



The Issue of Formaldehyde in Wood-based Panels

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Trabzon, Turkey

Eleftheria Athanassiadou

CHIMAR HELLAS S.A.

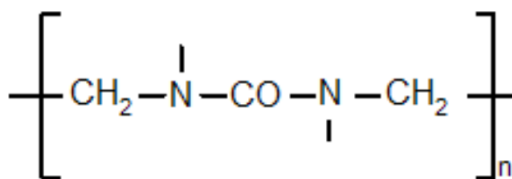
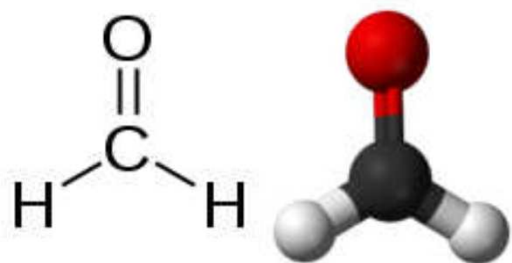


Outline

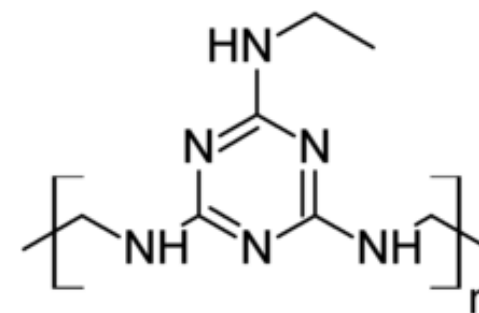
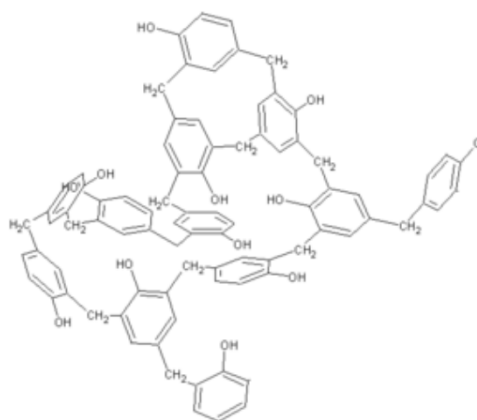
- The formaldehyde debate
- Occupational exposure limits
- Formaldehyde test methods
- Emission standards for wood based panels
- Summary



Formaldehyde-based Resins



- Important type of wood adhesives: performance, applicability and cost
- Thermosetting polymers, poly-condensation products of Formaldehyde, Urea, Melamine, Phenol





Formaldehyde

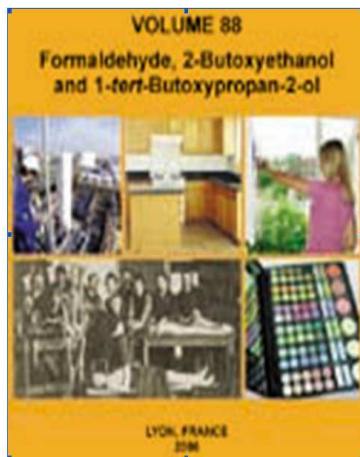


- **Formaldehyde**, the simplest aldehyde, colorless gas at room temperature with characteristic pungent odor
- Important precursor to many chemicals, polymers, resins, coatings, plastics. Used as disinfectant & preservative, used in textile finishing.
- Naturally occurring substance found in living organisms, in combustion gases, emitted from products made with it or absorbing it, occupational exposure in varnishing, production of textiles & clothes, board mills and foundries
- Short life as it is decomposed by photochemical processes or bacteria (biodegradation)
- Irritant, toxic, causes allergies, chronic exposure increases risk for cancer





Re-evaluation of formaldehyde I



- **World Health Organisation's International Agency for Cancer Research (IARC)** recommended (monograph vol. 88, 12/2006) classification of formaldehyde from Group 2A-“probably carcinogenic to humans” to **Group 1**-“carcinogenic to humans”. This recommendation is not legally binding and was reaffirmed by IARC in 2009 and 2012 (monograph 100F).

