THE SIZING AGENT FOR CARBON FIBER STRAND

REINFORCING THERMOPLASTIC RESINS

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Carbon fiber-reinforced thermoplastic resins composites, synthesized by using the carbon fiber as a reinforcing material have various superior properties, such as high tensile strength, high tensile modulus, excellent heat resistance, excellent chemical resistance, excellent fatigue characteristic, excellent abrasion resistance, small linear expansion coefficient, consequent excellent dimensional stability, excellent electromagnetic wave-shield ability, high X-ray transmittability and the like. Therefore, carbon fiber-reinforced thermoplastic composites have widespread applications in various market sectors, such as automotive, household, sports, leisure, aerospace industry, general industries and the like.

Conventional carbon fiber-reinforced thermoplastic composites are produced in many cases, using a thermosetting resin such as epoxy resin or the like as the matrix. However, from the standpoint of recyclability and rapid moldability, recently attention has been paid to thermoplastic resin as a matrix resin. Polypropylene resin is inexpensive and having superior qualities in moldability, water resistance, chemical resistance, electrical insulation, etc. Therefore, use of polypropylene resin as a matrix of fiber-reinforced thermoplastic resin is expected to increase strikingly in the future. However, since polypropylene resin is a crystalline resin and moreover has no polar group in the molecule, it has low affinity with carbon fiber. It is known in the art that fiber-matrix interface interactions influence many bulk mechanical properties of reinforced composites. Thus, to effectively transfer the applied load from a weaker matrix resin to stronger fibers, it is necessary to improve fiber matrix interactions, especially in carbon fiber reinforced thermoplastic composites.

Carbon fiber strand is continued by a large number of ultrafine carbon fibers. Such carbon fiber strand has a small elongation, and tends to generate fluff. To carbon fiber strand is ordinarily added a sizing agent in order to prevent the generation of fluff and improve the collectability of carbon fiber to improve the handleability of carbon fiber and, in producing a carbon fiber-reinforced thermoplastic resin, to improve the affinity of carbon fiber strand with thermoplastic resin. For these reasons, it is desired to develop a sizing agent for carbon fiber strand, which has good affinity with thermoplastic resins (e.g. polypropylene resin), is low in fluffing particularly when subjected to fretting, and has appropriate drape.

In our study, a one-step direct method of making a high molecular weight functionalized polyolefin aqueous emulsion is provided. In this one-step direct method, a functionalized polyolefin having a molecular weight of at least 10,000, a fatty acid, a base, a surfactant, and water are heated in a pressure reaction vessel to a temperature above the emulsification temperature of polyolefin with agitation for a period of time sufficient to form an aqueous emulsion. This high molecular weight functionalized polyolefin aqueous emulsion can be added to a sizing composition and applied directly onto carbon fiber in the carbon fiber manufacturing process.
In the experiment, the PP wax is acidified and then react with a high molecular weight polyether amine. In certain conditions, the stable aqueous emulsion is prepared by the melting method or solution method. In order to make the acidification of PP wax the best, we found the best process parameters, including PP wax and maleic anhydride mass ratio of 100: 10, PP wax and BPO mass ratio of 100: 3, 110 ℃, 3 hours, and nitrogen protection. After that, the reaction with polyether amine, the best process is modified PP wax and polyether amine mass ratio of 100: 5, the reaction temperature of 105 ℃, the reaction time of 1.5 hours, also needing for nitrogen protection. Then, the emulsification process is the most critical. the emulsification temperature is 95 ℃ and the speed of water drip is 2ml/min. During the stirring process, the stirring speed changes with the viscosity of the liquid, and the emulsification time is 2h. After that, we can get the co-emulsion of toluene, water and PP wax, and toluene is removed by steaming to get PP wax water-based emulsion. Finally, we get a stable emulsion with 38% solid content, 58nm average particle size, pH =7.56, -58mv Zeta potential. On another type of emulsification, the pressure reactor is needed. Only a certain percentage of the PP wax, surfactants, polyether amines and water are added to the autoclave at one time, rose to 140 ℃, maintain at 3 to 4 atmospheres, stir at high speed for 2 to 3 hours, and then slowly cooled to room temperature to obtain a stable emulsion. The experiment results show that the solid content of the emulsion is 33%, the average particle size reaches 38nm, the pH is 7.35 and the zeta potential is -45mv. Both of the prepared emulsions can be used to sizing carbon fiber and glass fiber, and have good bonding effect on fiber reinforcing polypropylene resin.