FORMALDEHYDE - A HEADACHE OR WINDOW OF OPPORTUNITY

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Summary
Consumers in the developed countries are becoming increasingly concerned about the safety of the products they use. Japan in particular is leading the way to lowering formaldehyde emission limits for wood products used within buildings. These changes provide both challenges and a window of opportunity for New Zealand companies. New Zealand resin suppliers and wood product manufacturers are world leaders in low emission technology and are now in the unique position of being able to brand New Zealand products as certified high quality low emission product from a sustainable resource. However it is likely that this window of opportunity will be short lived.

Background
Rotting Homes a Growing Problem; One News; May 2002
"Leaking and rotting houses are sending shudders through New Zealand's building industry ….."

CCA Treated Timber: Consumer Safety At Risk; ACA Australia; July 2003
"Arsenic is a known human carcinogen. Last year, the Washington-based Environmental Working Group released their study on children's playgrounds made from CCA treated timber. What researchers found was the amount of arsenic a child would get on its hands was more than was considered safe in the US to drink in a glass of water."

Sick-house Syndrome Spreads To Schools: Kyodo News; October 2003
"Sick-house syndrome (a skin and respiratory ailment that is linked to chemical pollutants in enclosed areas) appears no longer confined to residential houses. Education officials in Japan have detected air pollutants linked to sick-house syndrome in many education facilities, causing headache and nose and throat irritation among students."

Introduction
In the past four years there have been a number of news headlines that have brought into question the healthiness of our wood based products. Copper chrome arsenate (CCA), *Stachybotrys* associated with leaky homes and formaldehyde in indoor air, have all had their share of the media focus. While the scientists and health professionals may still be debating the true dangers presented by each of these issues, in many cases the public and authorities have made their decisions and the regulatory process has begun. For those of us involved with formaldehyde emission from wood products the headlines have been just the tip of the iceberg. Behind the scenes there has been a growing labyrinth of new regulations necessitating development of advanced adhesive, manufacturing and testing technologies and also quality certification systems for the finished product.

The trend to control formaldehyde-emitting products has had a growing affect on the wood products industry in New Zealand. Panel products, (MDF, particleboard and plywood) and engineered wood products, (Laminated Veneer Lumber and Glued Laminated Lumber) often use formaldehyde based adhesives and therefore continuously emit small, decreasing amounts of formaldehyde gas into the atmosphere. There are two options for reducing the formaldehyde emission from these types of product. The first is to move to non-formaldehyde adhesives, but these are normally more expensive and there are other health issues associated with some of these chemicals. The second widely adopted option has been to develop the

formaldehyde resins technologies to enable production of products that comply with the new low emission requirement.

Over the past seven years TimberTest has been a world leader in the technologies associated with formaldehyde emission of testing wood based products. In the last three years TimberTest has also been active in the submission process involved with the regulatory changes resulting from sick buildings in Japan and Korea. In these countries it was found that the gases given off by the building materials, insulation, furniture and fittings were causing flu like symptoms in people living in some buildings. Whilst many of the pollutants found in these modern buildings may not have caused problems in the past, the air tightness of some modern buildings was found to be leading to a build up in pollutants. Since the beginning of the official reaction to the issue there has been a stream of regulation changes in Japan. Firstly the various testing standards and specifications were updated, followed by legislation to control the distribution and use of the products. Finally the most recent notifications have regarded a shift to ISO product certification guides to bring the new regulations into line with World Trade Organisation recommendations.

For the manufacturing exporters and resin suppliers these changes have provided a number of challenges, however the new technologies developed for the Japanese markets will provide opportunities in other regions where there are indications that there are also moves to lowering formaldehyde emission standards. For TimberTest these changes have meant constant development and change with ongoing investments in equipment and systems to provide the service needed by the manufacturing exporters.

Sick House Countermeasures in Japan

After reports that some buildings were making people sick and measurements of gases in the indoor air indicated that the concentration of pollutants in some buildings in Japan were above the World Health Organisation recommendations, the "Sick House Countermeasures" [(1)] were instigated to combat the problem. Whilst other volatile organic compounds (VOC's) have also been included in the specifications, the initial regulatory reaction has focussed mainly on formaldehyde. Formaldehyde produces a number of a skin and respiratory ailments and is also classed as a probable carcinogen by the International Agency for Research on Cancer[(2)]. The Japanese sick house countermeasures include recommendations, laws and regulations falling into a number of categories, i.e. indoor air guidelines, emission classifications, building regulations, testing standards and the JIS/JAS-mark quality control for product sold in Japan.

Japanese Ministry of Health, Labour and Welfare Guidelines for Indoor Air Quality [(3)]

The primary reference for indoor air quality is the World Health Organisation (WHO) recommendations on indoor air quality. These documents provide maximum recommended levels of pollutants in indoor air. Based on the WHO recommendations the Japanese Ministry of Health, Labour and Welfare has produced guidelines covering a range of VOC's including formaldehyde. This guide recommends the maximum formaldehyde in indoor air should be less than 100µg/m^3. In New Zealand, the Ministry for the environment has recently produced a similar document[(4)].

