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«Sıcak Kutu Maça Üretiminin Dünü, Bugünü ve Geleceği»

«Hot Curing Core Production Systems: Yesterday – Today – Tomorrow»

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3.Oturum: Döküm Teknolojileri Demir&Çelik

3rd Session: Casting Technologies Iron&Steel

Oturum Başkanı/Session Chairman: Prof. Dr. Cahit Ensari (Yalova Üniversitesi)

Hot Curing Core Production Systems

Yesterday – Today - Tomorrow

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September 2016

HÜTTENES-ALBERTUS

Agenda

- Structure of the Hot Cured Binding Systems
- Reduction of Free Formaldehyde
- Gas Pressure Evolution
- Case Study: Increase of Thermal Stability and Decrease of Deformation
- Core Production Advices
- Summary

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Resin Structure

Basic Raw Materials

- Formaldehyde
- Phenol
- Urea
- Furfuryl Alcohol
- Additive (Catalyst)

Resin Structure

Resin	Thermoset	Resital	Furesan
Condensation product: ✓ Formaldehyde ✓ Urea	Condensation product: ✓ Formaldehyde ✓ Urea ✓ Furfuryl Alcohol	Condensation product: ✓ Formaldehyde ✓ Phenol	Condensation product: ✓ Formaldehyde ✓ Urea ✓ Furfuryl Alcohol
		Condensation product: ✓ Formaldehyde ✓ Phenol ✓ Urea	Condensation product: ✓ Formaldehyde ✓ Urea ✓ Furfuryl Alcohol ✓ Phenol

Structure of Hardener

Basic Raw Materials

- Ammonium Nitrate
- Sulphonic Acid
- Urea
- Polyvinyl Alcohol
- Salts of organic acids

Structure of Hardener

Hardener AT Series	Hardener	Furedur
✓ Ammonium Nitrate ✓ Urea ✓ Salts of organic acids	✓ Urea ✓ Sulphuric Acid	✓ Sulphonic Acids ✓ Sulphuric Acid ✓ Salts of organic acids ✓ Polyvinyl Alcohol ✓ Urea

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Change Content of Free Formaldehyde

- Hot Box Resins had a content of free formaldehyde up to 4%.
- These resins are high reactive and have a short curing time, generating high productivity.
- Changings in the air regulations (TA-Luft in Germany) required a drastic reduction of the free formaldehyde content of the resin.
- Reducing the free formaldehyde content up to 1.5% was possible, but not beyond this border.
- The development of a Warm Box System started. With these systems the content of free formaldehyde was decreased to <1%.
- Due to further R&D work, Warm Box Systems with a content of free formaldehyde of 0,1%, were developed.

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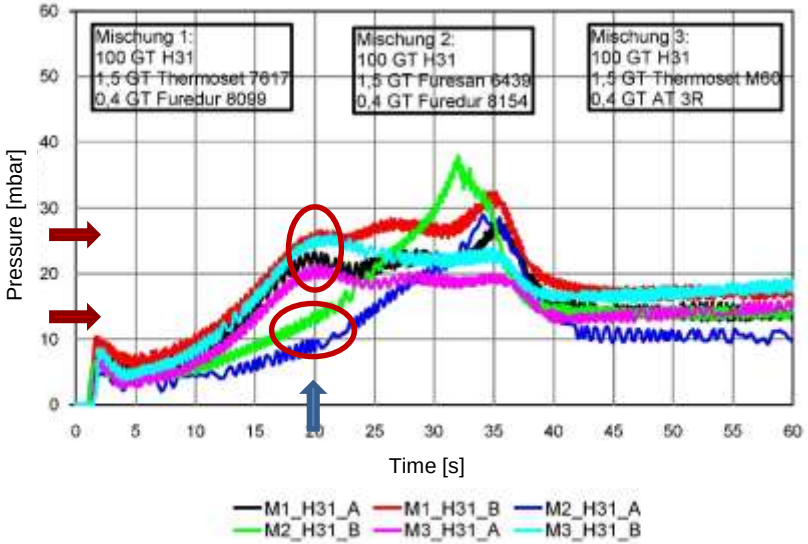
Gas Pressure Curves

