WeCo mettop UrbanGold recycling for a green future

COMBINED COMPETENCE UNDER ONE ROOF

METTOP

- Tankhouse Technology

Mettop Group Presentation

mettop UrbanGold recycling for a green future WeCo

2005
Founding of Mettop by Iris and Andreas Filzwieser and Stefan Wallner

mettop

2007
Patent registration METTOP-BRX Technology for tankhouse optimization

2009
Patent registration ILTEC Technology for water free cooling

2014
Founding of UrbanGold for Copper Recycling

UrbanGold recycling for a green future

2015
PIERER Konzern gesellschaft mbH

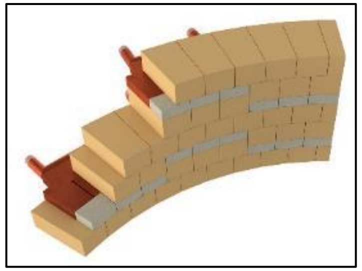
Pierer Konzerngesellschaft AG gets part of the company

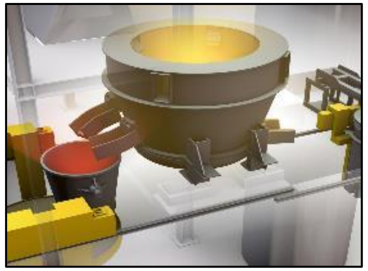
2018
First industrial scale plant for E-waste recycling

2019
Mettop becomes shareholder of Welding Copper in Spain

WeCo

Overview Products and Services





Non-ferrous metals units

Products:

- HENRI ®
- Gas Purging Systems
- CFM Coolers
- ionicLife cast

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 ® Technology
- Cathode spacers
- Complete Tankhouse

ILTEC for vessel cooling

Products:

- IL-B2001 ©
- Ionic Liquid Technology for vessel cooling
- Furnace integrity optimization

Overall Process & Technology Consulting

Field Studies & Trainings

Process and 3D Plant Engineering

TO KNOW IS BETTER THAN TO GUESS

Research & Development & Innovation

DigMet

METTOP-BRX Technology

New Approach to Higher Current Densities and Higher Productivity

Overview Products and Services

Tankhouse Solutions

More than 400 A/m^2 –
yesterday an illusion, today reality

Innovative technology to us means considering new directions and adopting unconventional approaches to maximize productivity and quality.

In order to increase the productivity of a copper tankhouse, the current efficiency and/or current density have to be increased..

in /company/mettop

METTOP-BRX Technology

Available systems for refining and winning electrolysis

Conventional Refining Electrolysis

Copper cathodes
MOTHERSHEETS

max. 300 A/m^2

Conventional Refining Electrolysis

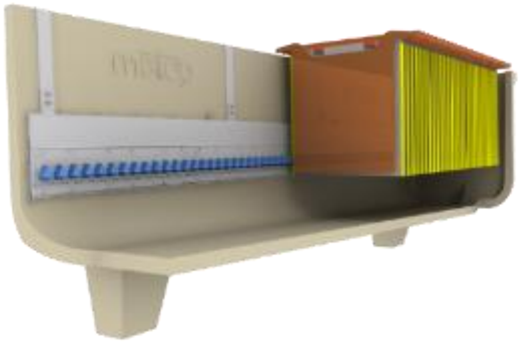
Copper cathodes
STAINLESS STEEL

max. 350 A/m^2

METTOP-BRX Refining Electrolysis

Mothersheets or
stainless steel

max. 450 A/m2



Meet customers' problems – considerations to choose METTOP-BRX Technology

Targets for Tankhouse optimization:

- High current efficiency
- High chemical cathode quality
- Low operating cost
- Lower footprint
- Low bound capital

METTOP-BRX Technology enables higher current densities and will result in higher productivity.

