Mettop GmbH
Introducing Mettop

Mettop GmbH, founded in 2005 by Dr. Iris & Dr. Andreas Filzwieser, is an independent Austrian engineering company, specialised in the design, optimisation, and engineering of technologies for metallurgical processes.

It is active in the field of pyro- as well as hydrometallurgy of non-ferrous metals and recently also started with innovative cooling systems for the iron and steel industry. With its headquarter in Leoben, Austria but customers all over the world, Mettop is a global player for creating new pathways for the entire metallurgical industry.
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.
Mettop’s History and Timeline

Technical Milestones

- **2007**: Patent registration METTOP-BRX Technology for tankhouse optimisation
- **2009**: Patent registration ILTEC Technology for water free cooling
- **2017**: Exclusive license agreement for ILTEC Technology with SMS group

Company Milestones

- **2005**: Founding of Mettop by Iris and Andreas Filzwieser and Stefan Wallner
- **2014**: Founding of Urban Gold for Copper Recycling
- **2015**: Pierer Industry AG gets part of the company with 24.9%
- **2016**: Founding of PolyMet Solutions a 50/50 joint venture with SMS group
Mettop´s Numbers and Facts

Turnover [€]

2005: 78,612
2006: 362,900
2007: 519,602
2008: 794,000
2009: 812,760
2010: 4,499,638
2011: 1,420,677
2012: 1,093,178
2013: 513,552
2014: 1,868,115
2015: 2,800,000
2016: 2,800,000
2017: 2,800,000
Customers Worldwide

European Customers:

- ArcelorMittal Bremen
- Atlantic Copper
- Aurubis
- Boliden
- Böhler Edelstahl GmbH
- Buderus Edelstahl GmbH
- Daniele
- Harjavalta
- KGHM Polska Miedź
- New Boliden
- Nyrstar
- Montanwerke Brixlegg
- PolyMet Solutions GmbH
- Primetals Technologies Austria GmbH
- SMS group

voestalpine Stahl Donawitz GmbH
voestalpine Stahl GmbH
Welding Copper
Zakłady Magnezytowe Ropczyce S.A
### Mettop at a Glance

**Meet Customers Problems – Tailor-made Process Optimisation**

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The use of high current density and the METTOP-BRX Technology requires an adequate tankhouse design. Optimum performance can only be achieved with a comprehensive design of the overall process and complete tankhouse equipment.

Mettop makes use of the most modern construction methods and elements for optimisation. The applied 3D construction method, CFD modelling as well as process modelling enables a perfect synergy of refractory design, positioning of purging plugs and arrangement of cooling solutions.

The combined knowledge about refractories and metallurgy is designated to be part of the entire process concept. The broad product portfolio and holistic concepts include different coolers as well as cooling media. Especially the water free cooling with ILTEC creates new pathways towards safe and effective cooling.
METTOP-BRX Technology
High Current Density Tankhouse
METTOP-BRX Technology

Yesterday an Illusion, today Reality – High Current Density Tankhouse

In order to create new benchmarks in terms of tankhouse performance, by using the METTOP-BRX Technology a current density of up to 420 A/m² at a current efficiency of above 98 % can be achieved.

With the implementation of the parallel flow in a tankhouse, outstanding results can be achieved and summarised as follows:

- Higher electrolyte flow rate (up to three times higher than a standard flow rate) and a flow directly in front of the cathode
- Decreased hydrodynamic and diffusion boundary layer
- Direct introduction of the inhibitors close to the active cathode surface
- More homogeneous distribution of inhibitors on the cathode surface
- Simultaneous introduction of the inhibitor glue guarantees the same glue activity all over the cell lengths
- More homogeneous current density distribution (precisely fixed distance between anodes and cathodes)
- More homogenous electrolyte temperature distribution because of direct electrolyte introduction
- Increased product quality in terms of surface quality

Mettop provides two different approaches for a tailor-made optimisation of customer’s tankhouses:

**Brownfield approach – Parallel Flow Device (PFD):** Upgrading an existing tankhouse means to maintain the existing geometry while increasing the productivity. This is realised by installing PFDs in the existing cells.

