

Xiangguang Copper – the benchmark for refineries by using the METTOP parallel flow system

DI Regina Krenn, METTOP GmbH

European Metallurgical Conference
Emc 2023

EMC sponsored by:

KÜTTNER

 **NICKELHÜTTE AUE**
Member of JACOBS METAL GROUP

wieland

SMS  **group**

HATCH

BEFESA

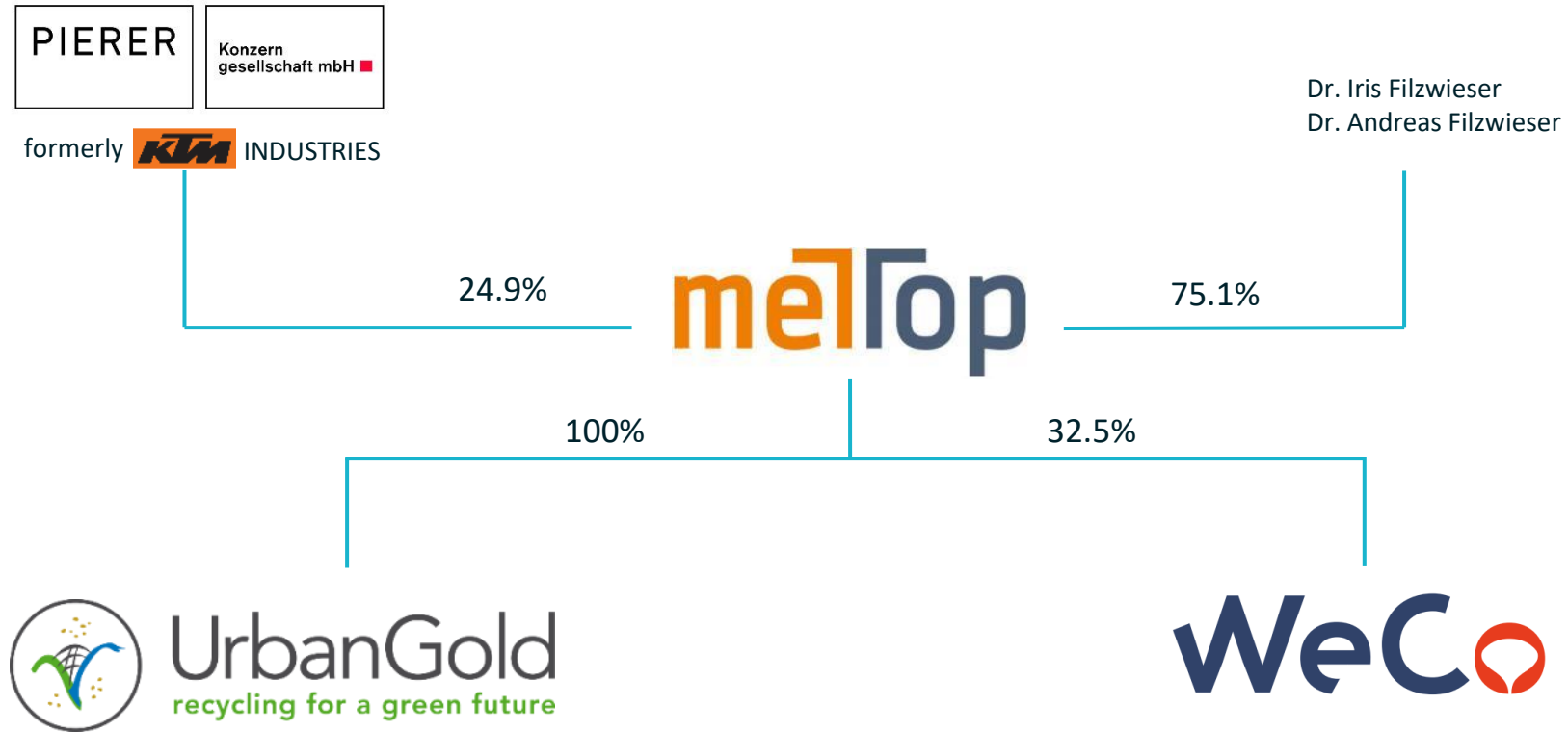
 **Aurubis**
Metals for Progress

Metso:Outotec

GLENCORE
Nordenham

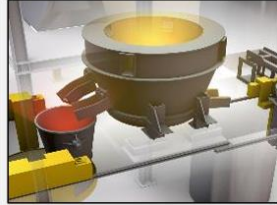
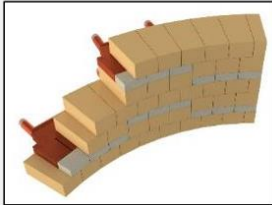
organized by

 **GDMB**
Gesellschaft der
Metallurgen und Bergleute e.V.





• Overview Products and Services



Non-ferrous metals units

Refractories non-ferrous

E-waste recycling UrbanGold

Tankhouse technology

ILTEC for vessel cooling

- Products:**
- ◆ HENRI[®]
 - ◆ Gas Purging Systems
 - ◆ CFM Coolers
 - ◆ ionicLife cast

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

- Products:**
- ◆ Process Engineering
 - ◆ UG Compact
 - ◆ UG Flex
 - ◆ UG Classic
 - ◆ Market Studies

- Products:**
- ◆ METTOP-BRX[®] Technology
 - ◆ Cathode spacers
 - ◆ Complete Tankhouse

- Products:**
- ◆ IL-B2001[©]
 - ◆ Ionic Liquid Technology for vessel cooling
 - ◆ Furnace integrity optimization

