AWB – the binder system for a clean foundry

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AWB – Project Partners

Hydro Aluminium Deutschland GmbH

Institute of Applied Materials Sciences at Duisburg/Essen University

Minelco GmbH, Essen

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Project Partners: Norsk Hydro / Hydro Aluminium

Norsk Hydro founded in 1805

Employees worldwide end 2004:		36,938
Core business:	**Oil & Energy**	
	Turnover 2004	12.025 billion US $
	Aluminium	
	Turnover 2004	13.175 billion US $

Casting Operations in:

Germany	(engine blocks, cylinder heads for Ford, Audi, DaimlerChrysler)
Austria	(cylinder heads for Ford, Audi, BMW Isuzu, GM)
Hungary	(cylinder heads for Audi, Renault, GM, BMW)
Sweden	(automotive & transportation parts for Volvo, Scania, DaimlerChrysler)
Mexico	(cylinder head, engine blocks for GM)

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Project Partners: University of Duisburg and Essen



Origins of the University date back to 1891 when it was one of 4 Universities in Germany educating students in iron and steel making and foundry technologies

During the 1980's, industrial developments caused many Universities to close their metallurgy and foundry technology faculties with Duisburg now being the largest in Germany with nearly 230 students

In 2004, Duisburg University was merged with the neighbouring University of Essen.

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Project Partners: Minelco Group/Minelco GmbH

Minelco-Group

- Founded in 1989
- Integral part of LKAB, Europe's largest iron ore producer
  (Turnover 2004 = 998 mill. €, 1.half 2005 = 774 million €)
- 12 Companies, 3 Representative Offices, 20 Production Sites
- Turnover 2004 = 175 million €, 1.half 2005 = 114 million €
- 354 employees in Europe, USA and Asia
- Industries served:

Foundry
Polymer & Rubber
Paint
Refractory
Sealants & Adhesives
Special Applications
Steel
Surface Treatment

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Inorganic binders: Industry requirements

Low rate of emissions, higher rate of safety in :

- core production,
- casting (low gas formation = less casting defects)
- decoring and sand reclaiming

Easy handling

- storage
- transport
- waste disposal

Cost effectiveness

- minimum technical investment to change to new process
- lower operating costs

➢ **For Europe necessary to secure existing plant locations and enable possible extension. What about the US?**

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AWB Process: Key facts

- **Inorganic binder system**
  - Sodium silicate: x SiO_2 • y Na_2O • H_2O
  - Additives to optimize the process, e.g. NaOH

- **Main process differences to existing technologies**
  - Hardening by physical elimination of water
  - Tool temperature >140-200°C (280–390°F)
  - Negative pressure within the core box during shooting and curing
  - Microwave drying

- **Cycle times : < Hotbox ; = Isocure**

- **Reversible Sol-Gel conversion**

- **Sand/Binder mixture can be stored indefinitely if properly sealed**

- **Cores storable for several weeks when fully dried**
  - non-sensitive to CO_2
  - humidity rate >60 % should be avoided

