

COMBINED COMPETENCE UNDER ONE ROOF



# ILTEC Technology

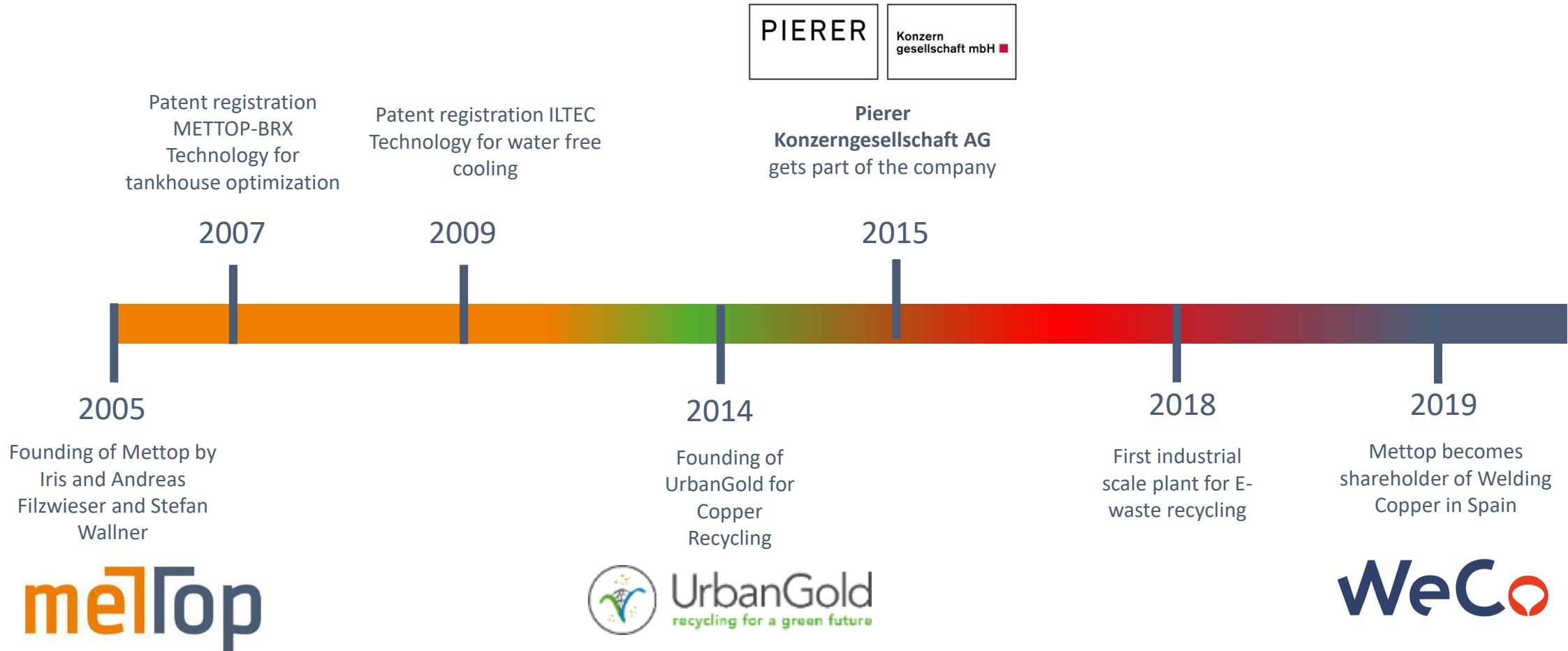
A new formula for furnace safety

## Organization Chart

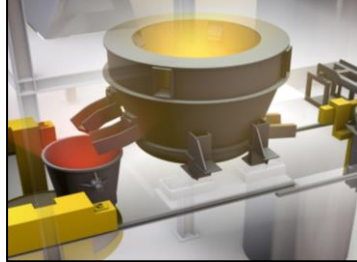
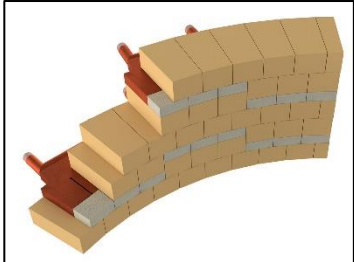


Key to Mettop's position as an expert partner is the open-minded, creative spirit of our team. We develop innovations in cooperation with renowned institutes and universities and especially with YOU! This interaction with third parties constantly provides new dynamics and fresh inspiration.

## History and Timeline



## Overview Products and Services



### Non-ferrous metals units

#### Products:

- ◆ PolyCONVERT<sup>®</sup>
- ◆ PolyREFINE<sup>®</sup>
- ◆ HENRI<sup>®</sup>
- ◆ Gas Purging Systems
- ◆ Coolers

### Refractories non-ferrous

#### Products:

- ◆ 3D Engineering + supply
- ◆ CFD modeling
- ◆ HT-calculations
- ◆ EXP-calculations

### E-waste recycling UrbanGold

#### Products:

- ◆ Process Engineering
  - ◆ UG Compact
  - ◆ UG Flex
  - ◆ UG Classic
- ◆ Market Studies

### Tankhouse technology

#### Products:

- ◆ METTOP-BRX<sup>®</sup> Technology
- ◆ Cathode spacers
- ◆ Complete Tankhouse

### ILTEC for vessel cooling

#### Products:

- ◆ IL-B2001<sup>®</sup>
- ◆ Ionic Liquid Technology for vessel cooling
- ◆ Furnace integrity optimization

