based on biomass materials. This work is aimed at developing rigid polyurethane biofoam with similar properties to commercial foam for the potential application in thermal insulation. we designed a hybrid biofoam by self-catalyzing/rising process from substituting petroleum polyol with soy polyol.

Rigid polyurethane foams are widely used in a variety of industries, because of their low thermal conductivity, good adhesion, good dimensional stability, and excellent mechanical strength even at low density (Abdel Hakim et al., 2011; Shimizu et al., 2012). With an increasing awareness of the environment and the future availability of petroleum resources, it has become important to look for alternative processes and raw materials from renewable or sustainable resources (Septevani et al., 2015). The polyols that play an important role in the urethane foam industry are conventionally derived from petrochemical crude oils and coals. In view of the need for environmentally friendly aspects and sustainability, a way to prepare polyols from vegetable oils such as soybean, canola, castor, and palm oils is of increasing importance. This interest is economically driven because vegetable oils are renewable, easily processed, can be made biodegradable, and offer both cost and performance that is comparable to petroleum-based polyols (Ristić et al., 2012; Xia and Larock, 2011; Yang et al., 2012).

Producing polyols from soybean oil means using a renewable resource, which is abundant in supply and relatively low in cost. These new chemical processes are aimed at reducing the environmental footprint, in particular the production of carbon dioxide, which is the most notable greenhouse gas. The polyurethanes produced from these polyols can compete in many aspects with polyurethanes derived from petrochemical polyols (Javni et al., 2003). About 40% of standard petroleum polyols in spray-on polyurethane applications have now been replaced by soybean oil-based polyols (Pfister and Larock, 2010), the cost of which is approximately 20% to 30% lower than the conventional polyols.

In this communication, rigid composite biofoams (Fig. 1) from a combination of a petroleum-based polyol (Jeffol A-630) and a soy-based polyol at various weight ratios were prepared using a self-catalyzing/rising process. Soybean phosphate ester polyol (SOPEP) was prepared by hydrolysis of epoxidized soybean oil (ESO) with phosphoric acid as a catalyst (Zhong et al., 2001), and incorporated into low volatile organic compounds (VOC) industrial foam because of its relatively high hydroxyl number. Jeffol A-630 polyol is an amine-based, low-viscosity triol developed specifically as cross linker for urethane foams. It is used primarily in rigid spray polyurethane foam systems based on aromatic-amino polyols and polymeric isocyanates and is known as polyisocyanurate (PIU) foam. These foams are chemically and thermally more stable than polyurethane foams (Sharma and Kundu, 2008). The schematic illustration of reaction and macromolecular network structure of the obtained polyurethane biofoams is shown in Fig. 2. An interpenetrating polymer networks (IPN) biofoam is formed by using the mixture of above two polyols to react with polyisocyanurate simultaneously. SOPEP and Jeffol can react respectively with polymeric methyldiphenyl diisocyanate (pMDI) to form polyisocyanurate prepolymer first, and then react with rest of the polyol,

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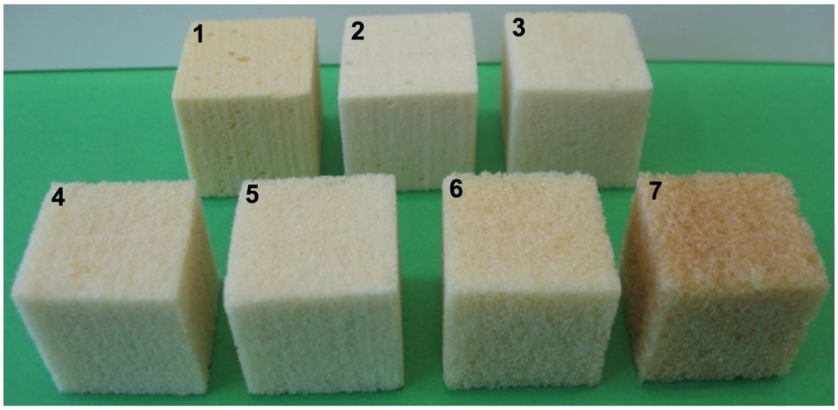

Fig. 1. Photographs of the biofoam samples.

