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TÜYAP Fair, Convention & Congress Center, İstanbul
7th International Ankiros Foundry Congress
7. Uluslararası Ankiros Döküm Kongresi

«Smart Degassing In Aluminium Alloys»

«Alüminyum Alaşımlarında Etkili Gaz Giderme»

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5.Oturum: Döküm Teknolojileri Demir Dışı

5th Session: Casting Technologies Non Ferrous

Oturum Başkanı/Session Chairman*: *Can Demir (Componenta Döküm. Tic. San. A.Ş.- Alüminyum)

Oturumlarda yer alan sunumlar 15 Eylül 2014 Pazartesi tarihinde kongre web sayfasına **(kongre.tudoksad.org.tr)** yüklenecektir.

Intelligent Degassing – Studies on Controlling the Hydrogen Removal from Aluminium

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Agenda

- Hydrogen solubility and removal
- Mixing purpose and rotor functions in aluminium degassing
- Pumping vs. Non-pumping designs
- Homogenising Capability of Rotors in Water
- Degassing Efficiency over Rotor Service Life
- Intelligent Degassing - SMARTT
- Summary and Conclusions

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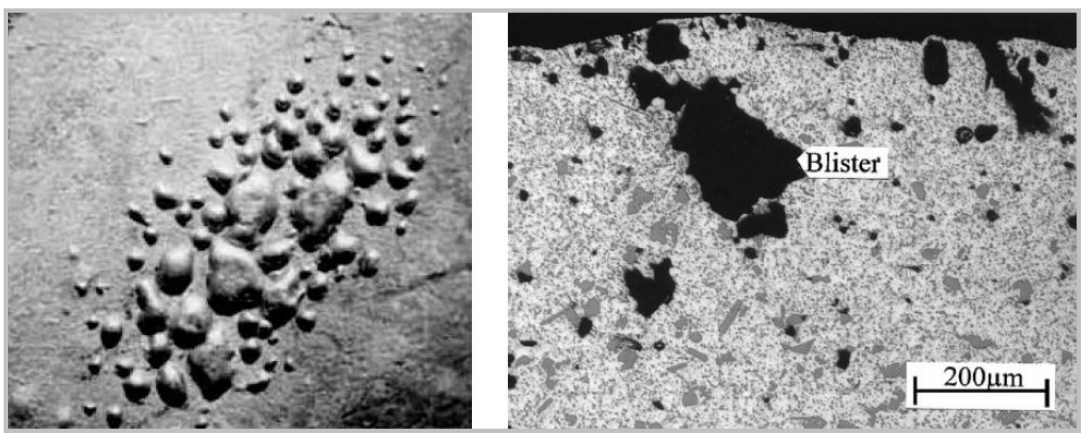
Hydrogen Solubility

- Gas porosity in aluminium is a well known phenomena for many years
  - Unacceptable surface quality
  - Surface blistering after heat treatment
  - Leakage problems
  - Reduced mechanical properties



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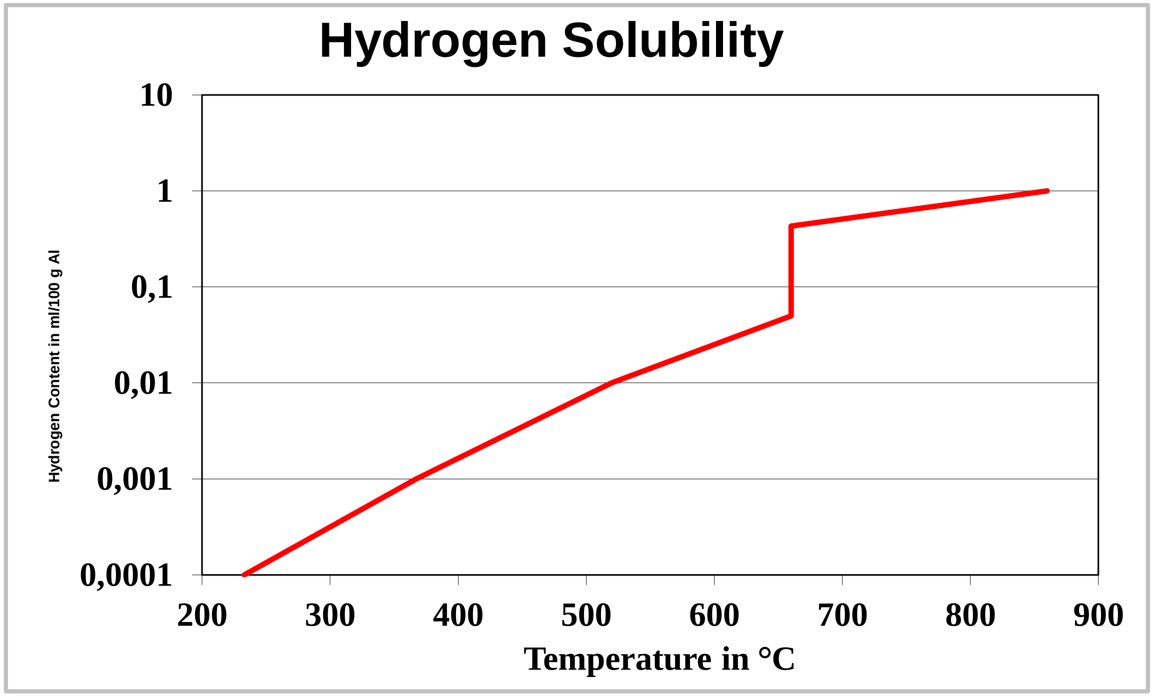
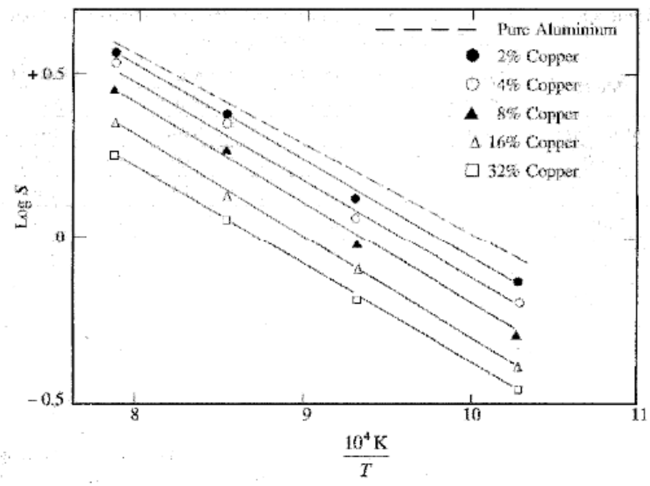
Factors Influencing Hydrogen Solubility