Gas Pressure Curves

Aluminium

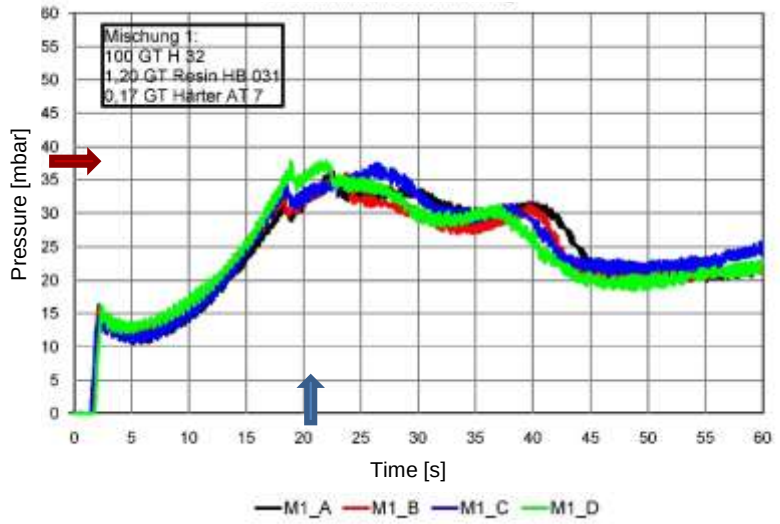


Mixture 1 / Hot Box
100 PBW sand H31
1.5 PBW Thermoset 7617
0.4 PBW Furedur 8099

Mixture 2 / Warm Box
100 PBW sand H31
1.5 PBW Furesan 6439
0.4 PBW Furedur 8154

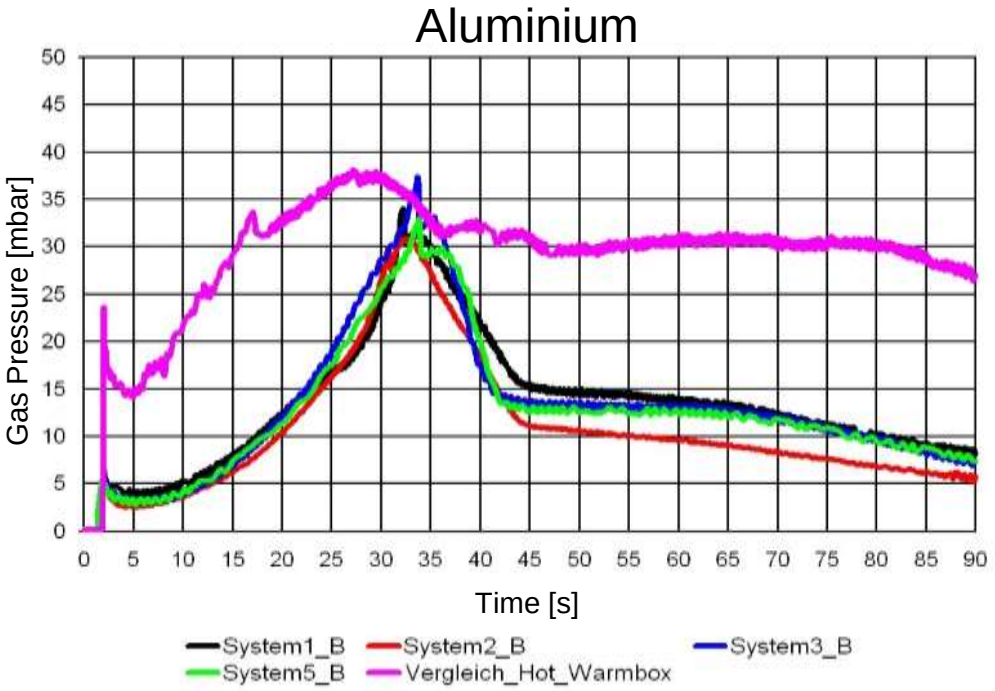
Mixture 3 / Hot Box
100 PBW sand H31
1.5 PBW Thermoset M60
0.4 PBW Härter AT 3R

Brass



Mixture: Hot Box
100 PBW sand H32
1.5 PBW Resin HB 031
0.4 PBW Härter AT 7

Gas Pressure Curves



Hot Box System

Warm Box Systems

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Problem: Deformation

Info:

- During a visit on November 6th 2015, we were informed, that a problem with deformation of a Warm Box core has occurred.

Problem description:

- In a core package, where Warm Box cores are glued, one of the fastened cores is getting a slight deformation during casting, in such a way, that casting cannot be used for the further processing.