Research & Development & Innovation

DigMet

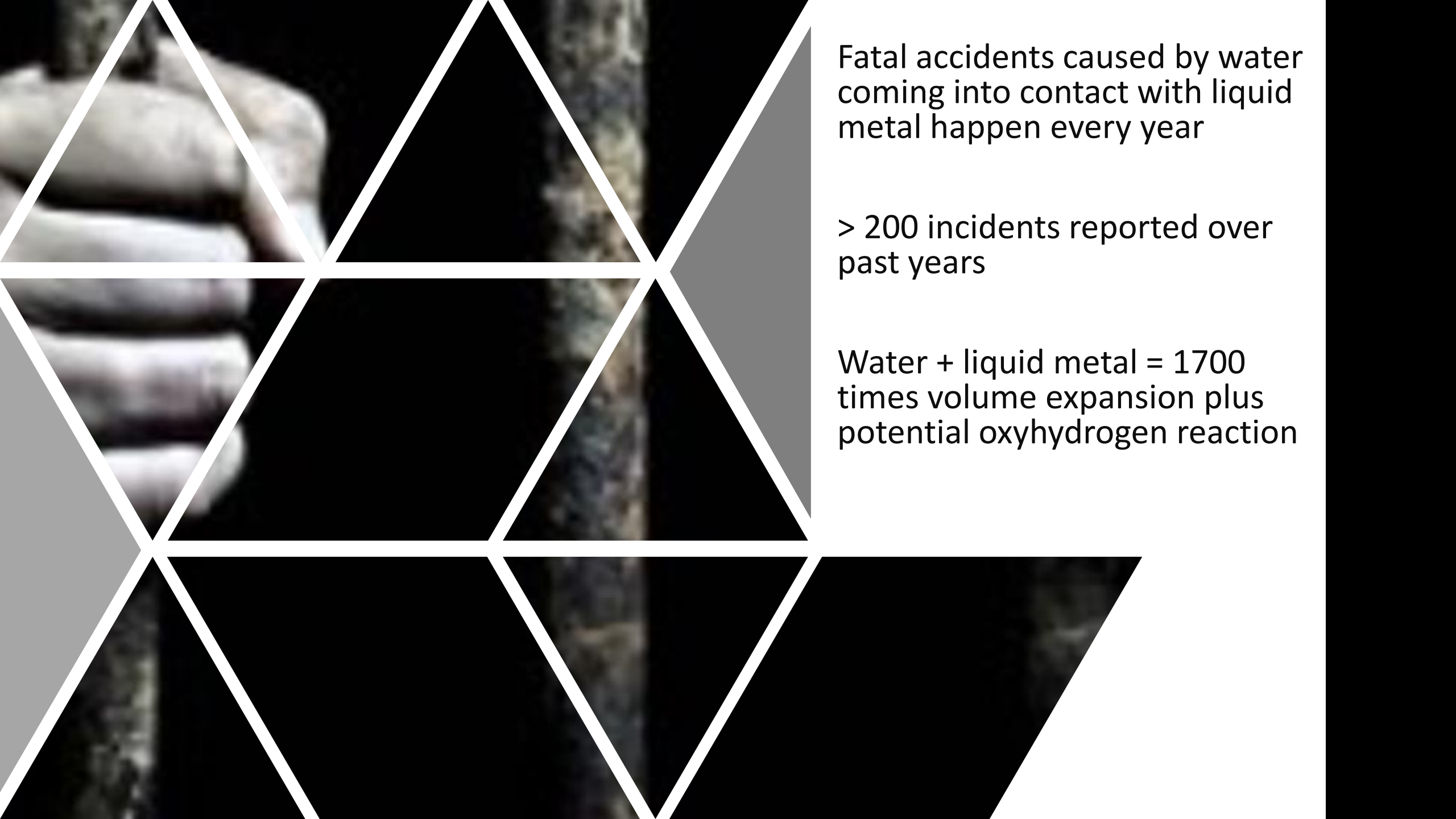


Overall Process & Technology Consulting

Field Studies & Trainings

Process and 3D Plant Engineering



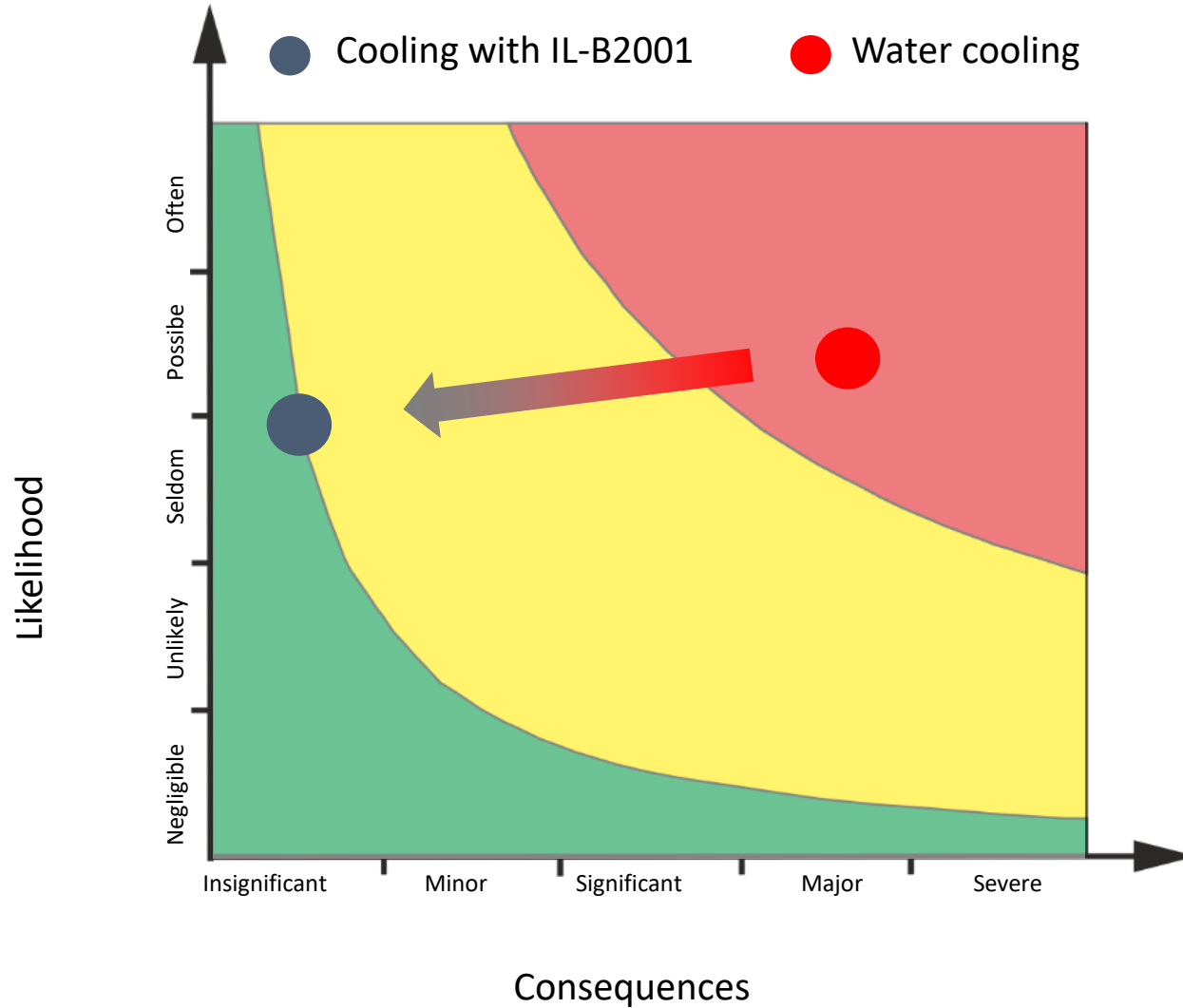


Fatal accidents caused by water coming into contact with liquid metal happen every year

> 200 incidents reported over past years

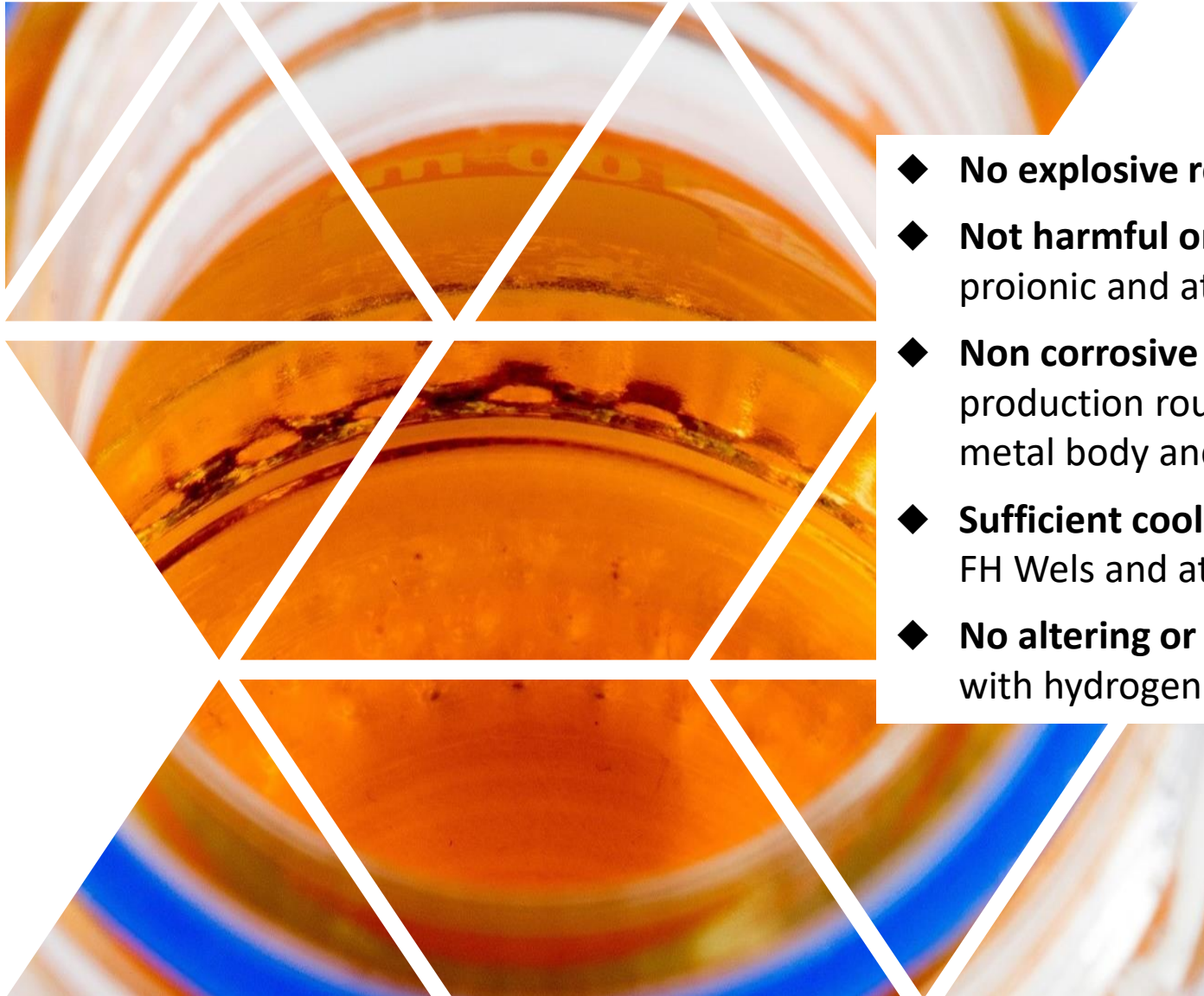
Water + liquid metal = 1700 times volume expansion plus potential oxyhydrogen reaction

## Re-defining safety



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

## Characteristics of new cooling medium



- ◆ **No explosive reaction** at contact with liquid metal
- ◆ **Not harmful or toxic** even when decomposed – tested at proionic and at Montanuniversität 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

## Characteristics of new cooling medium

	Symbol	Value	Unit	Range
Operation temperature		50-200	[°C]	$\Delta T = 150 \text{ }^\circ\text{C}$
Short term stability		250	[°C]	
Decomposition temperature		450	[°C]	
Minimum operation temperature		-10	[°C]	
Crystallization temperature		-30 – -40	[°C]	
Density	$\rho$	1.25 – 1.14	[kg/dm <sup>3</sup> ]	50 – 200 °C
Specific heat capacity	$c_p$	1.70 – 1.99	[J/gK]	50 – 200 °C
Dynamic viscosity	$\eta$	20 – 5	[mPa·s]	50 – 200 °C
Electrical conductivity	$\kappa$	30 – 130	[mS/cm]	50 – 200 °C

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

## Hardware



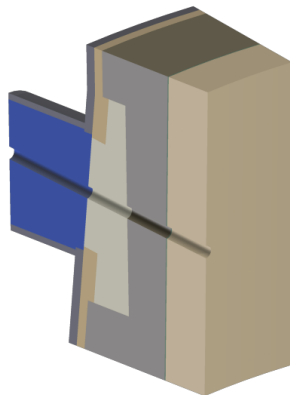
- ◆ Tank filled with IL-B2001, freeboard purged with nitrogen to prevent hydration
- ◆ Two identical pumps (one for standby)
- ◆ Two heat exchangers connected with secondary cooling circuit (one for standby)
- ◆ Measurement of temperature, flow, pressure and differential pressure