Overall Process & Technology Consulting

Field Studies & Trainings

Process and 3D Plant Engineering



Research & Development & Innovation





祥光铜业
XIANGGUANG COPPER

European Metallurgical Conference
E^{mc}2023

organized by



Possibilities to increase production

- Increasing amount of cells
- Increasing current density

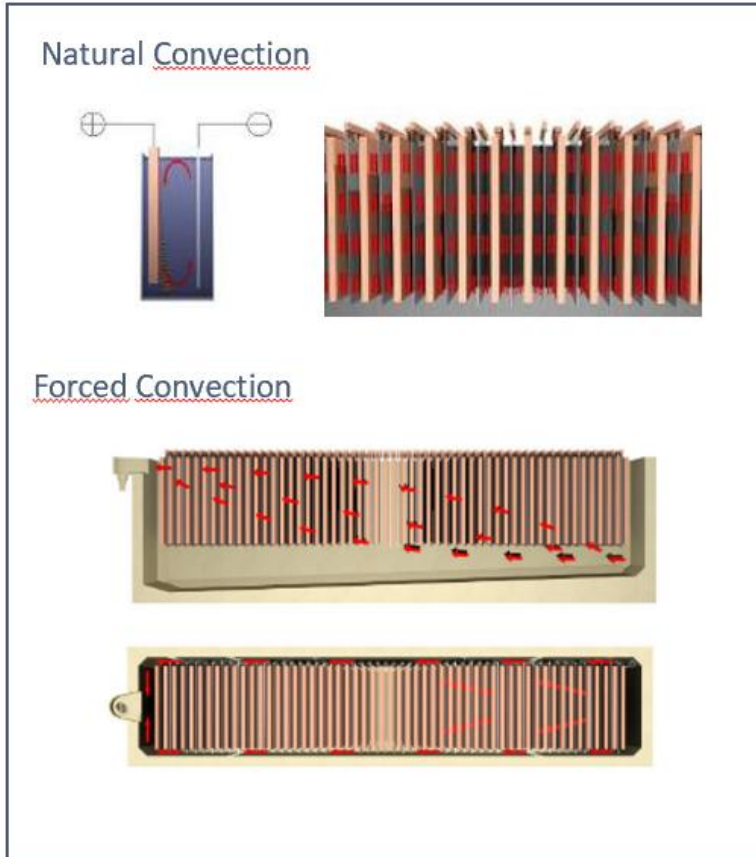
Possibilities to increase production

- Increasing amount of cells
- Increasing current density

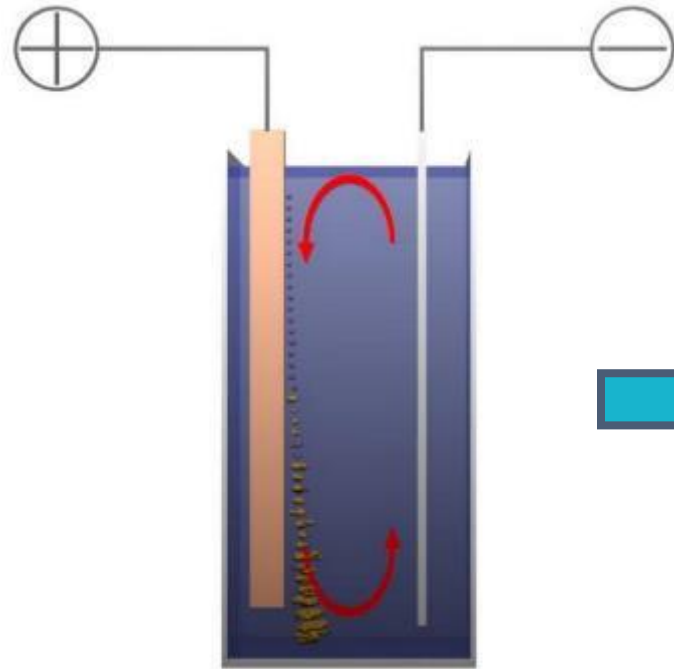
Current density can be calculated according to Fick's law (Equation 1):

$$i = n \cdot F \cdot D \cdot \left(\frac{\partial c}{\partial x} \right)_{x=0} = n \cdot F \cdot D \cdot \frac{c^0 - c^s}{\delta_N} \quad (1)$$