Used Warm-Box System

Furesan 7022	Warm Box resin
Furedur 8154	Adequate hardener for Warm Box resin
Trennmittel 7828	Fluidization agent
Sand	Thermal Reclaimed Sand

Thermal Reclaimed Sand – Sand-Analysis

		11-152206-0001 Therm. Reclaimed Braunschweig TSD 151118
Sieve Analysis > 1,000 mm	%	0,00
Sieve Analysis > 0,710 mm	%	0,00
Sieve Analysis > 0,500 mm	%	22,70
Sieve Analysis > 0,355 mm	%	60,83
Sieve Analysis > 0,250 mm	%	14,01
Sieve Analysis > 0,180 mm	%	1,30
Sieve Analysis > 0,125 mm	%	0,93
Sieve Analysis > 0,090 mm	%	0,24
Sieve Analysis > 0,063 mm	%	0,00
Sieve Analysis > 0,063 mm	%	0,00

Thermal Reclaimed Sand – Sand-Analysis

		11-152206-0001 Therm. Reclaimed Braunschweig TSD 151118
AFS-Number		35,10
Average Grain Size 01	mm	0,44
Theoretically surface	cm^2/g	54,39
Level of uniformity	%	84,00
Conductivity 33% Solution	µS/cm	29,50
pH-value 33% Suspension		7,95
Loss on ignition 900°C	%	0,04

Thermal Reclaimed Sand – Sand-Analysis

		11-152206-0001 Therm. Reclaimed Braunschweig TSD 151118
Clay content	%	0,04
Acid consumption	mgHCl/100 g	33,80
Residual acid	mgNaOH/100 g	
Water / Humidity	%	0,03
Surface – RFA		1,00
X-ray flourescence analysis		1,00

Thermal Reclaimed Sand – RF-Analysis

	11-152247-0001 Therm. Reclaimed Braunschweig Surface [%]	11-152247-0002 Therm. Reclaimed Braunschweig Inside [%]
Silicon Dioxide	99,32	99,74
Potassium Oxide	0,07	0,01
Calcium Oxide	0,28	0,04
Titanium Dioxide	0,02	0,01
Iron-III-Oxide	0,29	0,10
Zircon (IV) Oxide	0,01	0,00
Receipt Sample	1,00	1,00

Systems

- The currently used systems had to be improved to a system, which is able to decrease, respectively to eliminate the deformation during casting by adding a thermally stable material.
- This material has no influence on the bending strength.

Comparison of the Systems

Current System

- Furesan 7022
- Furedur 8154
- Trennmittel 7828

New System

- Furesan 8885
- Furedur 8154
- Trennmittel 7828

Systems

Mixture for both systems:

- Furesan 1.50 PBW
- Furedur 0.30 PBW
- Trennmittel 0.10 PBW

Parameter for core production:

- Shooting pressure 5.0 bar
- Shooting time 3.0 s
- Core Box temp. 230°C

Bending Strengths

Hardening time	Current System Hot / Cold [Mpa]	New System Hot / Cold [Mpa]
15 s	1.8 / 6.3	1.6 / 4.0
30 s	2.0 / 5.9	1.8 / 6.2
45 s	2.3 / 5.9	2.2 / 6.4
60 s	2.1 / 5.1	2.0 / 5.6
120 s	1.7 / 5.2	1.7 / 5.4

Bending Strengths after 1h VZ

Hardening time	Current System Hot / Cold [Mpa]	Future System Hot / Cold [Mpa]
15 s	1.6 / 6.1	1.6 / 4.0
30 s	1.9 / 5.6	1.8 / 5.8
45 s	2.2 / 5.5	2.0 / 5.9
60 s	2.0 / 5.0	2.1 / 5.5
120 s	1.7 / 5.0	1.8 / 5.3