Reference system as installed at Arcelor Mittal Germany

## Possible applications of ILTEC-Technology with IL-B2001

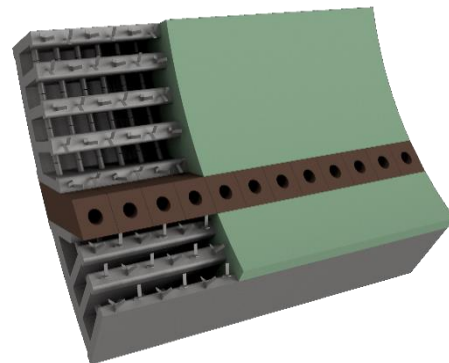
### Safety

- ◆ Replacing water with IL-B2001
- ◆ Examples: sidewall cooling, tap holes
- ◆ Reference: tap hole AM in Bremen



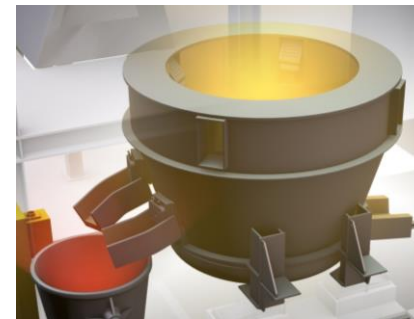
### New cooling applications

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



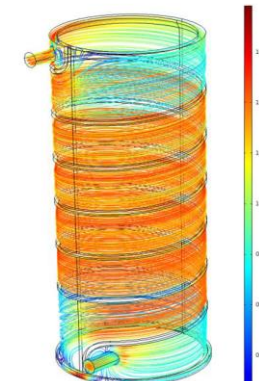
### New processes

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

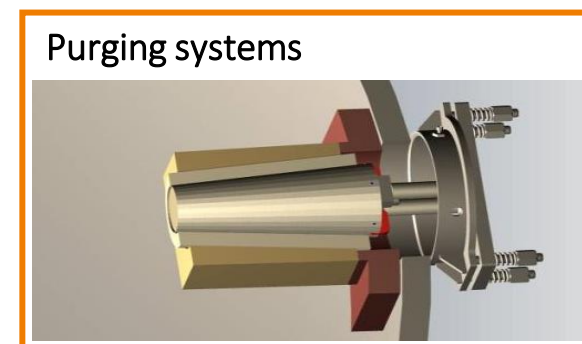
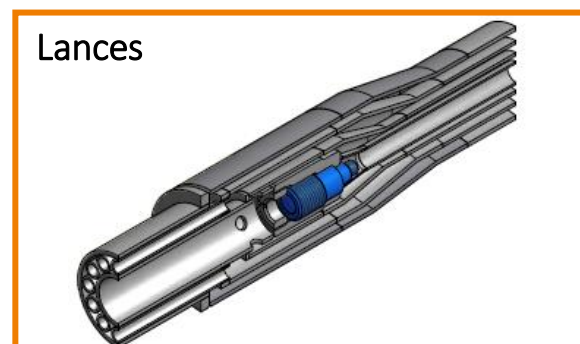
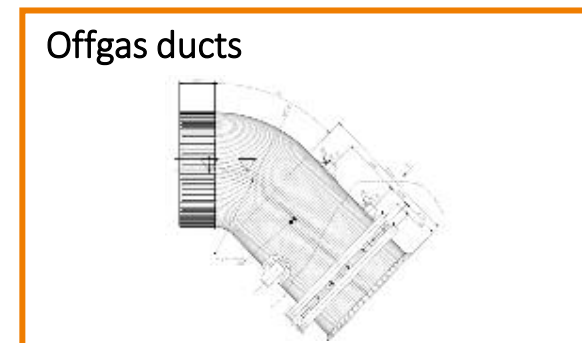
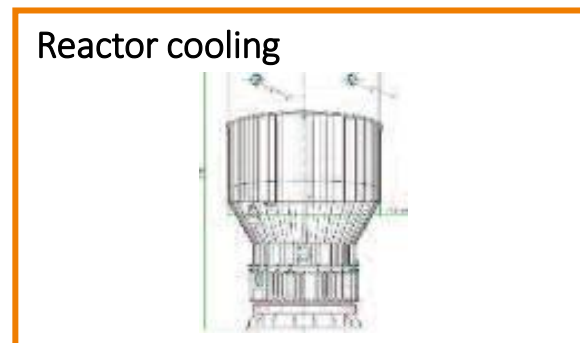
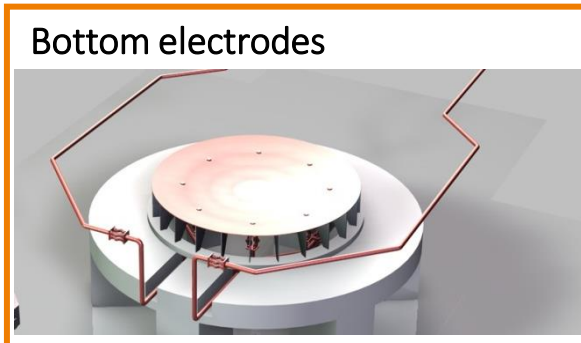
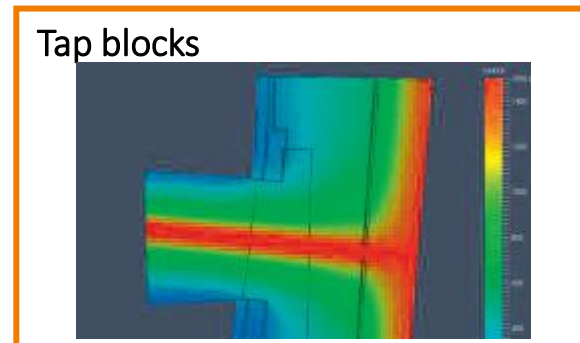
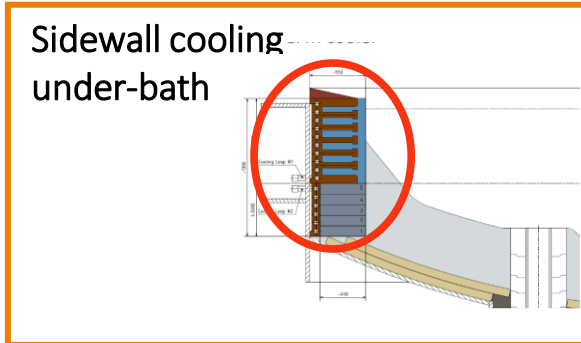


