Introducing Mettop

Mettop GmbH is an Austrian engineering company founded in 2005 by Dr. Iris & Dr. Andreas Filzwieser.

The company focuses on providing pyro- and hydrometallurgical process improvements and optimization for the non-ferrous industry as well as for iron and steel processing industry.
Mettop at a Glance
Meet Customers Problems – Tailor-made process optimization

**Tankhouse Engineering**
- METTOP-BRX Technology
- Basic Engineering
- Detail Engineering
- Feasibility Studies
- Consulting decreasing OPEX
- Consulting increasing Current Efficiency

**Furnace Integrity**
- Process Modelling
- CFD Simulation
- Gas Purging Systems
- 3D Refractory Engineering

**Cooling Technology**
- Cooling Solutions
- ILTEC Technology
- Feasibility Studies
Furnace Integrity
Holistic Approach for Optimized Furnace Performance
Furnace Integrity
Optimized Metallurgical Performance

Process Modelling
- HSC Modelling

Refractory Engineering

Furnace Modules and Components
- Special Copper Coolers
- Purging Systems
Furnace Cooling
Special cooler design for optimized cooling performance
Why Cooling?
Advantages of an Optimized Cooling Solution

• Cooling of refractory is inevitable for smelting operations to intensify their performance.

• Better cooling of the refractory leads to a more steep temperature gradient within the lining.

• Steeper temperature gradient means less area for possible infiltration of liquid slag or metal.

• Less infiltration leads to better wear performance of the refractory material.

• Better performance of refractory lead to increase in lifetime, increase in campaign lifetime and to a more cost saving and economical production.
Different Cooling Solutions

Standard Coolers

Stave Coolers

Copper cooler (stave) for a blast furnace shaft cooling solution.

Plate Coolers

Different solutions for side wall cooling of an electric arc furnace

- Plate coolers at the outer wall, behind the brickwork
- Plate coolers in between the layers of the bricklining for an even better cooling performance
- Different copper cooling panels
Different Cooling Solutions

High Intensity Coolers

**Waffle Type Coolers**

Refractory filled and dovetailed grooves on the element hot face and cooper fins between.

Source: M.W. Kennedy, p. Nos, M. Bratt and M. Weaver: Alternative coolants and cooling system designs for safer freeze lined furnace operation.

**CFM Coolers (Composite Furnace Modules)**

Casted copper fingers combined with castable refractory.
CFM - Examples of Use
Composite Furnace Module Cooling

Anode Furnace – Off gas Junction

Electric Arc Furnace – Off gas opening

Tilting Furnace – Charging mouth
Cooling Technology
Revolutionary new: ionic liquid cooling technology (ILTEC)
ILTEC Technology
Why rethinking cooling solutions?

Fatal accidents caused by water coming into contact with liquid metal happen every year. Water + liquid metal = 1700 times volume expansion plus potential oxyhydrogen reaction.
Furnace Integrity
Optimized Safety
ILTEC Technology

Revolutionary new and water free cooling technology

The ILTEC Technology is characterized by the following:

• Instead of water the ionic liquid IL-B2001 is used as cooling medium
• IL-B2001 is a salt which is liquid at room temperature and can be used up to 200 °C operating temperature
• If there is a leak in the cooling system, the IL-B2001 decomposes into its components (at 450 °C) without sudden increase in volume and without formation of hydrogen. If it comes in contact with liquid metal there will be no explosions and work safety can be guaranteed
• No corrosion problems, since the IL-B2001 can be used as a cooling medium at higher temperatures (above the dew point of the exhaust gases)
• Due to the higher temperature (up to 200 °C), the dissipated heat can also be recovered again. This advantage will play a particularly important role in the future
## Ionic Liquid IL-B2001

### Characteristic Properties

<table>
<thead>
<tr>
<th></th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation temperature</strong></td>
<td></td>
<td>50-200</td>
<td>°C</td>
<td>ΔT = 150 °C</td>
</tr>
<tr>
<td><strong>Short term stability</strong></td>
<td></td>
<td>250</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td><strong>Decomposition temperature</strong></td>
<td></td>
<td>450</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td><strong>Solidification range</strong></td>
<td></td>
<td>-63 – 15</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td>$\rho$</td>
<td>1.25 – 1.14</td>
<td>kg/dm$^3$</td>
<td>50 – 200 °C</td>
</tr>
<tr>
<td><strong>Specific heat capacity</strong></td>
<td>$c_p$</td>
<td>1.38 – 1.70</td>
<td>J/gK</td>
<td>50 – 200 °C</td>
</tr>
<tr>
<td><strong>Dynamic viscosity</strong></td>
<td>$\eta$</td>
<td>20 – 5</td>
<td>mPa·s</td>
<td>50 – 200 °C</td>
</tr>
<tr>
<td><strong>Thermal expansion coefficient</strong></td>
<td>$\alpha$</td>
<td>6.61 ·10$^{-4}$</td>
<td>1/K</td>
<td></td>
</tr>
<tr>
<td><strong>Electrical conductivity</strong></td>
<td>$K$</td>
<td>30 – 130</td>
<td>mS/cm</td>
<td></td>
</tr>
</tbody>
</table>

