European Regulations for Formaldehyde

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Topics of this presentation

- Introduction
- Formaldehyde testing methods in Europe
- Regulations in Europe
- International Formaldehyde testing methods
- Correlation chamber versus some other test methods
- FPC methods: advantages and disadvantages
- Prospects

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Introduction (1)

- WKI = Wilhelm-Klauditz-Institut = Fraunhofer-Institut for wood research
- WKI is one of approximately 60 research instituts of the Fraunhofer Gesellschaft (12.000 researchers and employees)
- Head of Department “Quality Assessment”
- Convenor of CEN/TC 112 “Wood-based panels” WG 4 “Test methods”
- Convenor of ISO/TC 89 “Wood-based panels” WG 5 “Test methods

Introduction (2)

- Formaldehyde is a most simple but highly reactive organic compound
- It is a natural trace compound and an important substance for chemical and technical applications and for hygienic purposes
- It is used for the formulation of wood-based panel adhesives
- It is a very valuable compound in these applications and difficult to substitute

Introduction (3)

- 2004: World Health Organisation advisory body – International Agency for Research on Cancer - IARC proposes to reclassify formaldehyde
- IARC proposal contains serious contradictions but initiates worldwide discussions about formaldehyde
- The formaldehyde reclassification remains open
- Pressure on politics, authorities and industry will trigger reevaluation of exposure levels and emission classes

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Formaldehyde testing methods in Europe

- **Reference method:**

  Chamber method EN 717-1 with three volume options

- **Derived methods:**

  Perforator method EN 120

  Gas analysis method EN 717-2

  Flask method EN 717-3

  (Desiccator method ISO/DIS 12460-4 or JIS A 1460 or JAS 233)

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European chamber method EN 717-1

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European chamber method EN 717-1

Determination of formaldehyde emissions („steady state“) up to 28 days in ppm or mg/m³

Test conditions: t = 23 °C, a = 45 %, q = 1m²h/m³

Emission class E1:

steady-state concentration ≤ 0.1 ppm (0,12 mg/m³)

Perforator method EN 120

- Determination of formaldehyde content in mg/100 g
- Extraction of panel specimen with toluene
- Suitable for uncoated PB, MDF and OSB
- Emission class E1: ≤ 8.0 mg/100 g

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Gas analysis method EN 717-2

- Determination of formaldehyde content in mg/m²xh
- Suitable for coated PB, MDF
- Suitable for plywood (coated and uncoated)
- Emission class E1: ≤ 3,5 mg/hxm²

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Flask Method EN 717-3

- Determination of formaldehyde release in mg/kg
- Suitable only for internal production control of wood-based panels
- no official limit values published

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Desiccator method ISO/DIS 12460-4

- Determination of formaldehyde release in mg/l
- Suitable for uncoated and coated boards (MDF and PB)
- F**** limit value: 0,3 mg/l

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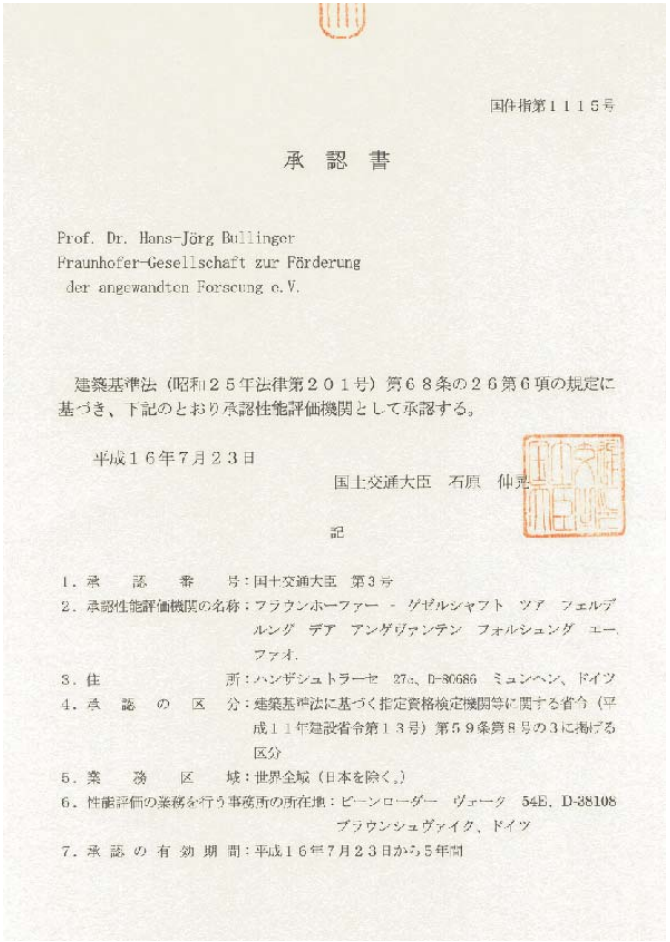
Europe's first recognized organization for tests according JIS



