Hybridization and Functionalization of Aqueous-based Polyurethanes

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Conventional solvent-based polyurethane (PU) has been well established for wide applications, such as textile treatment, coating, adhesive, and so on. Due to the requirements of safety, health, economic, and environmental protection, the solvent-based PU is restricted and has been phasing out and tends to be gradually replaced by aqueous-based PU. Therefore, aqueous-based PU is becoming the world market trend, which is a kind of environmental friendly product.

Aqueous-based PU dispersion can be easily prepared by a conventional PU pre-polymer process with the incorporation of ionic center becomes part of polymer backbone and then it is dispersed into water phase. Although aqueous-based PU has many applications, its chemical resistance, physical and mechanical properties are still insufficiency comparing with solvent-based PU. Because of aqueous-based PU is a linear thermoplastic polymer with lower average molecular weight.

Their properties modification of aqueous-based PU are normally performed by a post-curing reaction or a combination of polymer hybridization and curing reaction to enhance the polymer cross-linking density. A latent curing agent is added to aqueous polymer emulsions and resulting in self-curable aqueous PU system. The curing reaction takes place on drying and forming cross-linked PU. The hybridization process of aqueous PU dispersion with other aqueous polymer emulsions can be blended in aqueous phase at ambient temperature and forming stable homogeneous hybridized polymer emulsions. And a latent curing agent is added into the hybridized polymer emulsion and the resulted PU hybrid is obtained from this self-curable hybridized polymer emulsion on drying, which is similar to the self-curable aqueous PU system.

A self-cured PU hybrid is formulated by mixing aqueous-based PU dispersion with aqueous-based epoxy resin or acrylate emulsion in aqueous phase and then treated with an aziridine containing curing agent. The self-curing reaction of PU hybrid can only take place on drying or at pH drops below 7.0. The performance properties are improved of these self-cured PU hybrids and its application cost also can be reduced according to hybridization ratio of polymers and the compensated properties of final PU hybrid.

Furthermore, a special function is added to aqueous-based PU in order to increase the application value additional to the property modification. For examples, flame retardation, polymeric dye, hydrophilic property and etc.

The flame retardation property of polymer is introduced by a phosphorus and nitrogen containing curing agent. The incorporation of phosphorus and nitrogen content that contribute the flame retardation elements on top of cross-linking function of the curing agent. This type curing agent serves as a dual-function for aqueous-based PU, which is suitable for coating application.

An organic soluble dye (dispersed dye) or a water-soluble dye (direct dye) is incorporated into PU backbone by an addition reaction of reactive dye with its NCO groups. The resulting dye containing PU dispersion is treated with a latent curing agent and becomes a self-curable aqueous-based polymeric dye, which becomes a solvent and water resistant polymeric dye after dry at ambient temperature or contact with acid paper. This polymeric dye dispersion has potential for printing ink and dyeing applications.

A hydrophilic character, which is brought to PU by using a hydrophilic moiety containing polyol reacts with polyisocyanate and becoming part of polymer. The hydrophilic moiety polyol includes non-ionic polyethylene glycols and ionic groups, such as carboxylate and sulfonate ions. A self-curing system of this hydrophilic PU is formulated, which is applied on textile surface by a thin-layer coating process.

Hybridization process and functionalization chemistry of aqueous-based PU dispersion as well as the final polymer properties will be presented.

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