

**Resins of the future:
The continuing evolution of resins for wood based panels**

Presentation by Mr. A.C. Markessini to the European Panel Federation Annual General Meeting, Paris, France, June 23, 2000.

- Today, I will:
 - Address the major resin industry focus: formaldehyde-based resins;
 - Outline the new technical developments in the field and point out the current market trends;
 - Show some concrete examples of our new developments

FORMALDEHYDE BASED RESINS

- Formaldehyde-based resins, mainly urea-formaldehyde resins, have been the most important type of adhesive for the industrial production of wood-based panels since the 1920's.
- Today, the UF resins dominate the world market, 60% of the North American market and 85% of the European market.
 - The reasons for this are clear: UF resins are low in cost compared to PMDI or phenolic resins, and they are versatile in use and can be tailored to specific requirements.
- As you know, formaldehyde itself was actually designated as a possible carcinogen in 1978. This poisoned public opinion against formaldehyde for any application. Now we know the original analysis was wrong.
- A joint US-Canadian study recently released put the lifetime risk of cancer from occupational exposure to formaldehyde at 1 in 10 million people for smokers, and 4.1 in 1 billion people for non-smokers. This is for an exposure level of 0.1 ppm for 40 years, 5 days a week, 8 hours a day.
- Also, the UK Health and Safety Executive (HSE) reported in December last year, and I quote, "There is no evidence of any different ill-health effects associated with exposure arising from the machining of MDF to those associated with similar exposure arising from machining other forms of wood." This includes pure wood.
- The issue of formaldehyde emissions has been addressed through extensive Research and Development by reducing Formaldehyde/Urea molar ratios from 1.5-1.7 down to 1.05-1.20 and by creating formaldehyde catchers.

New regulations

- Finally, the enforcement of stringent regulations regarding the formaldehyde emissions was implemented in many European countries, particularly Germany, Belgium and Austria, has led to very positive results. For example, the maximum allowable formaldehyde limit for particleboard in Germany today is 6.5mg/100g board.

As a consequence of all these, today in Europe the problem of formaldehyde emissions from wood based panels is regarded as fully solved.

I believe it is important that all of us in this industry keep putting this message forward whenever we can. The facts are on our side and the industry has done its part. Some negative impressions of formaldehyde still exist, and we need to help correct this.

NEW DEVELOPMENTS & MARKET TRENDS

→ Much research is concentrated today on developing new products and processes to reduce the demands of the wood-based panels industry on petrochemical by-products. The development of new resins from natural and renewable resources is a major priority in the field. Recent developments are:

Lignin-modified PF resins

Industry has been trying since the 1980's to produce lignin-modified PF resins suitable for FB, OSB and PL. The target to replace as much as 35% of the phenol in such modified PF resins claimed to be achieved in the USA.

Tannin based adhesives

One German company has developed a tannin-based adhesive for marine grade OSB. Tannin extracts from radiata pine bark, mimosa and quebracho currently being used successfully in Chile and Australia for PB, MDF and OSB.

PF resins from pyrolysis oil

New technologies for the pyrolysis of biomass have been developed in the recent years. Transformation of wood, forest residues and other biomass to a liquid product called pyrolysis oil or bio-oil have shown promise in replacing partially phenol in the production of modified PF resins. Up to 50% of the phenol has been replaced by pyrolysis oil.

Barkboard

A new technology is being developed in North America to produce an OSB-type board called *Barkboard* using high pressure and temperature to exploit the bark's inherent phenolic compounds to bond the particles.

Increased competition and cost pressure is leading resin to diversification and manufacturing 'tailor-made' end products. Some trends in this direction include:

Faster resin systems

Research continues to increase plant capacity with new binding agents with ever-improved reactivity. This requires more efficient hardener and accelerator systems.

Improving moisture resistance

Another trend is strengthening melamine fortified UF resins, MUF to improve hydrolytic resistance and reduce swelling of panels.