Examples of applications:

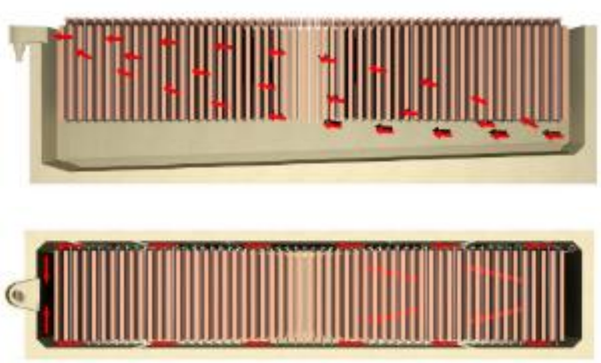
- Refining and winning electrolysis for copper
- Electrolysis for zinc
- Tankhouses for descaling

Different flow mechanisms and improvement by METTOP-BRX Technology

Conventional

Natural Convection

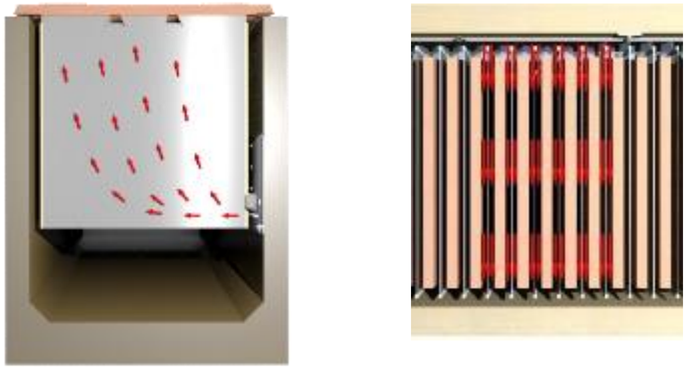
Forced Convection



METTOP-BRX Technology

Natural Convection

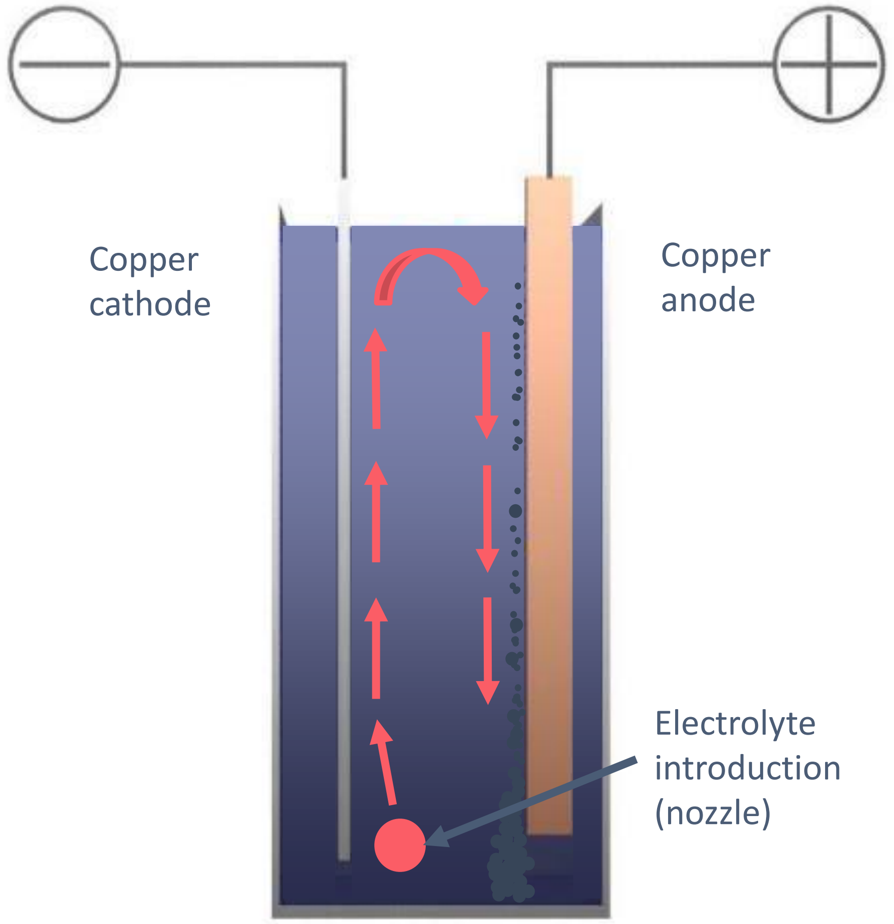
Forced Convection



Flow of electrolyte in-between the electrodes

METTOP-BRX Technology

More homogeneous conditions and no influence of anode slime



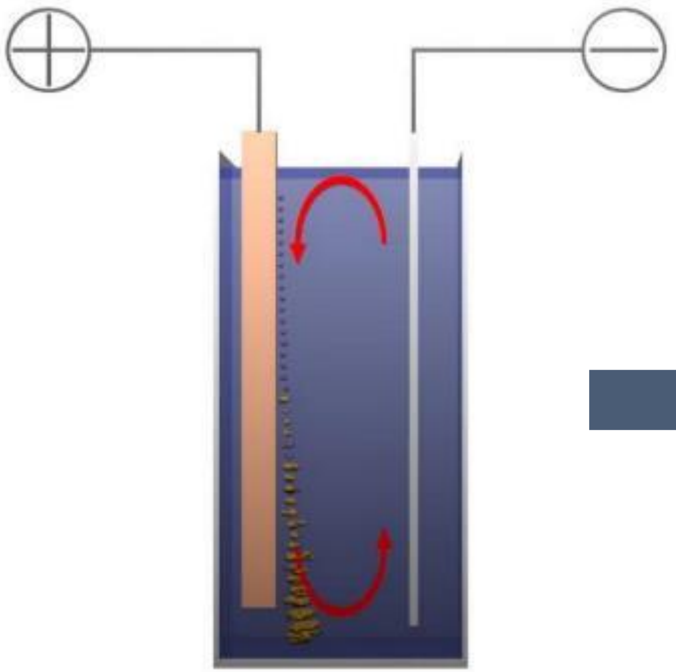
Improvements:

- 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

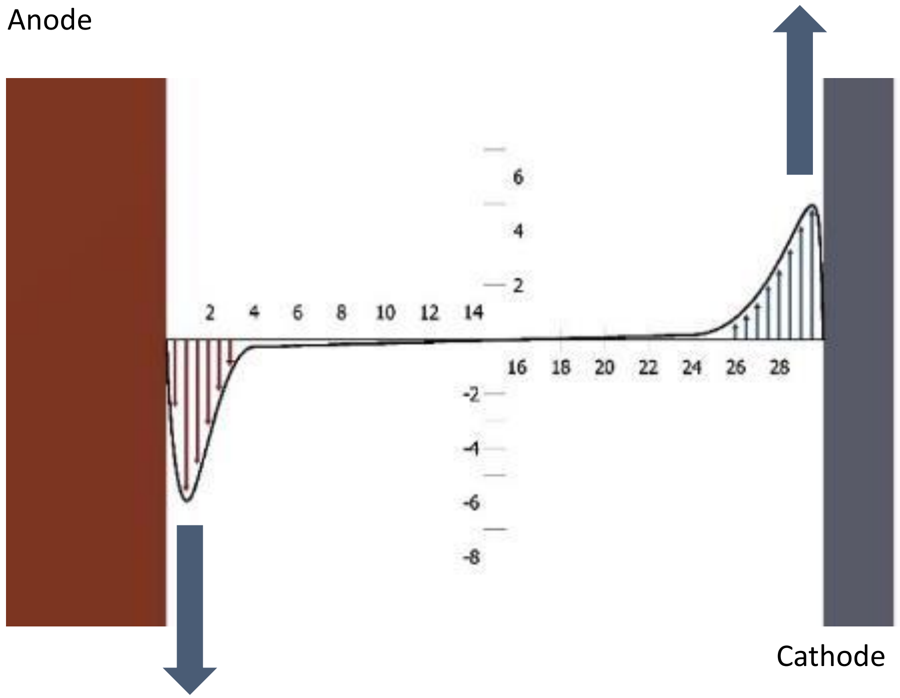
METTOP-BRX Technology

What is different? - Improvement flow mechanism by Mettop’s BRX Technology

Natural Convection



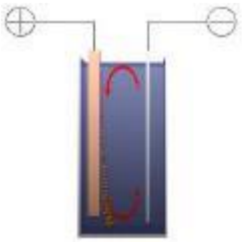
Natural & Forced Convection

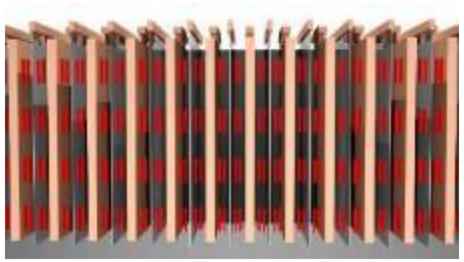


METTOP-BRX Technology

What is different? - Improvement flow mechanism by Mettop's BRX Technology

Enhanced Natural Convection





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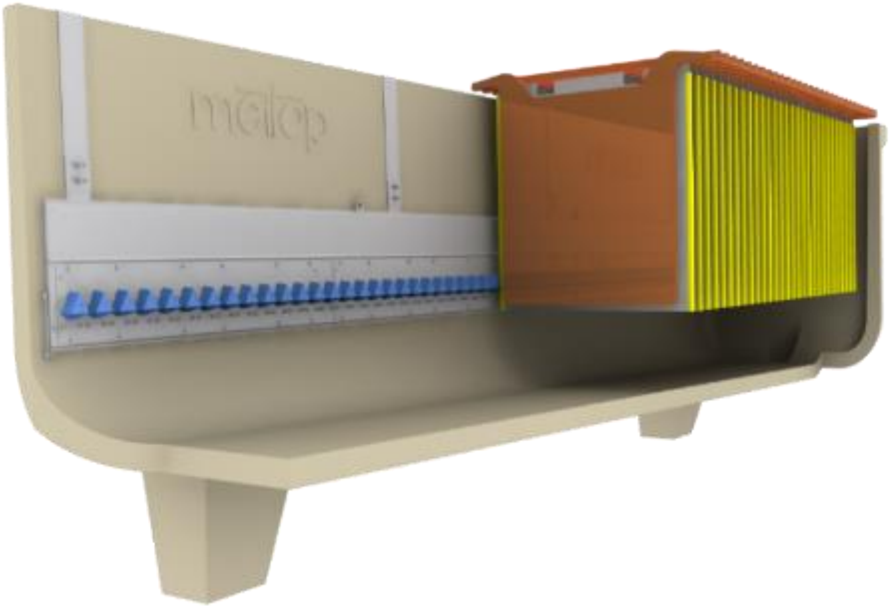
Forced Convection

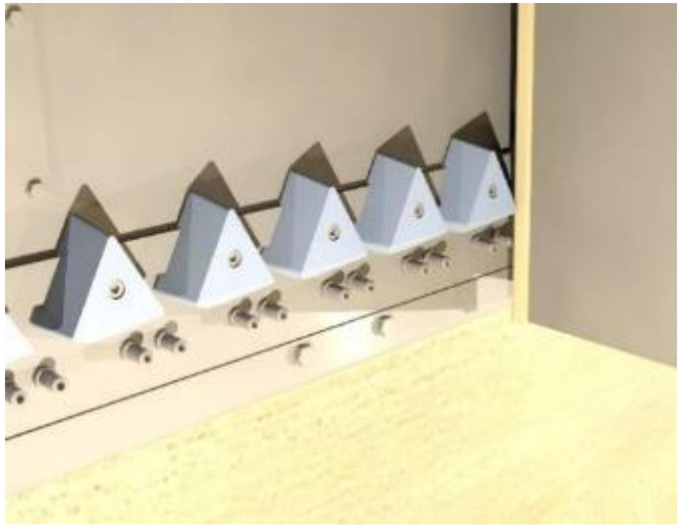
- Higher electrolyte flow rate and flow directly in front of the cathode leads to a decreased diffusion boundary layer.
- Direct introduction of the inhibitors near the active cathode surface lead to a more homogeneous distribution
- Current density distributions is more homogenous
- Direct electrolyte introduction leads to a more homogenous electrolyte temperature distribution

Using the METTOP-BRX Technology a current density of up to 450 A/m² at a current efficiency of above 98 % can be achieved.

Can Mettop’s BRX Technology be realized in existing Tankhouses?

Brownfield Approach – Parallel Flow Device (PFD) for upgrading existing tankhouses





- Special positioning devices – cathode spacers for accurate electrode positioning
- PFDs are customer-tailored to guarantee optimum results for each specific tankhouse.

METTOP-BRX Technology

Is Mettop's BRX Technology a proven Technology?

Montanwerke Brixlegg AG, Austria – Upscaling an Existing Tankhouse in 2007

- 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.

祥光铜业
XIANGGUANG COPPER

METTOP-BRX Technology

Is Mettop's BRX Technology a proven Technology?