### Heat recovery

- ◆ Example: ER systems for EAF, BOF, CC, SAF, cooling systems



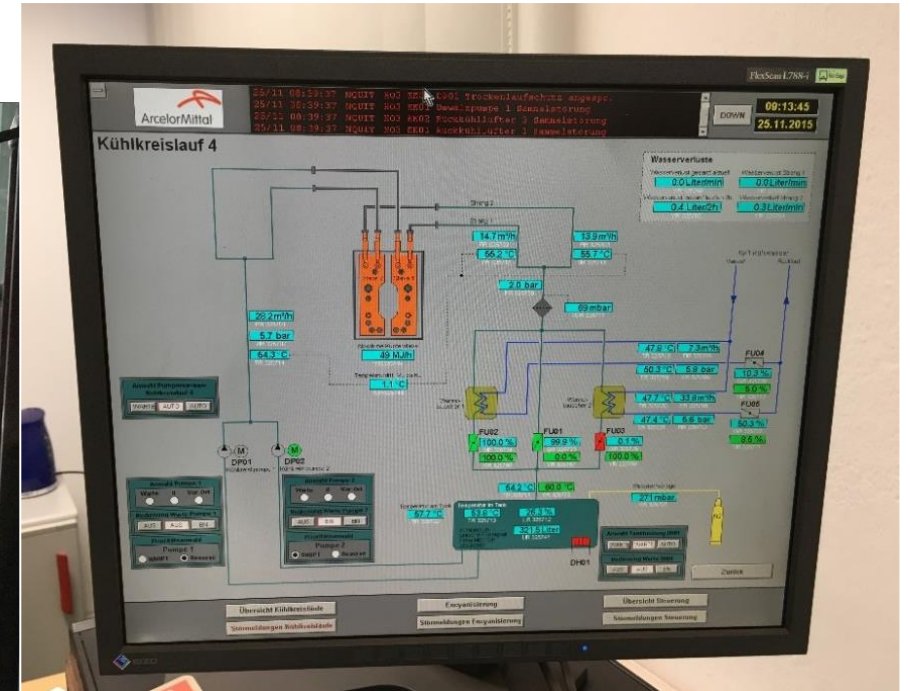
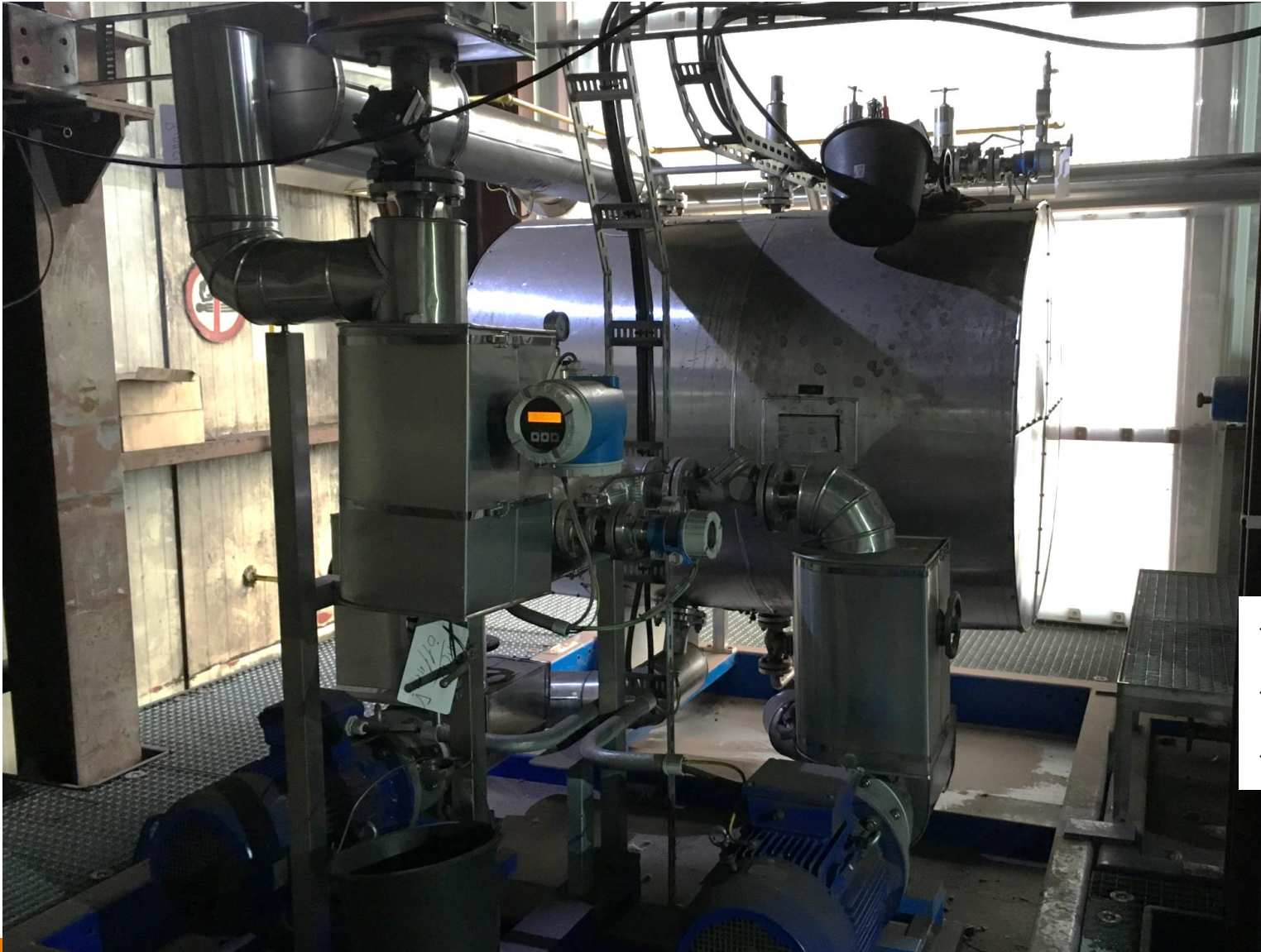
## Possible applications of ILTEC-Technology with IL-B2001



## References of industrial scale use (as of October 2022)

Application	Benefit	Supply lines	Overall flow capacity	Country	Start Up
Cooling of shaft part of <b>plasma furnace</b>	Guaranteeing higher temperature inside the furnace for preventing corrosion from sulfuric acid	3	30 m <sup>3</sup> /h	Norway	January 2015
<b>Blast furnace</b> tap hole	Increasing safety	2	30 m <sup>3</sup> /h	Germany	October 2015
Test for cooling <b>EHF bottom shell</b>	Increasing the lifetime of refractory beneath bath level	2	20 m <sup>3</sup> /h	Germany	Tests performed in Summer 2017
Cooling of <b>pipes of copper coolers</b> during the casting process	Increasing process safety and improve copper cooler quality	4	50 m <sup>3</sup> /h	Spain	January 2018
Cooling of connection flanges at the <b>RH degassing vessel</b>	Increasing process safety and prevent warping	2	15 m <sup>3</sup> /h	Austria	June 2018
Side wall cooling in cyclone furnace	Side wall cooling for improved lifetime in highly stressed burner areas	1	10 m <sup>3</sup> /h	Denmark	Test in Summer 2019
<b>Tap hole cooling</b> at slag cleaning furnace	Increased safety	1	10 m <sup>3</sup> /h	Germany	Test in Summer 2019
<b>Lance cooling</b> at TBRC converter	For submerged oxygen blowing	1	10 m <sup>3</sup> /h	Korea	October 2020
<b>ZnMg bath</b> cooling	Longer campaigns; temperature regulation of zinc bath	3	40 m <sup>3</sup> /h	Hungary	Summer 2023
Sidewall cooling of <b>Mitsubishi Converting Furnace</b>	Safe cooling of copper elements below bath level	12	100 m <sup>3</sup> /h	South Korea	March 2023

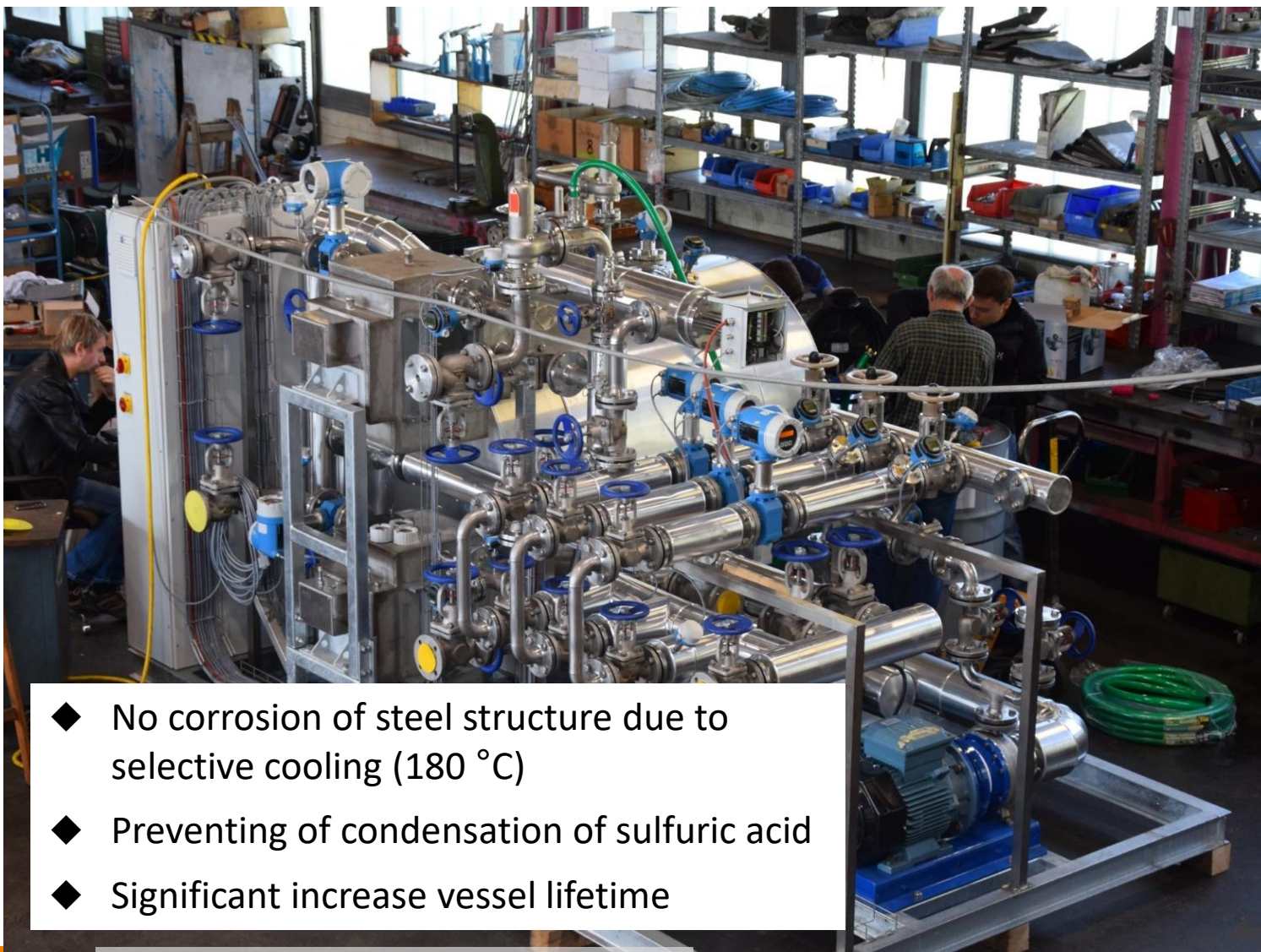
Reference Arcelor Mittal, Bremen/Germany  
In operation since October 2015