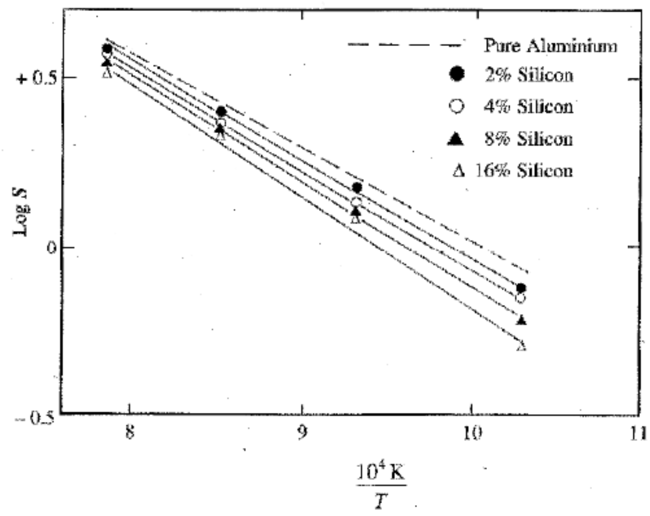
- Temperature (liquid – solid)



Factors Influencing Hydrogen Solubility

- Temperature (liquid – solid)
- Alloy composition

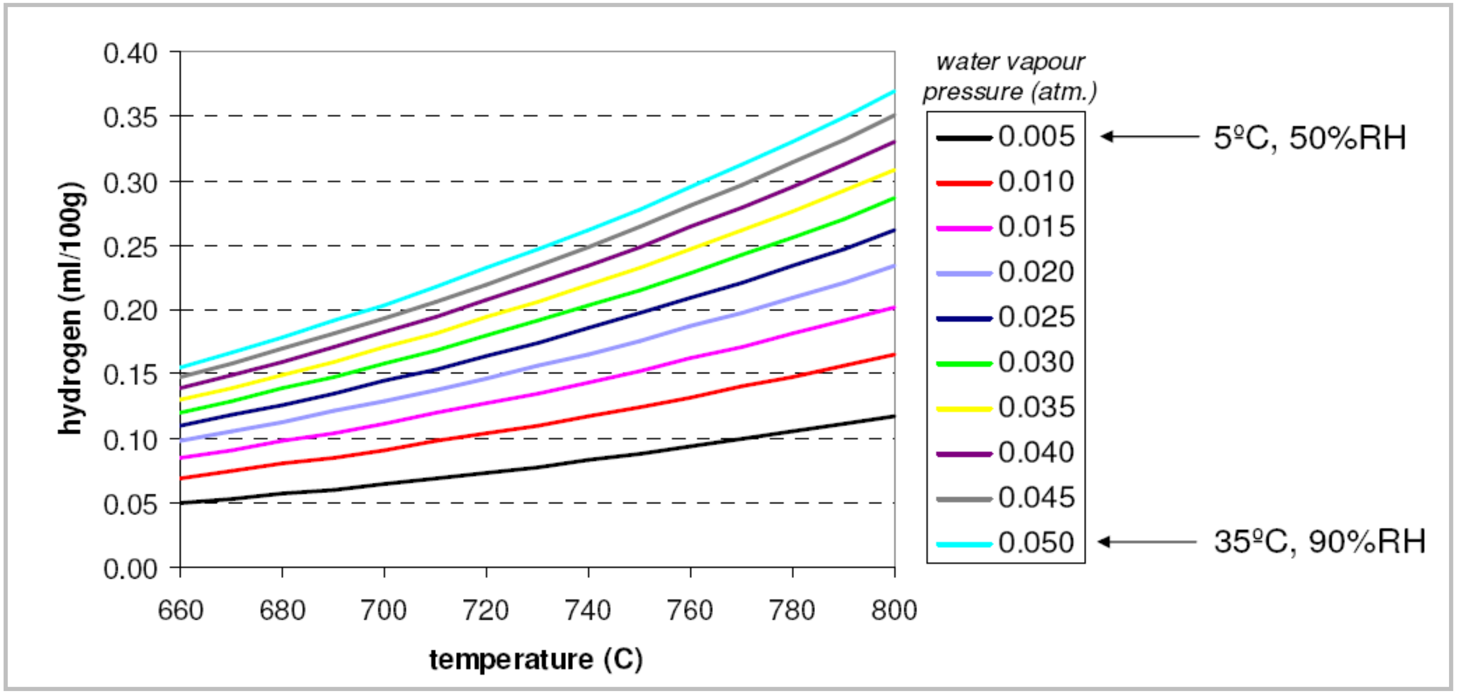




Magnesium increases solubility
Copper, silicon and zinc degrease solubility

Factors Influencing Hydrogen Solubility

- Temperature (liquid – solid)
- Alloy composition
- Ambient conditions



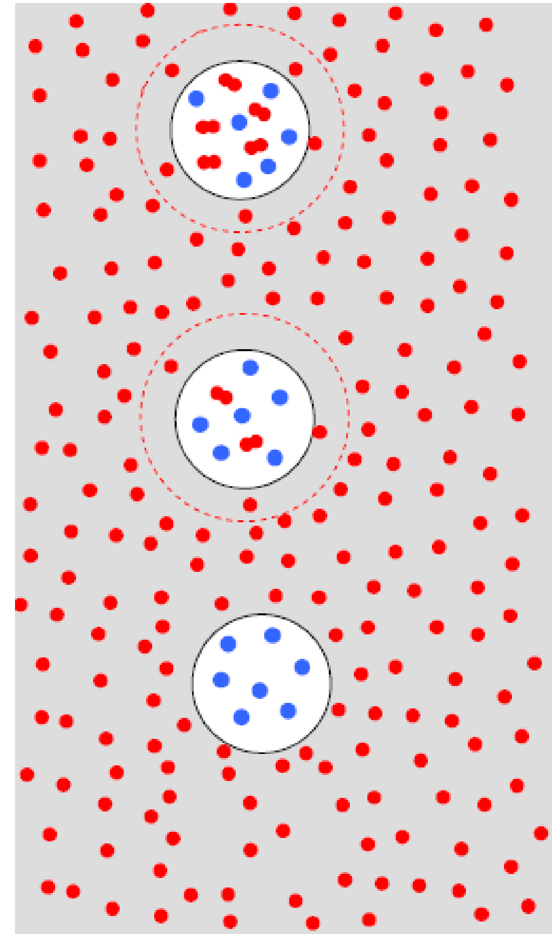
Principle of Hydrogen Removal

Start with a dry inert gas bubble

Establishing a local equilibrium between:

- Hydrogen concentration in diffusion layer
- Partial pressure of hydrogen in the inert gas bubble

Hydrogen concentration in inert gas bubble increases



H Atom, solved in melt

