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PhD thesis abstract

Synthesis and application of new bio-polyols based on vegetable raw materials for the production of bio-composites in the form of rigid polyurethane-polyisocyanurate foams

mgr inż. Marcin Borowicz

supervisor dr hab. inż. Joanna Paciorek-Sadowska, prof. nadzw.
auxiliary supervisor dr inż. Joanna Liszkowska

PhD thesis entitled "Synthesis and application of new bio-polyols based on vegetable raw materials for the production of bio-composites in the form of rigid polyurethane-polyisocyanurate foams" consists of two parts - literature review and experimental part. The basic raw materials used to production of rigid polyurethane-polyisocyanurate foams was discussed in literature part of this dissertation, as well as the current development trends of polyol raw materials and polyurethane materials. An important issue of this part was also the review of the literature regarding the possibility of biodegradation process of PUR materials.

The experimental part consisted of own research, which concerned the synthesis of new bio-polyol based on white mustard oil and evening primrose oil and their use as raw materials for the production of rigid polyurethane-polyisocyanurate foams.

In the first step of the research, the oleochemical raw materials were subjected to in-depth analysis to determine their suitability for the synthesis of new bio-polyol. Therefore, characteristic parameters such as iodine value, epoxide value, acid number, hydroxyl number, density, viscosity and molecular weight were determined. The chemical structure was also examined by FTIR, ^{1}H NMR and ^{13}C NMR spectroscopy. The obtained results confirmed the reasonableness of choice of these raw materials for the synthesis of new polyols.

In the next step, oils from white mustard seed and evening primrose seed were subjected to a two-step synthesis consisting in the epoxidation of double bonds and the opening of the obtained epoxide rings by various glycols. As a result of the synthesis, eight new bio-polyols were obtained, which were thoroughly characterized by the determination of the hydroxyl number, acid number, density, viscosity, water content, molecular weight and functionality. The chemical structure of the new compounds was confirmed by FTIR, ^{1}H NMR and ^{13}C NMR spectroscopy.

Bio-polyols based on white mustard oil and evening primrose oil were used in the synthesis of rigid polyurethane-polyisocyanurate foams. The addition of new compounds to the polyurethane formulation was carried out by partially replacing the petrochemical polyol therein. The obtained materials were subjected to mechanical tests (including compressive strength, brittleness, etc.), accelerating aging tests (stability of linear dimensions and geometric volume, loss of mass), thermal insulation tests (structure analysis, heat conduction coefficient determination, etc.) and flammability tests (residue after combustion, LOI). Furthermore, selected foams were tested for the biodegradation process in the soil environment.

The important results of this doctoral thesis were the synthesis of new plant-based bio-polyols, which were successfully used as a partial replacement for petrochemical polyol. Rigid polyurethane-polyisocyanurate foams obtained on their basis were characterized by better functional properties than unmodified foams. Moreover, the addition of new bio-polyols into the polyurethane matrix has significantly contributed to the increased biodegradability of these materials.