Xiangguang Copper, China – Installation of a new Tankhouse in 2011

- Pumps for direct pumping (i.e., no overhead tanks) for approximately 100 l/min per cell
- New design of electrical system for 420 A/m² (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/m²

Performance

Standard tankhouse

Tankhouse1 Standard

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Average
Current density, A/m^2	265	265	265	265	294	294	294	265	265	265	**273,70 A/m²**
Current efficency, %	97,66	97,74	97,71	97,65	97,44	98,2	98,74	98,67	98,79	98,76	**98,14 %**
Production, t	152452	168494	202470	138263	197865	188468	217468	179765	178042	138085	**176137,20 t**
Scrap rate, %	15,68	15,55	15,25	15,69	15,55	14,96	14,25	12,57	13,06	12,71	**14,53 %**
DC power consumption, kWh/t	278,28	282,41	271,41	291,39	290,72	295,2	299,06	285,76	279,52	290,142	**286,39 kWh/t**
Amount of steam , t	67568	67111	82203	63508	88558	82599	99511	85128	88291	68230	**45,00 kg/t**
Cu in cathode, %	99,9976	99,9977	99,9976	99,9977	99,9978	99,9977	99,9978	99,9977	99,9977	99,9976	**99,998 %**
No. of workers	130	130	130	130	130	103	103	103	103	103	
Cathode quanlity , (in% LME A)	100	100	100	100	100	100	100	100	100	100	**100,00**
Ag in cathode, %	0,000915	0,000955	0,000889	0,000812	0,000823	0,000954	0,000948	0,000899	0,000969	0,001046	**9,21 ppm**

Mettop Technology

Tankhouse 2 METTOP

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Average
Current density, A/m^2	410	410	410	385	385	410	410	385	385	385	**397,5 A/m²**
Current efficency, %	99,17	99,19	99,25	99,2	99,22	99,31	99,21	99,28	99,21	99,19	**99,223 %**
Production, t	271580	265258	282285	252859	245415	262972	244838	283211	263247	201528	**257319,3 t**
Scrap rate, %	13,2	13,25	13,17	13,22	13,18	13,13	12,57	12,44	12,51	12,74	**12,941 %**
DC power consumption, kWh/t	361	359	362	359	353	363	377	355	358	362	**360,9 kWh/t**
Amount of steam , t	3658	4103	4430	4132	4322	4102	3906	4519	4106	3785	**1,6 kg/t**
Cu in cathode, %	99,998	99,998	99,9979	99,9978	99,9978	99,9979	99,9979	99,9977	99,9977	99,9977	**100,00 %**
No. of workers	100	100	100	100	100	100	100	100	100	100	**100**
Cathode quanlity , (in% LME A)	100	100	100	100	100	100	100	100	100	100	**100**
Ag in cathode, %	0,000486	0,000513	0,000498	0,000568	0,000589	0,000445	0,000425	0,000434	0,000389	0,000468	**4,82 ppm**

Performance comparison

Standard vs Mettop

	Standard	Mettop
Current density	273,7 A/m²	**397,5 A/m²**
Current efficency	98,1 %	**99,2 %**
Production	176137,2 t	**257319,3 t**
Scrap rate	14,5 %	**12,9 %**
DC power consumption, kWh/t	286,4 kWh/t	**360,9 kWh/t**
Amount of steam	45 kg/t	**1,6 kg/t**
Cu in cathode, %	99,998 %	**99,998 %**
No. of workers	103	**100**
Cathode quanlity , (in% LME A)	100	**100**
Ag in cathode	9,2 ppm	**4,8 ppm**

Technology Comparison at Xiangguang Copper

Official statements XG

XGC

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

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Shandong Province, P.R, China, 252327
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XGC

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

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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/m²	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

