

Waterproofing of tissue using supercritical fluid CO₂ impregnation process

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Abstract

The analysis of the substances currently used as waterproofing agents was made. The urgency of the task of finding new repelling agents are soluble in supercritical fluids is shown. Ammonium palmitate is proposed as a potential hydrophobing agent for cotton fabrics alternatively to fluoropolymers. An experimental study of the solubility of ammonium palmitate in pure and modified polar with additives – acetone and dimethyl sulfoxide – supercritical carbon dioxide (SC-CO₂) was presented. The measurements were performed in the temperature range from 308.15 to 333.15 K in the pressure range from 10.0-32.5MPa. The studies were carried out on the plant, implementing dynamic method of solubility studies, created on the bases of supercritical fluid extraction system R-401, produced by “Reaction Engineering Ink.” (South Korea). Experimental data of solubility are described using the Peng-Robinson equation of state. The description was based on the model of Mukhopadhyay and Rao, in which to improve the accuracy of the solubility description, saturated vapor pressure of ammonium palmitate was used as a second adjustable parameter in addition to the binary interaction coefficient. These solubility results formed the basis of the process of SC-CO₂-impregnation treatment of the five types of cotton fabric ammonium palmitate in order to make them water repellent, implemented as part of this work. We used to comb cotton fabric with a surface density of 250 g/m², linen cotton fabric with a surface density of 110 g/m², shirts cotton fabrics from twisted yarn, ribbon cotton belt LE-50-68-HB and tape cotton belt LE-10-70-HB. The process was carried out with the parameters corresponding to the maximum possible solubility of ammonium palmitate in pure and modified supercritical CO₂ in a static mode. Duration of the treatment of in supercritical fluid conditions ranged from 1 to 5 hours. After completion of the experiments, the contact angle of the treated fabric samples was determined. As a result of the SC-CO₂ - impregnation process, the contact angle has exceeded the values of 120°, and for some samples 150°, which is allowed to assume that these samples became ultra- ($\theta > 120^\circ$) and a superhydrophobic ($\theta > 150^\circ$).