H_2 Molecule within inert gas bubble

Inert gas

Boundary layer of diffusion

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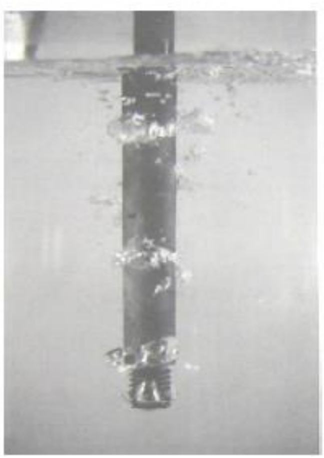
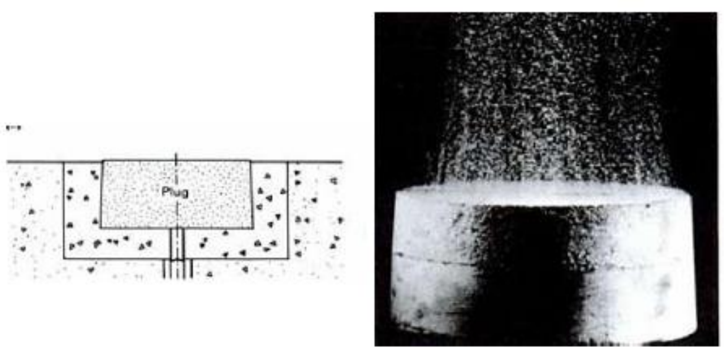
Mixing purpose and rotor functions

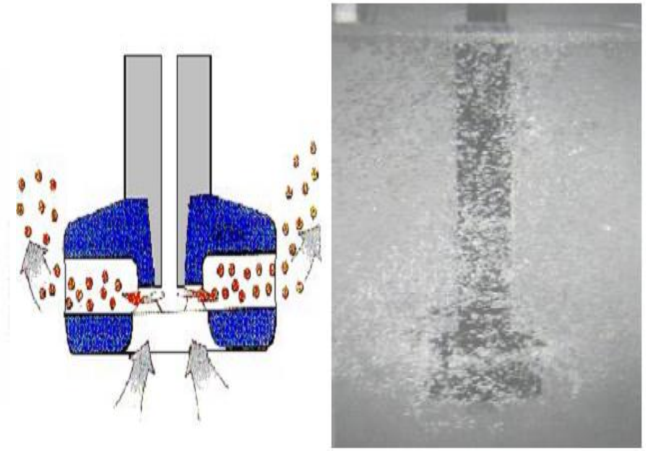
- Small inert gas bubbles for bigger surface
- Slow vertical bubble movement
- Homogeneous bubble distribution
- Homogeneous temperature and alloying element distribution



Lance



Porous block



Rotary degassing

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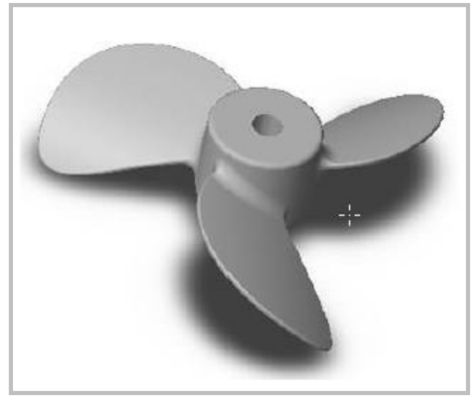
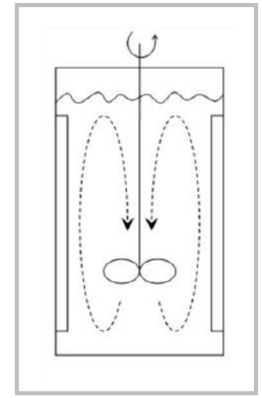
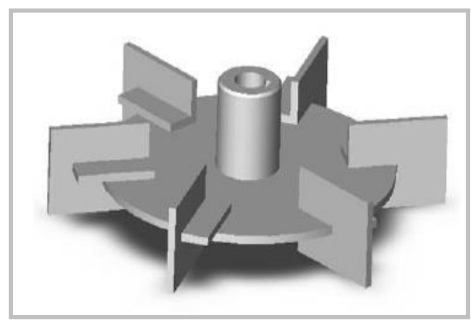
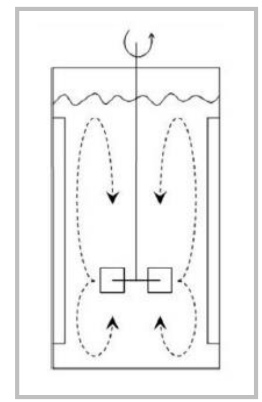
Mixing purpose and rotor functions