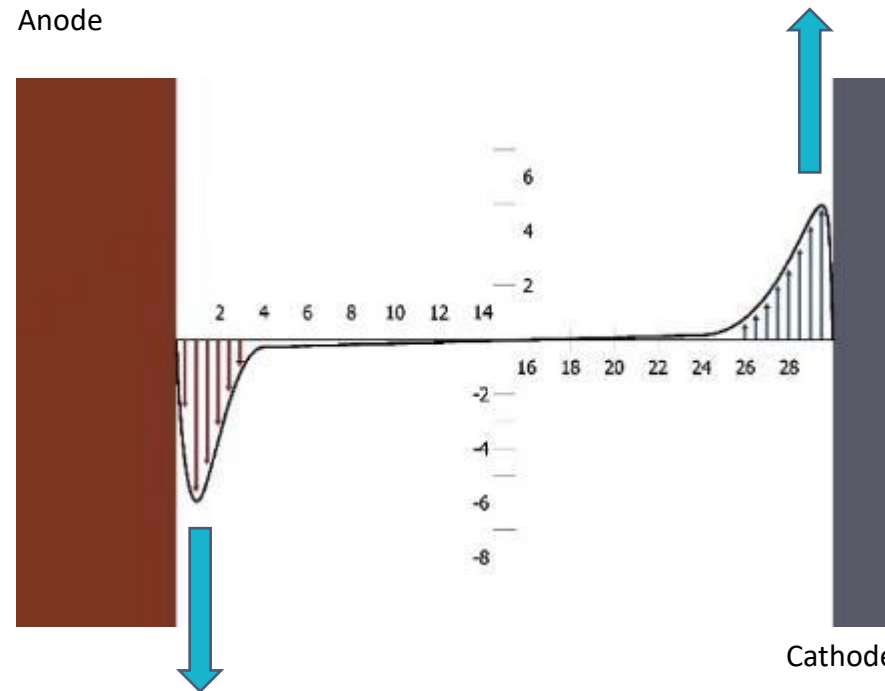
Conventional



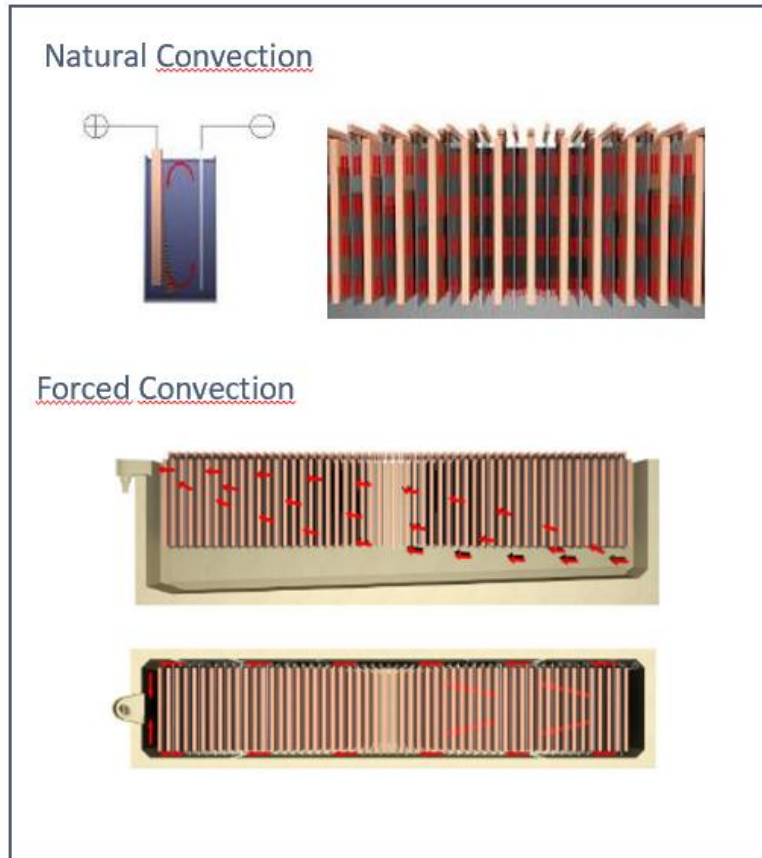
Natural Convection



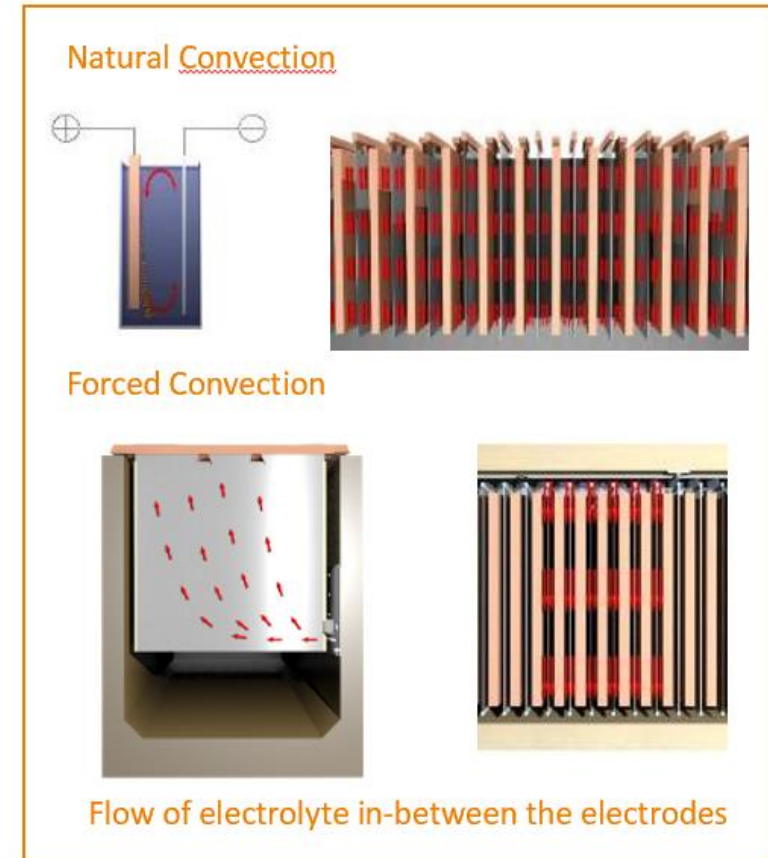
Natural & Forced Convection

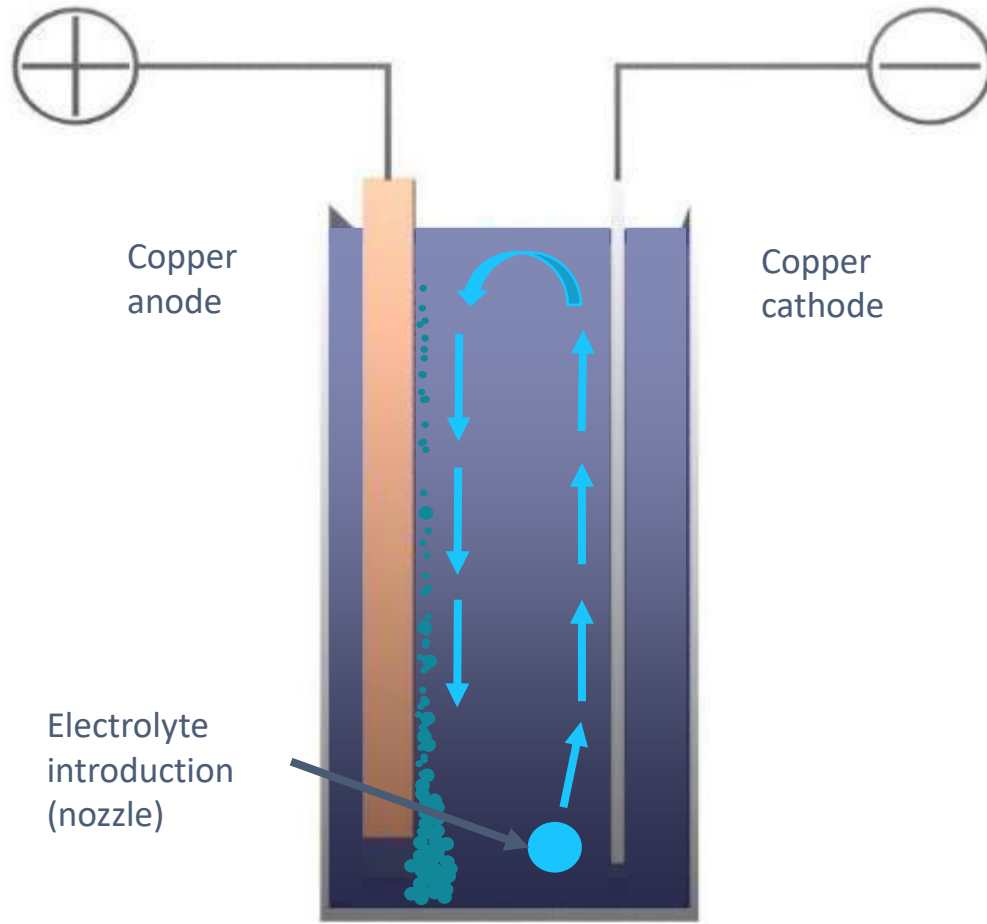


Conventional



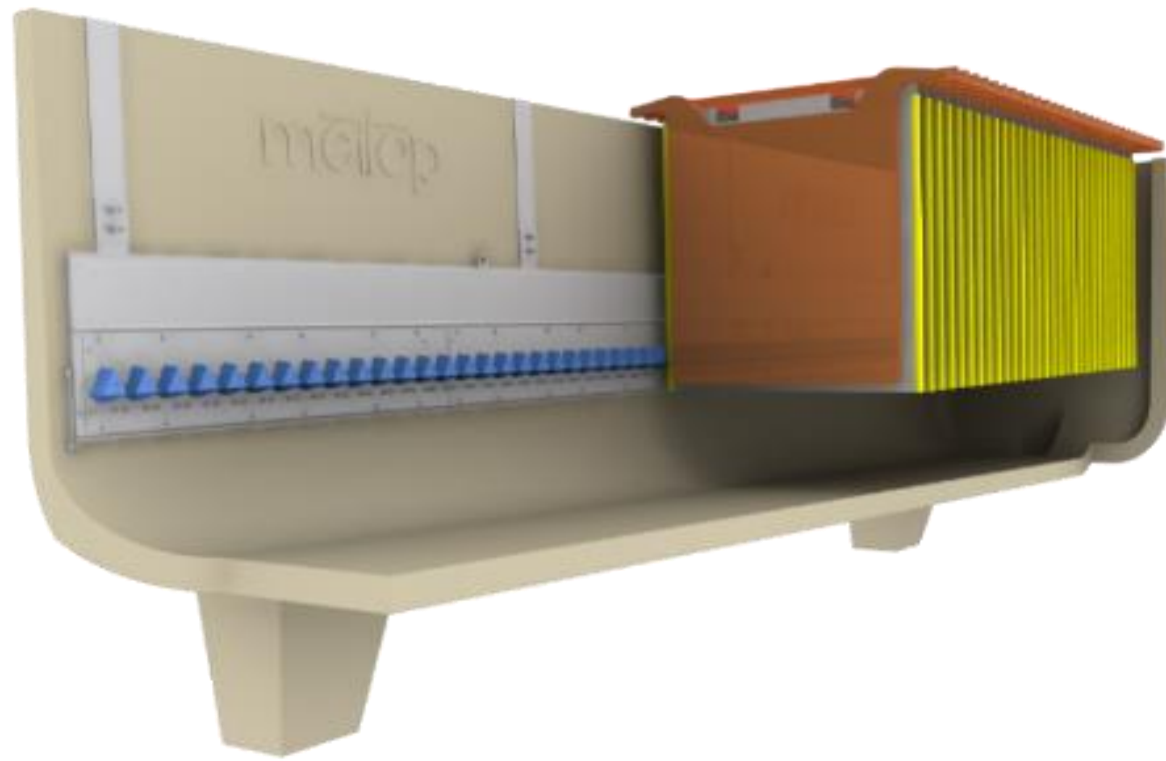
METTOP-BRX Technology



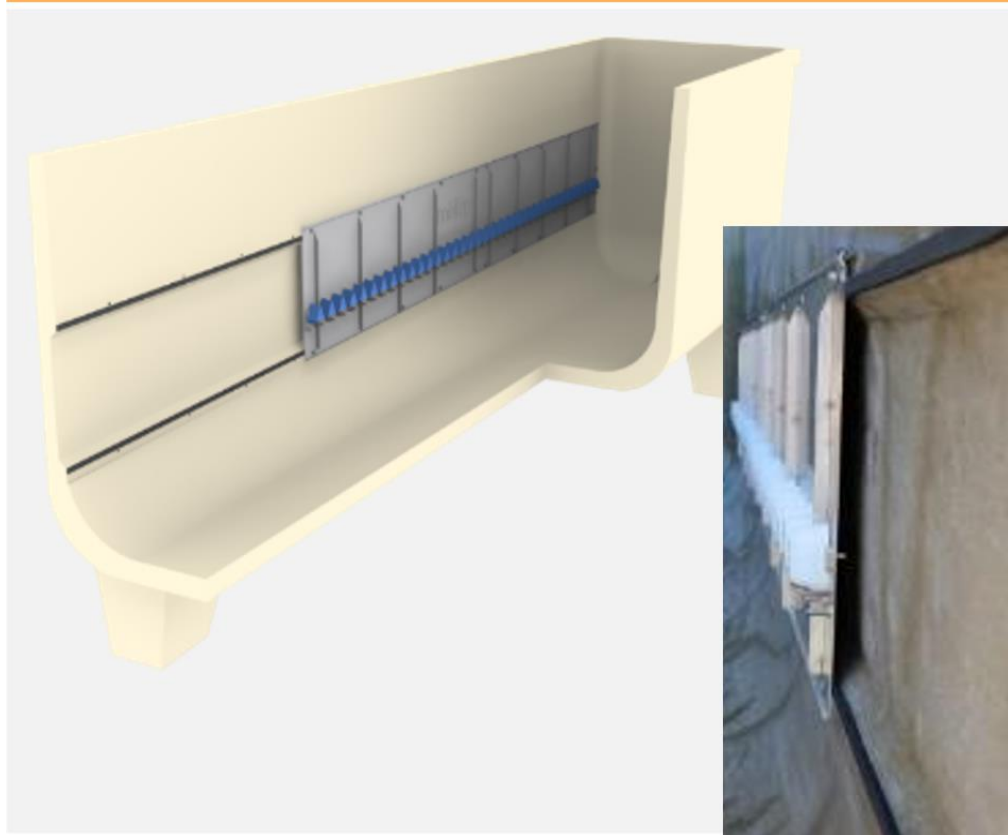


Improvements:

- Introduction of the electrolyte near the active cathode surface -> **direct injection of the inhibitor** near the surface -> increasing quality of the cathodes
- More **homogeneous temperature** distribution
- No influence of **anode slime settlement** because of enhancement of the already existing flow, resulting from natural convection



Modular installation of the parallel flow plates



New cell design for parallel flow plate (PFP)





