Wood Adhesive Trends in Asia

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Abstract

The production volumes and trends of wood adhesive usage in East Asia, especially in China and Japan, are presented in relation to the production trends of wood-based composite products. The trends in these regions and countries are also compared to those of the United States and Europe. This paper includes statistical data on Japan and China.

Introduction

Reliable statistical data on China and Asia could not be obtained because of the large discrepancies among the sources of information and the classification of adhesives, such as the identification between urea-formaldehyde (UF) and melamine-urea-formaldehyde (MUF) resins. Generally speaking, however, in China the demand for wood adhesives is dramatically increasing as a result of the increasing production of wood composites which was estimated during the last Wood Adhesives conference in 2000 (9). This trend is expected to continue in the near future. In Japan, wood adhesive demand is still decreasing slightly owing to economic conditions. The utilization of domestic softwood is an urgent problem. Therefore, the demand for phenol-formaldehyde (PF) resin can be estimated to be increasing. The demand for aqueous vinyl polymer solution-isocyanate (API) is also expected to increase for use in plywood as well as structural laminated wood products. The trends of wood adhesive usage in other Asian countries did not change greatly over the past five years.

Comparison of Worldwide Wood Adhesive Production

Figure 1 compares the 2004 production amounts and types of wood adhesives among China, Japan, and other Asian countries as well as the United States and the European Union (EU) (3). China has first place in the production of wood adhesives and also in that of amino resins including urea-formaldehyde (UF) and melamine-urea-formaldehyde (MUF) resins, which are used in manufacturing interior-grade wood composites. Japan uses amino resins for interior-grade plywood, as do other Asian countries such as Indonesia and Malaysia. The United States uses large amounts of phenol-formaldehyde (PF) resins in the production of structural panels.

Figure 2 was synthesized by the data (1,5,7,8) which had been reported in Wood Adhesives 2000 (9) and also...
compared production amounts of amino resins (UF/MUF/MUPF), PF, and diphenylmethane diisocyanate (MDI). In Figure 2, the data of North America included the United States and Canada, and those of Europe included the European Union (EU) and were based on 1997. Therefore, a direct comparison cannot be performed between Figures 1 and 2. Especially the total amount of wood adhesives excluding poly(vinyl acetate) (PVAc) emulsion adhesive of China was estimated below 500,000 tons. This is not consistent with the current data (4), in which the total amount of wood adhesives is estimated to be approximately 920,000 tons. The largest share of amino resins is in Asian countries and Europe, and the largest share of PF resin usage is in North America as shown in Figures 1 and 2.

As for the other Asian countries, the total production of wood adhesives in 2004 was estimated to be approximately 600,000 tons, which is larger than the amount for Japan. But, as previously mentioned, the types of wood adhesives used resemble those for Japan except for the rather high share of PF resins. In most of the East Asian countries, interior-grade plywood is still the predominant wood composite product. Generally speaking, in Asian countries other than China and Japan, the market for MUF resin is larger than that for PF and UF resin. The annual production of PF resin in other Asian countries is estimated to be 30,000 tons, and Taiwan produces approximately 13,000 tons. Many Japanese companies have established joint enterprises with Indonesia and Malaysia. These two countries have increased their production volumes remarkably and exported product to Japan, while Japan has decreased their exports.

**Wood Adhesive Production in China**

The available Chinese information (4) in Figure 3 shows the annual production amounts of the primary wood adhesives for the last three years in China. The production amounts in 2003 were 1,180,000 tons of UF resin, 45,000 tons of MUF resin, 135,000 tons of PF resin, and 500,000 tons of PVAc emulsion, respectively. By these data, UF resin shares more than 90 percent of amino resins, and the share of MUF is estimated to be quite low. In Figure 1 according to Japanese information (3), the production amounts of UF and MUF in 2004 were each estimated to be 450,000 tons. Therefore, the classification between UF and MUF is considered different. Formaldehyde emission from wood products is still a big problem though Chinese information indicated that UF resins are synthesized with the lower molar ratio of F/U = 1.2 (4). Therefore, the application of an effective reduction method is necessary and the utilization of melamine will increase.