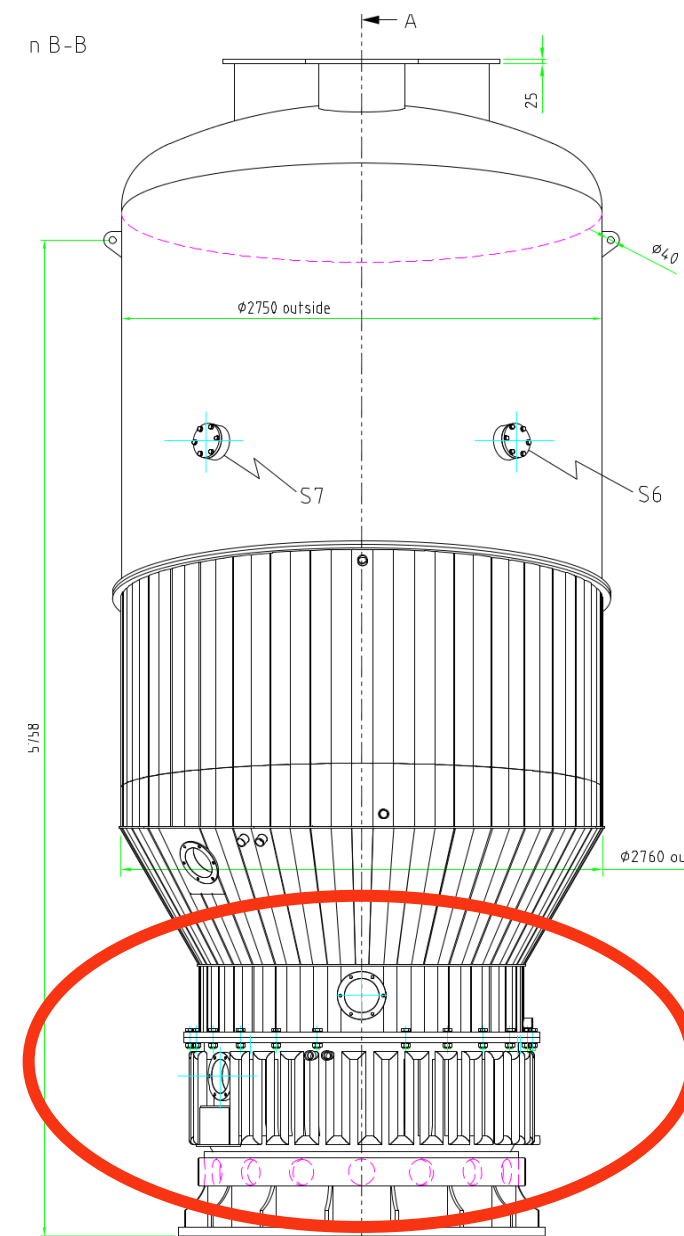
- ◆ Fully integrated in existing process control
- ◆ Increasing safety
- ◆ No altering effects of ionic liquid

## Reference Zinc Oxide Furnace

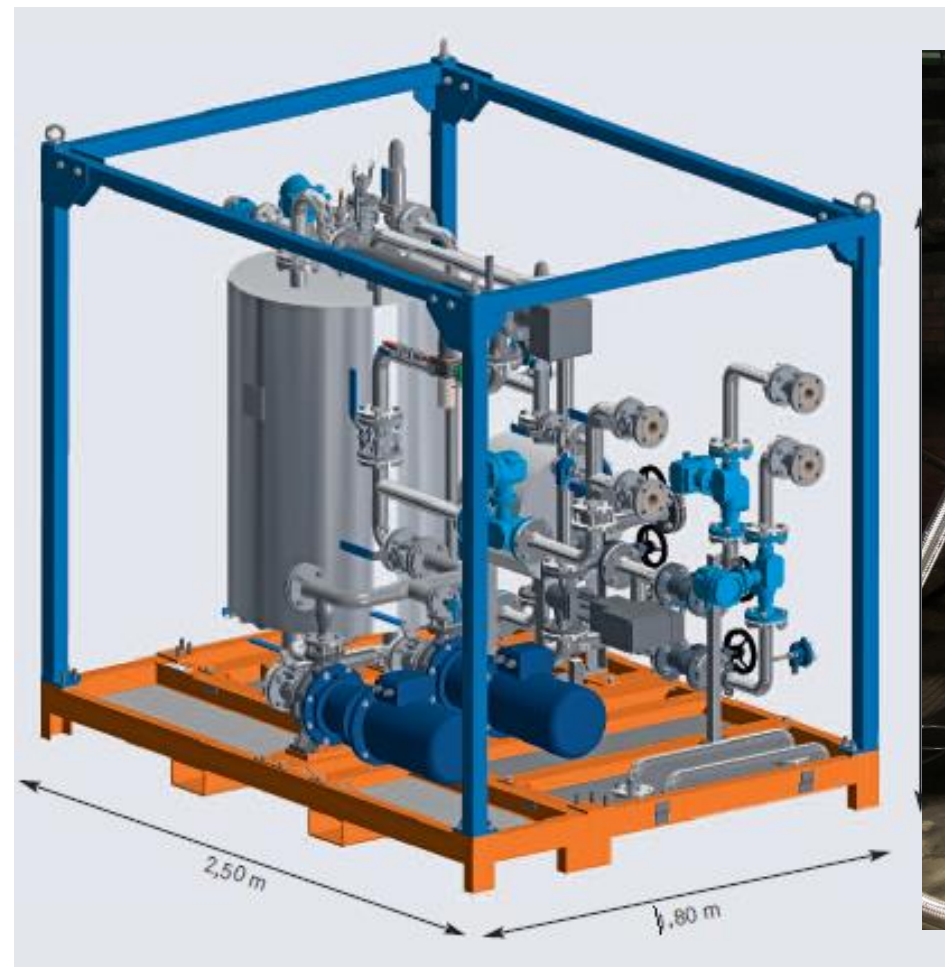
Høyanger, Norway in operation since January 2015



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



Aspects test trails for our clients – piloting and industrial scale tests of ILTEC

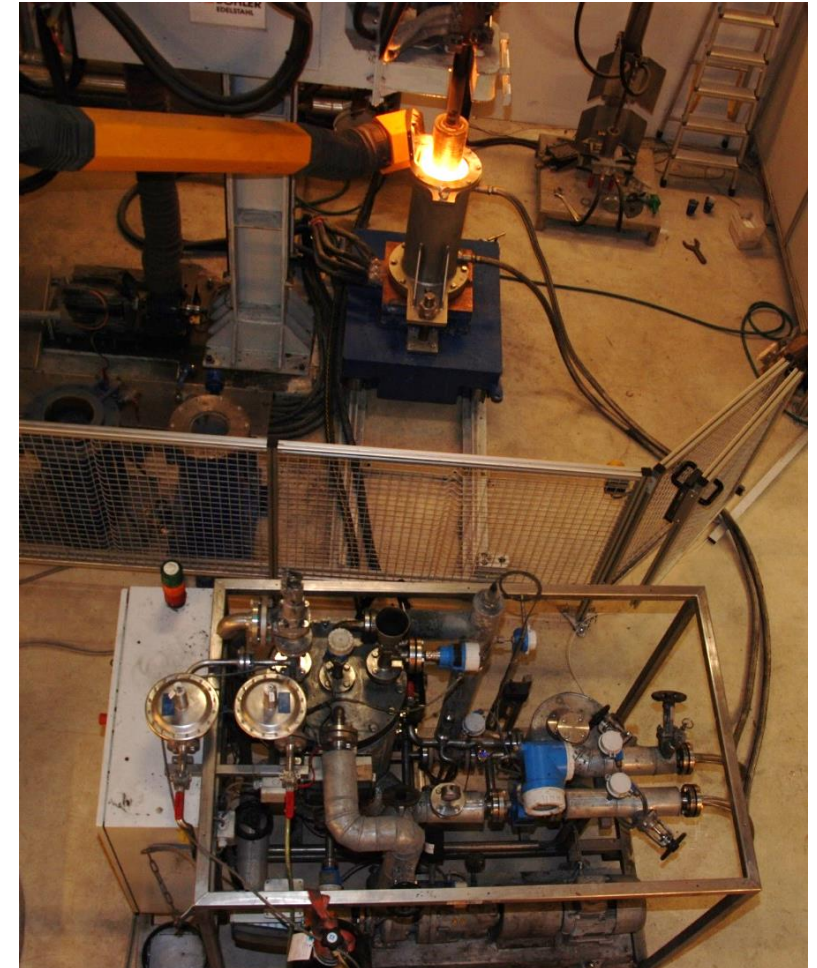
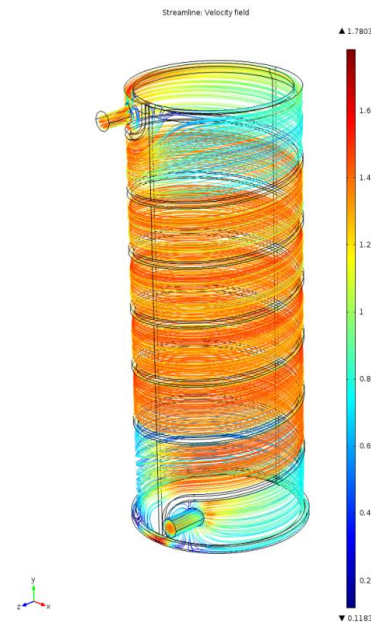