- Rotor characterisation
  - Homogenising
  - Gas dispersion
  - Suspension of solids
  - Liquid-liquid-blending
  - Heat transfer
  - Reactions









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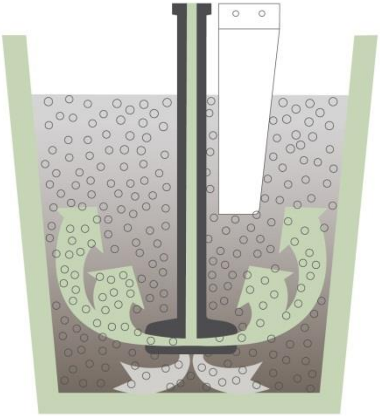
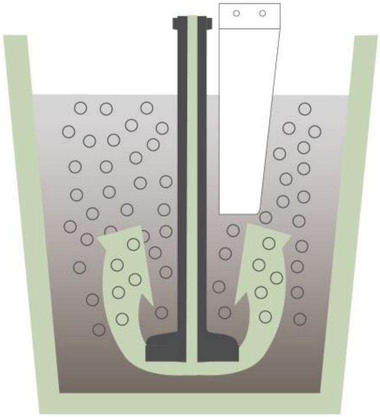
Pumping vs. Non-pumping designs





Pumping rotor

Non-pumping rotor

Homogenising Capability in Water

Pumping rotors

Non-pumping rotor

Type XSR

Type FDR

Trial procedure:

350 rpm rotor speed

Pictures taken 4 seconds after ink addition

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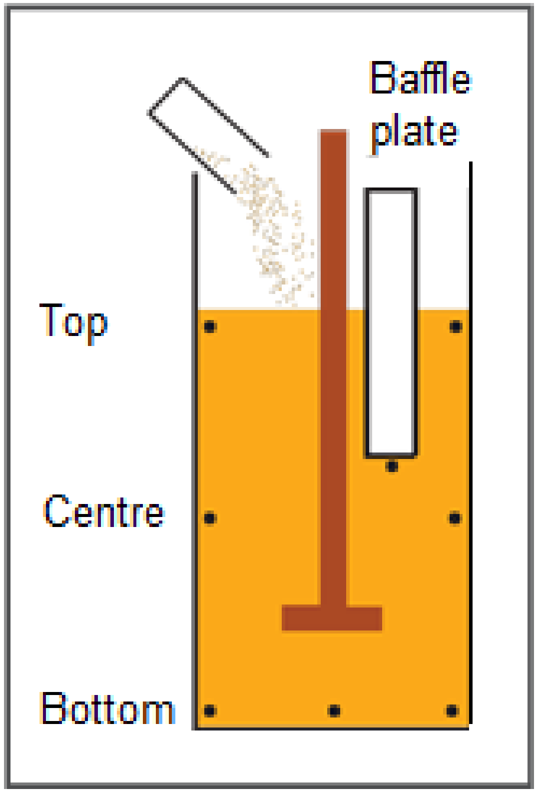
Homogenising Capability in Water



- Water filled Perspex tank (60 cm diameter, 90 cm depth)
- 250 – 260 kg of water
- 8 type T thermocouples
- Addition of 7000 ml of hot water @80 °C
- Rotors run at 400 rpm