- Almost no vapour pressure below decomposition temperature
- Not flammable below decomposition temperature
- Non toxic
- Non-corrosive
Ionic Liquid IL-B2001

Optimized Safety

Industrial Scale Tests with IL-B2001 introduced into liquid steel melt

No reaction when liquid steel melt gets in contact with IL-B2001

Improved safety standards
ILTEC Technology

Hardware

Main components:

• **Tank** filled with **IL-B2001**, the freeboard volume above the liquid level is purged with nitrogen to prevent hydration of the liquid through moisture in the air
• Two identical **pumps** (one for redundancy in case of breakage or malfunction) guarantee the flow of the IL through the entire pipe system
• Two **heat exchangers** for removing the heat to the secondary cooling circuit, again one in operation, one for redundancy
• Numerous **measuring devices** (digital as well as analogue) throughout the entire system to measure temperature, flow, pressure and differential pressure
• Variety of **valves**, adjusting **wheels** and shut-off devices for all different operation modes
ILTEC Technology
Scope of Service by Mettop

Basic and detailed Engineering

Manufacturing and Assembly of ILTEC including IL-B2001

Installation and Start up on Site
ILTEC Technology
Possible applications of ILTEC-Technology with IL-B2001

Substitution of water in existing systems
Blast furnace taphole, formerly cooled with water

New cooling applications
Side Wall Cooling beneath bath level
No cooling so far because of danger

Possibility of heat recovery
Sufficient heat transfer and higher outlet temperature of up to 200 °C enables heat recovery
ILTEC Technology
Excerpt of the limitless Possibilities
Primary Metallurgy - BF

Potential Application for ILTEC and Optimized Coolers (CFM)

Blast Furnace

- Tap hole
- Tuyere cooling
- Side wall cooling – stave cooling
- Casthouse main runner system –
- Hot metal trough

Side wall cooler

Wear zone in hot metal trough

Cooled copper tuyere
ILTEC Technology
ArcelorMittal Bremen Tap Hole, initially water cooled
ILTEC Technology
Industrial scale application at Blast Furnace – CFM Modelling

Temperature distribution during tapping and during normal operation

Temperature distribution during tapping and during normal operation
Blast Furnace Tap Hole
Substitution of water in existing tap hole

Tape Hole Cooling
Blast Furnace
ArcelorMittal, Bremen (Germany).
since October 2015
Iron and Steel Industry
Potential Application for ILTEC and Optimized Coolers (CFM)

EAF Furnace:

- Cooling of bottom shell side wall
- Cooling of upper shell panels
- Siphon tapping
- Cooling of Offgas System – Gas Cleaning
- Lance and lance manipulator
- Eccentric bottom tapping
- Cooling of area of slag door
- ........

Side wall hot spot  Cooled off gas duct  Slag door wear area  Cooled eccentric bottom tapping
**Side Wall Cooling**

Plate cooler in bottom shell

**Different approaches for side wall cooling:**
- Plate cooler for cooling in between brick lining and steel shell
- CFM cooler for whole side wall
- CFM cooler for slag line and copper cooler behind brick lining
**Side Wall Cooling**

CFM cooler in bottom shell

**Different Approaches for side wall cooling:**
- CFM cooler for whole side wall
- CFM cooler for slag line and copper cooler behind brick lining

- Copper fingers
- Castable refractory
- Transportation suspensions
- Copper back plate
- Monel pipes
- Slag level
- Liquid steel bath
- Sill level
- Gas purging plug
- Slag spout
- CFM cooler
Zinc Oxide Furnace
Industrial scale application for side wall cooling at higher temperatures

Cooling of furnace walls
For preventing temperatures below the dew point, installed at Nyrstar (Norway) and in operation since January 2015

- **No corrosion** of the steel structure due to selective cooling to temperatures of 180 °C and hence preventing of condensation of sulfuric acid
- **Increase lifetime** of entire vessel
ILTEC Technology

Hardware as installed in Hoyanger
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 voestalpine Donawitz GmbH, Austria.

Start up in 2017