- IARC monograph Vol 88: The highest occupational exposure in varnishing, production of textiles, garments, furs, certain jobs in board mills and foundries, lower exposure levels in formaldehyde production, wide range of exposure levels in resins production, exposure in wood products manufacture occurs during glue mix preparation, laying of mat, hot pressing and sanding





Re-evaluation of formaldehyde II

- Numerous toxicological & cancer studies for formaldehyde since 1980. Major studies in Europe and USA still ongoing.
- **CARB** formaldehyde emission limits for composite wood products are in force since **January 2009** and apply throughout the US from **January 2013**.
- **US** EPA current classification: **probable human carcinogen (B1)**. Draft toxicological review of formaldehyde-inhalation assessment released June 2010 supports carcinogenic effects.
- **EU** current formaldehyde classification: **category 2-suspected human carcinogen**. New classification of the European Chemicals Agency (ECHA) category **1B-presumed human carcinogen** will become effective EU-law as of 01.04.2015



Occupational Exposure Limits (1/3)

Country	Concentration, ppm	Type
Australia	1.0	TWA
Austria	0.3	TWA
Belgium	0.3	Ceiling
Brazil	1.6	Ceiling
Canada-Alberta	0.75	TWA
Canada-British Columbia	0.3	TWA
Denmark	0.3	TWA & STEL
Finland	0.3	TWA
France	0.5	TWA

Source: Formacare. IARC



Occupational Exposure Limits (2/3)

Country	Concentration, ppm	Type
Germany	0.3	TWA
Greece	2.0	TWA
Hong Kong	0.3	Ceiling
Ireland	2.0	TWA
Italy	0.3	Ceiling
Japan	0.5	TWA
Malaysia	0.3	Ceiling
Mexico	2.0	Ceiling
Netherlands	1.0	TWA

Source: Formacare. IARC



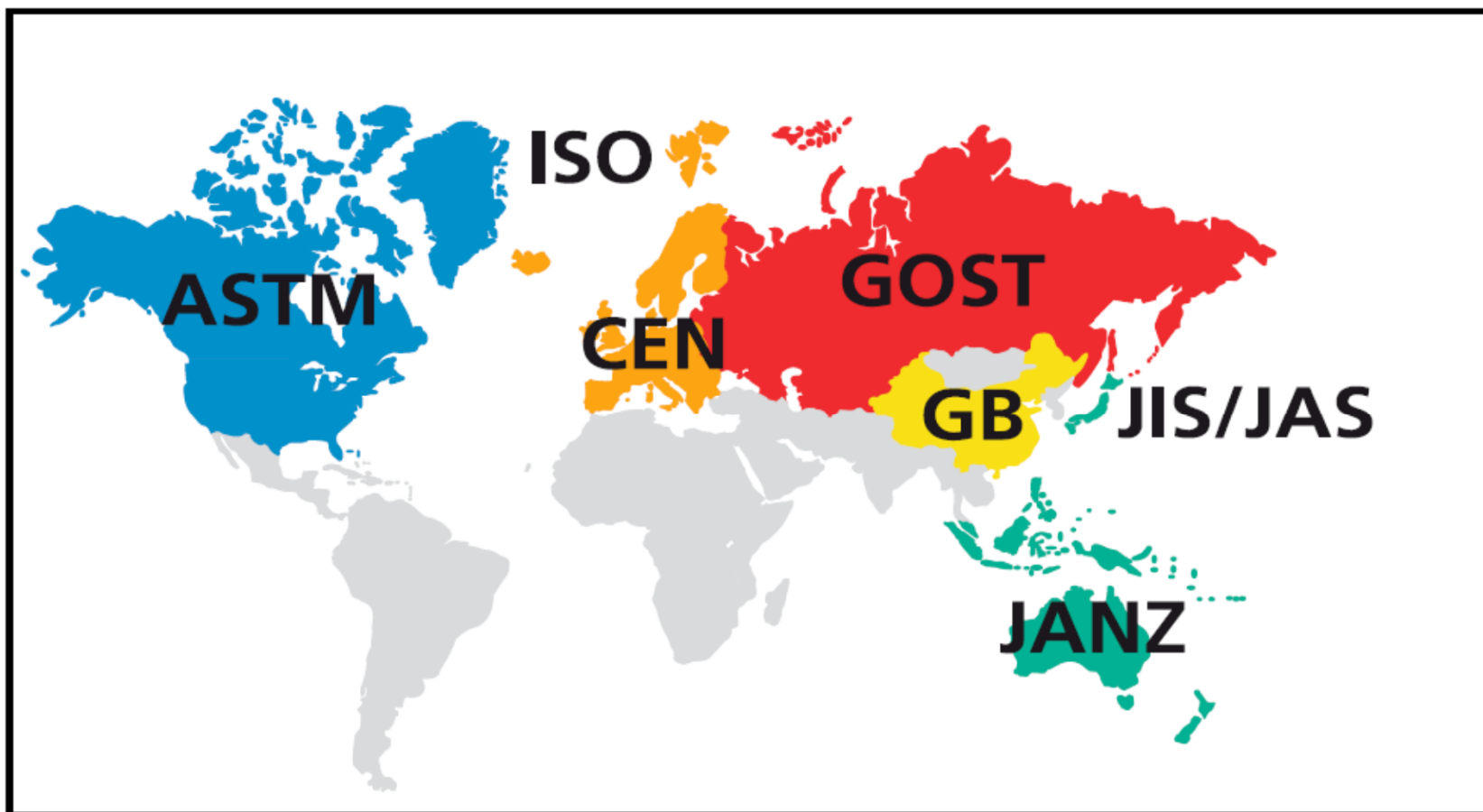
Occupational Exposure Limits (3/3)