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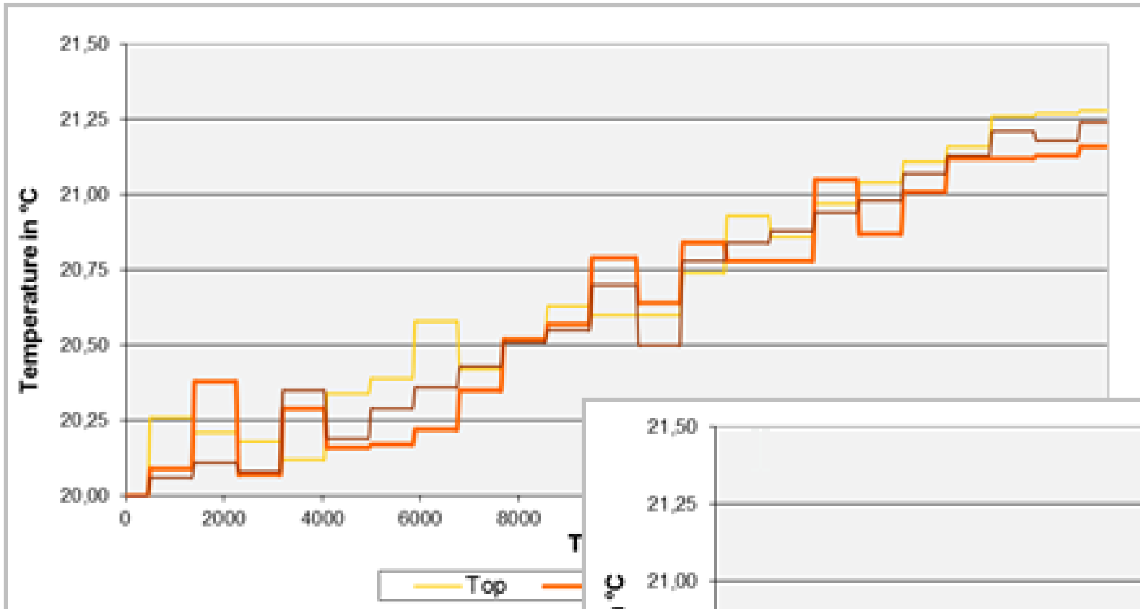
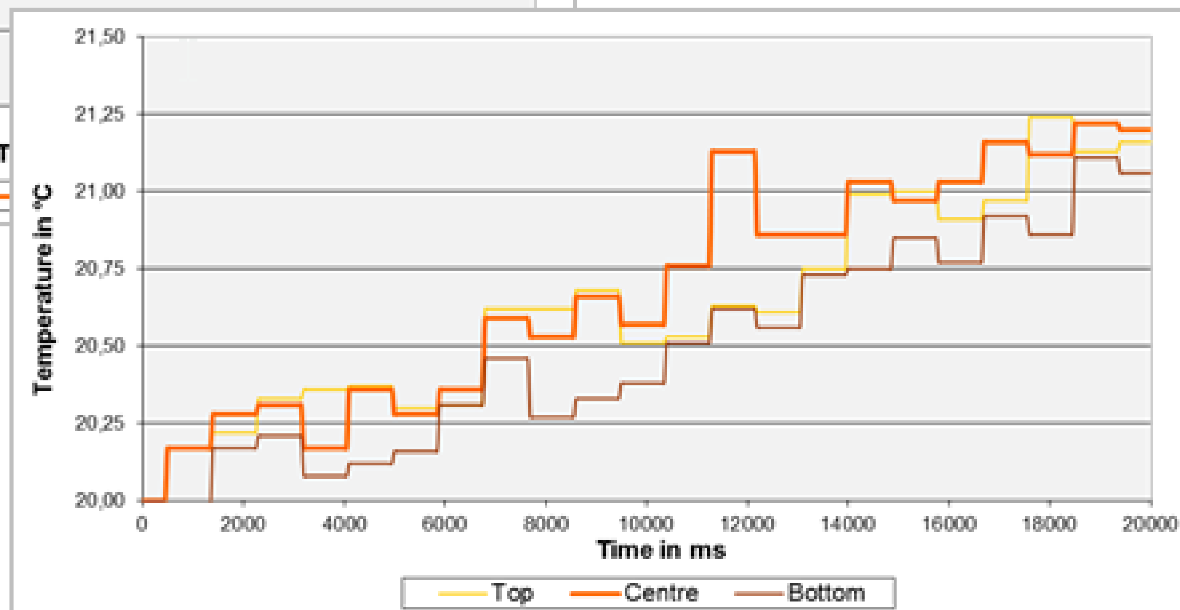
Homogenising Capability in Water



Pumping rotors



Non-pumping rotors

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Efficiency over Rotor Service Life

- Design, shape and size significantly impact the ability to degas aluminium melts.
  - Does each particular rotor perform well throughout the entire service life?
  - What is the true valuable life of a rotor and therefore when should a rotor be changed?

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Efficiency over Rotor Service Life

Trial procedure:

200 kg crucible furnace with AlSi10Mg at 750 °C

175 mm diameter rotor at 320 rpm and 15 l/min nitrogen

52 – 54 % rH and 25 °C

Hydrogen curves were recorded by the ALSPEK H hydrogen analyser.

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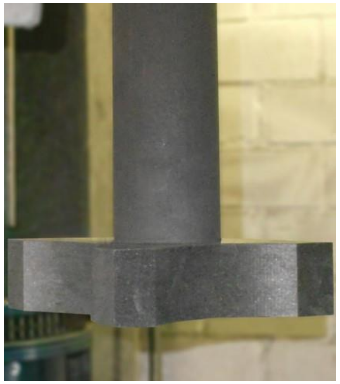
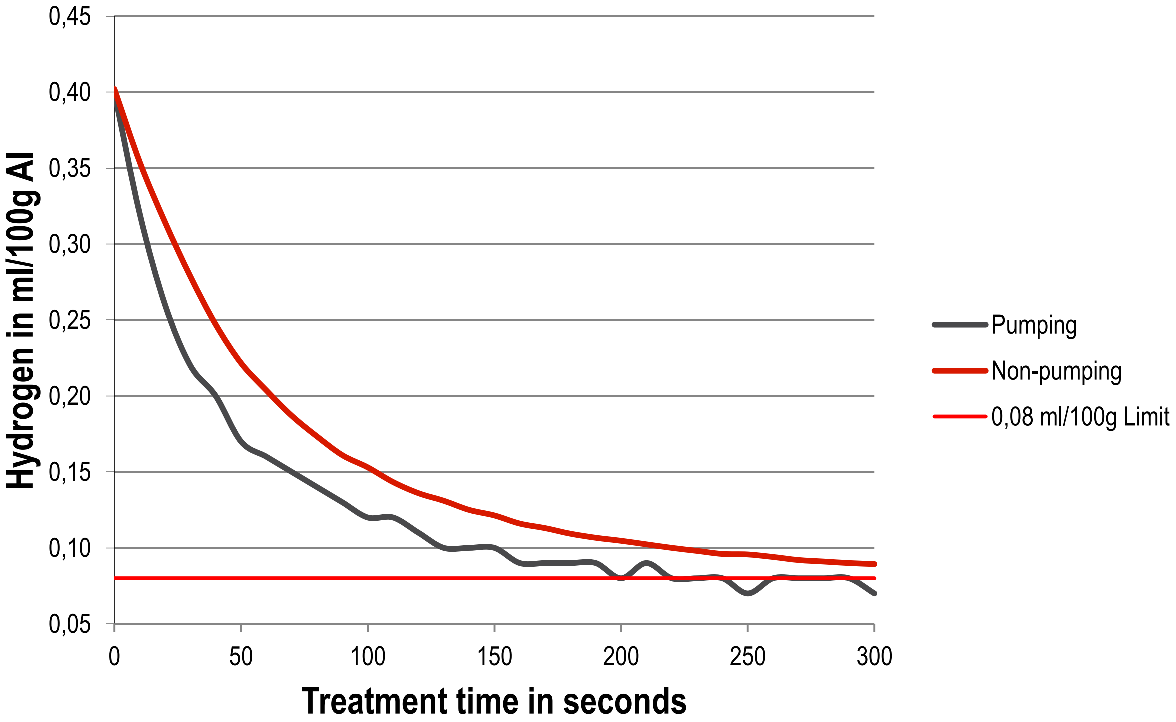
Efficiency over Rotor Service Life

