Isosorbide bis-methyl carbonate: Opportunities for an Industrial Model based on Biomass.

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Abstract— The chemical industry is facing a new revolution. As long as processes based on the exploitation of fossil resources emerged with force in the XIX century, Society currently demands a new radical change that will lead to the complete and irreversible implementation of a circular sustainable economic model. The implementation of biorefineries will be essential for this. There, renewable raw materials as sugars and other biomass resources are exploited for the development of new materials that will partially replace their petroleum-derived homologs in a safer, and environmentally more benign approach.

Isosorbide, (1,4:3,6-dianhydro-d-glucidol) is a primary bio-based derivative obtained from the plant (poly) saccharides and a very interesting example of a useful chemical produced in biorefineries. It can, in turn, be converted to other secondary monomers as isosorbide bis-methyl carbonate (IBMC), whose main field of application can be as a key biodegradable intermediary substitute of bisphenol-A in the manufacture of polycarbonates, or as an alternative to the toxic isocyanates in the synthesis of new polyurethanes (non-isocyanate polyurethanes) both with a huge application market. New products will present advantageous mechanical or optical properties, as well as improved behavior in non-toxicity and biodegradability aspects in comparison to their petro-derived alternatives.

A robust production process of IBMC, a biomass-derived chemical, is here presented. It can be used with different raw material qualities using dimethyl carbonate (DMC) as both co-reactant and solvent. It consists of the transesterification of isosorbide with DMC under soft operational conditions, using different basic catalysts, always active with the isosorbide characteristics and purity. Appropriate isolation processes have been also developed to obtain crude IBMC yields higher than 90%, with oligomers production lower than 10%, independently of the quality of the isosorbide considered. All of them are suitable to be used in polycondensation reactions for polymers obtaining. If higher qualities of IBMC are needed, a purification treatment based on nanofiltration membranes has been also developed.

The IBMC reaction-isolation conditions established in the laboratory have been successfully modeled using appropriate software programs and moved to a pilot scale (production of 100 Kg of IBMC). It has been demonstrated that a highly efficient IBMC production process able to be up-scaled under suitable market conditions has been obtained. Operational conditions involved the production of IBMC involve soft temperature and energy needs, no additional solvents, and high operational efficiency. All of them are according to green manufacturing rules.

Keywords Biomass, catalyst, Isosorbide bis-methyl carbonate, polycarbonate, polyurethane, transesterification.

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