Anyway, production amounts have increased dramatically in China since 1995. Figure 4 shows the total production amount of wood adhesives (UF, MUF, and PF resins) used for manufacturing wood-based composites from 1997 to 2003, and data is estimated for 2005 and 2010. It is estimated to attain 1,690,000 tons in 2010.

The main usage of UF resins is in manufacturing plywood in China. China began to export plywood to the United States several years ago, while it had previously imported plywood. As the production of medium density fiberboard (MDF) used for construction of homes is increasing, accompanied with the development of economics, the demands of UF and MUF resins are also expected to increase. The market size of MUF resins will be three- to five-fold of Japan. The demand for PF resins is still not large.

Many Japanese companies manufacturing laminated woods have established factories in China and other Asian countries and production amounts are increasing.
API adhesive is used for structural laminated wood in a similar manner as in Japan. The present annual demand of API is approximately 15,000 tons, approximately one-third of which is imported from Japan.

**Trends of Wood Adhesive Production in Japan**

Figure 5 shows the annual production amounts of all of the synthetic adhesives as well as wood adhesives including UF, MUF, PF, and PVAc adhesives for Japan (3,6). The production of all of the adhesives had maintained a level of 1.2 million tons per year until 1997, but it decreased by 300,000 tons to 0.90 million tons in 2004. This decrease is considered to be due to the economic decline, and the decrease of UF resin production by 200,000 tons, which might be caused by the formaldehyde emission problem. As a result, the production of UF resin declined to 103,000 tons in 2004.

Figure 6 shows the annual change of production of wood adhesives in Japan. MUF resin remains at approximately 110,000 tons per year, which is almost the same level of UF resin. The annual production of PF resin had attained a level of 30,000 tons in 1990, but it has increased to 76,000 tons since 1990. In Japan, the production amount of resorcinol-formaldehyde (RF) resin was included statistically in that of PF resin and estimated to be approximately 1,500 to 2,000 tons per year. The production of API adhesives, which was initially developed in Japan, was approximately 10,000 tons per year in 1998. It increased to 25,000 tons in 2004 as shown in Figure 7 (4,6), because it began to be utilized for manufacturing of
Plywood according to the needs of non-formaldehyde adhesives for interior use.

Production Trends of Wood-Based Composites and Wood Adhesive Productions in Japan

Figure 8 shows the change in the annual demand of wood in Japan for the past 15 years (2). It stayed level at more than 100 million m³ until 1996 and has decreased to approximately 90 million m³ due to economic decline. The Japanese wood industry has primarily depended on the production of hardwood plywood since the end of World War II, and UF resin has dominated other wood adhesives. Figure 9 shows, however, the recent decrease of the domestic production of plywood, and imported plywood has attained almost 50 percent of the total plywood used in Japan (2). Moreover, importing hardwood logs from East Asia has become difficult. Therefore, a decrease of UF production may be anticipated. On the other hand, the demands of PF resin and PMF and PMUF co-condensed resins increase because the production of softwood plywood are increasing as shown in Figure 10.

The utilization of Japanese softwoods, especially Sugi (Cryptomeria japonica) which was planted after World War II, is an urgent problem in Japan. The production of structural-grade laminated wood is increasing remarkably (Fig. 11) and is estimated to increase more in the future. Therefore, the demands of RF (resorcinol) resin and API resin will increase. The production of softwood laminated veneer lumber was estimated to increase gradually (9), but has kept fairly low levels for five years as shown in Figure 12.
Table 1. Japanese Agricultural Standards (JAS) and Japanese Industrial Standards (JIS) for formaldehyde emission (revised March 29, 2003).

<table>
<thead>
<tr>
<th>Standard values after revision (March 29, 2003)</th>
<th>Standard values before revision (until March 28, 2003)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard value</td>
<td>Standard value</td>
</tr>
<tr>
<td>Marks</td>
<td>Avg.</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>F****</td>
<td>0.3</td>
</tr>
<tr>
<td>F***</td>
<td>0.5</td>
</tr>
<tr>
<td>F**</td>
<td>1.5</td>
</tr>
<tr>
<td>F*</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Revision of Japanese Standard for Formaldehyde Emissions