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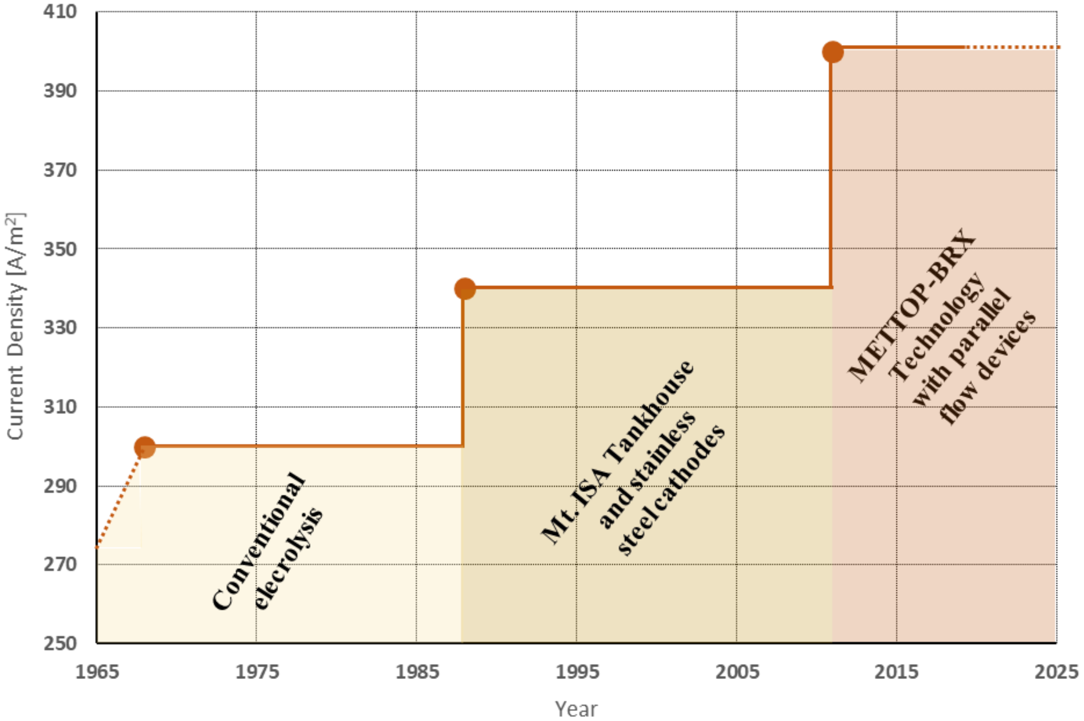
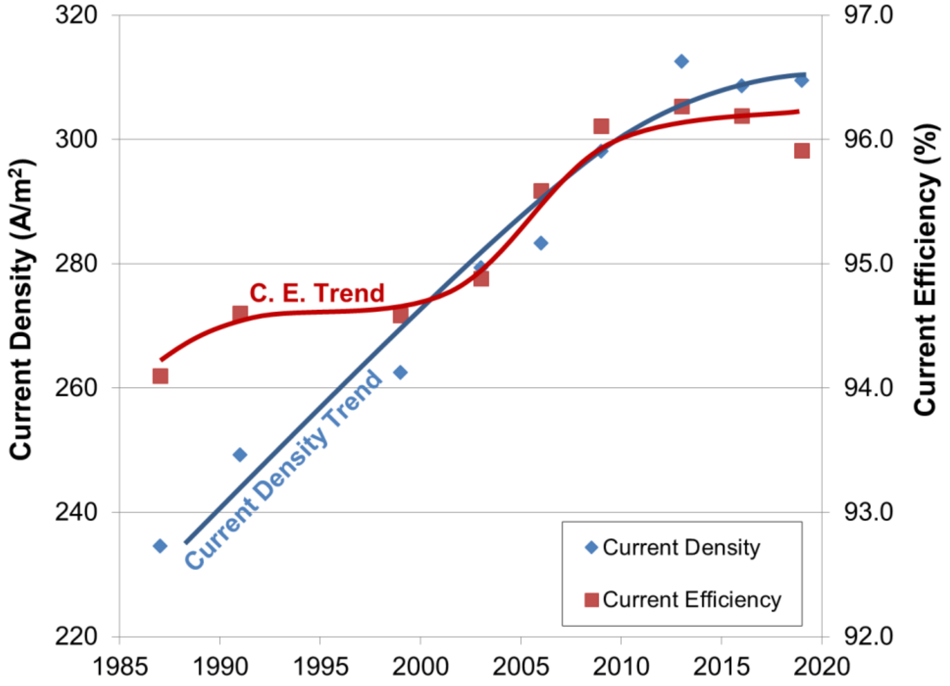
Engineering 500 000 t Tankhouse

