COMBINED COMPETENCE UNDER ONE ROOF

ILTEC Technology
A new formula for furnace safety
Introduction

Organization Chart
Overview Products and Services

- **Non-ferrous metals units**
  - Products:
    - PolyTBRC
    - Launder racks
    - Refining racks
    - Coolers
    - Purging system

- **Refractories non-ferrous**
  - Products:
    - 3D Engineering + supply
    - CFD modeling
    - Heat Transfer Calculations

- **E-waste recycling UrbanGold**
  - Products:
    - Process Engineering
    - UG Compact
    - UG Flex-HENRI
    - Market Studies

- **Tankhouse technology**
  - Products:
    - METTOP-BRX Electrolysis
    - Cathode spacers
    - Complete Tankhouse

- **ILTEC for vessel cooling**
  - Products:
    - Ionic Liquid Technology for vessel cooling

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**DigMet**

- Process & Technology Consulting
- Studies & Trainings
- Process and 3D Plant Engineering
Fatal accidents caused by water coming into contact with liquid metal happen every year

> 200 incidents reported over past years

Water + liquid metal = 1700 times volume expansion plus potential oxyhydrogen reaction
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The future in furnace cooling

- Revolutionary technology in vessel and equipment cooling
- Replacement of water for safe vessel cooling
- Injection tests in Cu and steel making units
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Re-defining safety

- Accidents occur
- When water is replaced by IL-B2001 -> explosion free environment
- Likelihood of incident comparable
- Consequences minimized
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Re-defining safety

- 2009 The idea was born by Mettop
- 2009 Preliminary tests and patent application by Mettop
- 2009 Design of characteristic and creation of various ionic liquids
- 2012 Completion of lab tests and final launch of IL-B2001
- 2012 Industrial scale trials in Austria
- 2012 European certification for industrial application
- 2015 First reference at Nyrstar, Norway
- 2016 JV PolyMet Solutions of Mettop and SMS group
- 2017 Exclusive cooperation agreement with SMS group
Properties of IL-B2001

Today:
- Operation temperature: 50°C - +200°C
- Decomposition temperature: 450°C
- Minimum operation temp: -10°C

Tomorrow:
- Target: -15°C - +300°C
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Characteristics of new cooling medium

- **No explosive reaction** at contact with liquid metal – tests done at University of Leoben, Montanwerke Brixlegg AG and Böhler Edelstahl GmbH
- **Not harmful or toxic** even when decomposed – tested at proionic and at Montanuniverität Leoben; REACH registered
- **Non corrosive** - chlorine free; production procedure – production route patented by Proionic; no restrictions for metal body and seals (EXEPTION: Viton sealing)
- **Sufficient cooling** due to sufficient heat removal – proven at FH Wels and at our reference plants
- **No altering or change in behaviour** - if there is no contact with hydrogen or water
## Properties of IL-B2001

<table>
<thead>
<tr>
<th>Property</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation temperature</td>
<td></td>
<td>50-200</td>
<td>°C</td>
<td>ΔT = 150 °C</td>
</tr>
<tr>
<td>Short term stability</td>
<td></td>
<td>250</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Decomposition temperature</td>
<td></td>
<td>450</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Minimum operation temperature</td>
<td></td>
<td>-10</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Crystallization temperature</td>
<td></td>
<td>-30 – -40</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>ρ</td>
<td>1.25 – 1.14</td>
<td>kg/dm³</td>
<td>50 – 200 °C</td>
</tr>
<tr>
<td>Specific heat capacity</td>
<td>c&lt;sub&gt;p&lt;/sub&gt;</td>
<td>1.67 – 1.99</td>
<td>J/gK</td>
<td>50 – 200 °C</td>
</tr>
<tr>
<td>Dynamic viscosity</td>
<td>η</td>
<td>20 – 5</td>
<td>mPa·s</td>
<td>50 – 200 °C</td>
</tr>
<tr>
<td>Electrical conductivity</td>
<td>κ</td>
<td>30 – 130</td>
<td>mS/cm</td>
<td>50 – 200 °C</td>
</tr>
</tbody>
</table>

\[ Q \ [W] = \dot{m} \ [m/s] \cdot c_p \ [J/gK] \cdot \Delta T \ [K] \]

Lower specific heat capacity can be compensated due to a higher temperature range and enables a heat transfer comparable to water \((c_p = 4.19 \text{ J/gK})\).
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Hardware

- Tank filled with IL-B2001, freeboard purged with nitrogen to prevent hydration

- Two identical pumps (one for standby)

- Two heat exchangers connected with secondary cooling circuit, (one for standby)

- Measurement of temperature, flow, pressure and differential pressure

Reference system as installed at Arcelor Mittal Germany
**Possible applications of ILTEC-Technology with IL-B2001**

<table>
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<tr>
<th>Safety</th>
<th>New cooling applications</th>
<th>New processes</th>
<th>Heat recovery</th>
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<tr>
<td>◆ Replacing water with IL</td>
<td>◆ New cooling panels</td>
<td>◆ New processes due to ILTEC</td>
<td>◆ Example: ER systems for EAF, BOF, CC, SAF, cooling systems</td>
</tr>
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<td>◆ Examples: sidewall cooling, tap holes</td>
<td>◆ Examples: underbath cooling, instruments, lances, tuyers, PS-converter, perm. electrode</td>
<td>◆ Example: HENRI reactor for e-waste recycling</td>
<td></td>
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<tr>
<td>◆ Reference: tap hole AM in Bremen</td>
<td>◆ Reference: Vessel cooling at Nyrsta</td>
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**Safety**