The Japanese Ministry of Welfare and Labor determined the target level of indoor concentration of formaldehyde as less than 0.1 mg/m³ (average for 30 min, 23C:0.08 ppm) in 1997 which is the same level as World Health Organization (WHO) standard. According to the target level, the Japanese Agricultural Standard (JAS) for plywood was revised on March 29, 2003, and simultaneously the Japanese Industrial Standards for particleboard (JIS A5908) and fiberboards (JIS A5905) were changed. The revision is shown in Table 1 and applies to plywood, particleboard, and fiberboard including MDF. The designation was classified by three kinds using numbers of star (*) marks corresponding to Fco, Fc1, and Fc2, and the kind of four stars (F****) was newly established. Correspondingly the Japanese Building Standards for Finishing Interior of House was also revised on July 1, 1993 as shown in Table 2. It was established by considering the

Table 2. Japanese Building Standards for finishing interior of house and regulation by formaldehyde emission materials.

<table>
<thead>
<tr>
<th>Formaldehyde emission rate (mg/m²h)</th>
<th>Construction materials permitted officially</th>
<th>Possible area for finishing materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Name</td>
<td>Ventilation rate, more than 0.5</td>
</tr>
<tr>
<td></td>
<td>Corresponding standard</td>
<td>Ventilation rate, more than 0.7</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 0.005</td>
<td>no regulation</td>
<td>No regulation</td>
</tr>
<tr>
<td></td>
<td>made with non-formaldehyde adhesives</td>
<td></td>
</tr>
<tr>
<td>0.005 ~ 0.02</td>
<td>Third kind materials</td>
<td>Within 2-hold of floor area</td>
</tr>
<tr>
<td></td>
<td>F*** (Eo, Fco)</td>
<td>Within 5-hold of floor area</td>
</tr>
<tr>
<td>0.02 ~ 0.12</td>
<td>Second kind materials</td>
<td>No regulation of under-roof</td>
</tr>
<tr>
<td></td>
<td>F** (E1, Fc1)</td>
<td>Within 0.3-hold of floor area</td>
</tr>
<tr>
<td>&lt; 0.12</td>
<td>First kind materials</td>
<td>Within 0.8-hold of floor area</td>
</tr>
<tr>
<td></td>
<td>F* (E2, Fc2)</td>
<td>Not permitted</td>
</tr>
</tbody>
</table>

Figure 12. Annual production of LVL in Japan (9).

Figure 13. Annual production of boards in Japan.

Figure 13 shows the annual production amounts of particleboard, hardboard, MDF, and insulation board. Among these, the production of MDF is increasing gradually similar to the other countries. The adhesives used for manufacturing MDF are mainly UF resins, but it will change to MUF resins with high melamine contents because of the reduction of formaldehyde emissions from the final products.
relation of formaldehyde emission rate with the ventilation rate and the area of finishing materials. No regulation is applied to the materials of special grade and they can be used in any area. Materials of this grade should be those made with non-formaldehyde adhesives or F***.

Conclusions

In conclusion, topics on wood adhesives in Asia are summarized as:

China
1. The demand of wood adhesives has increased remarkably since 1995 and is expected to continue to increase in the near future according to the increasing production of wood composites and economical development.
2. Formaldehyde emissions from wood products remain a big problem. Therefore, the application of effective reduction methods is necessary and utilization of melamine will increase.
3. The demand of plywood and MDF will increase.

Japan
1. The utilization of domestic softwood is an urgent problem. Therefore, the demand for PF resins is estimated to increase and that of UF resins will decrease.
2. Manufacturing of plywood with API adhesives has begun, and its demand will increase for use in plywood as well as laminated woods.
3. The regulation of formaldehyde emissions from wood-based materials was revised, and JAS for plywood and JIS for particleboard and MDF were changed. The Japanese Building Standards for Finishing Interior of House was also revised with consideration of the relationship of formaldehyde emission rate to the ventilation rate and the area of finishing materials.

Other Asian Countries
1. The market scale of MUF resins is larger than UF and PF resins.
2. Formaldehyde emission problems are the same as in China, and utilization of melamine will increase.
3. Many Japanese companies have established joint enterprises with Indonesia and Malaysia. These two countries have increased their production amounts remarkably and exported product to Japan.

Literature Cited