New products with special resin needs

New fast growing products that have special resin needs include:

- flooring grade fibreboard (HDF)
- Ultra light MDF
- V313 and V100 particleboard
- FR particleboard and FR MDF

There are also some global trends making an impact in the industry. Among them,

- **Mega-sites.** The European wood based panels production is integrating forwards and backwards to create mega-sites. This trend is considerably accelerating structural changes in the European industry.
- **New products.** New products such as OSB are growing rapidly worldwide. Especially for OSB in Europe, a very big leap in capacity in the years to come is expected. The increasing application of OSB products in interior design, house construction and other will lead to the reduction of its prime cost.
- **Agri-board.** Agri-board made from agricultural residues like straw (mainly wheat straw) is new board product that is rapidly growing in the U.S. and Canada. Today seven (7) mills are currently operating in N. America. The prime resin used is PMDI.
- **Recycling legislation.** Environmental legislation continues to push the field. Several EU member countries like Germany have already enacted environmental legislation that forbids the dumping of materials containing more than 5% organic matter in landfills by the year 2005. By the year 2010, 50% of all goods should be recycled. In the near future, none of the products made by the companies represented in this room will be permitted to go to landfills in Europe.

OUR NEW DEVELOPMENTS

Our efforts today are focused - as I have mentioned - on improved final product performance, that is, wood panels with high mechanical strength and water resistance as well as low formaldehyde emission.

We been unique in our approach to resin delivery – developing tailored solutions and producing as close as possible to board producers. As mega-sites become more prevalent, the ability to integrate resin production into these full integration facilities becomes critical.

A.C.M.'s strength has always been our R&D department, the Adhesives Research Institute, which is a pioneer in research guided by protection of the environment and preservation of our precious ecological system. Following on the industry trends, let me now briefly present you a few of our most recent developments:

Firstly,

→ **Colourless OSB:** We have developed a resin system to produce light coloured OSB type panels. The system uses a special melamine-urea-phenol-formaldehyde (MUPF) resin and an adapted hardener and avoids using PMDI resins.

Secondly,

→ **UF-bonded strawboard:** We are currently scaling up a technology to produce agri-fibre panels using urea-formaldehyde resin.

This technology will be unique in the market since strawboard today is produced only with the use of PMDI resins.

Thirdly,

→ **Substitution of phenol in PF resins:** A totally natural resin is the target of our ongoing research and this is part of those efforts. Through appropriate modification of extracts from various natural products up to 50% of the phenol needed has been replaced, leaving the resin less toxic and more environmentally friendly. A reduction in the adhesive cost of up to 10% can be achieved.

CONCLUSION

→ In the continuing evolution of resins for wood-based panels, we see now that the main barrier for growth – the formaldehyde emissions - has been removed.

→ Actual market requirements have introduced considerable and important impulses. The main driving forces today in our industry are 'cheaper', 'quicker', 'greener' and 'more complex'.

The first two, 'cheaper' and 'quicker', are caused by the high competition trying to minimise costs at a certain level of product quality and performance. The third, 'greener', originates from the public opinion and the stricter regulations and environmental policies. The 'more complex' stands for new and specialised products and processes. It is true after all that development in wood-based panels is directly linked to development in resins and resin additives.

→ Despite prejudgements, both the wood based panels industry and the resin industry have shown a high commitment and capability to innovation. Progress in R&D during the last decade has demonstrated many successes.

→ Finally, the future will herald an even faster pace of change than the great leaps we have seen in the past. The partnership between panel producers and resin manufacturers will become closer, driven by competition and striving toward excellence, to the benefit of both.

Thank you all. I would be happy to answer any questions.