- ◆ Test rig available allowing industrial scale tests at existing furnaces

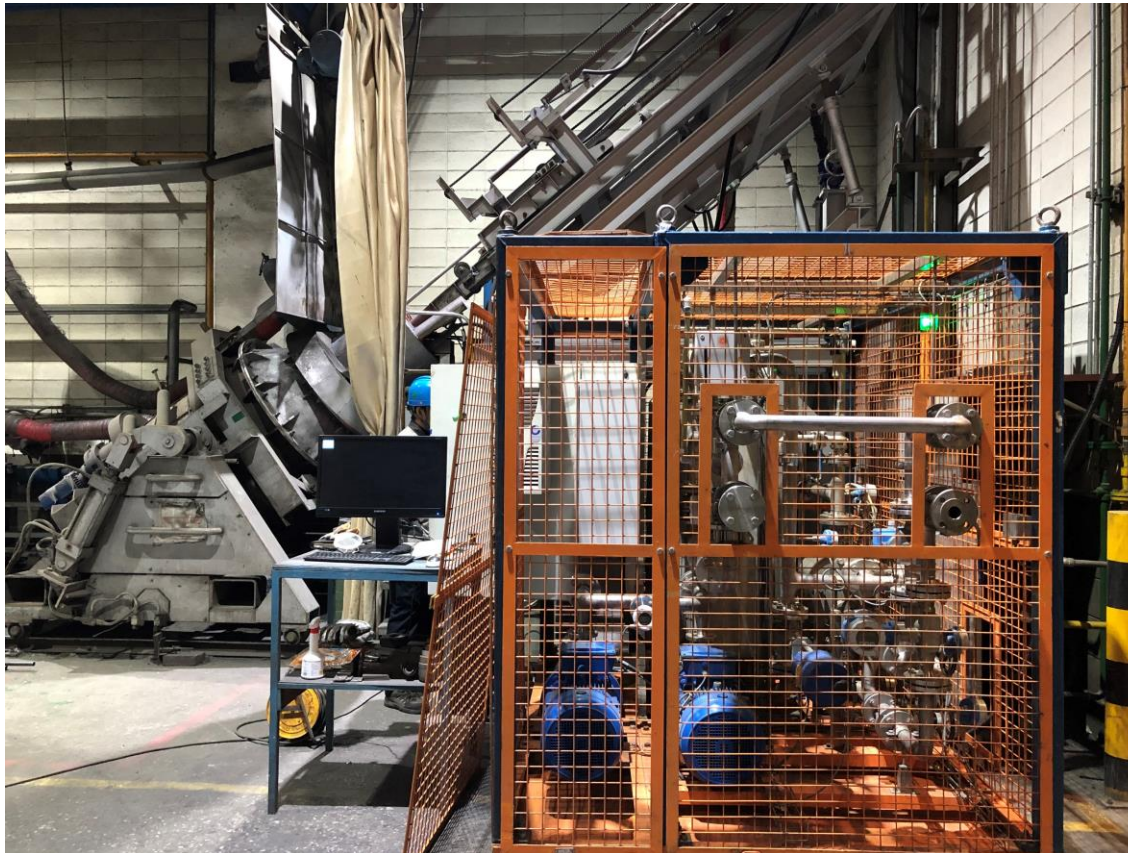


Electro slag remelting process

Mould cooling done with IL-B2001

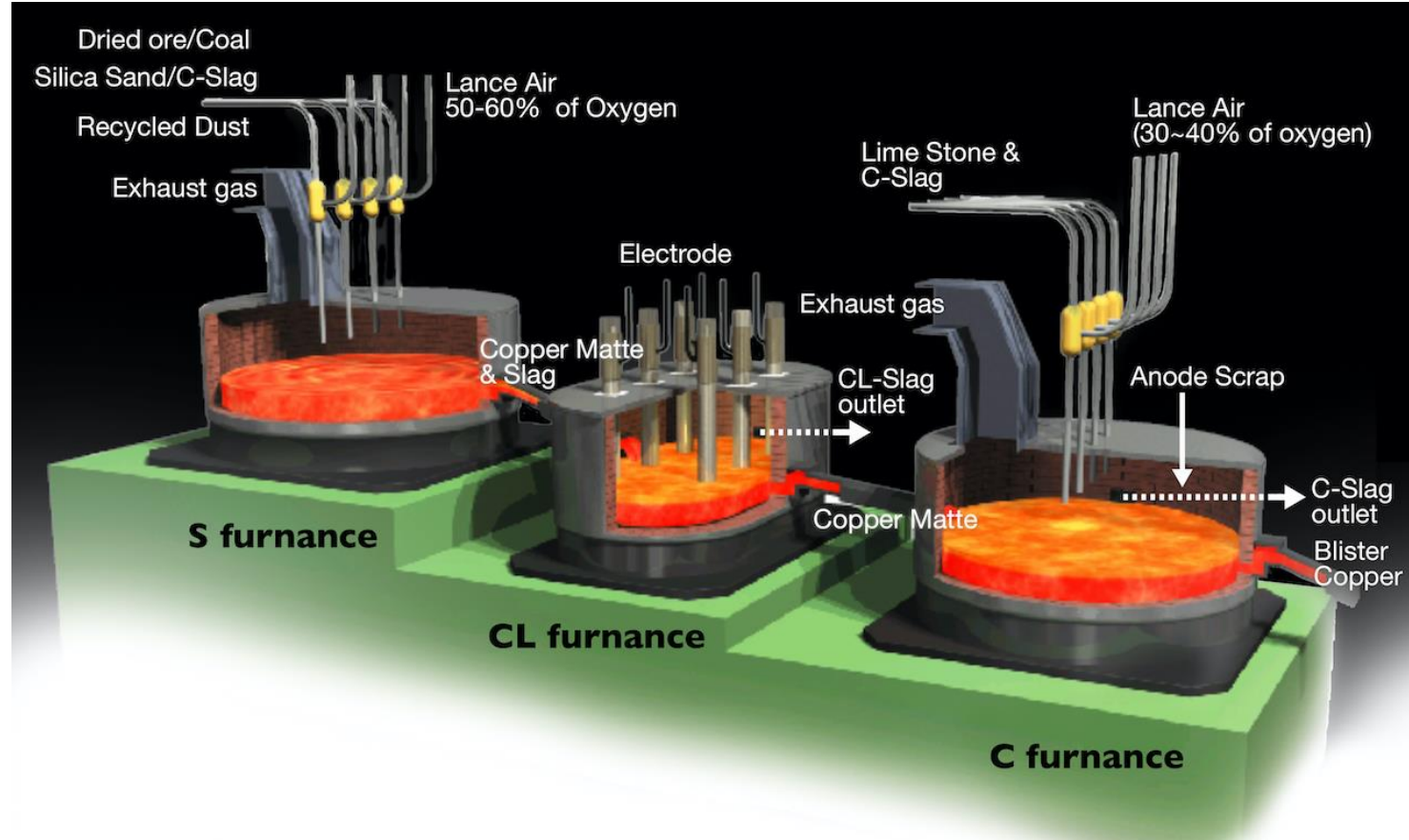


ILTEC Test in December 2019/ permanent installation installed in October 2020



- ◆ Lance cooling for more safety when lowering the TBRC lance closer to bath surface
- ◆ Increased productivity when lowering lance (slag penetration)

Installation March 2023

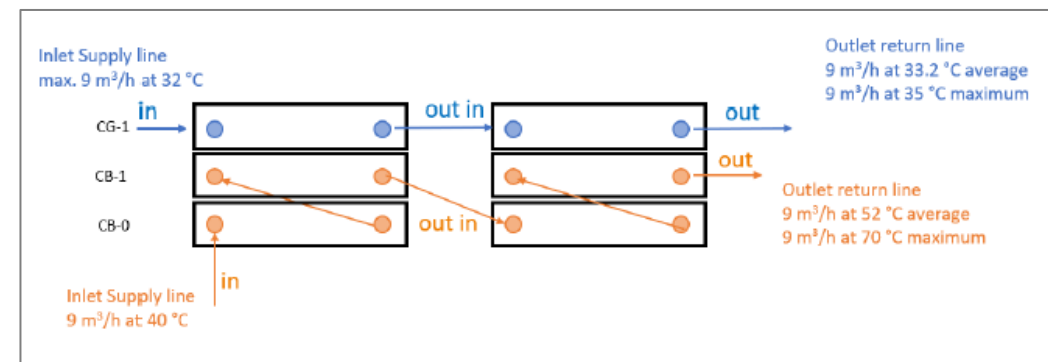
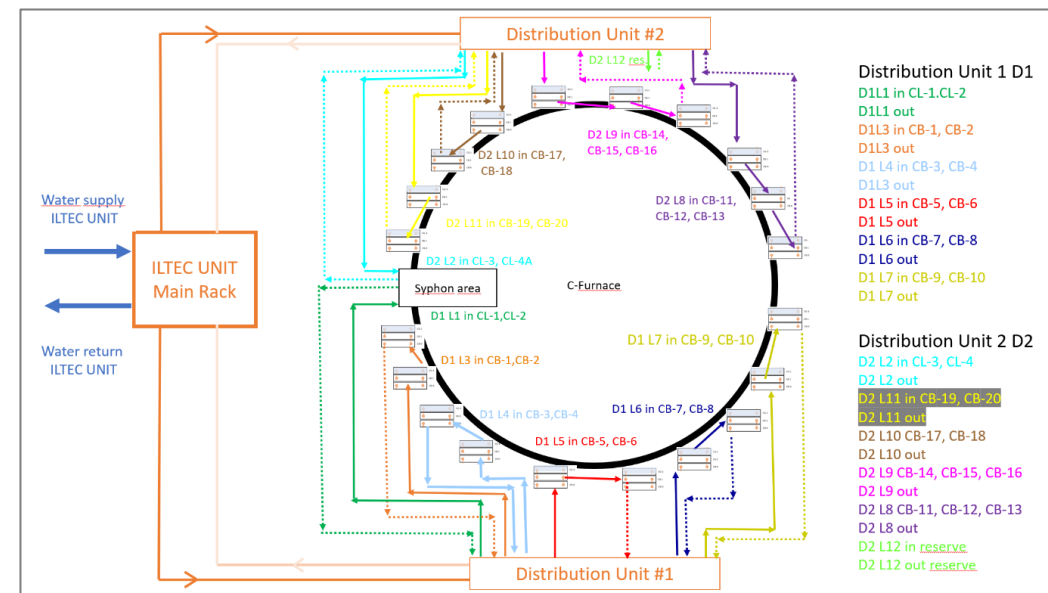