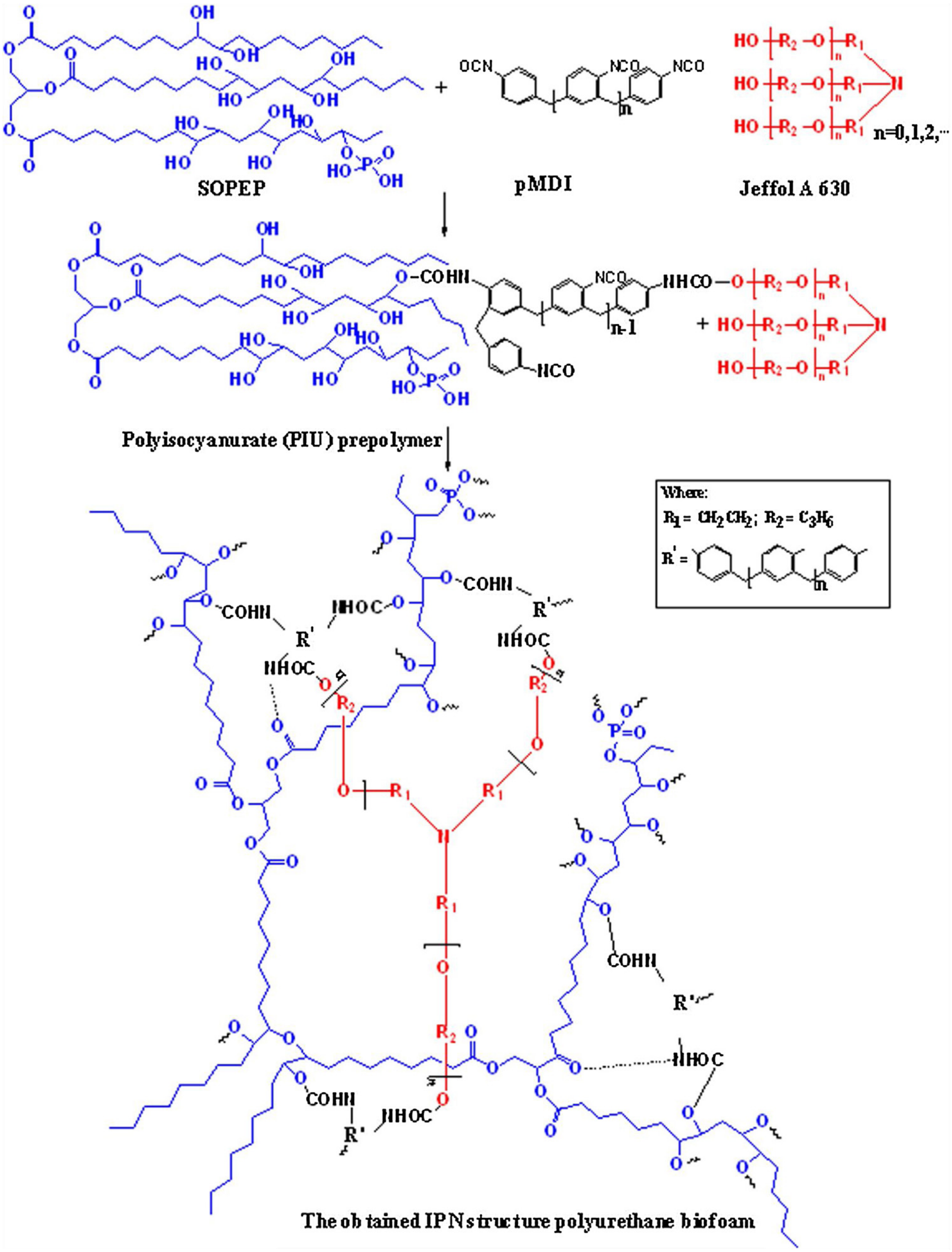

Fig. 2. Schematic illustration of reaction and macromolecular network structure of the obtained polyurethane biofoams.