**Greenfield approach – Parallel Flow Plate (PFP):** To achieve the best possible tankhouse performance, the PFP is integrated into the polymer concrete cells. These integrated units allow maximum productivity and, at the same time, superior quality.
METTOP-BRX Technology

Change of the Flow Pattern and Improvement by METTOP-BRX Technology

Background of the METTOP-BRX Technology is a special electrolyte inlet, which introduces the fresh electrolyte exactly where it is needed – directly in front of the cathode, thus allowing the increase of the current density by up to 50 %, while maintaining a high current efficiency and a good cathode quality – or even improving it.

An essential fact is that the injection of the electrolyte will not influence the natural downwards convection in front of the anode surface in a negative way. Therefore, the anode slime settling and the precious metals discharge are not negatively influenced by this technology.
**METTOP-BRX Technology**
Parallel Flow Device (PFD) and Parallel Flow Plate (PFP)

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**Parallel Flow Device – PFD**

Brownfield approach – PFD for upgrading existing tankhouses

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**Parallel Flow Plate – PFP**

Greenfield approach – PFP for optimised tankhouse performance

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The core of the METTOP-BRX Technology is a Parallel Flow Device, which introduces the **fresh electrolyte between each pair of electrodes** within the tankhouse. Special positioning devices – so-called cathode spacers - provide an accurate electrode positioning, as well as a defined relative position of cathode and nozzles. The nozzles, which are individually designed for each tankhouse, direct the fresh electrolyte in an upwards flow in front of the cathode surface, thus **enhancing the already existing flow** resulting from natural convection. The PFDs are customer-tailored to guarantee optimum results for each specific tankhouse.

The Parallel Flow Plate (PFP) is a **combination of PFD and the cell** itself: In new tankhouses or cells the METTOP-BRX Technology can be integrated in the polymer concrete cells. The main idea is to cast the cell in a way that the volume for the electrolyte distribution system is already included. Therefore, only a **stainless steel front plate with nozzles and cathode spacers** – the Parallel Flow Plate – is attached to the cell. Implementing PFPs minimises the installation effort, as only the front plate has to be mounted. Furthermore, these systems can be preassembled at the cell supplier and the customer can install the complete cells just like normal cells.
METTOP-BRX Technology

References – Full Industrial Applications

**Primary Smelter:**
Xiangguang Copper Co., Ltd. – China

- TH no 1: Standard
  - 720 cells
  - 280 A/m²
  - 200 000 t/year
  - $\eta > 97\%$

- TH no 2: Mettop-BRX
  - 720 cells
  - 420 A/m²
  - 300 000 t/year
  - $\eta > 98\%$

This first Greenfield METTOP-BRX tankhouse started up in summer 2011 at Xiangguang Copper, a primary copper producer in China. In December 2011, the average current density of the new tankhouse was higher than 98% (98.5%) at current density of 410 A/m², and the quality of the produced cathodes was excellent. In 2012 Xiangguang Copper used 420 A/m² and achieved an average current efficiency of 98.3%. Today Xiangguang Copper reports current efficiency of > 99% at 420 A/m².

**Secondary Smelter:**
Montanwerke Brixlegg AG – Austria

Half of the tankhouse at 400 A/m² with a current efficiency higher than 96%.

The longest-standing METTOP-BRX Technology application is found at Montanwerke Brixlegg AG, a secondary copper producer in Austria, where after years of investigation, development and high current density tests – 52 cells of the new tankhouse were equipped with PFDs in 2007. Due to the excellent results regarding cathode quality and current efficiency, the use of the METTOP-BRX Technology was extended by another 104 cells in 2011, using both PFDs and PFPs. Since autumn 2011, the new rectifier has been in operation, enabling a current density of more than 420 A/m², and half of the entire tankhouse has been operated at high current density.
Furnace Integrity
Holistic Approach for Optimised Furnace Performance
Furnace Integrity

Optimised Metallurgical Performance – Holistic new Process Concepts

**Process Modelling**

With the variety of different modelling tools and study work, a profound knowledge of the process itself can be obtained. Depending on the accuracy of the available data, more effective models can be created.