Country	Concentration, ppm	Type
Norway	0.5	TWA
South Africa	2.0	TWA
Spain	0.3	STEL
Sweden	0.5	TWA
Switzerland	0.3	TWA
United Kingdom	2.0	TWA
USA-ACGIH	0.3	Ceiling
USA-NIOSH	0.016	TWA
USA-OSHA	0.75	TWA

Source: Formacare. IARC



Formaldehyde Test Methods



Source: Schripp, Fraunhofer WKI



Formaldehyde Test Methods

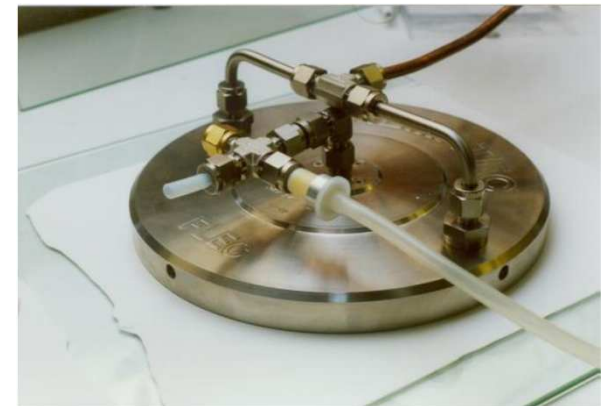
Test Method	Standard, standard draft or method name
Chamber	EN 717-1, ASTM E 1333, ASTM D 6007, JIS A 1901, JIS A 1911, ISO 12460-1, ISO 12460-2, GOST R 52078, ISO 16000-9, CEN/TS 16516
Gas Analysis	EN 717-2, ISO 12460-3, GOST 3916
Flask Method	EN 717-3, AWWPA method
Desiccator	ASTM D 5582, JIS A 1460, JAS 235, JAS 233, AS/NZS 4266.16, ISO 12640-4
Perforator	EN 120, ISO 12460-5, GOST 10632/3916
Other	Field and Laboratory Emissions Cell (FLEC) ISO 16000-10, Dynamic Micro Chamber (DMC)