国住指第１１１５号

承　認　書

Prof. Dr. Hans-Jörg Bullinger
Fraunhofer-Gesellschaft zur Förderung
der angewandten Forscung e.V.

建築基準法（昭和２５年法律第２０１号）第６８条の２６第６項の規定に基づき、下記のとおり承認性能評価機関として承認する。

平成１６年７月２３日

国土交通大臣　石原　伸晃

記

1. 承　認　番　号：国土交通大臣　第３号
2. 承認性能評価機関の名称：フラウンホーファー・ゲゼルシャフト　ツア　フェルデルンング　デア　アンゲヴァンテン　フォルシュング　エー．ファオ．
3. 住　　所：ハンザシュトラーセ　27c、D-80686　ミュンヘン、ドイツ
4. 承　認　の　区　分：建築基準法に基づく指定資格検定機関等に関する省令（平成１１年建設省令第１３号）第５９条第８号の３に掲げる区分
5. 業　務　区　域：世界全域（日本を除く。）
6. 性能評価の業務を行う事務所の所在地：ビーンローダー　ヴェーク　54E、D-38108　ブラウンシュヴァイク、ドイツ
7. 承認の有効期間：平成１６年７月２３日から５年間

- 2004 WKI became the first European test institute which was recognized to do formaldehyde tests according to JIS standards as official test organization

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WKI test equipment

- **EN 717-1 (Chamber)**
  - 1 x 48 m^3 (VOC)
  - 1 x 38 m^3
  - 1 x 25 m^3
  - 1 x 24 m^3 (2009)
  - 26 x 1 m^3 (VOC)
  - 8 x 0,5 m^3
  - 4 x 0,25 m^3
  - 10 x 0,023 m^3
- **ISO/DiS 12460-4, JIS A 1460, JAS 233 (Desiccator)**
  - 13 x
- **EN 717-2 (Gas analysis)**
  - 10 x
- **EN 717-3 (Flask method)**
  - 50 x
- **EN 120 (Perforator)**
  - 16 x

Methods for formaldehyde analysis

- **Acetyl-aceton method:**
- the determination is based on the Hantzsch reaction in which formaldehyde reacts with ammonium ions and acetylaceton to yield diacetyldihydrolutidine (DDL)
- **Analytical evaluation:**
- photometrical detection or fluorescence spectroscopy

Regulations in Europe (1)

1980	Some European countries started with formaldehyde regulations on particle boards
Since 1985	Emission class E1 (0,1 ppm boards) became obligatory for wood-based panels in Austria, Denmark, Germany, Sweden an some more European countries

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Regulations in Europe (2)

- since 2004: Emission classes E1 and E2 were established by European Standard EN 13986 for use in construction
- where formaldehyde-containing materials, particularly resins, have been added to the product as a part of the production process, the product shall be tested and classified into one of two classes: E1 and E2
- the test requirement does not apply to wood-based panels to which no formaldehyde containing materials were added during production or in post-production processing; these may be classified E1 without testing

Regulations in Europe (3)

- Examples of such panel products are:
- Cement bonded particle boards (unfaced)
- Wet process fibreboard (unfaced), when no formaldehyde emitting resin has been added to the process
- unfaced, coated or overlaid wood based panels glued with resins emitting either no formaldehyde or negligible amounts of formaldehyde after production as e.g. isocyanate, or phenolic glue.