Standards Specifying Emission Classifications

The reference studies for categorisation of products into "classes" is determined using standard test chambers with a fixed ratio of the formaldehyde emitting material to chamber volume and with controlled air exchange rates.

In Japan these classifications exist in each of the many standards that cover the wide range of wood based building products. For example MDF, Particleboard, Plywood, Glulam and LVL all have their own standards [(5,6,7,8)]. However in conjunction with the sick house countermeasures, the terminology and emission classes used in the standards have been harmonised. These harmonised classes are identified using star ratings, from two star to four star, the lower the emission the more stars (F**, F*** and F****).

The high level of formaldehyde found in Japanese buildings was not predicted because formaldehyde emitting products were controlled under the existing law. However investigation revealed that some Japanese buildings were hotter, more humid and had fewer air exchanges than the "standard conditions" assumed for the predictions of emission. Since formaldehyde emission from wood based products is higher in such hot, humid conditions the emission was tested in the conditions actually found within the buildings.

This process led to the introduction of a new very low emission category, initially termed Super E0, and now known in harmonised terminology as F****.

Introduction of the F**** class has created both challenges and market opportunities for New Zealand manufacturers. There was little experience world wide with producing formaldehyde based resin products at such low emission levels. In Germany for example, another country sensitive to indoor air quality issues, the limit is more than twice the F**** value. The requirement for low emission products has put pressure on the New Zealand manufacturing exporters, on the resin manufacturers to develop a new range of ultra low emitting resins and on TimberTest to provide the accurate testing required for development and export certification.

Japanese Amended Building Standard Law

The regulations regarding the use of product to be used within buildings are contained in the Building Standard Law[(1)]. This document specifies the amount of F*** and F** which may be used within a room depending on air exchange and room size. F**** is unrestricted and this has resulted in a very large demand for F**** product.

JIS/JAS-mark Quality Systems

Manufacturers of formaldehyde emitting construction materials for use within buildings in Japan must have proof that their manufacturing systems are suitable. For most companies this means accrediting their plants to the JIS or JAS-mark. These are quality management systems similar to ISO9002 except audits may only be conducted by certifying bodies accredited by the Japanese authorities.

For Particleboard and MDF which are regulated under the Japanese Industry Standards (JIS), the JIS-mark is not presently compulsory, there is an alternative "Ministerial Approval" process which allows for product certification by authorised Japan based laboratories. For construction materials covered by Japanese Agricultural Standards (JAS), such as Plywood, LVL and Glulam, the JAS-mark is compulsory.

It is possible to manufacture in a factory without the JIS/JAS-mark accreditation and "mark" the product during a later process. For example, a non-JIS/JAS-mark manufacturer in New Zealand can export to Japan where the product is further processed by a factory with the JIS/JAS-mark accreditation.

Laboratory Testing

A cornerstone of this maze of regulations is the testing laboratory, which receives representative samples and determines the classification for a shipment or run of the product. The emission testing of product exported to Japan has been particularly problematic. Some of the problems are typical of the testing of many other products. For example every trade region uses different testing methods and for technical reasons it has been hard to produce accurate conversion factors to benchmark the new specifications in Japan against those of other regions. One of the early projects conducted by TimberTest was to produce these conversion factors allowing New Zealand companies to rank their products in other world markets.

The second issue has been that the testing standard specified for products exported to Japan, known as the "Japanese Desiccator Test" had been written when emission levels were up to ten times the level of the new specifications. When TimberTest first started carrying out formaldehyde emission it was apparent that New Zealand products were not receiving the same emission rating from all laboratories. TimberTest instigated a number of round robin trials with other laboratories and these indicated that different laboratories gave quite different results. In fact different laboratories testing the same product gave results spanning from the lowest to the highest emission class. There were also problems with repeatability, in that when one laboratory tested the same product on several occasions they could rate the product as a different emission class each time they tested it. These problems were not just confined to production laboratories, but included government and private research laboratories. This was obviously creating some major headaches for both the producers and the resin developers since identical products could obtain different emission ratings depending on when and where they were tested. Of particular concern were situations where the seller and buyer of products exported from New Zealand could not agree on the emission classification of products. In addition the fact that laboratories could not agree made the whole classification system questionable.

To investigate this problem visits were arranged to laboratories in Singapore, Malaysia, Japan, Norway, Germany and the UK to establish how the emission testing was being conducted. The differences between the methodologies being used were simululated in the TimberTest laboratory to determine which of the factors were causing the differences in test results. This work was then published to stimulate discussion on reaching agreement on how the testing should be conducted[9]. At this time there was also the "Joint Japan Australia and New Zealand Standards Harmonisation Committee" producing joint test methods called "JANS". During this process the Japanese, Australian/New Zealand standards were harmonised to produce a common set of methods with the objective of reducing trade barriers between these countries. Based on the TimberTest studies, TimberTest produced a new JANS formaldehyde emission testing standard. This harmonised method was then adopted by both JIS (Japanese Industry Standards) and AS/NZS standards.

