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Synthesis and Properties of Oxidized Corn Starch Based Wood Adhesive

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Abstract : At present, formaldehyde-based adhesives such as urea-formaldehyde (UF), melamine-formaldehyde (MF), melamine – urea-formaldehyde (MUF), etc. are mostly used in wood-based panel industry because of their high reactivity, chemical versatility, and economic competitiveness. However, formaldehyde-based wood adhesives are produced from non-renewable resources and also formaldehyde is classified as a probable human carcinogen (Group B1) by the U.S. Environmental Protection Agency (EPA). Therefore, there has been a growing interest in the development of environment-friendly, economically competitive, bio-based wood adhesives to meet wood-based panel industry requirements. In this study, like a formaldehyde-free adhesive, oxidized starch – urea wood adhesives was synthesized. In this scope, firstly, acid hydrolysis of corn starch was conducted and then acid thinned corn starch was oxidized by using hydrogen peroxide and $CuSO_4$ as an oxidizer and catalyst, respectively. Secondly, the polycondensation reaction between oxidized starch and urea conducted. Finally, nano – TiO_2 was added to the reaction system to strengthen the adhesive network. Solid content, viscosity, and gel time analyses of the prepared adhesive were performed to evaluate the adhesive processability. FTIR, DSC, TGA, SEM characterization techniques were used to investigate chemical structures, thermal, and morphological properties of the adhesive, respectively. Rheological analysis of the adhesive was also performed. In order to evaluate the quality of oxidized corn starch – urea adhesives, particleboards were produced in laboratory scale and mechanical and physical properties of the boards were investigated such as an internal bond, modulus of rupture, modulus of elasticity, formaldehyde emission, etc. The obtained results revealed that oxidized starch – urea adhesives were synthesized successfully and it can be a good potential candidate to use the wood-based panel industry with some developments.

Keywords : nano-TiO_2, corn starch, formaldehyde emission, wood adhesives
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