Comparison between new rotors





Target limits:	Pumping rotor:	0,08 ml H_2 / 100 g Al
	Non-pumping rotor:	0,10 ml H_2 / 100 g Al

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Efficiency over Rotor Service Life

Pumping rotor

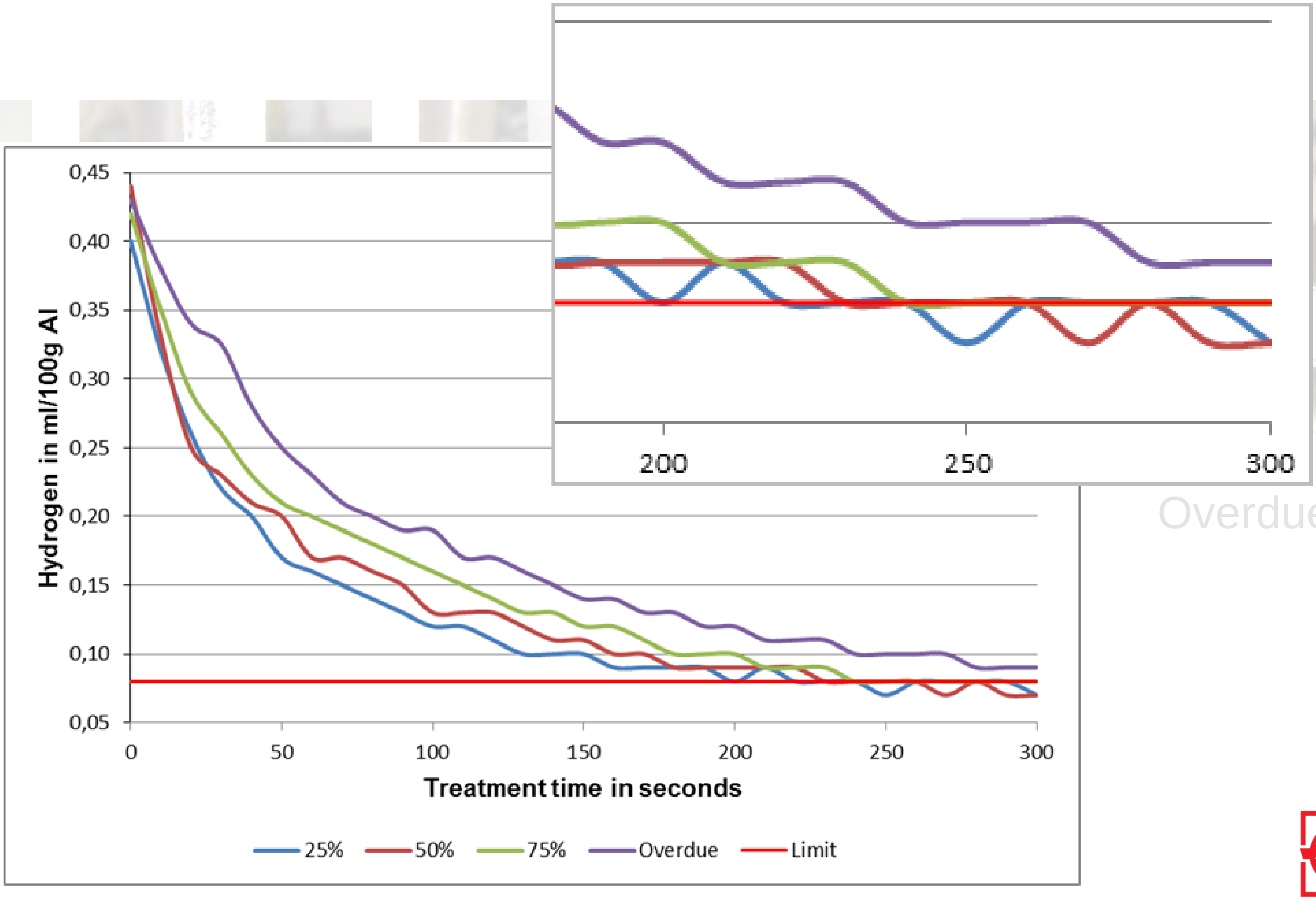
New | After 25 % | After 50 % | After 75 % | Overdue

of total service life

Efficiency over Rotor Service Life

Pumping rotor

New



Overdue

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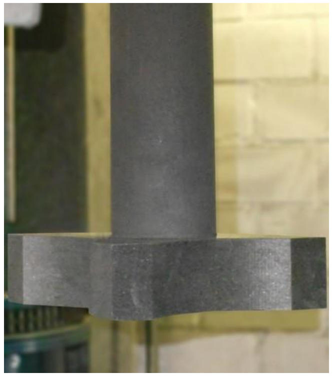
Efficiency over Rotor Service Life