- Higher **current density** and **increased production**
- Additive adjustments for **current efficiency increase**
- Better **cathode quality** due to more homogeneous additive distribution
- **Shorter down times** when filling the groups due to higher flow and faster filling
- Higher flow for **faster heating-up** of the anodes
- **Fewer shorts occur** due to accurate cathode positioning/guiding system.



- New design of electrical system for 420 A/m^2 (2 electric circuits) and new design of heat exchangers
- Continuous addition of inhibitors
- **Increase in productivity** from 200 000 t/year (conventional cell) to 300 000 t/year (METTOP-BRX)



Xiangguang Copper reports current efficiency of $> 99 \%$ at 420 A/m^2

Tankhouse no. I (standard technology)

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Current density, A/m ²	265	265	265	265	294	294	294	265	265	265
Current efficiency, %	97,7	97,7	97,7	97,7	97,4	98,2	98,7	98,7	98,8	98,8
Scrap rate, %	15,7	15,6	15,3	15,7	15,6	15,0	14,3	12,6	13,1	12,7
DC power, kWh/t	278,3	282,4	271,4	291,4	290,7	295,2	299,1	285,8	279,5	290,1
Amount of steam, t	67 568	67 111	82 203	63 508	88 558	82 599	99 511	85 128	88 291	68 230
Cu in cathode, %	99,9976	99,9977	99,9976	99,9977	99,9978	99,9977	99,9978	99,9977	99,9977	99,9976
No. of workers	130	130	130	130	130	103	103	103	103	103
Quality, (in% LME A)	100	100	100	100	100	100	100	100	100	100
Ag in cathode, ppm	9,15	9,55	8,9	8,1	8,2	9,5	9,5	9,0	9,7	10,5

average
273,7 A/m²
98,1 %
14,5 %
286,4 kWh/t
 450 t (total)
99,99769 %
116,5
100 %
9,2 ppm

Tankhouse no. II (METTOP-BRX technology)

