COMPOSITES BASED ON RENEWABLE RESOURCES: NOVEL THERMOSET FROM HEMPSEED OIL AND HEMP FIBER REINFORCEMENT

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Driven by the need for replacing petroleum based materials, the production and use of thermoset matrices based on renewable resources is gaining importance. Next to the employment of natural fibers, the production and use of matrix thermosets based on renewable resources is gaining importance. Thus, the overall objective of the present study is to develop a composite which is based on hemp. Novel thermoset resin from hempseed oil as matrix and hemp fibers as reinforcing materials are used. Main focus is on optimizing matrix formulation and curing parameters in order to maximize the degree of cross-linking and mechanical performance characteristics as well as bio-based carbon content. Fatty acids of hemp seed oil were functionalized by epoxidation of double bonds. A highly efficient procedure yielding maximum epoxidation was established. The epoxidized oil was cross-linked by adding a petrochemical-based hardener (Methyltetrahydrophthalic Anhydride, MTHPA), and a catalyst (2-Ethylimidazole). Systematic variation of functionalized oil and hardener concentration was done for establishing a high degree of crosslinking. A hardener concentration of 40 wt.% leads to best mechanical properties, resulting in high glass transition temperature (T_g) and storage modulus. Hardener concentration exceeding 40 wt.% yield at least partial antiplastification. An increase in catalyst concentration decreased initial temperature of reaction, reaching saturation and maximum conversion at a concentration of 2.6 wt.%. The effects of curing temperature and time on conversion and mechanical performance was investigated with the optimized mixing ratio of 100:70:4.6 (functionalized oil: hardener: catalyst). After generating a polymer physical property profile of the novel thermoset matrix, fiber reinforcing with hemp fabrics was done by applying vacuum infusion technology. For characterizing mechanical properties of the composites tensile, in plane shear and compression tests were performed. The attained extensive set of information emphasizes a great potential of a novel thermoset representing an innovative, and sustainable substitute for petrochemical based composites. The research project is funded by the Austrian Ministry for Transport, Innovation and Technology in frame of the program “Produktion der Zukunft” under contract no. 848668, project “Green Composites for Green Technologies”. The used hemp seed oil was given by Waldland Naturstoffe GmbH.