HSC modelling

CFD modelling

**Refractory Engineering**

Mettop uses 3D refractory engineering to optimise refractory linings and furnace concepts which allows the automatic generation of a complete parts list and an easy visualisation of the different lining approaches.

Efficient cooling is of major importance for improving the furnace availability and with gas purging an increased process efficiency can be achieved.

Special copper coolers

Purging systems

**Furnace Modules and Components**
Process Modelling
Metallurgical Optimisation by Thermal and Thermodynamical Modelling

**Thermal Modelling with CFD**

The tool of CFD modelling enables both, thermal modelling for heat load as well as temperature distribution and flow optimisation of gaseous and liquid media.

The scope of interest might comprise of:
- Heat and energy losses
- Temperature distribution within all layers
- Areas of increased temperature (hot spots)
- Expansion for the correct heating up phase
- Cold spots for preventing hydration and corrosion

The velocity and patterns of flowing media and the impact of geometric changes can contribute to an improvement at distinct areas but also within the overall process. Sometimes minor changes in geometry have huge effect.

**Thermodynamical Modelling with HSC**

The thermodynamic modelling tools enable a profound knowledge of the process. Given the accuracy of the available data, meaningful models can be created.

The following can be derived from an accurate HSC model, which is basically combination of the software HSC Chemistry and FactSage:
- Chemical compositions
- Element distribution
- Temperatures
- Mass flows
Refractory Design

Why rethink Refractory Lining?

Upgrading of the existing furnace refractory design can lead to a wide range of improvements and benefits for the customer:

- Optimised **visualisation** of the refractory material by using exclusively 3D engineering
- **Prolonged refractory lifetime** by contribution to optimised operation (heating-up specifications and expansion calculation)
- Speeding up the installation by providing lining sequences step by step
- Best furnace availability due to support before, during and after installation on-site
- Comparing different suppliers’ grades to guarantee the **best available product**
- **Cost saving lining concepts** by choosing price optimised material
- Best available concepts by implementation of most modern operational systems (purging systems, cooling solutions and tuyere arrangements)

With these tools it is possible to achieve the following objectives:

- Increased time of furnace campaigns
- Optimisation of furnace availability
- Decrease of costs for refractory material
Refractory Design
Meet Customers Problems – Scope of Supply by Mettop

3D Engineering

Optimised visualisation of the refractory material leads to optimised furnace performance. Each brick is actually drawn and a bricklist can be generated automatically.

3D engineering of the furnace allows the automatic generation of a complete part list of all bricks and additional fixtures (e.g. steel plates, hanging hooks, expansion inserts). These are named systematically and are saved in a comprehensive list. Each brick format and every additional part is only drawn once and then copied, so that the part list can be generated automatically and contains all the information required for the refractory lining installation, as for example the required amounts of brick formats and qualities, the number of expansion inserts, weight, volume and positioning of bricks in different furnace areas.

Quality Concept

Independent and process orientated optimised concept. As an independent refractory supplier without any production site or contract to refractory producers, Mettop can select the best available material.

As an independent refractory supplier without a production site or contract to refractory producers, Mettop can select the best available material to provide an independent and process-oriented optimised concept. Since the scope of supply refers to refractory engineering but not refractory manufacturing, a totally neutral material list, without any relation to single manufacturers, can be offered.
Refractory Design

Meet Customers Problems – Scope of Supply by Mettop

Lining Sequence
Visualisation of the refractory material and step by step instruction for the lining leads to a better result at the installation on site and a more economic lining.

In order to make the installation and the lining work on site as fast and smooth as possible, a visualisation of the lining sequence can help immensely. With the 3D engineering tool, a brick by brick illustration of the entire lining can be provided.

Holistic Approach
Combined with the refractory engineering, cooling elements, purging opportunities combined with the steelwork can be taken into account. Leading to an optimisation of the entire process.

Since Mettop combines substantiated knowledge about refractories with profound metallurgical know-how, it makes sense to be part of the entire process concept. On letting Mettop be part of the process, all tools comprising modelling, refractory design, cooling systems and construction tools an optimised process can be realised.
Cooling Solutions
Customised cooling concepts for optimised cooling performance
Why Cooling?