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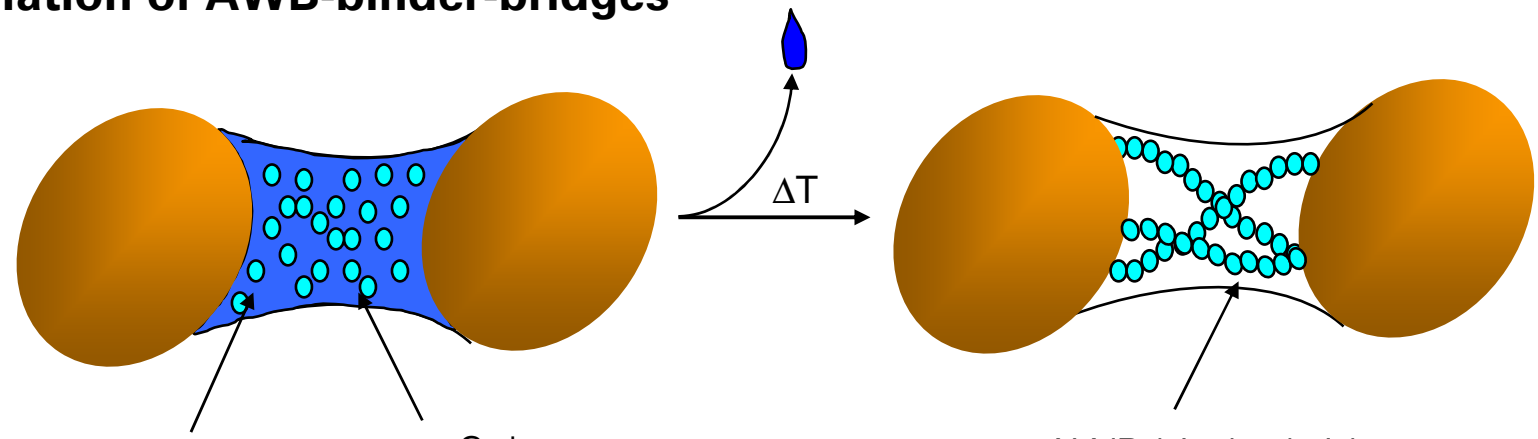
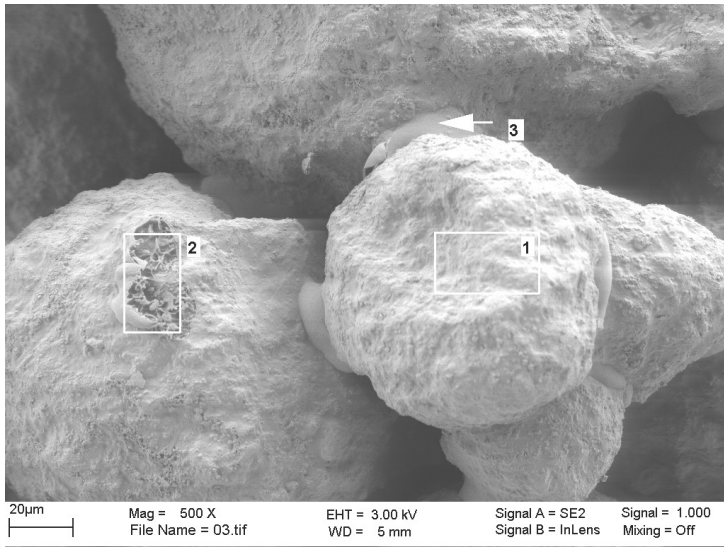
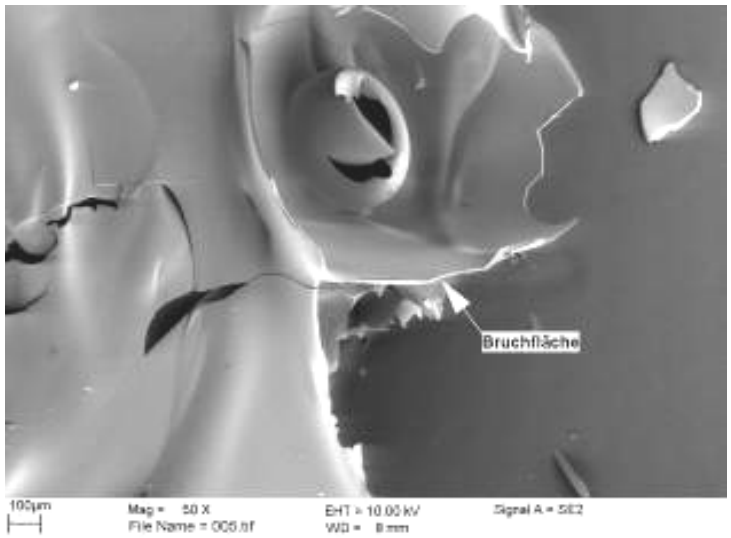
AWB binding processes

Formation of AWB-binder-bridges







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Example: Gravity die casting of cylinder heads
Quality requirements on cores

Core production

- low surface roughness
- sufficient handling strengths

During casting:

- thermal stability
- no hazardous emissions (small quantities of water vapour only)
- dimensional stability