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Current density, A/m ²	410	410	410	385	385	410	410	385	385	385
Current efficiency, %	99,2	99,2	99,3	99,2	99,2	99,3	99,2	99,3	99,2	99,2
Scrap rate, %	13,2	13,3	13,2	13,2	13,2	13,1	12,6	12,4	12,5	12,7
DC power, kWh/t	361	359	362	359	353	363	377	355	358	362
Amount of steam, t	3 658	4 103	4 430	4 132	4 322	4 102	3 906	4 519	4 106	3 785
Cu in cathode, %	99,998	99,998	99,9979	99,9978	99,9978	99,9979	99,9979	99,9977	99,9977	99,9977
No. of workers	100	100	100	100	100	100	100	100	100	100
Quality, (in% LME A)	100	100	100	100	100	100	100	100	100	100
Ag in cathode, ppm	4,9	5,1	5,0	5,7	5,9	4,5	4,3	4,3	3,9	4,7

average
397,5 A/m²
99,2 %
12,9 %
360,9 kWh/t
16 t (total)
99,99784 %
100
100 %
4,8 ppm

	Standard	METTOP-BRX
Current density, A/m ²	273,7 A/m²	397,5 A/m²
Current efficiency, %	98,14 %	99,22 %
Scrap rate, %	14,527 %	12,941 %
DC power, kWh/t	286,3892 kWh/t	360,9 kWh/t
Amount of steam, t	450,0509 t (total)	15,95799 t (total)
Cu in cathode, %	99,99769 %	99,99784 %
No. of workers	116,5	100
Quality, (in% LME A)	100 %	100 %
Ag in cathode, ppm	9,21 ppm	4,815 ppm



Main Performance Figures for PF Electrolysis Technology of Xiangguang Copper

Sep 18th. 2020

The following are the main production performance figures of Xiangguang Copper from Jan 2019 to Aug 2020:

Item No.	Description	Unit	Figures
1	No. of Cells	pc	720
2	Output of cathodes	kt	470.14
3	Recovery of copper	%	99.7
4	Current density	A/m ²	385
5	Anode life	d	16
6	Cathode life	d	5/5/6
7	Rate of scrap	%	12.5
8	Cell voltage	V	0.32-0.50
9	Current efficiency	%	99.27
10	Cell utilization rate	%	93
11	Electrolyte circulating velocity	L/min	80-150
12	Steam consumption	t/t-Cu	0
13	Ac Power consumption	KWH/t-Cu	450
14	Complementary energy consumption	Kgce/ t-Cu	55.31

Zhou Songlin

Vice President

Yanggu Xiangguang Copper Co., Ltd

A handwritten signature in black ink, appearing to be '周松林' (Zhou Songlin), written in a cursive style.

Add: No.1 Xiangguang Road, Shifo Town, Yanggu County, Shandong Province, P.R, China, 252327
Tel: +86 635 713 5054



STATEMENT
For
PARALLEL FLOW TECHNOLOGY APPLICATION

Sep 12, 2020

Xiangguang Copper started the copper smelter construction in 2005 and the smelter was put into production in 2007. The Phase 1st tankhouse has a capacity of 200k tons, adopting conventional permanent stainless steel cathode electrolysis technology (720 cells). The smelting capacity of Xiangguang Copper was increased to 500k tons in 2011. To meet up with the smelting capacity, Xiangguang Copper cooperated with Mettop in its Phase 2nd tankhouse, adopting the new parallel flow technology in all the 720 cells. Thanks to the higher current density, the Phase 2nd tankhouse capacity reached 300k tons. The total electrolysis capacity (Phase 1st + Phase 2nd) reached 500k tons.

The Phase 2nd tankhouse of Xiangguang was put into production in June, the current density reached the 385A/m² in July and 420A/m² in October in 2011, every indicator is excellent and the production has been very stable up to now. Comparing to the conventional electrolysis technology adopted in Phase 1st, the parallel flow technology has the following advantages:

➤ Higher capacity

The operation current density of Phase 2nd tankhouse of Xiangguang is 420A/m² and that of the Phase 1st tankhouse is 280A/m². With the same number of cells, the capacity is increased by 50%.

➤ Lower investment

Comparing to conventional electrolysis technology, the investment of civil construction of Parallel Flow technology is lower, saving about 17%.

➤ Shorter anode life and lower fund occupation

With Parallel technology, the anode life is shortened from 20 days to 15 days and the anodes stored in the cells are less, thus the fund occupation of copper, gold and silver

Add: No.1 Xiangguang Road, Shiflo Town, Yanggu County,
Shandong Province, P.R. China, 252327
Tel: +86 635 713 5054



is lower.

➤ Improved copper quality

The copper content of cathode copper maintains above 99.9975% and is in accordance with high purity cathode copper standard. The quality of cathode copper is better than that of conventional permanent stainless steel cathode electrolysis technology.

➤ Higher silver reclaim rate

The silver content in the Phase 2 tankhouse cathode copper is less than 5ppm, while it is about 10ppm in Phase 1st tankhouse cathode copper. The silver reclaim rate is also higher.

➤ Higher current efficiency and lower comprehensive energy consumption

The current efficiency of Phase 2nd tankhouse is about 99.4%, while it is 97.5% for Phase 1st tankhouse. In addition, steam is not necessary for heating up in Phase 2nd tankhouse. The comprehensive energy consumption in Phase 2nd tankhouse is about 25% lower than that of Phase 1st tankhouse.

