Preliminary

Chemical Components of Pyrolized Liquid of Wood-Based Materials and their Bioactive Efficiency*[1]

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(Received May 31, 2002)

Key words : pyrolysis, wood-based material, thermal degradation, bioactive efficiency, wood-vinegar-liquor

Introduction

Recycling of wood wastes is becoming an important issue in the efficient utilization of natural resources and the prevention of water and air pollution caused by less-considered disposal of these materials. Pyrolysis of wood wastes has been considered to be one of the promising methods of supplying wood charcoal as solid material and liquor as liquid material containing wood-vinegar-liquor and wood-tar.

Wood wastes discharged from dismantled wooden houses contain not only solid wood but wood-based materials such as plywood or other wood-based panel products which are composed from wood and adhesive. When wood-related wastes of these materials are pyrolyzed by heating, the chemical components are assumed to be included in the liquid products that derive from adhesive chemicals as well as wood.

In this study, the chemical components of pyrolyzed liquid obtained from commercial wood-based materials were analyzed and evaluated. In addition, the effectiveness of this liquid in controlling wood-destroying fungi was examined with consideration of the bio-active components included in the liquid product.

Materials and Methods

Chips from two types of plywoods and particleboards bonded with urea- and phenol-resin adhesives, and medium-density fiberboard (MDF) bonded with urea-resin adhesive were prepared and oven-dried. The plywood was made from red melanti (*Shorea* sp.), particleboard from mixed species of softwood and hardwood, and MDF used mixed tropical hardwood as the raw materials. These wood-based materials were supplied from the manufacturers as commercial products. Solid wood of red melanti was also applied to pyrolysis treatment as genuine woody material for reference.

The chips were carbonized with a laboratory-scale furnace under the heating conditions of target temperature of 500°C at a heating rate of 4°C/min controlling the temperature with thermocouples inside of the furnace heater. A constant rate of argon gas flow at 100 ml/min was maintained in the heater throughout the pyrolysis reaction. Iced water was used in the traps for condensation of the exhausted gas, and the pyrolyzed liquid was collected dividing into three parts with the rising of the heater-temperatures from room temperature (RT) to 300°C, 300–400°C and then 400–500°C. The target temperature of 500°C was maintained for one hour.

Gas chromatography - mass spectrometry (GCMS-QP5000, Shimadzu) was employed for chemical analysis of the liquid components. A column (DB-1701 ; J & W Scientific) with a diameter of 0.25 mm and length of 60 m was maintained at 45°C for 4 min, then the temperature was raised to 280°C at a heating rate of 3°C/min, and held at 280°C for 15 min. The retention time for GCMS reported earlier[1,2] was used for identification of the components, introducing the experimental analysis using standard chemicals in some cases. To determine relative concentrations of each component, 0.15% pyrene was added as an internal standard.

The pyrolyzed liquid was tested for its fungicidal effectiveness using a monoculture of *Fomitopsis palustris* and *Trametes versicolor* on the agar medium. The fungal development was measured on the medium containing the liquid diluted to a concentration of 0.1% with sterilized water.

Results and Discussion

Little difference was observed in the total yield of the pyrolyzed liquid from solid wood and wood-based materials, however the chemical composition of the liquid greatly differed among solid wood and the types of the three wood-based-materials. Resin types also contributed to the differences.

When plywood or particleboard bonded with urea-resin adhesive was pyrolyzed, the characteristic components such as acetamide or pyrrole were identified in the liquid, and these were assumed to be derived from the glue-adhesive (Fig. 1). A large number of these nitrogenous compounds possibly due to the thermal degradation of the adhesive were detected at the relatively low heating temperature zone of RT–300°C. Although little difference was recognized in the chemical components of the liquid obtained from solid wood and plywood or particleboard in the temperature ranges of 300–400°C and 400–500°C,

*[1] Part of this paper was presented at the 52nd Annual Meeting of Japan Wood Research Society in Gifu, April, 2002.