Formaldehyde Test Methods

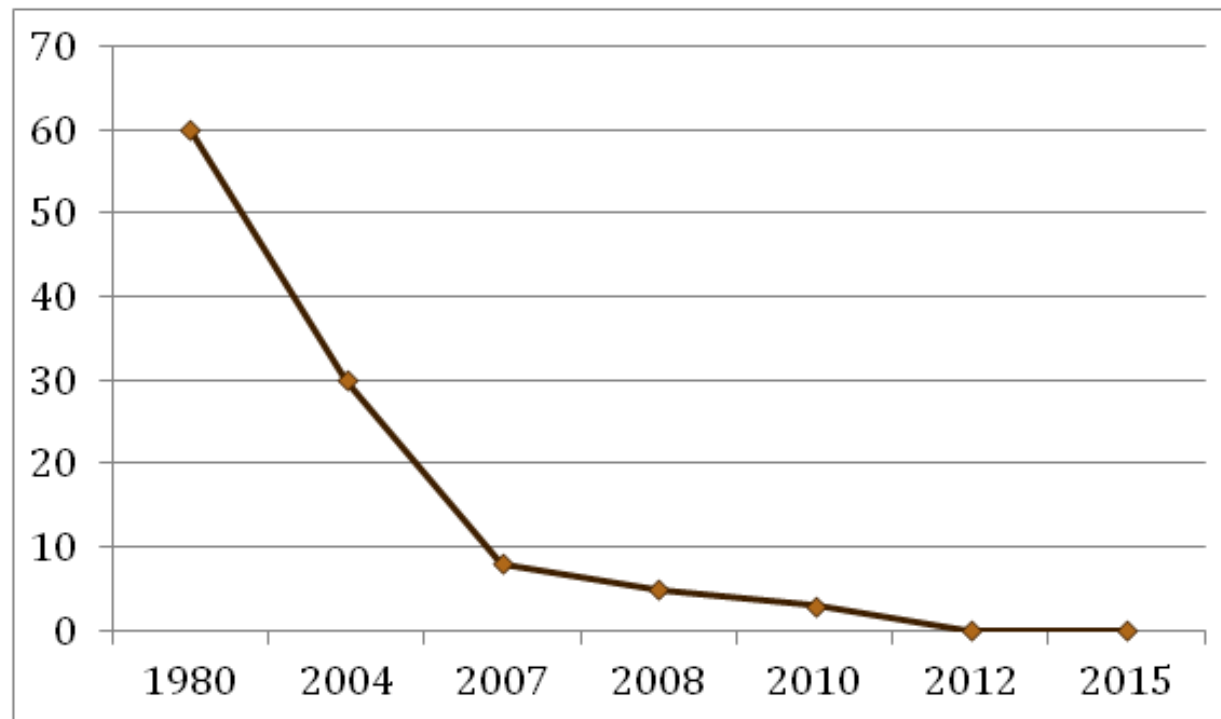


Source: Fraunhofer WKI,
CHIMAR lab, DIBt





Evolution of standards for formaldehyde emission



European Standards

Board class	HCHO limit	Test method
E1 - PB, MDF, OSB	Release $\leq 0.124 \text{ mg/m}^3 \text{ air}$ $\leq 8.0 \text{ mg/100g}$	EN 717-1 EN 120
E1 - PW	Release $\leq 0.124 \text{ mg/m}^3 \text{ air}$ $\leq 3.5 \text{ mg/h} \cdot \text{m}^2$	EN 717-1 EN 717-2
E1 - MDF	$\leq 4.5 \text{ mg/h} \cdot \text{m}^2$	EN 717-2
E2 - PB, MDF, OSB	Release $> 0.124 \text{ mg/m}^3 \text{ \& } < 0.3 \text{ mg/m}^3 \text{ air}$ $> 8.0 \div \leq 20 \text{ mg/100g}$	EN 717-1 EN 120
E2 - PW	Release $> 0.124 \text{ mg/m}^3 \text{ \& } < 0.3 \text{ mg/m}^3 \text{ air}$ $> 3.5 \div \leq 8.0 \text{ mg/h} \cdot \text{m}^2$	EN 717-1 EN 717-2
E2 - MDF	$> 4.5 \div \leq 10.0 \text{ mg/h} \cdot \text{m}^2$	EN 717-2

Source: EN 13986, Schwab, Fraunhofer WKI

NOTE: E1 rolling average for half year $< 6.5 \text{ mg/100g}$ PB/OSB, $< 7 \text{ mg/100g}$ MDF



Japanese Standards

Board class	HCHO limit	Test method
F****/SE0	$\leq 0.3\text{mg/L}$	JIS A 1460
F*** /E0	$\leq 0.5\text{mg/L}$	JIS A 1460
F**	$\leq 1.5\text{mg/L}$	JIS A 1460

Source: JIS A 5908 & 5905 (PB & FB), JAS (PW)

F** class in Japan is more or less equivalent to European E1-class

F*** and F**** are of much lower emission than the E1

F**** emission is close to the emission of solid untreated wood



US CARB Formaldehyde standards & limits (in effect throughout the US)

	CARB Phase 2 Emissions Standards				
	Emissions Standards (ppm)	ULEF – Reduced		NAF & ULEF – Exempt	
		Cap (ppm)	Target (90% of Samples – ppm)	Cap (ppm)	Target (90% of Samples – ppm)
Particleboard	0.09	0.08	≤ 0.05	0.06	≤ 0.04
Thin MDF	0.13	0.11	≤0.08		
MDF	0.11	0.09	≤0.06		
HWPW-VC	0.05	0.05		0.05	
HWPW-CC	0.05				