Regulations in Europe (4)

- The limit values for the formaldehyde class E1 are given in Table B.1

		Panel product		
		Unfaced	Unfaced	Coated, overlaid or veneered
		Particleboard OSB MDF	Plywood Solid wood panels LVL	Particleboard OSB MDF Plywood Solid wood panels Fibre boards (wet process) Cement bonded particleboards LVL
Initial type testing [a]	Test method	ENV 717-1		
	Requirement	Release ≤ 0,124 mg/m^3 air		
Factory production control	Test method	EN 120	EN 717-2	
	Requirement	Content ≤ 8 mg/100 g oven dry board See NOTE 3	Release ≤ 3,5 mg/m^{2}h or ≤ 5 mg/m^{2}h within 3 days after production	

[a] For established products, initial type testing may also be done on the basis of existing data with EN 120 or EN 717-2 testing, either from factory production control or from external inspection.

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Regulations in Europe (5)

- the EN 120 values for particleboards, OSB and MDF apply to boards conditioned to a moisture content of 6,5 %.; in the case of particleboards or MDF with different moisture contents, the EN 120 test results (known as the perforator value) shall be multiplied by the F factor given in EN 312 (particleboards), EN 622-1 (MDF) or EN 300 (OSB); the F factors in these three standards are only valid for boards within the specified moisture content ranges given in the three standards;

- Experience has shown that to ensure compliance with the limits in Table B.1 the rolling average of the EN 120 values found from the internal factory control over a period of ½ year should not exceed 6,5 mg HCHO/100 g panel mass for particleboards and OSB or 7 mg HCHO/100 g panel mass for MDF

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Regulations in Europe (6)

- 2006: Emission class E1 became obligatory for panel production of EPF European Panel Federation members
- 0.05 ppm boards can be marked with an environmental label („Blue Angel“)
- 0.03 ppm boards are obligatory for members of the German Association of Producers of Prefabricated Houses BDF (since 2003)
- 0.03 ppm boards are about equal to the Japanese emission class F****

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Formaldehyde testing methods of ISO

- **Reference method:**

  1 m^3 Chamber method: ISO/FDIS 12460-1

- **Derived methods:**

  Small chamber method: ISO/DIS 12460-2

  Gas analysis method ISO/DIS 12460-3

  Desiccator method ISO/DIS 12460-4

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Correlation 1m³ chamber versus:

Perforator method

Gas analysis method

Desiccator method

for PB and MDF

Conditions of the chamber test EN 717-1

- Temperature 23 °C ± 0.5 K
- Rel. humidity 45 % ± 3 %
- Loading rate 1 m²/m³ *
- Air exchange rate 1 / hour
- Air velocity 0.1 to 0.3 m/sec

* equal for PB, MDF and OSB

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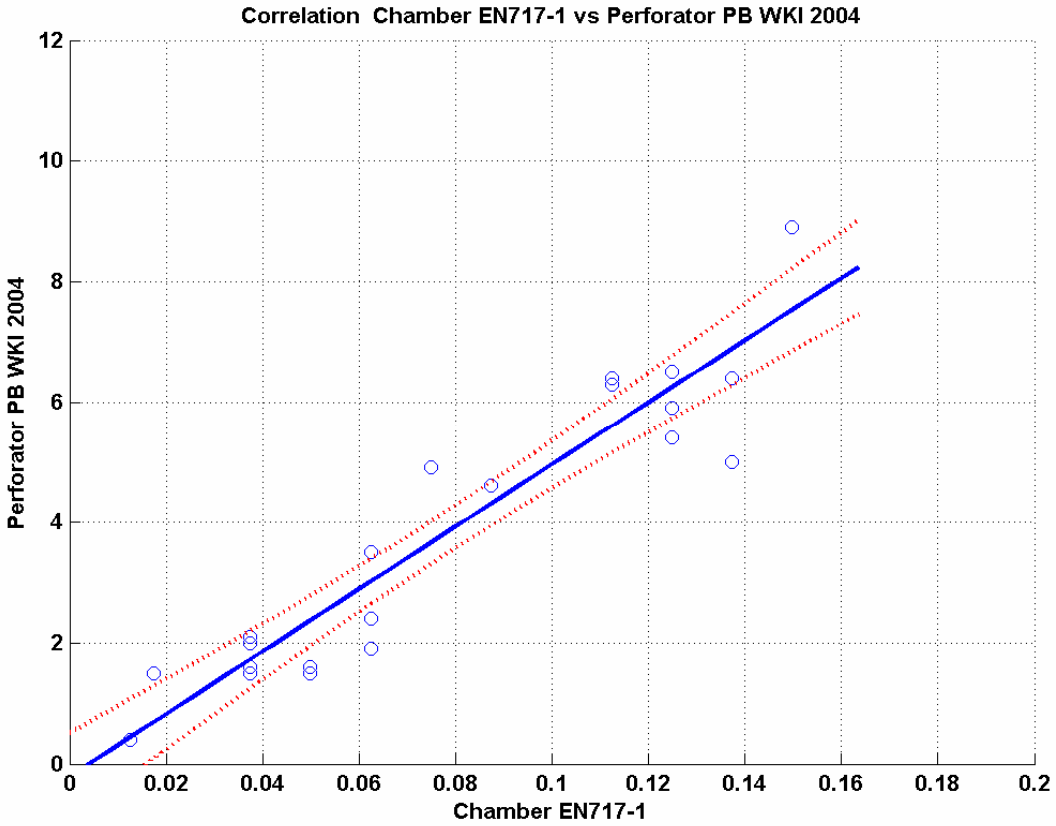
PB: Correlation chamber versus perforator