De-coring

- easy with existing equipment

- AWB meets all these requirements

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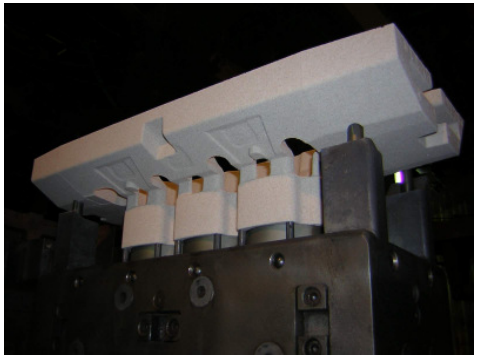
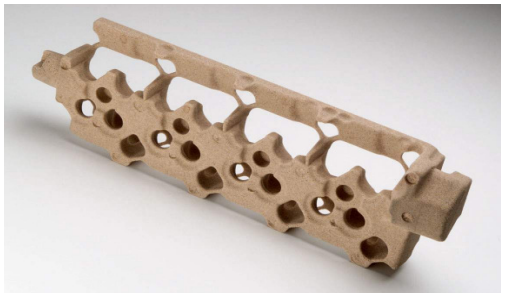
Selection of Cores produced with AWB



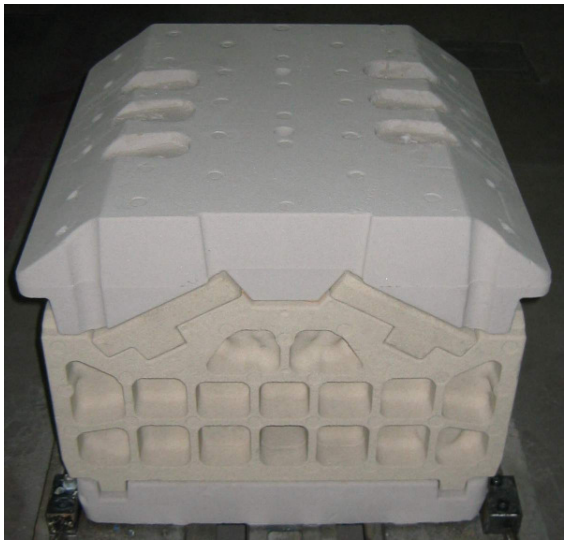
Water jacket for engine block, aluminium, 6 kg