Hot Distortion

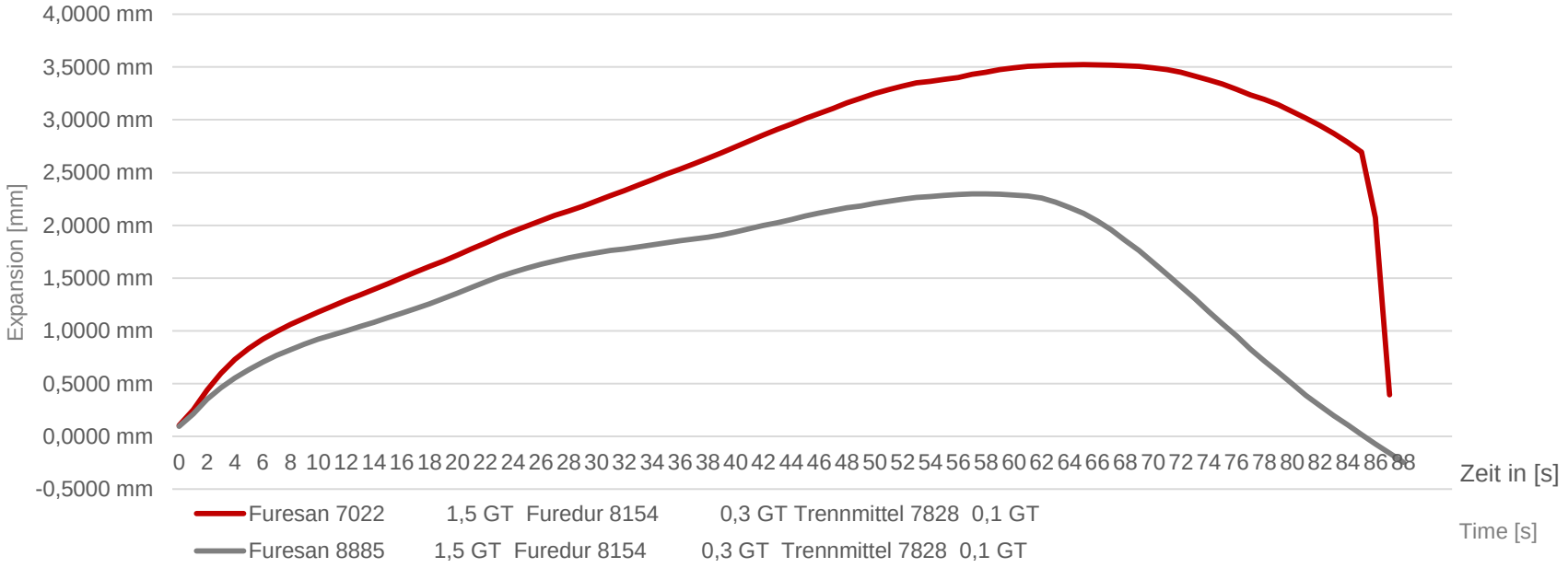

Fig. 1 Hot Distortion Test Curves

Test Setup

The addition of the material which increases the thermal stability, also decrease the expansion of the core. This statement is confirmed by the chart presented in Fig.1.

Advice:
A further minimization of the expansion is possible by application of special minerals (Bauxite Sand).

Test Setup

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Core Production

Warm Box Systems are used for core production of:

- Radiators
- Heater components
- Heat Exchangers
- Ventilated brake disks
- Fittings / Sanitary Casting
- Water Jacket Cores for motors and cylinder heads
- Crankcase Cores
- Cores for gear boxes

Core Production

To mixer and the core shooting machine, attention must be paid to the following:

- Cooling for the mixer, if possible
- Water cooling for the following areas:
  - Sand funnel
  - Shooting pipe
  - Shooting head
  - Shooting plate and nozzles (7 – 12°C)
- Core box heating (gas, electric, heat transfer fluid)
- Core box temperature 150 – 230°C

Core Production

Following moulding materials may be used for core production:

- Silica Sand
- Chromite Sand
- Zircon Sand
- Bauxite Sand
- Thermal reclaimed sand
- Mechanical reclaimed sand (pH-value and loss of ignition are to be observed)

Core Production

The next order must be followed during preparation of the mixture:

- Sand – Hardener – Resin – Parting Agent
- Sand - Additives (iron oxide) – Hardener – Resin – Parting Agent

Changing of order:

- Resin – Hardener: Reduction of bending strength up to approx. 20%
- Addition of parting agent before hardener and resin: strong reduction of bending strength

General compound addition:

- Resin 1.0 – 2.0 PBW
- Hardener 0.2 – 0.5 PBW
- Parting Agent 0.1 – 0.2 PBW

Core Production

Core shooting is dependant on:

- Core geometry – the more filigree the core, the more shooting nozzles, the more pressure. The shooting pressure should be as low as possible and not higher than necessary.
- Shooting nozzle should not be placed above sharp edges in the core box.
- A sufficient number of venting nozzles should be set.
- The core box should be tightly closed (core box material must be correlated to curing temperature).
- Big differences of the core's wall thicknesses should be avoided (burning of thinner areas).

Core Production

Hardening of the cores is dependant on:

- Core geometry: hardening times could be between 30 and 360 sec
- Core box temperature (cope usually 5 – 15°C lower)
- Composition of mixture (alkaline sand require an extended hardening time or a higher addition of the hardener)

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Summary

- Hot Curing Binding Systems evaluated from simple to complex structures.
- Modern Warm Box Systems are offering products with a content of free formaldehyde of 0.1%.
- During pouring and solidification of the casting, the gas pressure evolution of the Warm Box Systems is slowly and smooth.
- High thermal stability and lower expansion of the core may be achieved by modifying the Warm Box resin with the addition of adequate material.
- By following a strict guideline at core production - constant and optimal manufacturing may be reached

Thank you for your attention!

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