Ashlee Cribb, GP, Wood Adhesives 2013

NOTES: Based on the primary test method [ASTM E 1333-96 (2002)] in ppm

HWPW-VC/CC: Hardwood Plywood veneer core/composite core

See also CARB 2008, Same as ANSI A208.1&2 for PB and MDF



ULEF Emission Target and Cap Values

Less frequent testing	PB	MDF	Thin MDF	HWPW
ULEF-target	0.05	0.06	0.08	0.05
ULEF-cap	0.08	0.09	0.11	0.05
TPC exemption	PB	MDF	Thin MDF	HWPW
ULEF-target	0.04	0.04	0.04	0.04
ULEF-cap	0.06	0.06	0.06	0.05

Values in ppm.
Source: CARB 2008





CARB P2 vs. European & Japanese Standards

P2 (ppm)	E1	F***	F****
HWPW (0.05)	More	More	Comparable
PB (0.09)	More	Comparable	Less
MDF (0.11)	Comparable	Less	Less

Values in parenthesis are the CARB Phase 2 standards in ppm.
“More” means the proposed standard is “more stringent” than applicable E1, F***, F**** standards.

Source: CARB 2008

AS/NZ Standards

Board class	HCHO limit	Test method
E0 - PB, MDF	$\leq 0.5\text{mg/L}$	AS/NZS 4266.16
E1 - PB	$\leq 1.5\text{mg/L}$	AS/NZS 4266.16
E1 - MDF	$\leq 1.0\text{mg/L}$	AS/NZS 4266.16
E2 - PB, MDF	$\leq 4.5\text{mg/L}$	AS/NZS 4266.16



Russian Standards

Board type	HCHO limit	Test method
Covered PB	Release $\leq 0.124 \text{ mg/m}^3 \text{ air}$	GOST R 52078
E1 - PW	Release $\leq 0.124 \text{ mg/m}^3 \text{ air}$ $\leq 3.5 \text{ mg/h} \cdot \text{m}^2$ $\leq 8.0 \text{ mg/100g}$	GOST 3916
E1 - PB	$\leq 8.0 \text{ mg/100g}$	GOST 10632
Furniture*	0.01 ppm	From 01.07.2014

*** This is the most severe ever formaldehyde limit for furniture**

Source: Schwab, Fraunhofer WKI



Chinese Standards

Table 1 Formaldehyde emission test method and limits for artificial board and product made from them

Product name	Test method	limits	usage	Symbol of the limit
MDF, HDF, PB, OSB etc...	Perforator	≤9mg/100g	can directly used for indoor	E1
		≤30mg/100g	Can used for indoor after surface treatment	E2
Plywood, Plywood with decorative foil, Plywood with lumber-core	desiccator	≤1.5mg/L	can directly used for indoor	E1
		≤5mg/L	Can used for indoor after surface treatment	E2
Artificial board with surface treatment(including Melamine foiled floor, plywood lumber core, bamboo floor, board with melamine foils)	Climate chamber	≤0.12mg/M3	can directly used for indoor	E1
	Desiccators	≤1.5mg/L		
a. When there is a need for arbitrary, Climate chamber is the method b. E1 can be used for indoor directly, E2 must have surface treatment before being used indoor				

“Artificial board”: PB, MDF, HDF, PW

Source: Schwab, Fraunhofer WKI



German Blue Angel

The German Blue Angel certification for environmentally friendly products requires a formaldehyde emission limit of 0.05 ppm.

RAL UZ-76





Summary

- Occupational exposure limits for formaldehyde are set by governments as a means of health protection.
- A variety of test methods for measuring product emission levels are applied worldwide, producing a corresponding variety of test results. Each method measures a slightly different emission characteristic and frequently produces results in different and non-interchangeable units. This proliferation of test methods and incomparable results often creates confusion.
- A most common misunderstanding is that citing a formaldehyde level of a wood product is meaningless unless the test method and conditions are also cited. In test methods the conditions of use of a product are simulated.
- The re-evaluation of formaldehyde has triggered a demand for lower emission limits. The target is to attain emission values **at the level of natural wood.**





Location & Contact

Sofouli 88, 55131 Thessaloniki, GREECE

Tel: +30 2310 424167

Fax: +30 2310 424149

e-mail: eathan@ari.gr & office@ari.gr

www.chimar-hellas.com





Thank You!