Brake disc, grey iron, 4.5 kg

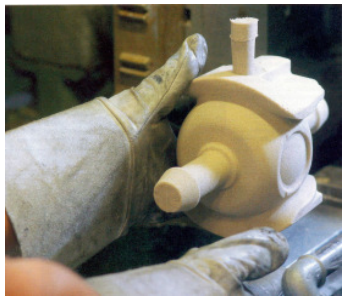
Intake manifold, aluminium, 1.8 kg



Water jacket for cylinder head, aluminium, 1.2 kg

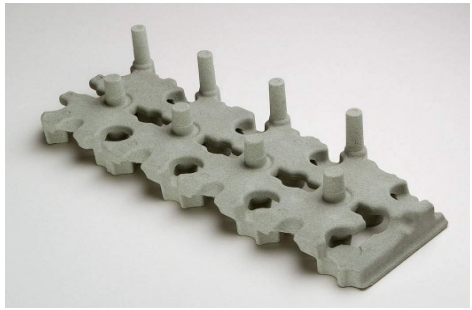


Outer cores of package for engine block, aluminium, cores between 5 – 45 kg



Differential housing, grey iron, approx. 800 g

Water tap, brass, 500 g



Oil gallery for cylinder head, aluminium,1.4 kg

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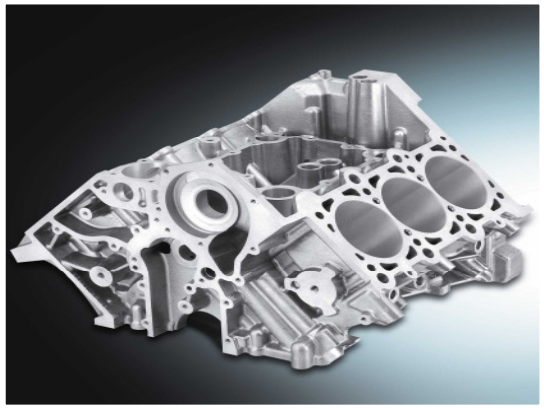
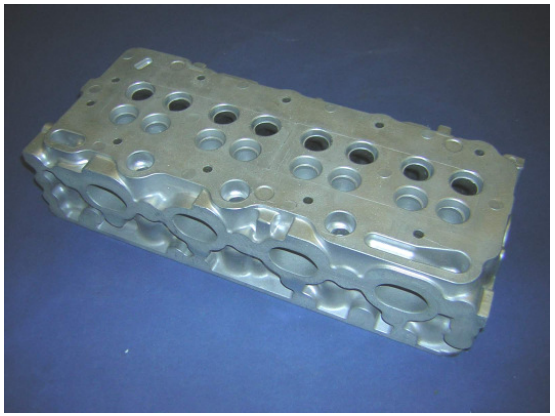
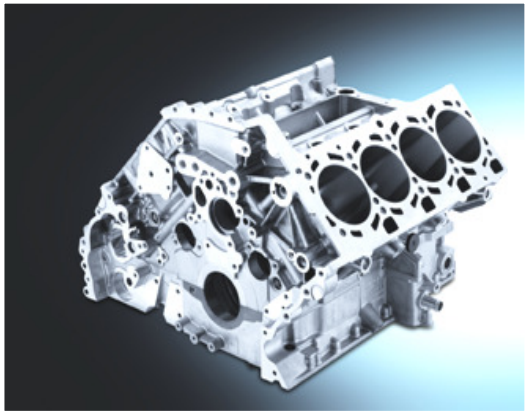
Castings produced from AWB-cores





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Advantages for occupational health and safety

Reduction of emissions

- no scorched cores – no smoke formation

- elimination of hazardous emissions such as BTX, formaldehyde
  - i.e. healthier working conditions

organically bonded cores

AWB-cores

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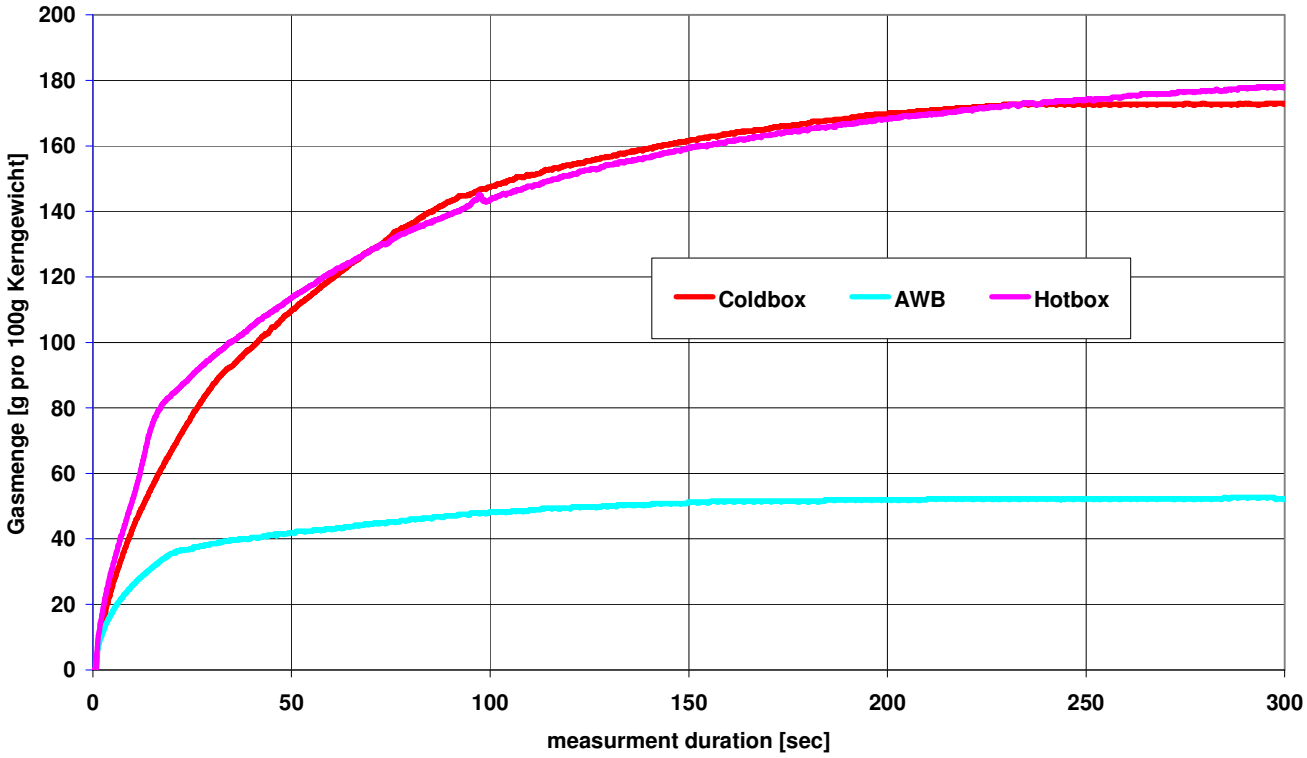
Cogas® Test

