



**XXI ENCONTRO  
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PORTUGUÉS DE  
QUÍMICA**

**Pontevedra (España)**

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# XXI ENCONTRO GALEGO-PORTUGUÉS DE QUÍMICA

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*Galicia (España)*



**Colegío Oficial de  
Químicos de Galicia**



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- CAT 06 Hydrophobicity in catalysis for wet peroxide oxidation
- CAT 07 Aerogéis de carbon dopados con nanopartículas de Co(0) en la síntesis eficiente y selectiva de heterociclos nitrogenados
- CAT 08 Síntesis de  $\beta$ -aminocetonas por reacción de Mannich modificada usando arcillas ácidas como catalizadores
- CAT 09 Production of biodiesel through esterification catalyzed by ionic liquids
- CAT 10 Síntesis de quinolinas polisustituidas promovida por nanocatalizadores basados en aerogéis de carbón dopados con metales de transición

### **Educación y Enseñanza de la Química**

- EDU 01 La resolución de problemas como actividad en la docencia de la Química de los grados en Ingeniería Eléctrica y en Ingeniería Electrónica Industrial y Automática en el marco del Espacio Europeo de Educación Superior
- EDU 02 Práctica virtual de Laboratorio de Química: Calorimetría (determinación del calor específico del aluminio)

### **Ingeniería y Química Industrial**

- IND 01 Preparative Separation of Multicomponent Mixtures by Simulated Moving Bed Liquid Chromatography
- IND 02 Evolución del contenido de azufre en las especificaciones del gasóleo de automoción en España, 1975-2010
- IND 03 Resistência de um geocompósito de PP/PET à ação de líquidos
- IND 04 Problemas detectados en aplicaciones termográficas en ITV's como apoyo en la prevención de riesgos
- IND 05 Polyols production from lignocellulosic material applying liquefaction processes
- IND 06 Diseño de pretratamiento para fermentación ácida de residuos
- IND 07 Almond shell-based polyols through oxypropylation reaction
- IND 08 Estudio de la efectividad de un termofluido constituido con un inhibidor de corrosión base etilenglicol
- IND 09 Influencia de la contaminación por combustible sobre la viscosidad de un aceite lubricante para motores de combustión interna marinos
- IND 10 Comparación cualitativa del método electrolítico con distintos métodos de recuperación piezas de acero oxidadas en lanchas de instrucción

## Almond shell-based polyols through oxypropylation reaction

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Almond cultivation and processing industry generate 3 main types of residues: hull, shell and skin, representing 80% (w/w) of the whole almond fruit. Presently, the shell finds use as energy source being commercialized at a cost of 0.11 €/kg. Hull and skin have no economic value. Apart from the hull, that its use needs a strategy for its recover, both shell and skin can be easily recovered at the almond processing industries and are, therefore, the more attractive residues to develop novel applications. In this work the use of almond shell as a raw material to produce polyols through oxypropylation was studied.

The oxypropylation reaction was carried out in bulk in a pressure reactor using a set-point temperature of 160 °C. Three series were chosen (AS/PO of 30/70, 20/80 and 10/90) using three levels of catalyst content (5, 10 and 15%). Maximum pressure and temperature, and total reaction time (time to achieve a relative pressure of zero) were registered. The obtained polyols were characterized in what concerns unreacted biomass (UR), homopolymer content (content of PO oligomers resulting from the secondary homopolymerization reaction), hydroxyl number (IOH) viscosity, and by TGA (thermal stability).

Oxypropylation occurred at moderate conditions of temperature, pressure and time giving rise to liquid polyols with a homopolymer content ranging from 5-75%, a hydroxyl number between 250-520 mg KOH/g and viscosities up to 750 Pa.s. For the series 10/90 and 20/80 a maximum in homopolymer content was achieved when a catalyst content of 10% was used. For the series 30/70 a slight decrease of the homopolymer content was observed as the catalyst content increases. In a general way IOH increased with the increase of catalyst content, particularly for the low-AS content series (10/90 and 20/80). For the series with the higher amount of AS (30/70), this effect was attenuated. For the same catalyst content, viscosity increases with the increase of AS/PO ratio and a minimum in viscosity was encountered for all series when using 10% of catalyst, with a slight increase for 15%.

The unreacted almond shell residues varied between 5.0 and 37.3%, results in accordance with published data for other biomass substrates. The series 30/70 was the one that presented the higher amount of unreacted AS (28.7-37.3 %) independently of the used catalyst amount.

In a general way it was observed that low AS/PO ratios (i.e. 10/90) give rise to polyols with low unreacted AS residue, low viscosity (due to a high homopolymer content), and the lowest IOH number. Moreover the polyols based on this formulation presented the highest thermal stability, especially the 10/90/5. The polyols based on the AS/PO ratio of 30/70 presented high unreacted AS residues, low homopolymer content, high IOH number (the highest value correspond to the formulation 30/70/5, 518.2 mg KOH/g) and high viscosity.

To the best of our knowledge no other works concerning almond shell oxypropylation are available in the literature. In this context, the results presented here pointed out for the viability of using this agro-industrial residue to produce biobased polyols.

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