Development of innovative chemical processes for the recycling of synthetic textiles

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This research explores the chemical recycling of blended fabrics through a glycolysis process in order to face one of the biggest environmental pollution factor of these years: the textile waste. Combined textiles come from different fields such as fast fashion, automotive, upholstery, furniture and technical clothes and lot of them are made of different materials, difficult to be treated together. The final goal is to obtain, with a single process, a liquid product that can be useful in the production of new polyurethane foams.

Glycolysis is a well-known technique that exploits a glycol as a medium in which the polymer chain of the plastic material, in this case polyurethane, polyethylene terephthalate, polyamide and others, are broken, usually under the action of a catalyst and the temperature.

Once the individual materials were tested, the focus was on their combinations, increasing the degree of complexity by changing the variables and the materials involved. The application of some DoE was necessary to optimize the different operating conditions (ratio waste/glycol, material content, reaction temperature and time, catalyst or glycol typology, source of waste).

The resulting polyols from the glycolysis processes were then characterized in terms of viscosity and hydroxyl number. Both of them are important because the product must be compatible with the virgin polyol used to produce new foams: the viscosity must be lower than almost 10.000 cP and the hydroxyl number must stay between a specific range, depending on the kind of the final foam. Furthermore, the free aromatic amine content in the polyol must be evaluated using high-performance liquid chromatography (HPLC). This value must stay below the regulation limit of 0,1% wt due to the cancerogenic nature of the byproducts of the glycolysis reaction. A possible selective separation phase (hot filtration) is contemplated to remove the percentage of unreacted and solid material.

Finally, the polyols were tested into many formulations to produce new PU foams with ever-increasing quantity of recycled polyol. The new foams, characterized in terms of morphological, mechanical and thermal properties, shown good results even with a percentage of recycled polyol up to 50% in the formulation.

Due to the good results obtained and the upcoming laws (Extended Producer Responsibility, EPR), the industrial scale up of this process is already underway in collaboration with some industrial companies.

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