Correlation for 23 values (all): y =+51.653x-0.208 - R^2 =0.893 - s =0.815

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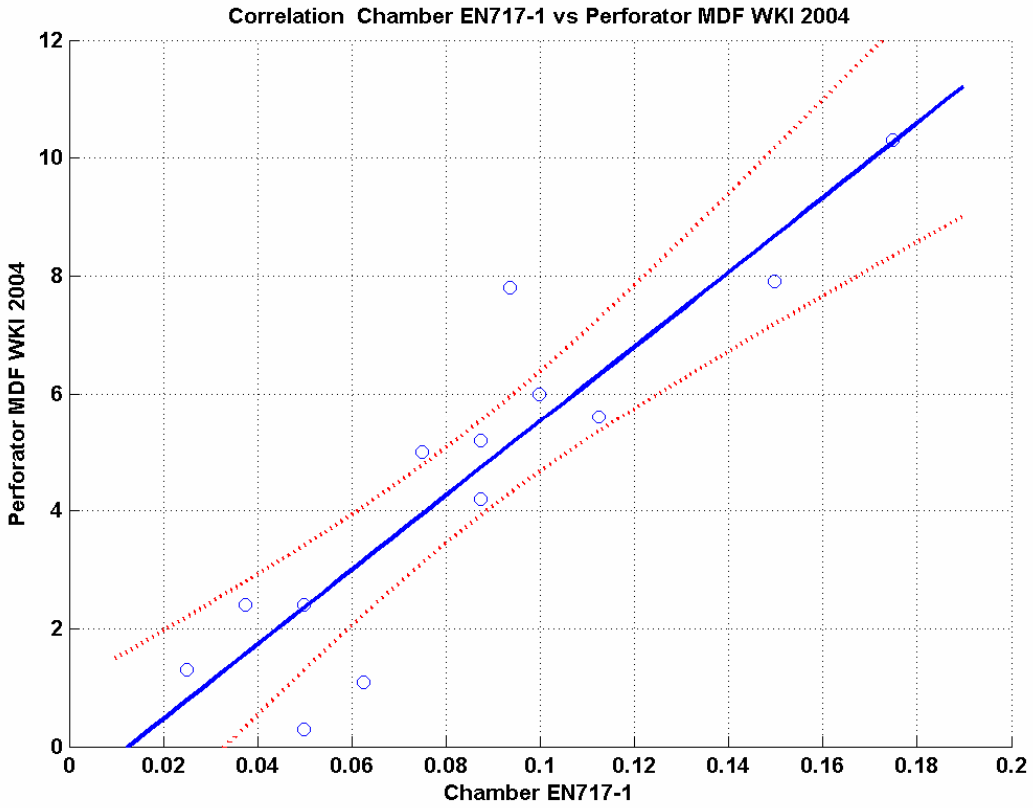
MDF: Correlation chamber versus perforator