Advantages of an Optimised Cooling Solution

An improved process performance can be achieved by installing and optimising cooling solutions:

- Cooling of refractory is inevitable for smelting operations to **intensify their performance**
- Intensified cooling of the refractory leads to a **steeper 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 leads to **increase in furnace lifetime**, increase in campaign lifetime and furthermore to a more cost saving and economical production route

The product portfolio comprises a holistic general concept:

- Individually designed and dimensioned coolers
- Independent and process-orientated optimised concepts
- Most modern construction and engineering tools
- Consideration of different available cooling media for additional safety
- Transport, installation and supervision on-site for a quick and smooth start-up
- After sales service on-site for the best possible operational result for the customer
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 (left)
- Plate coolers in between the layers of the bricklining for an even better cooling performance (middle)

Depending on the set-up of the system, the heat transfer can be set accordingly. Copper elements with water-cooling inside the furnace wall – as they are often used in flash furnaces and electric arc furnaces – are very effective; 100 kW/m² is a typical value for this type of cooling. An important aspect for water cooled elements is the overall and internal cooling channel design. A diligent design work guarantees effective cooling. The cooling channels can be either drilled or cast-in.

Mettop provides comprehensive solutions that enable the maximum benefits from cooling to be attained through the correct integration into the refractory lining. When installing cooling elements, the surrounding brickwork and the general furnace situation always have to be considered in the layout.
Different Cooling Solutions

High Intensity Cooling – the Freeze Lining Concept and Design of CFM Cooling Elements

Freeze Lining Concepts

This freeze lining concept is attributed to the fact that the removed amount of heat is high enough to create a frozen slag/metal layer upon the castable refractory.

CFM Coolers (Composite Furnace Modules)

The casted copper coolers consist of a copper back plate with copper fingers at the surface. Within the copper plate, the cooling pipes (made of either copper or Monel alloy) are casted for an optimised flow of the cooling medium, being water in most cases.

To further improve the system a water-free cooling with ionic liquid (ILTEC) can be realised.

As the demand for more economic and efficient processes in furnaces of the non-ferrous metals industry is steadily increasing, an optimised process performance can be supported by installing effective cooling systems. Mettop with its product portfolio and holistic concept is able to provide tailor-made solutions that include individually designed and dimensioned coolers for heat removal exactly as desired but furthermore modern design, simulation and engineering tools. This might be combined with the consideration of different available cooling media for an optimised plant safety and transport, installation and supervision on site for a quick and smooth start-up.
Gas Purging
Increasing Process Efficiency
Gas Purging

Advantages achievable with Gas Purging

Upgrade of existing furnace with gas purging equipment can lead to a wide range of improvements:

- **Homogenisation** of the temperature and bath chemistry in the molten bath
- Better kinetics due to **increased bath movement** and turbulence
- Decrease of slag overheating
- **Easier deslagging** when installing purging plugs at certain positions
- Decrease of slag coatings and accretions
- Lower sulphur and oxygen contents due to **lowering the partial pressure** when introducing nitrogen or noble gases
- **Extended refractory lifetime** in the anode furnace due to skip of oxidation step by using purging systems in PS converters

The **product and service portfolio** comprises a holistic general concept:

- Purging plugs and refractory, delivered and installed by Mettop
- Porous plug cooler for increased safety and prolonged lifetime
- Gas control unit for better control of the purging
- Installation and supervision on-site for best possible results
- After sales service for planned maintenance as well as unlikely events
- Spare parts delivery as a regular basis by means of a supply contract
Gas Purging
Optimised Performance for various Aggregates

Anode Furnace
Gas purging in the anode furnace results in 30% shorter oxidation, 50% shorter deslagging, less reductant consumption, less refractory wear, time savings and finally cost savings.

Peirce Smith Converter
Gas purging can also be applied in the converter to achieve lower sulfur content, lower oxygen content, decreased process time and decreased deslagging time.

Mettop offers gas purging systems to improve the efficiency of different furnace types in metallurgy. The system consists of a set of purging elements, such as porous plugs, the corresponding closing system for the furnace steelwork and a gas control and regulation unit. Porous plugs are used for the introduction of different gases (e.g., N₂) into the melt. Purging programs for different metallurgical processes and single process steps are developed to obtain the maximum benefits from gas purging. In drum type furnaces, it is also possible to equip the porous plug sets with an exchangeable mechanical system. This allows the plugs to be changed even under hot furnace conditions.