Non-pumping rotor



New

After 10 %

After 75 %

After 95 %

of total service life

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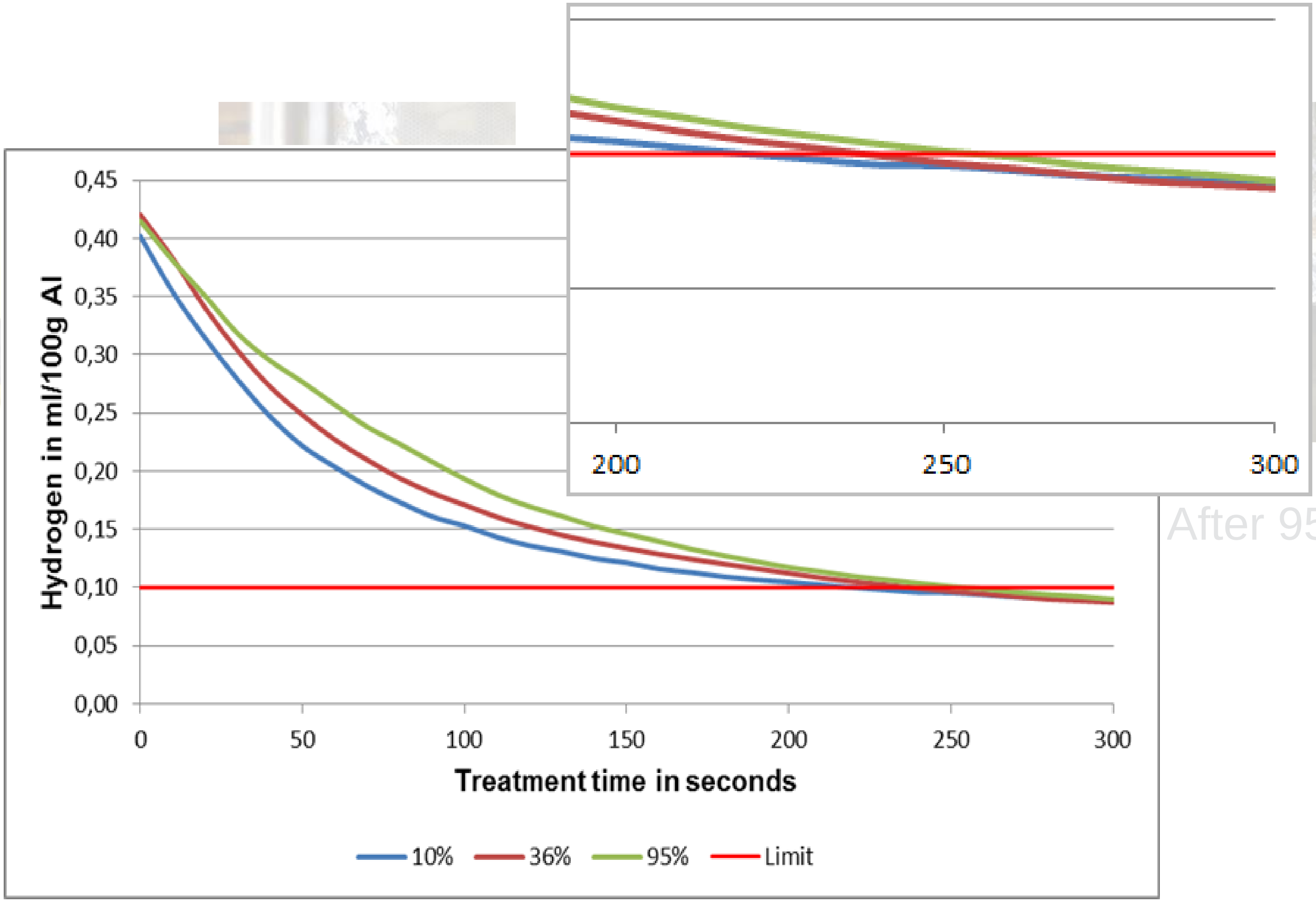
Efficiency over Rotor Service Life

Non-pumping rotor

New



After 95 %

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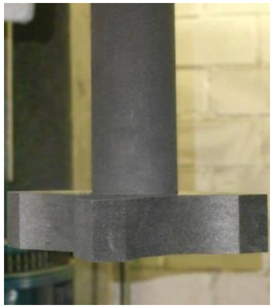
Efficiency over Rotor Service Life

Comparison of Results



Limit	[ml H_2/100 g Al]	0,08	0,10
Time to limit new rotor	[s]	230	220
Time to limit used rotor	[s]	250	260
Fading over service life	[%]	< 10	> 20

Pumping rotors provide consistent degassing efficiency because they compensate a loss in outer diameter and rounded edges by oxidation of the graphite actually increasing the pumping chamber size.
Foundries must define a maximum number of cycles or limit samples.

