
 ABSTRACTS (MASTER THESIS)

Effect of calcium carbonate addition on adhesion properties of sucrose-ammonium dihydrogen phosphate adhesive for particleboard

(Graduate School of Agriculture,
Laboratory of Sustainable Materials, RISH, Kyoto University)

Jiahua Zhou

Introduction

As a novel natural adhesive, mixture of sucrose and ammonium dihydrogen phosphate (ADP) has been investigated. The particleboard bonded with the adhesive had excellent physical properties, but pH of the solution after thickness swelling (TS) test showed low value of 2.9. This means that the particleboard had acidic property. Generally, acidic property of the particleboard causes corrosion of metal material such as a nail. To resolve the problem, addition of calcium carbonate (CaCO_3) which is sometimes used as a pH adjusting agent as well as a filler was attempted. In this study, the effect of CaCO_3 addition on the adhesion properties of sucrose-ADP adhesive for particleboard was investigated.

Materials and methods

Sucrose and ADP (mixture ratio of 85: 15) were dissolved in distilled water and the solution was used as an adhesive. CaCO_3 powder was added into the adhesive. The weight ratios of CaCO_3 to the solid-based adhesive were from 0 to 20wt%. In Group A, the mixture solution was dried immediately after mixing, while in Group B the mixture solution was dried after 6 h of conditioning. The drying condition was 80°C for 12 h. The dried mixture was heat-treated in an oven at 180°C for 10 min. The heat-treated powder was immersed in boiling water for 4 h, and the insoluble matter rate was determined from the weight change before and after the boiling treatment. The insoluble matter rate of the adhesive was calculated in consideration of the insoluble matter rate of CaCO_3 . The pH of the solution after boiling treatment was measured. Fourier Transform Infrared Spectroscopy (FT-IR) analysis of the insoluble matter was conducted. In manufacture of the particleboard, CaCO_3 powder was added into recycled wood particles. The adhesive was sprayed onto the particles at 20wt% solid content based on the dried particles. The weight ratios of CaCO_3 to the solid-based adhesive were from 0 to 40wt%. After drying the particles and mat-forming, the mat was hot-pressed at 200°C for 10 min. The pH value of the solution after TS test was measured as well as some physical properties such as TS, bending and internal bond strength. In addition, FT-IR analysis of the particleboard was conducted.

Results and discussion

The pH value of the adhesive increased as CaCO_3 content increased both in Groups A and B. This means that the acidic property of the adhesive became weak with increasing CaCO_3 content, irrespective of conditioning. In Group A, the insoluble matter rate of the adhesive was over 70%, irrespective of CaCO_3 content, and was higher than that of Group B. It was clarified that in addition of CaCO_3 , drying the mixture solution immediately was effective.

The pH value of the solution after TS test increased as CaCO_3 content increased. This means that the acidic property of the particleboard became weak with increasing CaCO_3 content. Furthermore, some mechanical properties of particleboard with certain CaCO_3 content slightly improved. The reason seemed to be that CaCO_3 could offset the acidic property of the particleboard, and would react with ADP to generate calcium phosphate such as hydroxyapatite.

Based on the results above, CaCO_3 addition was effective in weakening the acidic property of adhesive. The insoluble matter rate of the adhesive showed a high value if the mixture solution was dried immediately. In addition, CaCO_3 addition was also effective for offsetting the acidic property and improving some mechanical properties of the particleboard.