Summarised, gas purging systems are a profitable way to increase the energy and time efficiency of your pyrometallurgical vessels – resulting in a proven possibility of process cost savings.
ILTEC Technology
Ionic Liquid Cooling Technology
ILTEC Technology
New Pathways to safe and effective Cooling

**Substitution of Water in existing Systems**

Blast furnace taphole, formerly cooled with water

**New Cooling Applications**

Tuyere zone of Peirce Smith Converter, no cooling so far because of danger

**Possibility of Heat Recovery**

Sufficient heat transfer and higher outlet temperature of up to 200 °C enable heat recovery

With Mettop’s new and patented cooling technology ILTEC it is possible to realise a water-free cooling solution. The new cooling medium IL-B2001 enables a substitution of water as the state of the art cooling medium in an easy way and creates a perfectly safe operation mode for all application fields. This special ionic salt IL-B2001, with its superior characteristics regarding operation temperature (50 – 250 °C), physical properties and especially the total lack of reaction when getting in contact with liquid metal or slag, opens up a totally new way of the cooling process in metallurgical plants. But not only the properties of IL-B2001 make ILTEC unique, the combination with special cooler designs for high intensity cooling also enables new application fields.
**ILTEC Technology**

Re-defining the Term Safety and becoming Best Available Technology (BAT)

- Accidents happen from time to time
- When exchanging water by IL-B2001 - > explosion free environment that allows cooling in a safe and sound manner
- Probability remains at the same level BUT the extent of consequences can be tremendously shifted towards a decreased impact
- The diagram shows the path of becoming best available technology

- **Non-corrosive** because of chlorine free chemical composition and production procedure – production route patented
- Absolutely **no explosive reaction** at contact with liquid metal – tests carried out at University of Leoben, Montanwerke Brixlegg AG and Böhler Edelstahl GmbH
- **Sufficient cooling** due to sufficient heat removal – heat transfer and heat capacity of IL-B2001 are not limiting factors; proven at FH Wels and at our reference plan
- **No harmful decompositions products** in case of decomposition – tested at proionic and at Montanuniversität

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<table>
<thead>
<tr>
<th>Property</th>
<th>Symbol</th>
<th>Value</th>
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<tbody>
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</table>
### ILTEC Technology - References

**New pathways to safe and effective cooling**

#### Blast furnace taphole

In operation at **ArcelorMittal Bremen** since 2015

At ArcelorMittal Bremen, the demand for safer tap hole cooling at the blast furnace made Mettop apply the new cooling medium IL-B2001 at the tap hole 3.

The existing water cooling system was replaced by an ILTEC system. Since the start-up in October 2015, the system is running without problems and to the satisfaction of the customer.

#### Zinc oxide shaft furnace

In operation at **Nyrstar – Hoyanger** since 2015

Mettop’s new approach was to cool the side wall to a lower extent. The inlet temperature of the ionic liquid within the cooling panels was increased to 150 °C. This lead to the rise in the inside wall temperature to more than 200 °C and thus above the dew point of the sulphuric acid.

Since the start-up of the ILTEC system in the beginning of 2015 no corrosion occurred and the zinc-oxide furnace runs at full operation.

#### RH vessel flanges

For this special application of cooling the flanges of the RH degassing facility, the technology is even more sophisticated. Due to the regular changes of the nozzles and the lower vessel part respectively, a nitrogen purging to flush the cooled parts is implemented. This guarantees a perfectly safe operation mode and at the same time allows a loss-free change of vessel parts.

Installation at **voestalpine Stahl Donawitz GmbH** end of 2017

Creating an optimised solution for our customers, the scope of services not only includes the layout and manufacturing of an ILTEC facility, but also takes economical impact and metallurgical feasibility into account. Moreover, Mettop provides comprehensive after-sales service in order to maintain and ensure perfect functionality.

Our scope of service comprises of case verification on site, basic and detail engineering, installation and start up and after-sales service. Meaning we support you in all stages of the project.
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