Correlation for 13 values (all): y =+63.276x-0.799 - R^2 =0.820 - s =1.333

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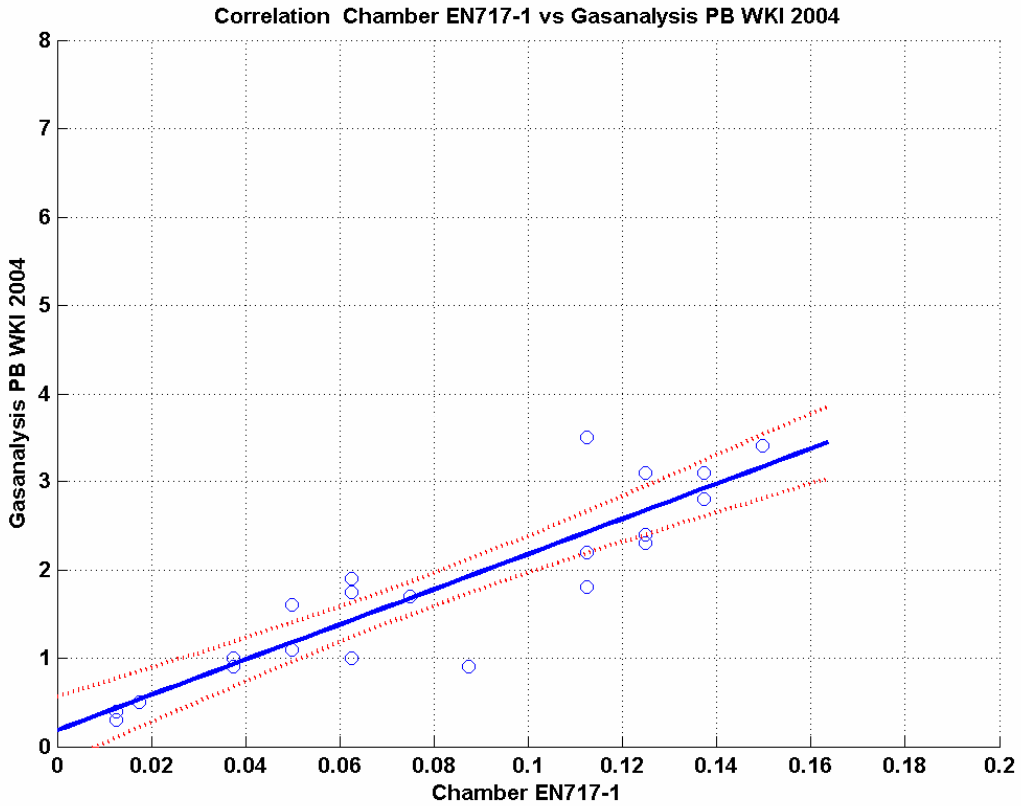
PB: Correlation chamber versus gas analysis



Correlation for 23 values (all): y =+19.899x+0.186 - R^2 =0.816 - s =0.429

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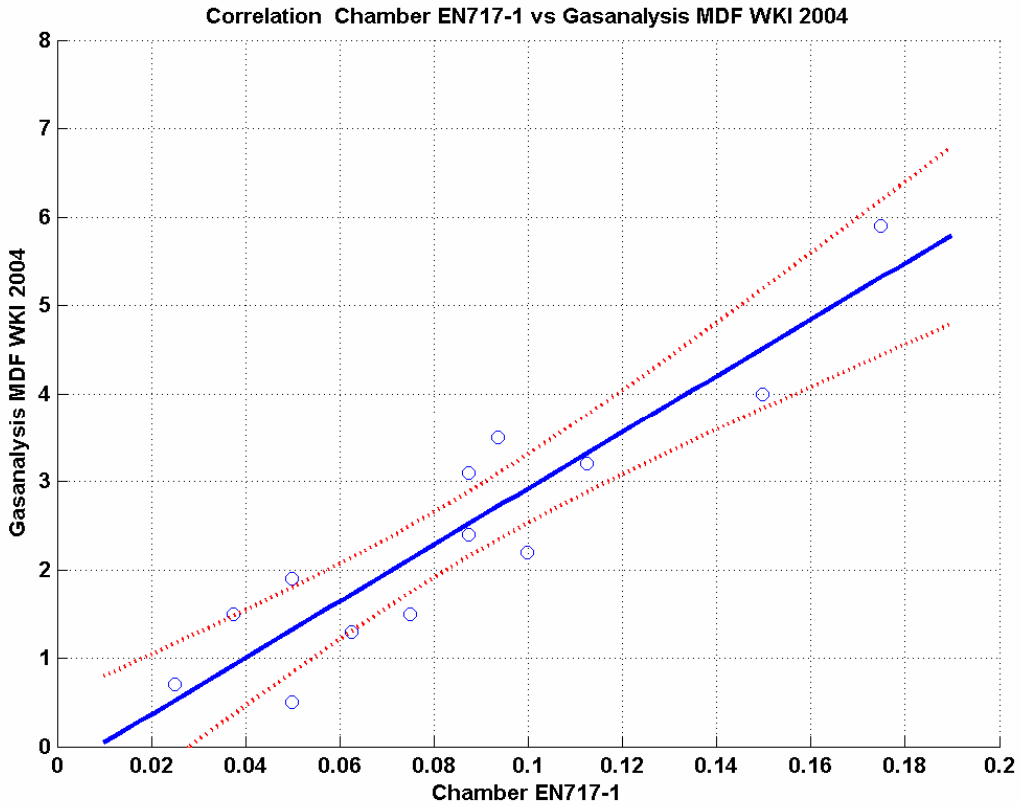
MDF: Correlation chamber versus gas analysis