Less gas formation during casting of AWB-cores compared to organically bonded cores

- therefore no gas cavities



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AWB: Shortcomings

- **AWB sand should not be mixed into organic systems:**
  - Strength of organic cores reduced
    - Isocure (Coldbox) - hardening sets in too early
    - Hotbox - hardening is delayed

- **Core Sands:**
  - silica sand a basic material for sodium silicates
    - Can react with binder in the contact region to the liquid metal
      - Leeds to sand remaining stuck to the casting
    - Using additives or coatings e.g. talc, prevents penetration

  - **But AWB allows use of a wide range of sands**
    - e.g. alkaline Olivine - not useable with organic resins

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AWB as replacement for:

- **Hotbox + Croning**
  - Effectiveness: immediate
  - Costs: only negligible alterations of the existing machinery are required

- **Isocure (Coldbox)**
  - Effectiveness: a change-over should be considered for new production lines
  - Costs: largely depend on existing machinery

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AWB: Energy saving and reduction of emissions

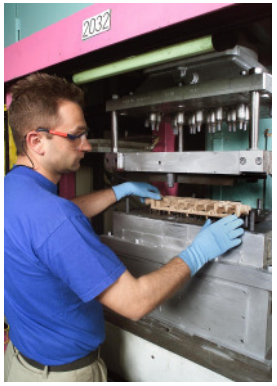
- **For the production of the AWB-binder**
  - Raw materials are almost unlimited, as base is silica sand and caustic soda or sodium carbonate
  - Production needs less energy than organic binders
  - No toxic gas during production

- **For use**
  - Low pressure pump, heated tools, microwave **but** no care for amines, which require treatment, i.e. washing
  - No catalytic treatment of exhaust gases
  - no risk of silicosis as e.g. Olivine sands can be used

- **Reclamation**
  - Easy mechanical or wet reclamation of sand
  - Residual binder quantities may be reactivated
  - No thermal heat treatment (e.g. 620°C (1150°F) for 30min) as for organic sands
  - No toxic material to be disposed of or burned

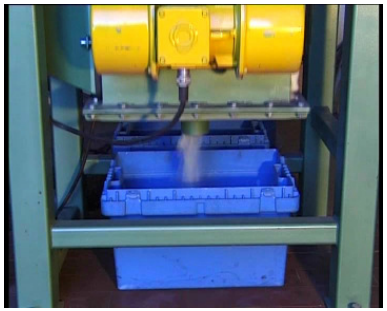
AWB – Process flow chart

Mixing



Core shooting

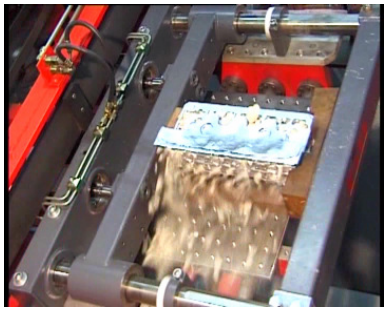
Microwave drying



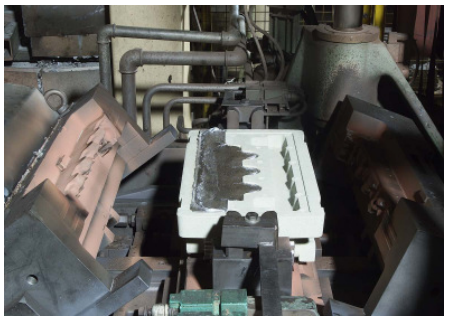
Sand reclamation

US Patent 2002-0029862-A1

Core storage



Decoring



Casting

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