TimberTest has also continued to run the round robin (LabCheck inter-laboratory trials) as a commercial service, with many laboratories around the world now taking part. Gradually the difference between the emission results from different laboratories has reduced. Additionally TimberTest and two other laboratories worldwide now have International Accreditation (IA) [*10] incorporating the Japanese emission test. The three IA laboratories have good reproducability, with all three rating products into the same emission class.

ISO Laboratory Standards and Certification Guides

During the introduction of the new regulations in Japan there has been opportunity via our Japanese Embassy to make submissions on the process. Government agencies and New Zealand companies including TimberTest put forward requests that JIS-mark and quality management of the laboratory testing should be by ISO standards to allow easier integration with the quality management systems already in place. Recent notification from the World Trade Organisation indicates that the Japanese based JIS-mark system will move to ISO product certification guides [11] and the new system will also require the use of IA laboratories. Since International Accreditation requires rigorous audits and a high level of technical competence it helps to ensure all IA laboratories rate products in the same manner. Additionally the results from an IA laboratory are accepted worldwide by the ILAC agreement [12,13], for example this means data from International Accreditation New Zealand laboratories (IANZ) like TimberTest, must be accepted as equivalent to that from Japanese accredited laboratories (IAJapan).

Trends in Other Trading Regions

In Europe most countries use the European Standards (EN) which stipulate both the formaldehyde emission test methods and the classification system. The lowest class in these standards is between two and three times the equivalent Japanese limit. The standard EN13986 " Wood-based panels for use in construction - Characteristics, evaluation of conformity and marking" [14], specifies the relevant characteristics that have to be satisfied in order for the product to be able to display the European conformity mark "CE". This denotes compliance with the Construction Products Directive (CPD). To place a wood-based panel for use in construction on the EU market the emission class must be specified and the emission must not exceed an upper value. However there is no EU wide building regulation specifying either the class or how much formaldehyde emitting material may be used within a building. Instead each country within the EU is acting independently depending on their stance regarding compulsory verses voluntary control. There are no immediate plans in the UK to bring in new legislation while other countries within the EU already have limitations on the use of formaldehyde emitting materials within buildings. Interestingly the UK - Building Research Establishment Ltd (BRE) has recently conducted a survey of formaldehyde levels in buildings and found that the levels were typically less than one third that recommended by WHO.

There are a number of voluntary environmental labels used within the EU [15]. The flower is the official EU wide label but is has not been widely adopted. Others such as the blue angel in Germany are better known. Internationally Accredited laboratories are widely used in EU and test results from these are accepted as proof that product meets the prescribed standard.

In the USA the United States Department of Housing and Urban Development have set maximum emissions for wood based products. The "HUD" marking system includes an emission classification requirement using ASTM testing standards, with lower limits that are similar to those in Europe.

Conclusions

The trend in the developed world is to an ever-increasing expectation that the products we use are safe for the general population and also for sensitive individuals. The definition of "safe" is a continuously moving target, creating niche opportunities for fast reacting companies.

There are trends toward harmonisation occurring within each of the trading blocks. The EU forms one trading region with agreement on testing methodology and CE marking. It will not be possible to place a construction product onto the European (EU) market unless it satisfies the essential requirements of the Construction Products Directive. Formaldehyde emission from such products is therefore controlled across the EU. Compliance with the Construction Products Directive is mandatory and a correctly CE marked product cannot be prohibited from entry into any country of the EU. National authorities may specify a particular requirement, such as emission class E1 may be specified in Germany for flooring whereas E2 may be accepted in a different member state.

Japan is a major influence within the Pacific Rim. There is a widespread move to use Japanese testing standards, not only by Australia and New Zealand but also in other Asian countries. At present JIS products may be used in Japan with "Ministerial Approval" however it is expected that in the future all companies exporting formaldehyde emitting JIS or JAS construction products for use within buildings in Japan must JIS/JAS-mark their products. Over the next two years the JIS/JAS-mark process will change with IA laboratory testing being introduced and a transition from Japanese ministerial law to ISO product certification guides. These changes are indicative of world trends to reduced trade barriers in accordance with the World Trade Organisation guidelines. As yet there are no laboratories in Japan with International Accreditation covering formaldehyde emission from wood based products. However given the current world trends Japan will almost certainly have such a facility within a few years. Once IA laboratories are generally used throughout the world the audit and review process will help reduce the problems associated with differences between laboratories.

To maintain our market share in the countries sensitive to these health issues requires an understanding of the underlying issues. We need to respond by modifying our products and the way we market them. Increasingly the perceived "healthiness" of our products can determine both price and saleability. New Zealand is a major exporter of low emission product to Japan and is a world leader in low emission MDF in particular. This places New Zealand manufacturers in an ideal position to take advantage of the worldwide trend to low emission panel products, but this will require an ongoing commitment to improvement of panel properties and lowering emissions.

TimberTest laboratory has International Accreditation and is recognised around the world as a leader in formaldehyde emission testing methodology. International Accreditation is a globally recognised laboratory quality standard meaning that certificates issued by TimberTest can be used to add a premium to the high performance low-emission panel products.

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