Estimation and Reduction of Greenhouse Gas Emission from Adhesives for Wood Based Materials

Principal Investigator: Yasuhiro Hirai
Institution: Kyoto University, Kyoto City, Kyoto, JAPAN
Tel: +81-75-753-7706
E-mail: hirai@eprc.kyoto-u.ac.jp
Cooperated by: Akita Prefectural University

[Abstract]

Key Words: Wood adhesives, Wood-based materials, Greenhouse gas inventory, Fossil carbon, Natural adhesives, Sucrose, Low-volume spreading, Ultrasonic atomization, carbon footprint

Wood-based materials contain fossil-derived synthetic adhesives, and fossil-derived CO_2 is emitted during incineration, but until now, no country has quantified this source in the national emission inventory. Therefore, this study aimed to develop a method for estimating CO2 emissions from wood adhesives and develop natural adhesives and small-volume-spreading techniques to reduce these emissions.

First, we conducted a survey of materials and fuel consumption to plywood and LVL plants to determine the volume of adhesives used by wood material. We also developed an estimation method to determine the fossil-derived carbon content from elemental analysis of N, Na, and Cl in wood materials. Based on this information, a dynamic flow estimation model for wood and wood adhesives was developed. The model estimated that this source emitted 420,000 t-CO_2 in 2020, which will increase to 460,000 t-CO_2 in 2050.

In the development of natural adhesives, we developed an adhesive with a 90% natural product ratio, an easy adjustment method (mixed aqueous solution), and adhesive performance equivalent to type 18 of the JIS standard for particleboard.

In developing small-volume-spreading technology, we confirmed that even if the spreading volume is 1/10 of the conventional level, the ordinal adhesive performance is not affected, and the adhesive durability is almost equivalent to the JAS standard. As a new technology for small-volume-spreading, we found that the ultrasonic atomization technology has the potential to compensate for the disadvantages of conventional small-volume-spreading methods (spray and inkjet methods), such as almost zero application loss and no clogging at the nozzle. Furthermore, as a side effect of small-volume-spreading technology, we found the possibility of reducing the thermal pressure time during plywood production and relaxing the drying conditions for veneers before applying the adhesives due to the reduction of adhesive-derived water content.

Based on the development of natural adhesives and small-volume-spreading technologies, along with the recycling of demolition materials into boards and the lengthening of building life, we estimated the CO_2 reduction by these measures by 2050. The results showed that a total reduction of about 45% is possible. Furthermore, by type of measure, we found that the additional contribution of material recycling is small, while the contribution of the other three measures is significant.

[References]

1) Hirai Y, Tsuchiya Y, Takeuchi N, Yano J, Sakai S: The 7th 3R International Scientific Conference, online (2021) “Reanalysis of Production Statistics on Wood-based Materials and Wood Adhesives in Japan by Data Reconciliation Method”
2) Takeuchi N, Tsuchiya Y, Hirai Y, Yamauchi H, Adachi K, Umemura K, Yano J, Sakai S: The 7th 3R International Scientific Conference, online (2021) “Fossil Carbon Content in Wood-based Materials Estimated by Elemental Analysis”
3) Hirai Y, Takeuchi N, Yano J: The 8th 3R International Scientific Conference, online (2022) “Estimation of Fossil Carbon in Wood Adhesives and Evaluation of the Effects of Reduction Measures”