XXI TECNICELPA

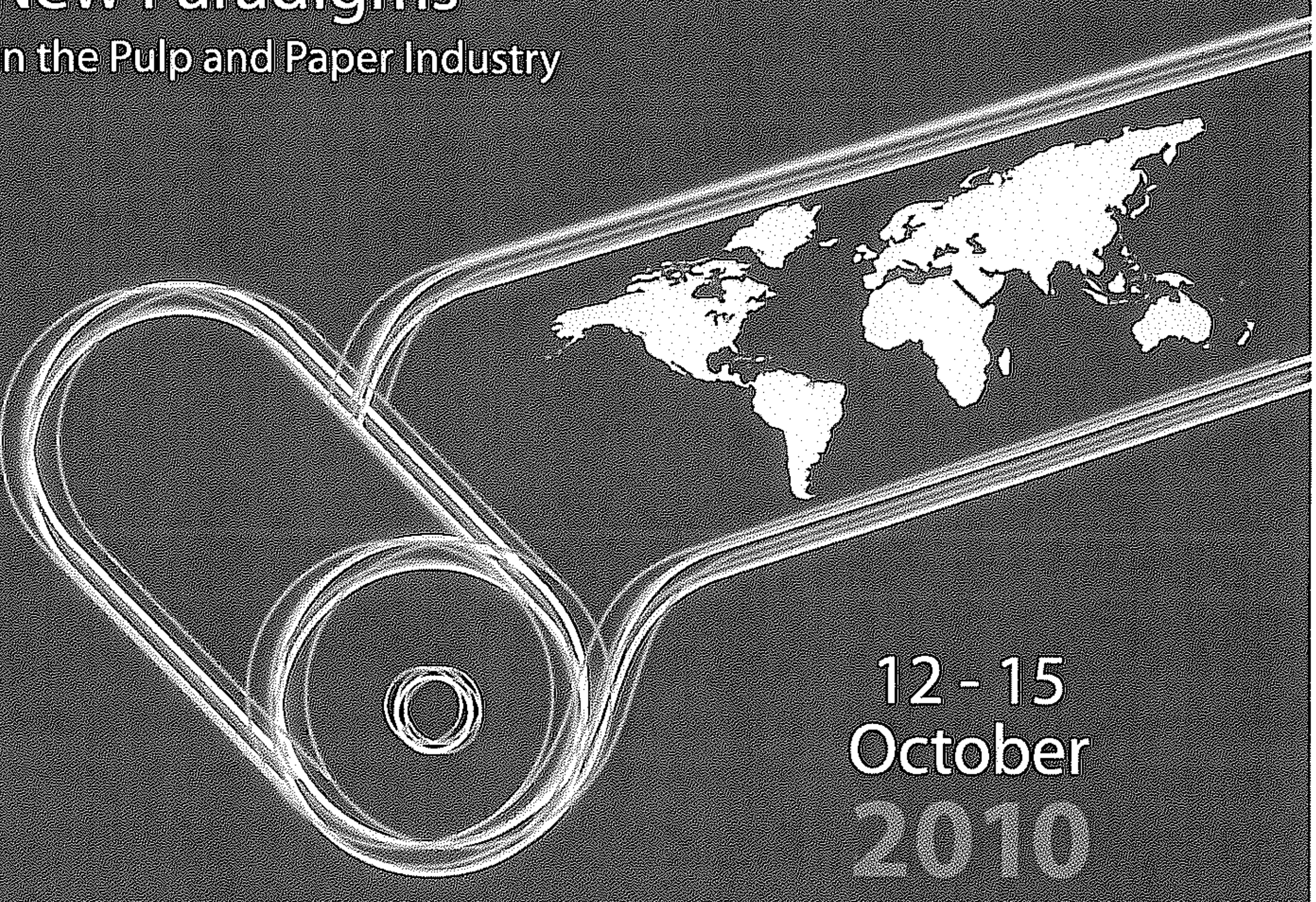
Conference and Exhibition

CIADICYP

VI IBEROAMERICAN CONGRESS
ON PULP AND PAPER RESEARCH

New Paradigms

in the Pulp and Paper Industry



12 - 15
October
2010
LISBON
PORTUGAL

www.tecnicelpa.com/ciadicyp/2010

TOPIC: BIOTECHNOLOGY AND BIOREFINERY *(cont.)* Pages

XXI TECNICELPA Conference and Exhibition / VI CIADICYP 2010
12-15 October, 2010 - Lisbon, Portugal

