BIODEGRADATION STUDY OF LIGNIN-BASED RIGID POLYURETHANE FOAMS

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INTRODUCCION

Polyurethanes are considered as one of the most versatile polymeric materials offering a wide range of products with applications in diverse sectors. Rigid polyurethane (RPU) foams belong to this class of products and represent a commercially important class of expanded materials.

Nowadays, due to economical and environmental concerns, development of low-cost polyols from abundant and renewable biomass resources has gained an increasing interest. These polyols constitute attractive choices for polyurethane and other industrial sectors. In this context, simple sugars and other substrates such as glycerol are commonly oxypropylated. More recently, oxypropylation of other biomass substrates, such as chitin and chitosan (Fernandes et al., 2008), cork (Evtouguina et al., 2000), sugar beet pulp (Pavier and Gandini, 2000), rapeseed (Serrano et al., 2010) and lignin (Cateto et al., 2009) have been performed with promising results.

During the late 1980s and 1990s, biodegradability started to be considered as a desirable characteristic not only for chemicals but also for solid materials such as polymers. In this context, green polyols with added biodegradable properties constitute attractive macromonomers for green and sustainable chemistry/processes.

Lignin is a random, amorphous three-dimensional polymeric network that is highly resistant to biodegradation being mostly degrading by higher fungi via oxidative processes. Nevertheless, potential applications utilizing lignin-degrading organisms and their enzymes have become attractive since they can provide both environmental friendly technologies for pulp and paper industry and added value to lignin-based products that can be presented as biodegradable.

In the present work RPU foams have been prepared from lignin-based polyols (LP) obtained by oxypropylation of two technical lignins (Alcell and Indulin AT) and biodegradability evaluated using respirometry tests in liquid and solid media. A RPU foam produced from a commercial polyether polyol (CP) based on sorbitol (Lupranol® 3323) was used as reference.

RESULTS AND DUSCUSSION

The lignin-based polyols were obtained by oxypropylation of Alcell and Indulin AT lignins with a formulation deduced from an optimization study, as described elsewhere (Cateto et al., 2009). Lignin base materials were fully characterized in a previous work (Cateto et al., 2008) and Table 1 summarizes the most relevant properties. The following terminology is used to identify the lignin-based polyol: L/PO/C (lignin/propylene oxide/catalyst content, v/w/%, w/w). Catalyst content is expressed on a free PO basis. The used polyols correspond to the formulation 30/70/2. Table 2 summarizes the obtained properties.

Table 1. Alcell and Indulin AT properties

	Alcell	Indulin AT
Ash (% w/w)	0.05	3.06
Sugar (% w/w)	0.20	2.00
OCH_3/C9 unit	1.11	0.77
ϕOH (mmol/g)	3.81	3.95
Total OH (mmol/g)	5.26	6.99
Mn (VPO)	760	1079

Table 2. 30/70/2 lignin based polyol properties

	Alcell	Indulin AT
I_{OH} (mg KOH/g)	279.7	348.8
μ (20 ºC, Pa.s)	48.96	66.56
Homo (%, w/w)	29.5	24.2

A typical RPU foam formulation includes the polyol (mixtures with LP/CP ratio of 50/50 or 100/0) combined with 10% (w/w) of glycerol (a co-crosslinking agent). A 100% Lupranol® 3323 based RPU foam was also prepared to be used as a reference. Additionally, the formulation includes a physical blowing agent (n-pentane at 20% (w/w)), a catalyst combination (mixture