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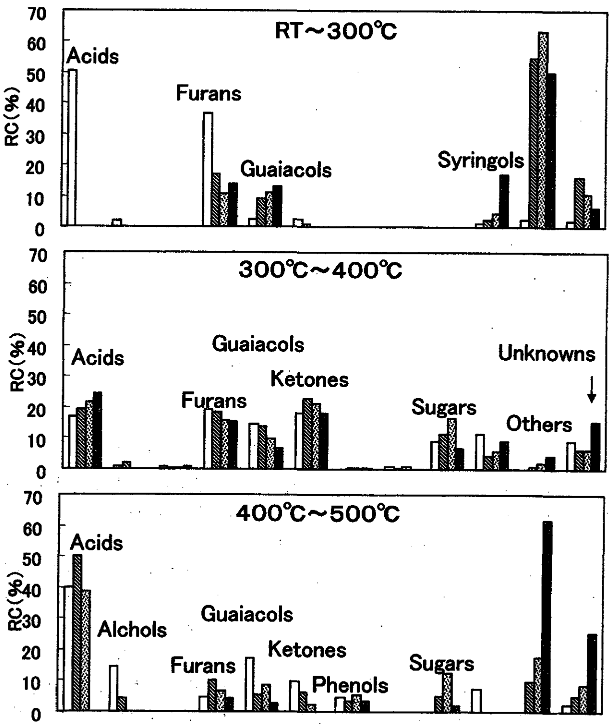

Fig. 1. Relative concentration of chemical components of pyrolyzed liquid of plywood, particleboard and MDF bonded with urea-resin adhesive. Legned: □; solid wood, ▧; plywood, ▨; particleboard, ■; MDF.

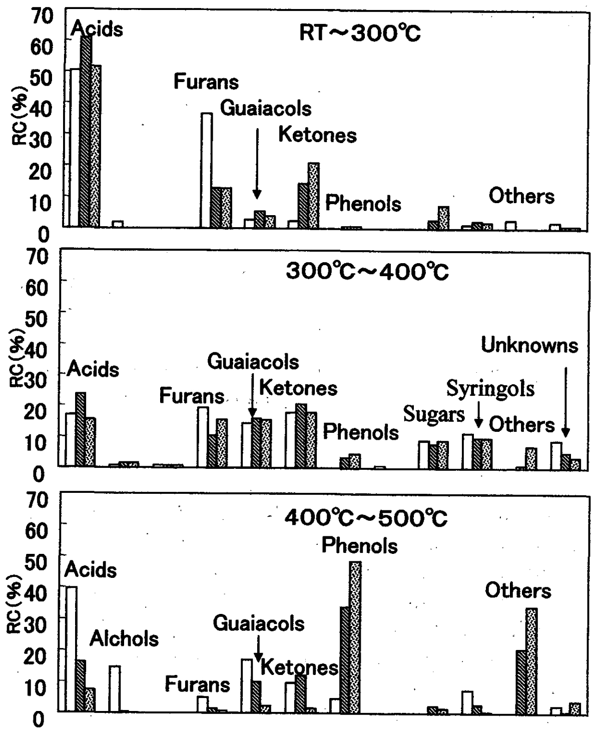

Fig. 2. Relative concentration of chemical components of pyrolyzed liquid of plywood and particleboard bonded with phenol-resin adhesive. Legned: □; solid wood, ▧; plywood, ▨; particleboard.

MDF led to the high production of the components derived from the adhesive in the range of 400–500°C.

When phenol-resin bonded plywood and particleboard were pyrolyzed, the yield of aromatic compounds including various types of phenol compounds increased along with the rise in heating temperature, and the maximum yield was obtained at the range of 400–500°C (Fig. 2). The increase of the components specific to glue-bonded materials around the high temperature zone was seemed to come from the degradation of phenolic resin used as an adhesive.

The components in the pyrolyzed liquid were assumed to consist of thermally degraded products of wood components such as cellulose or lignin, along with those of the adhesive resin used for glue. Chemical interaction between adhesive and wood components should also cause the production of distinctive compounds which were not derived from wood or adhesive individually.

Significant differences between plywood and particleboard were observed in the number of chemical components derived from adhesive, and it was remarkably larger in particleboard than plywood regardless of the type of adhesive used.

The fungicidal tests showed a significant difference in the effectiveness of preventing fungi between solid wood and wood-based materials, with the higher effectiveness being obtained for the latter materials. It was assumed that the chemical components derived from the glue-adhesives contributed to the increase in controlling the growth of microorganisms, as observed in the pyrolyzed liquid obtained in the range of RT–300°C for plywood and particleboard bonded with urea-resin, and of 400–500°C for those bonded with phenol-resin.

Acknowledgements

The authors deeply appreciate to Drs. K. Tsunoda, T. Yoshimura and all members of the Laboratory of Deterioration Control of Wood Research Institute, Kyoto University for their help and warm encouragement throughout the course of this study. Sincere gratitude is also extended to all members of the Laboratory of Wood Composite and the Laboratory of Structural Function for their warm hospitality while the first author spent two years in the Wood Composite Hall. The authors greatly thank Dr. M. Takatani of Department of Agriculture, Kinki University for his valuable suggestions.

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