- Replacing water with IL
- Examples: sidewall cooling, tap holes
- Reference: tap hole AM in Bremen

**New cooling applications**

- New cooling panels
- Examples: underbath cooling, instruments, lances, tuyers, PS-converter, perm. electrode
- Reference: Vessel cooling at Nyrsta

**New processes**

- New processes due to ILTEC
- Example: HENRI reactor for e-waste recycling

**Heat recovery**

- Example: ER systems for EAF, BOF, CC, SAF, cooling systems
Possible applications of ILTEC-Technology with IL-B2001

- Sidewall cooling under-bath
- Tap blocks
- Runners
- Bottom electrodes
- Reactor cooling
- Offgas ducts
- Instruments
- Lances
- Purging systems
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References of industrial scale use
## References of industrial scale use

<table>
<thead>
<tr>
<th>Application</th>
<th>Benefit</th>
<th>Supply lines</th>
<th>Overall flow capacity</th>
<th>Country</th>
<th>Start Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling of shaft part of plasma furnace</td>
<td>Guaranteeing higher temperature inside the furnace for preventing corrosion from sulfuric acid</td>
<td>3</td>
<td>30 m³/h</td>
<td>Norway</td>
<td>January 2015</td>
</tr>
<tr>
<td>Blast furnace tap hole</td>
<td>Increasing safety</td>
<td>2</td>
<td>30 m³/h</td>
<td>Germany</td>
<td>October 2015</td>
</tr>
<tr>
<td>Test for cooling EAF bottom shell</td>
<td>Increasing the lifetime of refractory beneath bath level</td>
<td>2</td>
<td>20 m³/h</td>
<td>Germany</td>
<td>Tests performed in Summer 2017</td>
</tr>
<tr>
<td>Cooling of pipes of copper coolers during the casting process</td>
<td>Increasing process safety and improve copper cooler quality</td>
<td>4</td>
<td>50 m³/h</td>
<td>Spain</td>
<td>January 2018</td>
</tr>
<tr>
<td>Cooling of connection flanges at the RH degassing vessel</td>
<td>Increasing process safety and prevent warping</td>
<td>2</td>
<td>15 m³/h</td>
<td>Austria</td>
<td>June 2018</td>
</tr>
<tr>
<td>Side wall cooling in cyclone furnace</td>
<td>Side wall cooling for improved lifetime in highly stressed burner areas</td>
<td>1</td>
<td>10 m³/h</td>
<td>Denmark</td>
<td>Test in Summer 2019</td>
</tr>
<tr>
<td>Tap hole cooling at slag cleaning furnace</td>
<td>Increased safety</td>
<td>1</td>
<td>10 m³/h</td>
<td>Test in Summer 2019</td>
<td></td>
</tr>
<tr>
<td>Lance cooling at TBRC converter</td>
<td>For submerged oxygen blowing</td>
<td>1</td>
<td>10 m³/h</td>
<td>Test in December 2019</td>
<td></td>
</tr>
</tbody>
</table>
Blast Furnace Taphole

Substitution of water in existing taphole

**Taphole cooling**

Blast Furnace
ArcheorMittal, Bremen (Germany)
since October 2015
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Industrial scale application at Blast Furnaces – CFM Modelling

Temperature distribution during tapping and during normal operation

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Temperature distribution during tapping and during normal operation
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Reference Zinc Oxide Furnace
Høyanger, Norway in operation since January 2015

- No corrosion of steel structure due to selective cooling (180 °C)
- Preventing of condensation of sulfuric acid
- Significant increase vessel lifetime
RH Degassing

Industrial scale application at a steel vacuum degassing system

**Cooling of all flanges**

as the connection parts between nozzle and lower part and lower and upper part for increased operating safety at Donawitz GmbH, Austria.
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For charging lance cooling in a TBRC converter – Start up in June 2019

ILTEC facility with two individual supply lines for cooling of the permanent charging lance and the camera installed in the TBRC converter.

Start up in June 2019
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Aspects test trails for our clients – piloting and industrial scale tests of ILTEC

- Test rigs available allowing industrial scale tests at existing furnaces (2 different sizes)
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Think out of the box – what might be all possible
Any other ideas?

- explosion safe furnaces
- corrosion free vessels and off-gas systems
- water free cooling towers
- energy recovery for various units
- safe and automated tapping systems
- production boost
- new metallurgical processes
- new other on-line instrumentations
- permanent lances
- permanent lining
- new type of induction heating/furnaces
- production boost
- new e-waste process
- lower insurance policy
Industrial proven new cooling method for furnaces for:

- Safety improvement
- New cooling application will change furnace and equipment concepts
- ILTEC will make new processes possible
- Energy recovery possible
- Test can be done with test rigg at your furnace
- Think out of the box – where does it make sense for you?