Correlation for 13 values (all): y =+31.961x-0.277 - R^2 =0.849 - s =0.606

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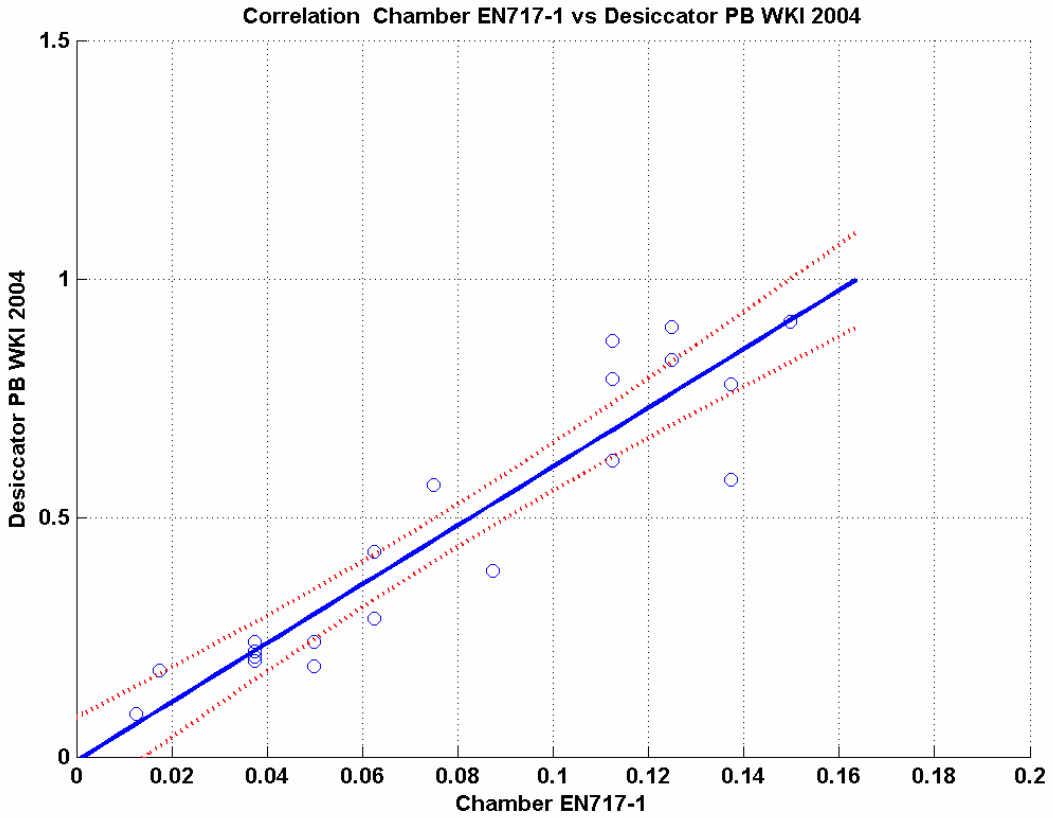
PB: Correlation chamber versus desiccator