◆ Converting furnace side wall cooling



## Installation March 2023

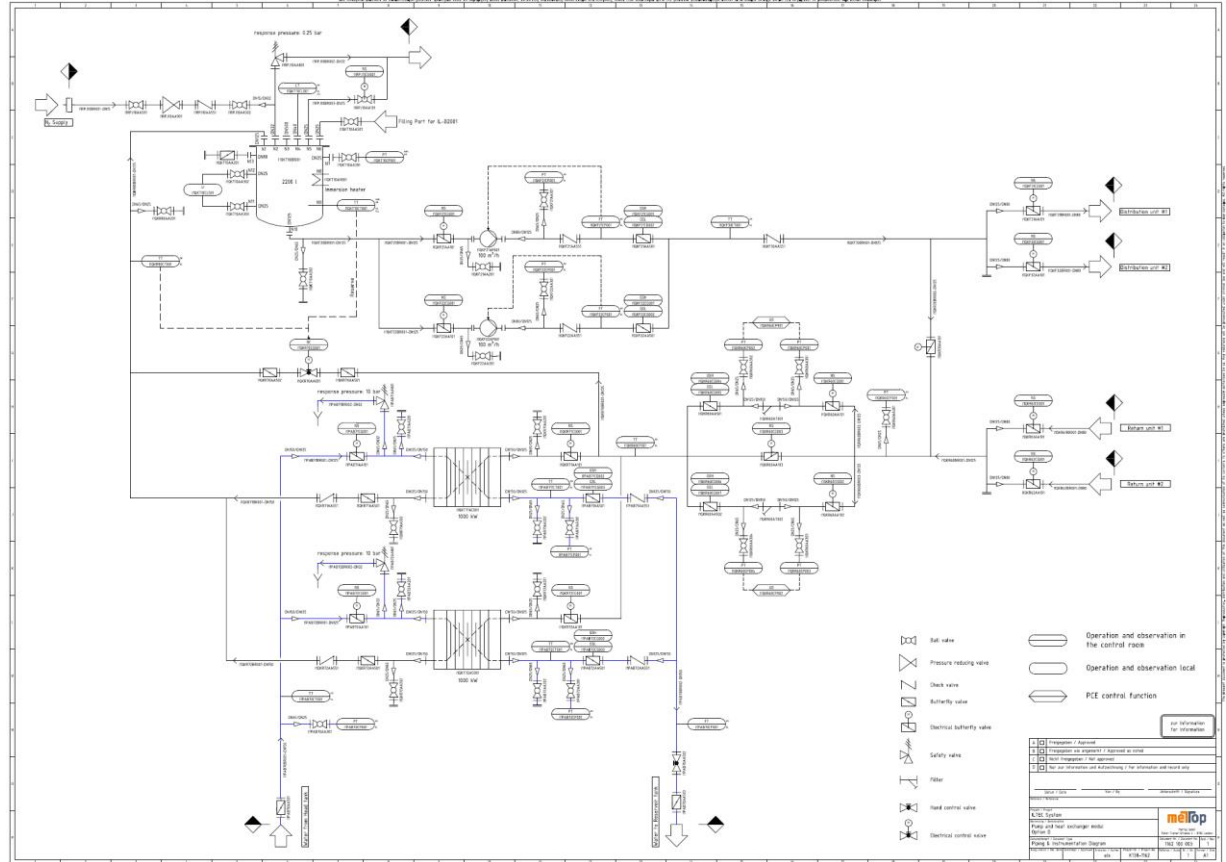
- Cooling elements below bath level are cooled with non-explosive IL-B2001
- Each line is flow, pressure and temperature controlled
- Heat load of each segment is calculated and regulated
- Freeze line thickness can be predicted
- Online furnace condition monitoring

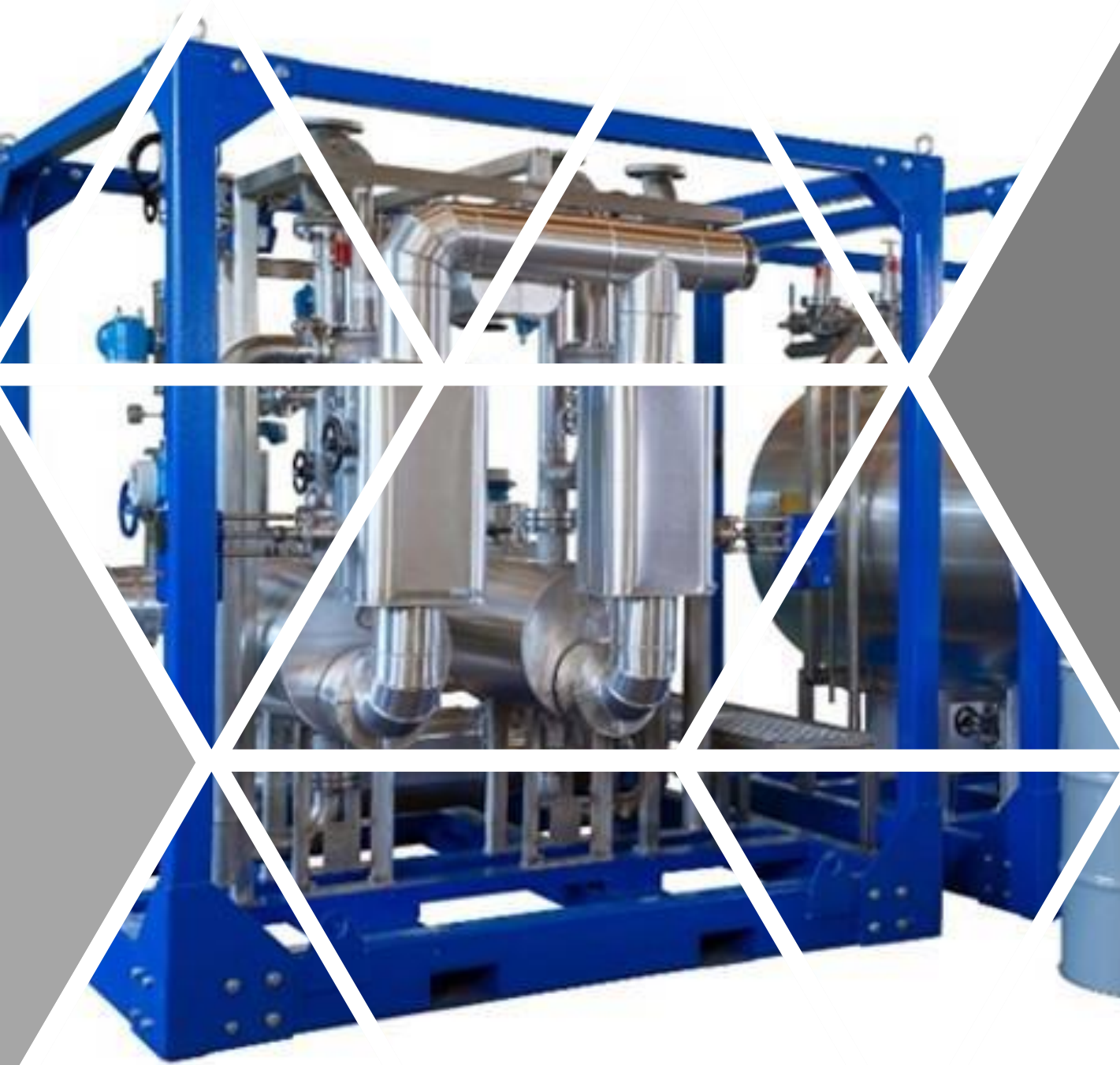


## Installation March 2023

### ILTEC System main parameters

	value	unit
Individual supply lines (one to each distribution unit)	2	---
Max. pump capacity	100	m <sup>3</sup> /h
Heat exchanger capacity (2 times)	1000	kW
Nominal inlet temperature IL-B2001	40	°C
Calculated outlet temperature max. IL-B2001	85	°C
Piping dimension IL-B2001 circuit	DN125/DN80/DN40	
Tank volume	2 000	dm <sup>3</sup>





**New casting concept:**

**ionicLife** cast



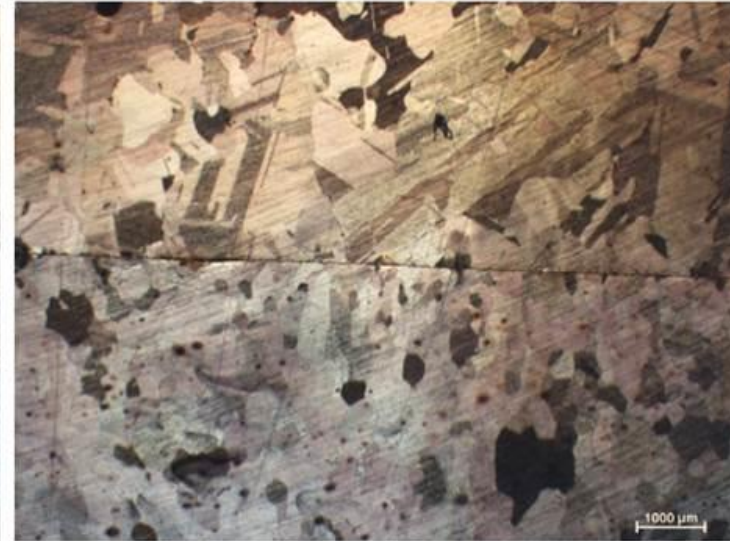
## Fundamental aspects

- ❑ A **perfect bonding** quality between the cooled copper pipe and the surrounding cast copper is essential for **long term durability** and lifetime of copper coolers.
- ❑ The perfect interface conducts the heat without loss and at the same time separates the tube from the casting so that cracks initiated by possible thermal cycles in the exterior of the part are deflected from the tube. Therefore the perfect interface is not considered a weld but has properties similar to a solder, braze or a mechanical shrink fit.