Zhou Songlin

Vice President

Yanggu Xiangguang Copper Co., Ltd



Add: No.1 Xiangguang Road, Shiflo Town, Yanggu County,
Shandong Province, P.R. China, 252327
Tel: +86 635 713 5054

Major Steps

Conventional Refining Electrolysis

Copper cathodes
MOTHERSHEETS

max. 300 A/m²



Conventional Refining Electrolysis

Copper cathodes
STAINLESS STEEL

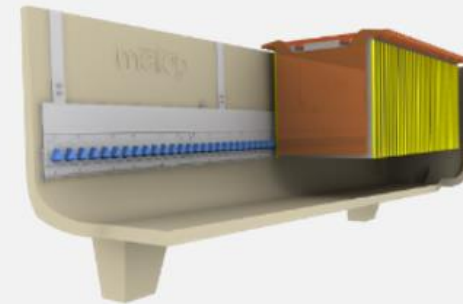
max. 350 A/m²



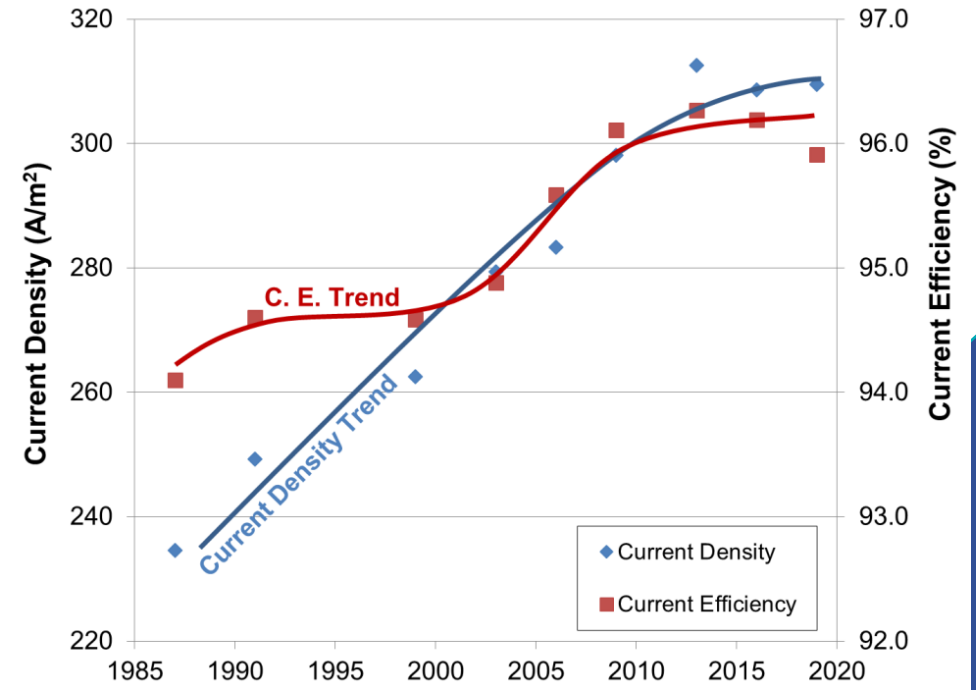
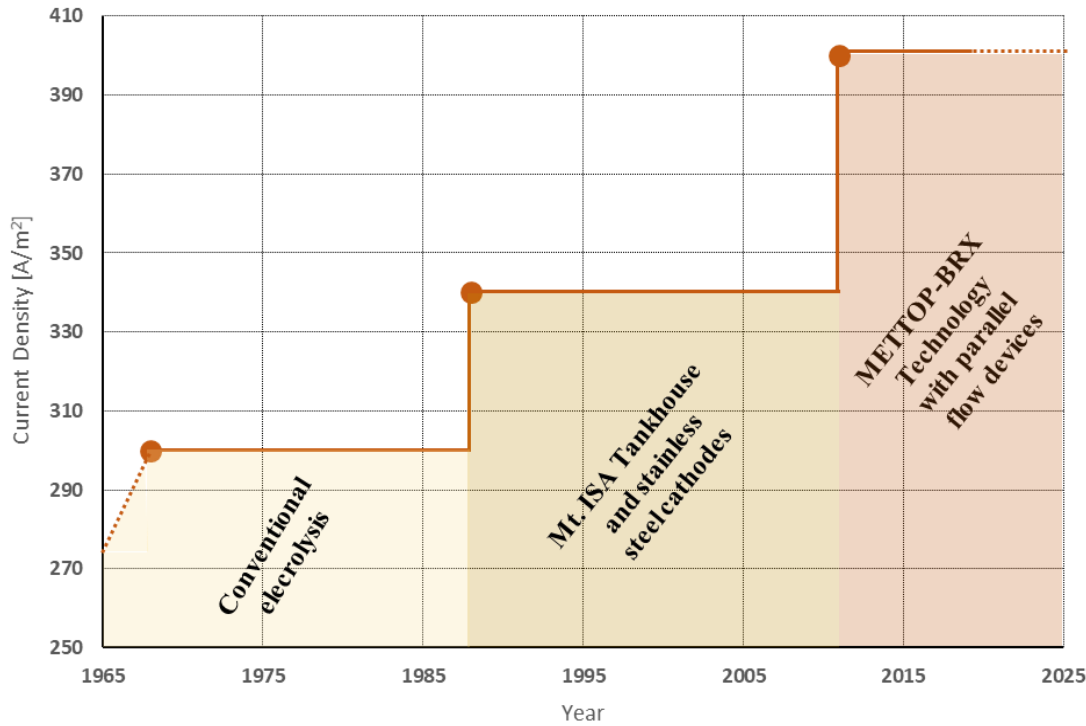
METTOP-BRX Refining Electrolysis

Mothersheets or
stainless steel

max. 450 A/m²



Average current density (according to Davenport 2019)	Maximum current density ISA Technology	METTOP-BRX Technology
300 A/m ²	330-350 A/m ²	380-420 A/m ²