Correlation for 23 values (all): y =+6.158x-0.009 - R^2 =0.881 - s =0.103

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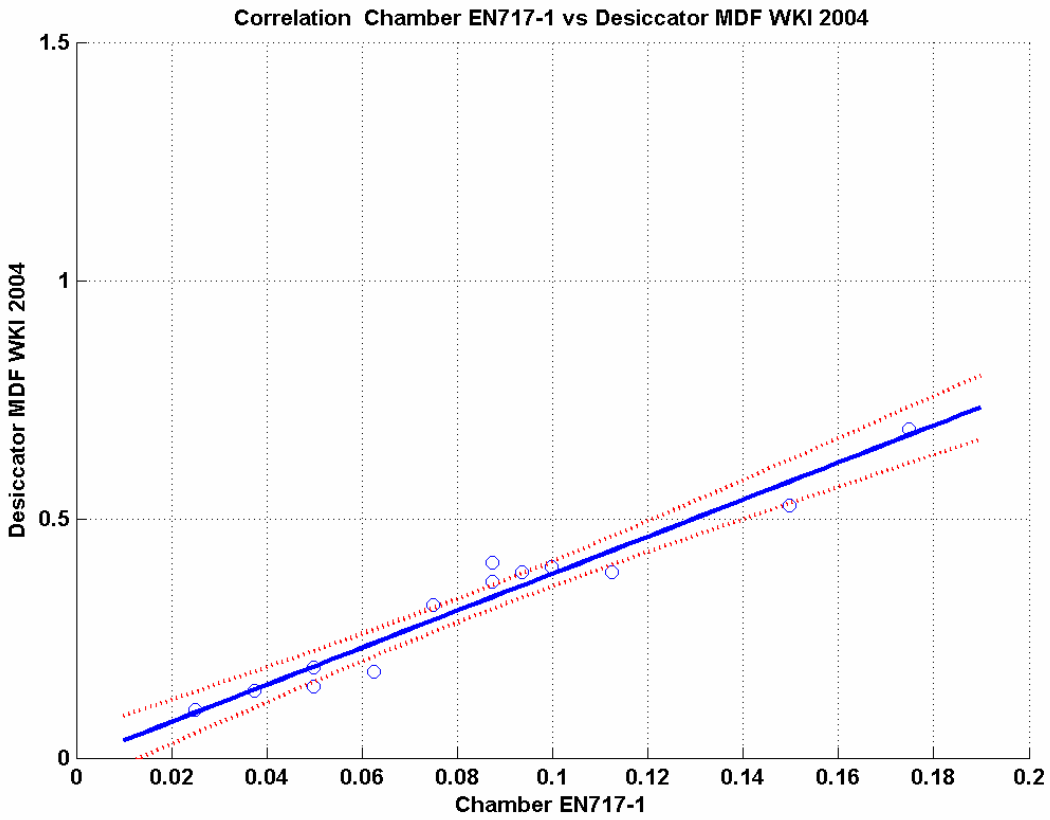
MDF: Correlation chamber versus desiccator