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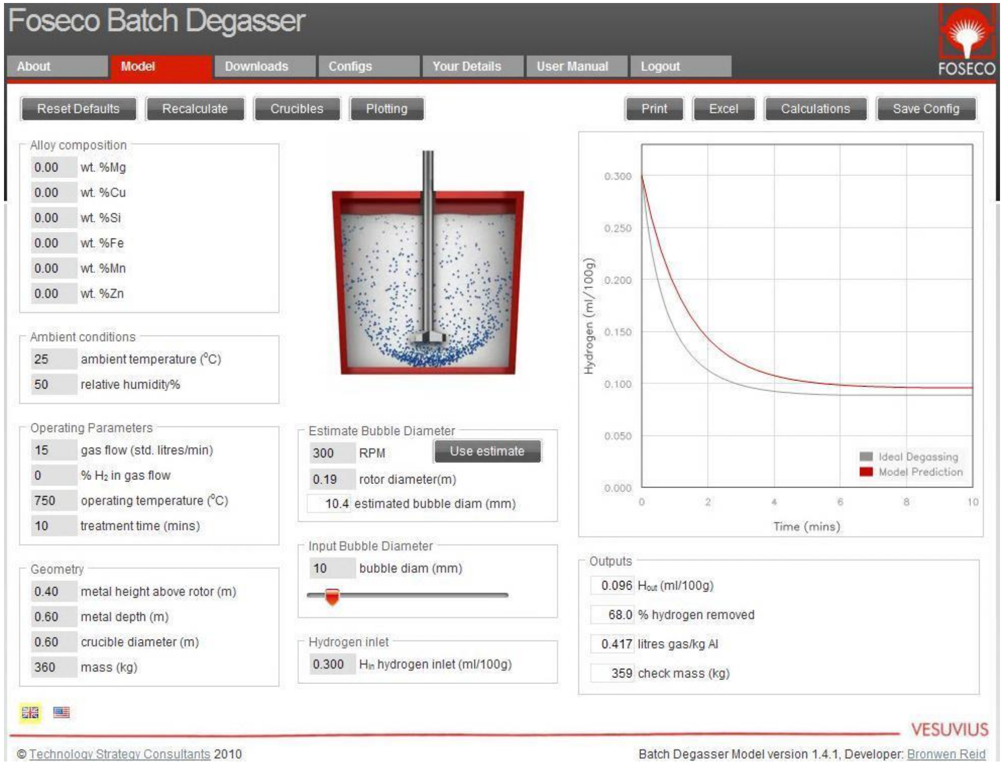
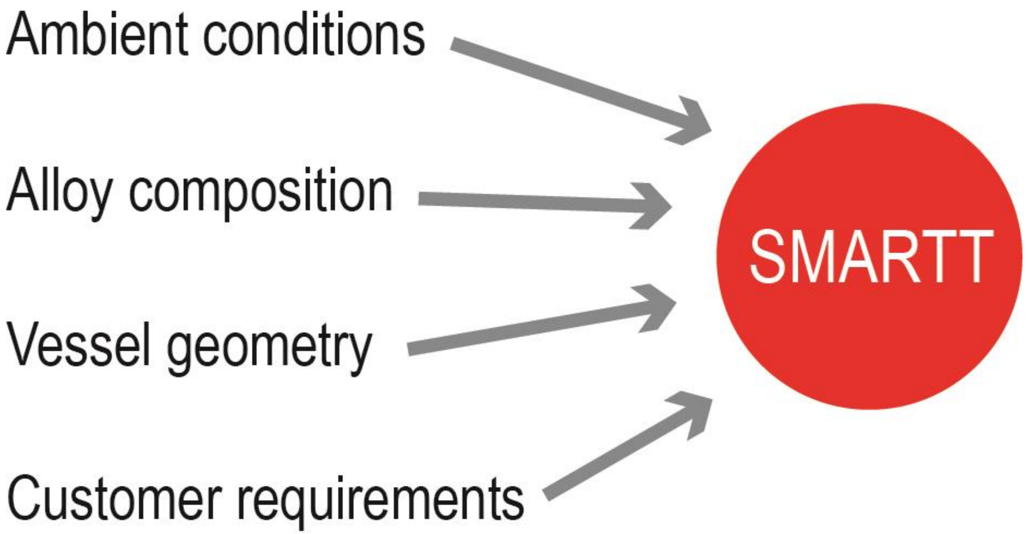
Intelligent Degassing - SMARTT



- Extensive laboratory work has enabled Foseco and tsc to develop a mathematical model which can be the basis of an intelligent system

Intelligent Degassing - SMARTT



- This model recognises changes in external conditions such as ambient temperature, atmospheric humidity and rotor wear, and can then catered for them during the subsequent metal treatment cycle.

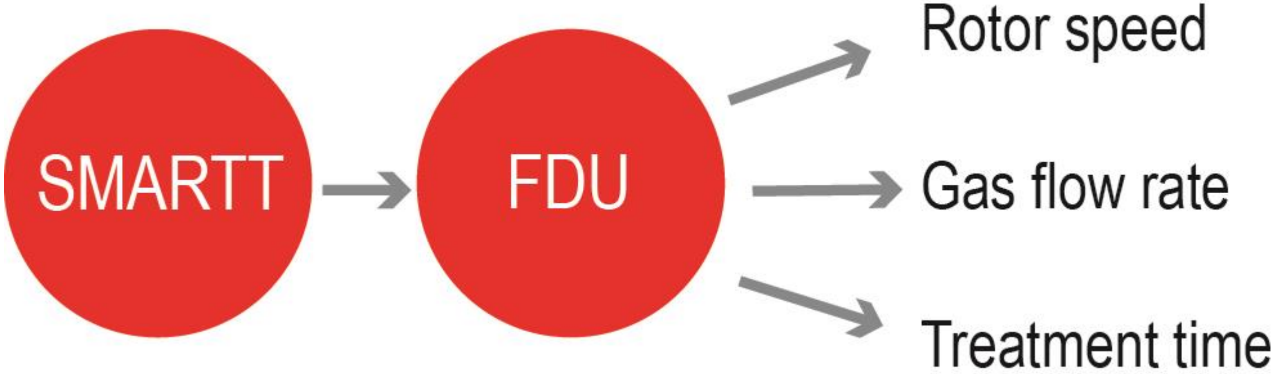
Intelligent Degassing - SMARTT

Ambient conditions

Alloy composition

Vessel geometry

Customer requirements



Summary and conclusions

- Pumping Rotors are far more efficient than non-pumping rotors in terms of mixing, improving metal quality, offering melt quality consistency and reducing the cost per treatment.
- Currently the efficiency loss experienced must be added to the treatment time for new rotors to reach the limit throughout their life.
- Degassing with a Foundry Degassing Unit using the mathematical model offers a further step forward in Process Control. SMARTT enables foundries to run the degassing process independent from operator involvement and getting reliable and constant results.

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