Overhead 1

Resins for the future: the continuing evolution of resins for wood based panels

A.C. Markessini
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Overhead 2

Resins for the future: the continuing evolution of resins for wood based panels

- Formaldehyde based resins
- New technical developments and current market trends
- A.C.M.'s new developments

Overhead 3

Formaldehyde based resins

- Urea-formaldehyde resins:
 - 60% of North American market
 - 85% of European market

Overhead 4

Formaldehyde based resins

“Hazard characterization and dose response assessment for carcinogenicity by the route of inhalation”

Sponsored by Health Canada and the United States Environmental Protection Agency

Predicted additional risk of cancer due to environmental and occupational exposures to formaldehyde emissions

Formaldehyde Exposure Concentration (ppm)	Exposure scenarios								
	Environmental ^a			Occupational ^b					
	Non-smoking	Mixed	Smoking	Non-smoking	Mixed	Smoking	Non-smoking	Mixed	Smoking
0.001	2.3X10 ⁻¹⁰	3.9X10 ⁻⁹	4.9X10 ⁻⁹	---	---	---	---	---	---
0.02	4.8X10 ⁻⁹	1.0X10 ⁻⁷	1.2X10 ⁻⁷	---	---	---	---	---	---
0.04	1.0X10 ⁻⁸	2.1X10 ⁻⁷	2.5X10 ⁻⁷	---	---	---	---	---	---
0.06	1.5X10 ⁻⁸	3.3X10 ⁻⁷	3.8X10 ⁻⁷	---	---	---	---	---	---
0.08	2.1X10 ⁻⁸	4.5X10 ⁻⁷	5.3X10 ⁻⁷	---	---	---	---	---	---
0.10	2.7X10 ⁻⁸	5.8X10 ⁻⁷	6.7X10 ⁻⁷	4.1X10 ⁻⁹	7.6X10 ⁻⁸	1.0X10 ⁻⁷	4.1X10 ⁻⁹	7.6X10 ⁻⁸	1.0X10 ⁻⁷
0.30	---	---	---	1.3X10 ⁻⁸	2.6X10 ⁻⁷	3.8X10 ⁻⁷	1.3X10 ⁻⁸	2.6X10 ⁻⁷	3.8X10 ⁻⁷
0.50	---	---	---	2.5X10 ⁻⁸	5.0X10 ⁻⁷	7.2X10 ⁻⁷	2.5X10 ⁻⁸	5.0X10 ⁻⁷	7.2X10 ⁻⁷
0.70	---	---	---	3.4X10 ⁻⁷	8.0X10 ⁻⁶	6.6X10 ⁻⁶	3.4X10 ⁻⁷	8.0X10 ⁻⁶	6.6X10 ⁻⁶
1.00	---	---	---	8.8X10 ⁻⁶	2.1X10 ⁻⁴	1.5X10 ⁻⁴	8.8X10 ⁻⁶	2.1X10 ⁻⁴	1.5X10 ⁻⁴

^a 80 year lifetime continuous exposure at indicated ppm.

^b 80 year lifetime continuous exposure at 0.004 ppm with 40 years occupational exposure (8hr/day, 5 days/week) at indicated ppm

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Formaldehyde based resins

“There is no evidence of any different ill-health effects associated with exposure arising from the machining of MDF to those associated with similar exposure from machining other forms of wood.”

- United Kingdom Health and Safety Executive report, December 1999

- Formaldehyde/Urea molar ratio: from 1.5-1.7 to 1.05-1.20
- Regulations on formaldehyde emissions

Overhead 6

New developments and market trends

Natural resins

- Lignin-modified PF resins
- Tannin based adhesives
- PF resins from pyrolysis oil
- Barkboard

Overhead 7

New developments and market trends

Competition trends

- Faster resin systems
- Improved moisture resistance
- New panels, new resins

Overhead 8

A.C.M.'s new developments

Helping define our future

The Adhesives Research Institute

Overhead 9

A.C.M.'s new developments

- Colourless OSB
- UF-bonded strawboard
- Phenol substitution

Overhead 10

Conclusion

- Formaldehyde based resins
- Market requirements
- The future

Overhead 11

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