POLYURETHANES AS A VIABLE ROUTE TO VALORISE LIGNIN

Carolina A.B. Cateto[1a,2], Maria F.F. Barreiro[1a*], Alírio E. Rodrigues[1b], Naceur M. Belgacem[2]

[1]Laboratory of Separation and Reaction Engineering (LSRE): a. Instituto Politécnico de Bragança, Campus de Santa Apolónia, Ap 1134, 5301-857 Bragança, Portugal; b. Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal (barreiro@ipb.pt, Phone:+351273303089, Fax: +351273313051)

[2]Matériaux Polymères, École Française de Papeterie et des Industries Graphiques (EFPG-INPG), BP 65, 38402 St. Martin d'Hères, France

ABSTRACT

Lignin is a renewable material obtained in huge quantities as a by-product of the pulp industry. Until now, it is mainly used as fuel and only a small amount is isolated from spent pulping and commercialized. Nevertheless, this quantity, estimated at 2%, corresponds to 1 million of tons per year worldwide. Additionally, based on its interesting functionalities and properties, lignin offers perspective for higher added-value applications.

The interest for developing lignin-based applications is nowadays driving by three major factors, namely (i) the availability of new lignin sources, such as, sulphur-free lignins; (ii) the growing interest on biorefinery concept (lignin accounts up to 30% of biomass weight) and (iii) the approach of sustainable chemistry where green processes and bio-based products are in focus.

This work presents a study concerning the use of lignin as a macromonomer in polyurethane (PU) synthesis based on four lignin samples (Sarkanda (Granit SA), Indulin AT (MeadWestvaco), Curan 27-11P (BorregaardLigno Tech) and Alcell (Repap Enterprises). They represent three different botanic origins (hardwood, softwood and non-wood), as well as three different pulp processes (kraft, soda and organosolv). The work started with lignin characterisation, giving particular emphasis to hydroxyl groups' determination. Therefore, lignin was used as a macromonomer in polyurethane synthesis, following two different approaches, namely: (i) its use as such without any purification or modification procedure and (i) its use after chemical modification (oxypropylation). A wide range of polyurethane materials (elastomers and rigid polyurethane foams) were prepared presenting properties which depended on the lignin type and content introduced. Briefly, for polyurethane synthesis purposes Alcell and Indulin AT were found to be the most viable raw-materials to be used as macromonomers. Alcell lignin presents high purity coupled with low molecular weight, while Indulin AT has the highest total hydroxyl content together with modest impurity content. Sarkanda and Curan 27-11P impurities and structural features constitute the main drawback for its application.

The statements presented in this work provide irrefutable evidence about the possibility to produce lignin-based polyurethane materials. Both mentioned approaches used lignin samples without any previous purification associated with bulk processes. Moreover, chemically modified lignin (oxypropylated lignin) was directly used to prepare polyurethane foams (i.e., no purification/separation processes were applied). These statements clearly evidence the environmental friendly connotations of this work. The approach of using lignin as such, i.e., without chemical modification seems to be the most attractive in terms of lignin content incorporation. In this work, by using non-modified lignin a higher amount of the studied here by-product was introduced into the final polyurethane materials. Thus, around 19% (w/w) of pristine lignin powder was introduced to prepare PUs *versus* 11% (w/w) when using oxypropylated lignin. In a general way, these materials could become more attractive by means of incorporating other bio-based components. In this context, polyurethane foams can offer a greater impact due to the current availability of bio-based raw-materials alternatives for this brand of products.

Keywords: bio-based, biorefinery, lignin, polyurethanes.