Example for a 500 000 t/a tankhouse

Item	Savings
CAPEX savings	18 000 000 US\$
Stock savings	50 600 000 US\$
Sum CAPEX + Stock	68 600 000 US\$
OPEX savings	4 300 000 US\$

Benefits:

- ✓ Better cathode quality
- ✓ Less portion of silver in cathode
- ✓ Possibility of usage of lower grade anodes
- ✓ Smaller tankhouse footprint
- ✓ Latest technology
- ✓ Lower CAPEX
- ✓ Lower OPEX

Today's most advanced tankhouse technology – the METTOP-BRX Technology – allows:

- Increasing the **current density and productivity** by up to 50 % compared to conventional copper electrorefining tankhouses.
- Can either be installed in **existing facilities** – in order to increase production – or considered in **new plants** – in order to reduce the footprint of the entire tankhouse.
- Right now the **benchmark** for a copper refinery is Xiangguang Copper, China, running their tankhouse no. 2 at 420 A/m² at a current efficiency > 99 % using the METTOP-BRX Technology.

Installation PFD at XIANGGUANG Copper



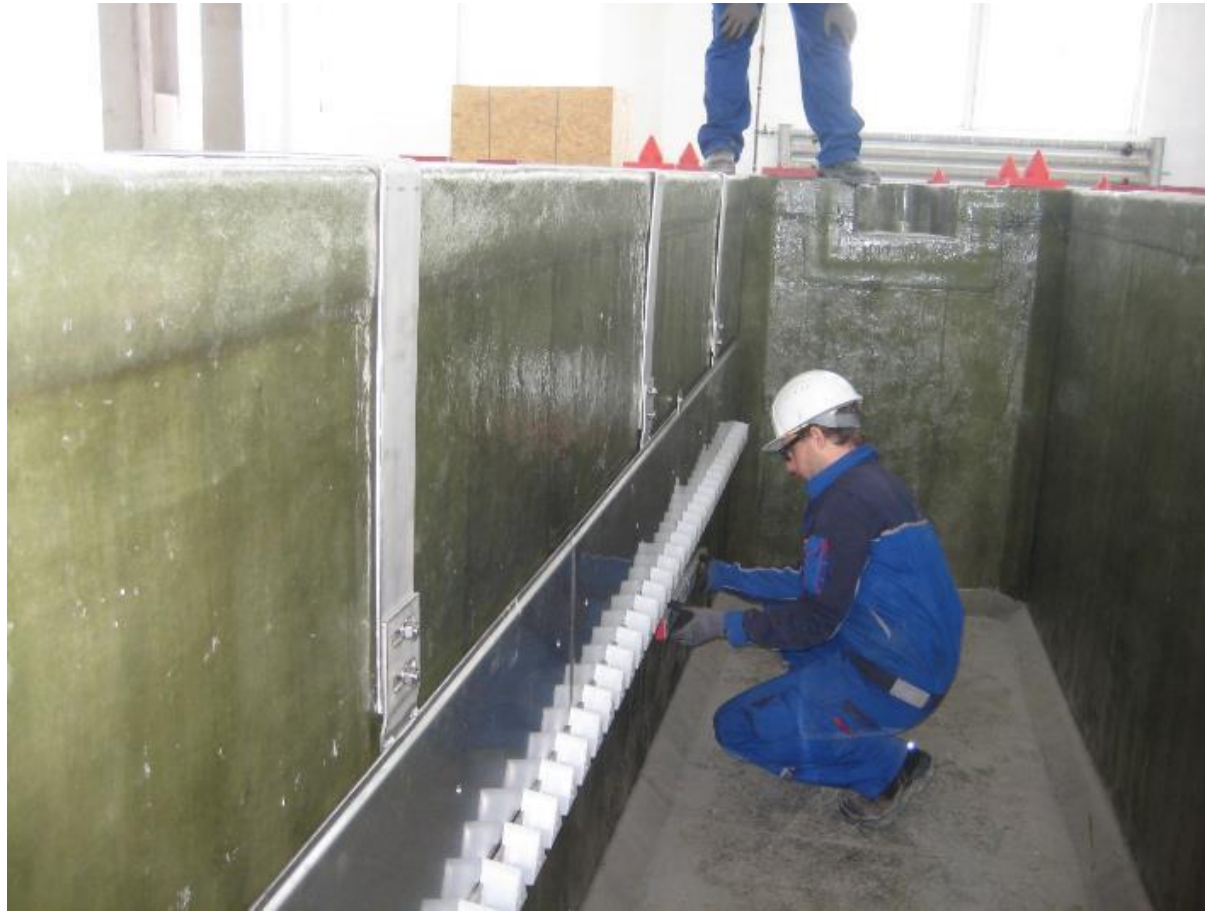
Installation PFD at XIANGGUANG Copper



Installation PFD at XIANGGUANG Copper



Installation PFD at XIANGGUANG Copper



Installation PFD at XIANGGUANG Copper



Installation PFD at XIANGGUANG Copper



Installation PFD at XIANGGUANG Copper



Installation PFD at XIANGGUANG Copper



THANK YOU!



✉ Regina Krenn
☎ METTOP GmbH
regina.krenn@mettop.com
+43 664 860 4560

EMC sponsored by:

KÜTTNER



NICKELHÜTTE AUE
Member of → JACOB METAL GROUP

wieland **SMS**  **group**

HATCH **BEFESA**

 **Aurubis**
Metals for Progress

Metso:Outotec

GLENCORE
Nordenham

European Metallurgical Conference
Emc2023