Correlation for 13 values (all): y =+3.881x-0.002 - R^2 =0.948 - s =0.041

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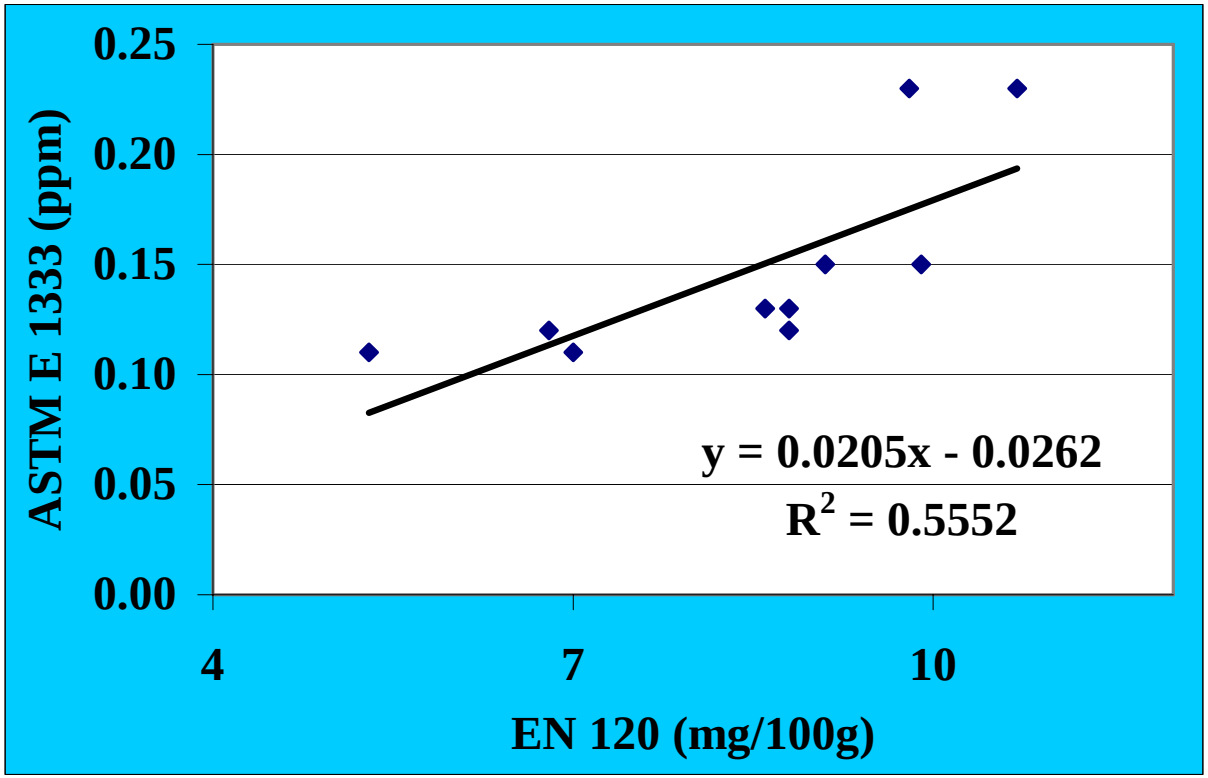
Correlation ASTM E 1333 (Chamber) versus EN 120 (Perforator) from Alpha Berry (Forintek)



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Summary

- **Particleboards**
- Chamber (717-1) – Perforator: R^2 = 0,893
- Chamber (717-1) – Gas analysis: R^2 = 0,816
- Chamber (717-1) – Desiccator: R^2 = 0,881
- Chamber (ASTM E 1333) – Perforator: R^2 = 0,555

- **MDF**
- Chamber (717-1) – Perforator: R^2 = 0,820
- Chamber (717-1) – Gas analysis: R^2 = 0,849
- Chamber (717-1) – Desiccator: R^2 = 0,948

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FPC methods: advantages and disadvantages (1)

Chamber	Gas analysis	Perforator	Desiccator
plus: test parameter similar to room conditions	**plus**: short term results	**plus**: very short term results	**plus**: cheap equipment
plus: large sample sizes to limit the influence of failures because of inhomogeneities	**plus**: simple handling	**plus**: cheap equipment	**minus**: samples have to be conditioned for 7 days
minus: long test period	**minus**: expensive equipment depending on the GA -producer	**minus**: critical because of toluene	
minus: expensive equipment			
Test period: 10 to 28 days	**Test period**: 4 hours	**Test period**: 2,5 hours	**Test period**: 24 hours plus seven days pre-treatment

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FPC methods: advantages and disadvantages (2)

DMC (dynamic micro chamber) according to WKI experiences

plus: very short test period

minus: expensive equipment

minus: equipment only available in USA

minus: background HCHO-level 0.04 ppm

Test period: 30 minutes plus 2 hours pre-treatment

Correlation with the European reference test method (EN 717-1): only for pre-conditioned (minimum 2 weeks) panels

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Prospects (1)

- The establishment of safer test procedures for low emission boards
- The integration of US and Japanese formaldehyde test standards, especially the desiccator method
- The evaluation of European and Japan testing standards by an EPF Formaldehyde Testing Project

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Prospects (2)

- Reclassification by IARC challenges the wood-based panel industries and glue producers
- Lower emission standards are to be established on a global basis
- Optimization of the whole system from glue to production process will be needed

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Prospects (3)

- Formaldehyde-based adhesives for wood-based panels are UF and MUF resins and to a lower extend PF resins
- The formaldehyde-free adhesive pMDI completes the family of essential resins for the wood-based panel industries
- For the next years, conventional adhesives with reduced or no formaldehyde emissions will maintain their dominating position
- The importance of alternative resins will increase but on a lower level as often proposed

Thank you for your attention!

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