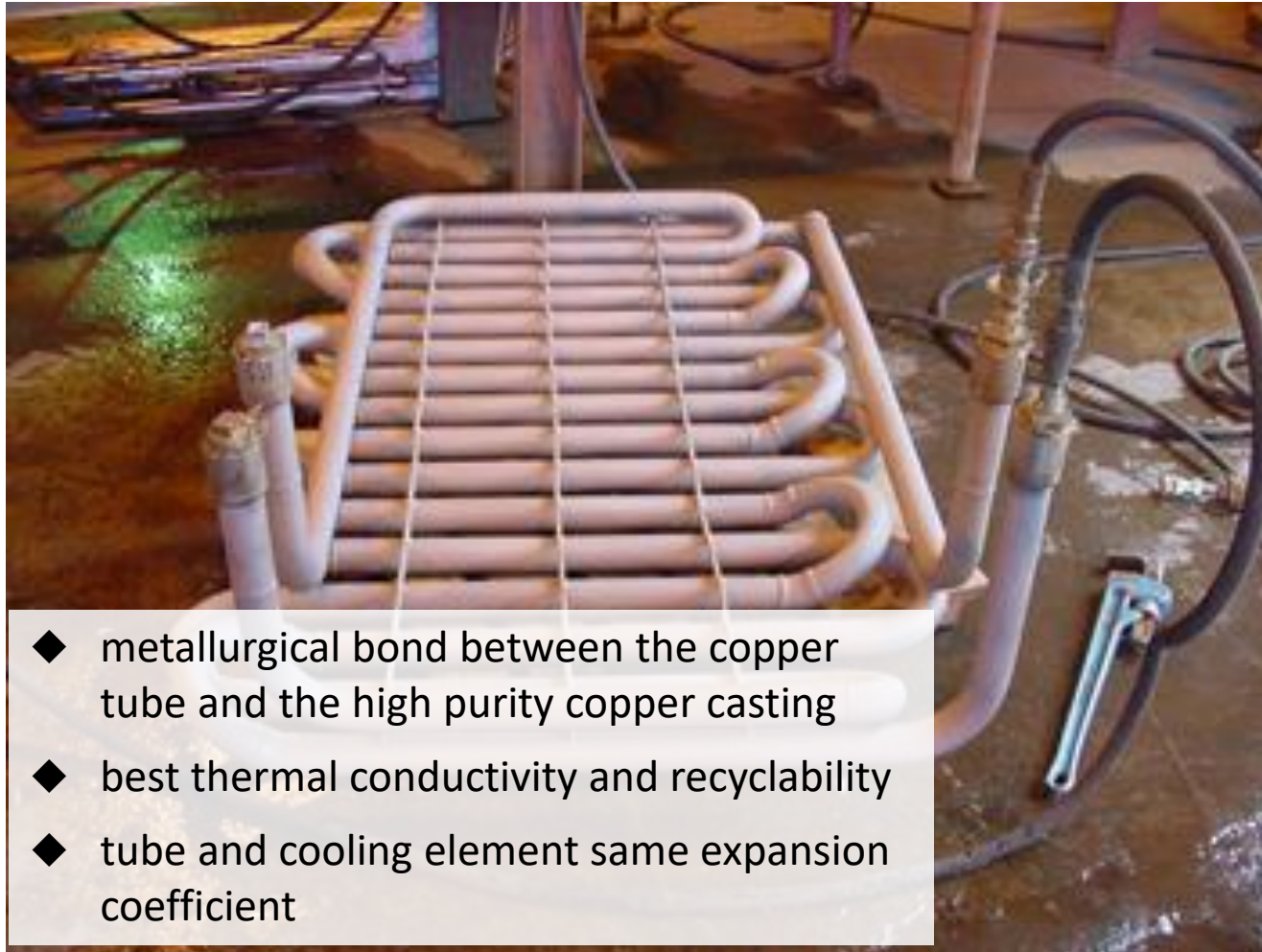
*good bonding*



*poor bonding*



## ionicLife cast



## References

### Slag Launder Customer A

Good reference lifetime: 8 months

Start of operation of the IonicLife cast cooler: June 2019 – still in operation



Parameter	Value	Unit
Final product weight	1584	[kg]
Circuit length	4100	[mm]
Number of circuits	3	-
Inclination of the tube	28°	[°]
Casting duration	136	[s]
IL-flow	7-8	[m <sup>3</sup> /h]
Tube ext./int. diameter	45/21	[mm]

## References

### Curved Launder Customer B

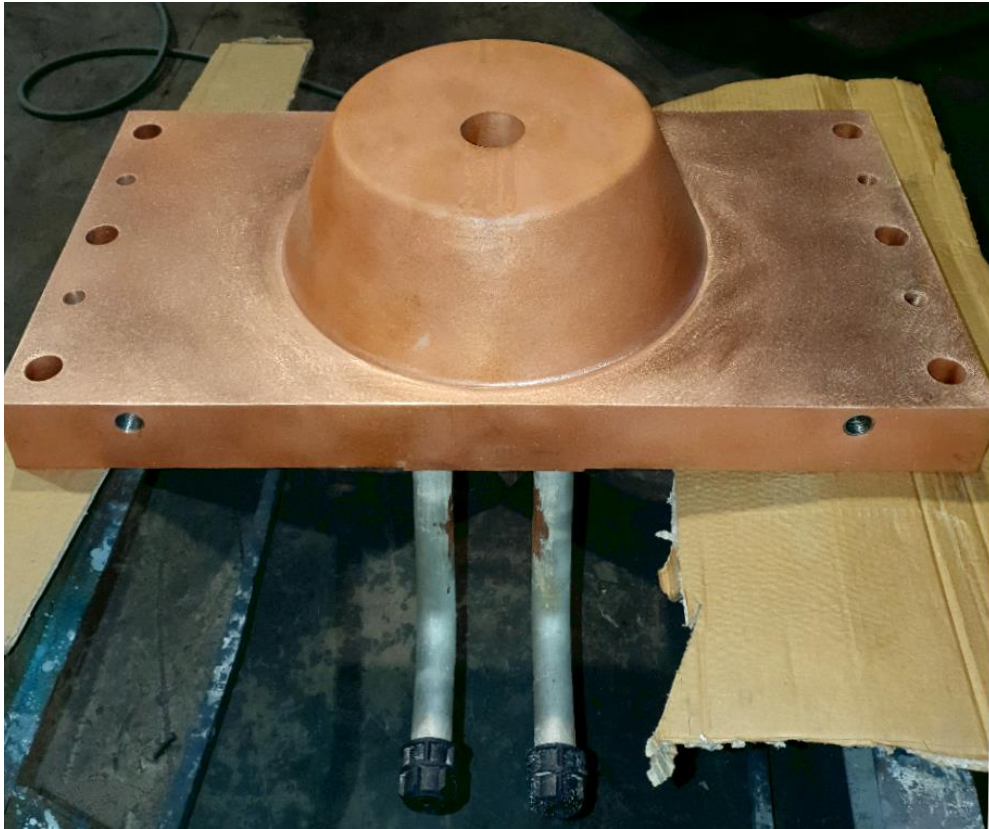
Best achieved reference lifetime so far was 4-5 months  
Begin of operation: August 2019 – still in operation



Parameter	Value	Unit
Final product weight	670	[kg]
Circuit length	1566-1951	[mm]
Number of circuits	4	-
Inclination of the tube	10-15	[°]
Casting duration	60-90	[s]
IL-flow	7-8	[m <sup>3</sup> /h]
Tube ext./int. diameter	45/21	[mm]

## References

### Matte tap hole for Customer E



Think out of the box – what might be all possible  
Any other ideas?



new e-waste process

explosion safe furnaces

corrosion free vessels  
and off-gas systems

permanent lining

water free cooling towers

new metallurgical  
processes

energy recovery for  
various units

new type of induction  
heating/furnaces

safe and automated  
tapping systems

production increase

permanent lances

lower insurance policy

new other on-line  
instrumentations



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 skid at your furnace
- ◆ Think out of the box – where does it make sense for you?



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