CHAPTER SIX

CONCLUSION

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6.1   Conclusion

As formaldehyde can off gas from the materials made therefrom, formaldehyde based resin bonded plywood and other composite wood products (CWPs) are potential indoor contaminants in respect of the release of formaldehyde. The phenomenon of formaldehyde emission and exposure is not a new issue.

In this study, the factors affecting the plywood formaldehyde emission are evaluated. As cellulosic material, the water in wood is readily changed. Therefore, the wood moisture content was discussed first and it was confirmed that higher formaldehyde emission are enhanced by greater moisture content. The emission from moisture contents of 18% was higher than 14%, 10%, and 6% was the lowest. In addition to the effects of moisture content to formaldehyde emission, the influence of the inner core (IC), which is stronger than the surface veneer (SV) for plywood panels, was evidenced.

Wood species and the respective physical properties also affect the formaldehyde emission. The yellowish wood species were found to emit more formaldehyde compared to the reddish wood. In addition, more acidic species have been proven to retard the formaldehyde emission. Although wood porosity has been demonstrated to have a less significant influence, when combined with the colour and pH effects, the wood species became a significant factor in predicting the formaldehyde emissions, for a given moisture contents.

The formaldehyde emission issue has caused public concern. The mandatory regulations enforced by the countries that are the major consumers of composite wood products have built up a quality control system and standards to protect the environment and human health from the carcinogenic effects of formaldehyde emission. Therefore, a variety of methodologies has evolved for the determination of formaldehyde. Solid phase micro-extraction sampling from absorption solution (SPME-A) and air sampling directly from wood specimen (SPME-W) have been introduced for the first time to study the formaldehyde emitted from plywood panels. Technically, SPME-A and SPME-W are applicable for wood based formaldehyde evaluation, similar to the existing methods, such as desiccate-acetyl acetone (DC-AA), small chamber-chromotropic acid (SC-CA) and liquid-liquid extractions in combination with different detectors (LLE-FID & LLE-ECD).

The correlations of standard methods to the SPME have produced very good coefficient value of above 0.90 for treated plywood panel and above 0.93 for original untreated panel. High precision has been shown by the analytical methods used. The validation of SPME is evidenced through their good linearity, precision and high recovery abilities. The application of the SPME-W method to the existing method also overcomes the risk of insensitive conventional methods for ultra-low formaldehyde emission.

Much concern has arisen over the accuracy, efficiency and sensitivity of the analytical methodology for formaldehyde as a result of the subsequent increase of indoor environment air tightness, better known as 'sick house syndrome.' The effort to reduce energy losses after the energy crisis in the 1970s, however, has accelerated the formaldehyde problem (FPL, 2006). The minimisation of formaldehyde emissions from wood products could result in a better quality of environment. The influence of surface veneer thickness and

scavenging are significant for the minimisation. The elevation of surface veneer thickness lowers the most easily liberated portion of free formaldehyde. From a long term perspective, the formaldehyde scavenger solution, FS 25% is highlighted. The FS 25% acting as the urea based scavengers are found to effectively minimise a large portion of the formaldehyde. It is able to reduce the initial amount of free formaldehyde, which also helps to capture the non-reacted formaldehyde present in the plywood panel, which is susceptible to hydrolysis.

6.2   Future Research

In order to change from the conventional methods to more advanced analytical techniques, it is necessary to ensure that the SPME-W is also suitable for the analysis of other wood products. Therefore, test samples should include particleboard, medium density fibreboard, oriented strand board and other wood composites in the analysis of formaldehyde emissions.

The robustness of the SPME-W should be improved to be truly implemented in the wood industry for a large quantity of analysis. More studies should be carried out to reduce the limitations in the new applications method, especially the repeated fibre derivatisation prior sample extraction. In this case, a more economic and highly effective derivatisation agent should be determined. Otherwise, the removal of the derivatisation procedure could be considered to shorten the interval for testing. This will further improve the efficiency of the SPME-W method.

More study is needed to improve the sensitivity of the SPME methods for extremely low levels of formaldehyde emissions. Therefore, the use of internal standard is suggested

for further investigation. The most suitable functional group of the internal standard should be discussed together with its working parameters and reaction mechanism in the future studies.

The correlation between SPME-W and other standard methods should be further verified for better reliability. In addition, the correlation of SPME-W with other standard methods (large chamber, perforator and gas analysis methods) as well as the newer methods (passive flux sampler, annular denuder, fields and laboratory emission cell) should be generated for its thorough coverage. Meanwhile, inter laboratory correlation of volatile formaldehyde by the SPME-W method should be carried out in the future for similar objectives.

Contrary to other composite materials, wood ages and its formaldehyde contents decay during its life-span. Testing samples is another means for further experimentation, especially for tracing the performance of formaldehyde minimisation treatments over time. Therefore, the formaldehyde emission of panels with larger veneer thickness and sample panels that underwent scavenging treatments should both be evaluated continuously for a longer time of monitoring for the emission deformation rate.