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Synthesis of pressure-sensitive adhesives based on butyl acrylate, effect of cross-linking agent

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Abstract: Synthesis of acrylate pressure sensitive adhesives (PSAs) latex is accomplished through out a semi-continuous emulsion copolymerization using butyl acrylate (BA) and acrylic acid monomers with urea formaldehyde resin (UF) as cross-linking agent to controlling the adhesive properties. Effect of prepared urea formaldehyde resin on the copolymer properties such as shear strength, tack and peel strength was investigated. As the amount of urea formaldehyde was increased (up to 2.20%) in the resin, shear strength was increased from 230 kPa to a limited value of about 513 kPa, peel strength was increased from 0.23 N/mm to 0.31 N/mm, however, the amount of tack of the latex was reduced (from 2.9 cm to 5.5 cm).

Keywords: pressure sensitive adhesive, emulsion polymerization, crosslinking agent, adhesive, acrylate latex.

Introduction

Pressure-sensitive adhesives are viscoelastic materials which can adhere strongly to solid surfaces upon applying of slight contact pressure within a short time [1]. Synthesis of acrylate PSAs latex is accomplished through out a semi-continuous emulsion polymerization using butyl acrylate (BA) and acrylic acid and so on monomers [1,2]. The term “pressure-sensitive” describes adhesives which in the “dry” form are permanently tacky at room temperature and firmly adhere to a variety of widely different surfaces upon contact without the need of more than finger or hand pressure [3]. Acrylic ester monomers are also widely used to synthesize PSAs through solution or emulsion polymerization[1,4].

The three properties which are useful in characterizing a PSA are tack, peel strength (adhesion) and shear strength (cohesion) [3]. Cross linking is one of the key techniques controlling balance between cohesive and adhesive strength of the PSA polymer [1,4]. Urea formaldehyde resin (UF) was used as cross-linking agent in this research.

Experimental/ Theoretical

Butyl acrylate and acrylic acid were prepared from Petro Chem., Dubai , UAE. UF was obtained from Samed Chemical Industries CO, Mashhad, Iran. Dioctyl sulfosuccinate (DOSS), stabilizer, was purchased from Sigma Aldrich CO. St. Louis, USA. Neonyl phenol ethoxylate (k30) was prepared from Kimiagran Emroz CO. Tehran, Iran. Commercial ammonium persulfates and sodium bicarbonate was used as initiator and buffer respectively, the chemicals were bought from Merck CO. Germany.

Emulsion polymerization technique was used to prepare the latex of butyl acrylate. The polymerization was performed in a four-inlet one-liter glass reactor equipped with temperature control, thermostat, mechanical stirrer and injection funnel. Pre-emulsion was prepared using BA (354 g), surfactant (DOSS, 9.5 g), k30 (3.75 g), water (114 ml), initiator (APS, 0.6 g) and sodium bicarbonate (0.7 g). The pre-emulsion (15%) was added to the reactor at the beginning of the polymerization. The rest of the pre-emulsion, however, was gradually injected into the reactor for about 5 h. The cross-linker (UF) (from 0.00 up to 2.20% of the pre-emulsion) was added after 2:30 h from started of the reaction.

Results

By increasing of the UF percentage, the cross-linker, into the resin up to 2.20 % of the total amount of synthetic resin, the shear strength was increase to a limited values (from 230 kPa to 513 kPa) (Fig 1), while, peel strength shows a maximum value of 0.31 N/mm (at 0.44-0.88 %) (Fig 2). However, tack of the resulted latex was decreased (from 2.9 cm to 5.5 cm) (Fig 3). All of the experiments were carried out after 24 h of the polymerization and the presented results are average of at least three samples.

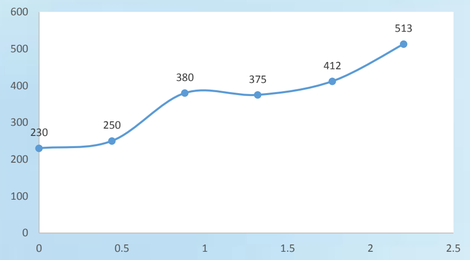

Fig. 1 Effect of UF concentration on shear of the latex.

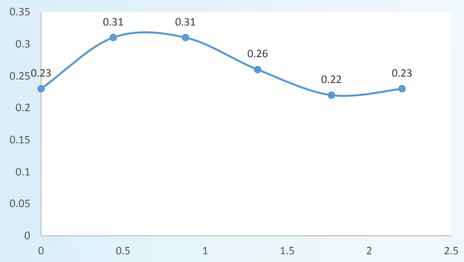

Fig. 2 Effect of UF concentration on peel strength of the latex.

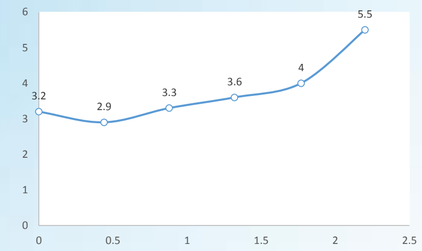

Fig. 3 Effect of UF concentration on tack of the latex.

Conclusions

As the amount of Urea Formaldehyde was increased (up to 3.09%) in the resin, shear strength was increased from 230 kPa to a limited value of about 513 kPa (Figure 1), peel strength were increased from 0.23 N/mm to 0.31 N/mm, however, the amount of tack of the latex was reduced (from 2.9 cm to 5.5 cm).

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