Comparision of current density – historical background



Milestones for electrolysis and increase in current density
(Source: Filzwieser, et al., 2009, Filzwieser et al., 2014)



Average current density and current efficiency (C.E.) from 1987 to 2016
Source: GLOBAL SURVEY OF COPPER ELECTROREFINING: 2019 WORLD TANKHOUSE OPERATING DATA; Michael S. Moats [2019]

Average current density (according to Davenport 2019)	Maximum current density ISA Technology	METTOP-BRX Technology
300 A/m²	330-350 A/m²	380-420 A/m²

Summary

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/m^2 at a current efficiency > 99 % using the METTOP-BRX Technology.

Cathode Spacers

Immediately increase your current efficiency up to 2-3%

COMBINED COMPETENCE UNDER ONE ROOF

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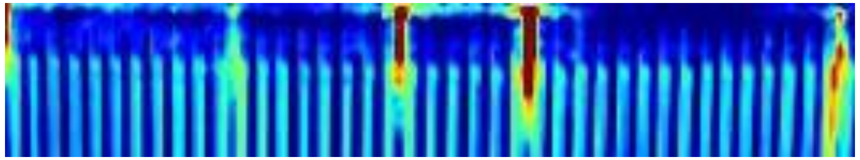
Cell voltage monitoring system

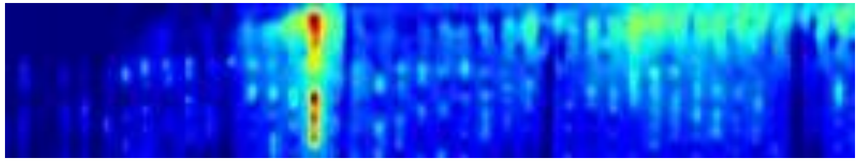
Automatic Detection

Detection with thermal cameras

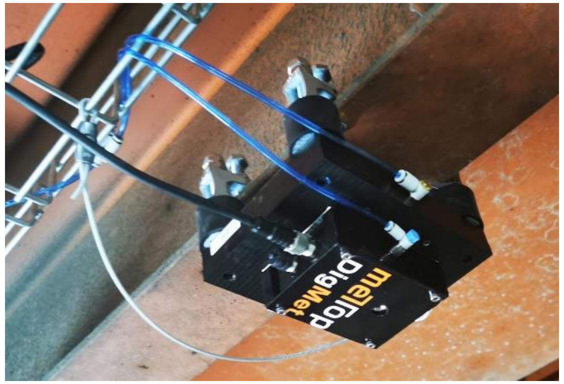
- Optimized for short-circuit detection
- Sulfuric acid resistant housing
- Detection despite cell cover



No cover



With cover



Benefit of automatic detection

Savings potential

- Higher current efficiency
- Lower reworking costs

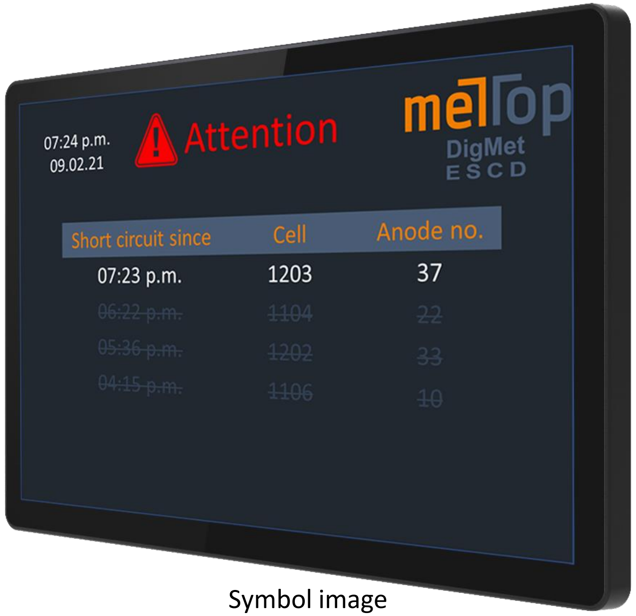
Minimization of the short circuit time from 12 hours to less than 2 hours

With increase of the current yield by 1% and annual production of 100,000 t a saving potential of 250,000 € results

Automatic Detection

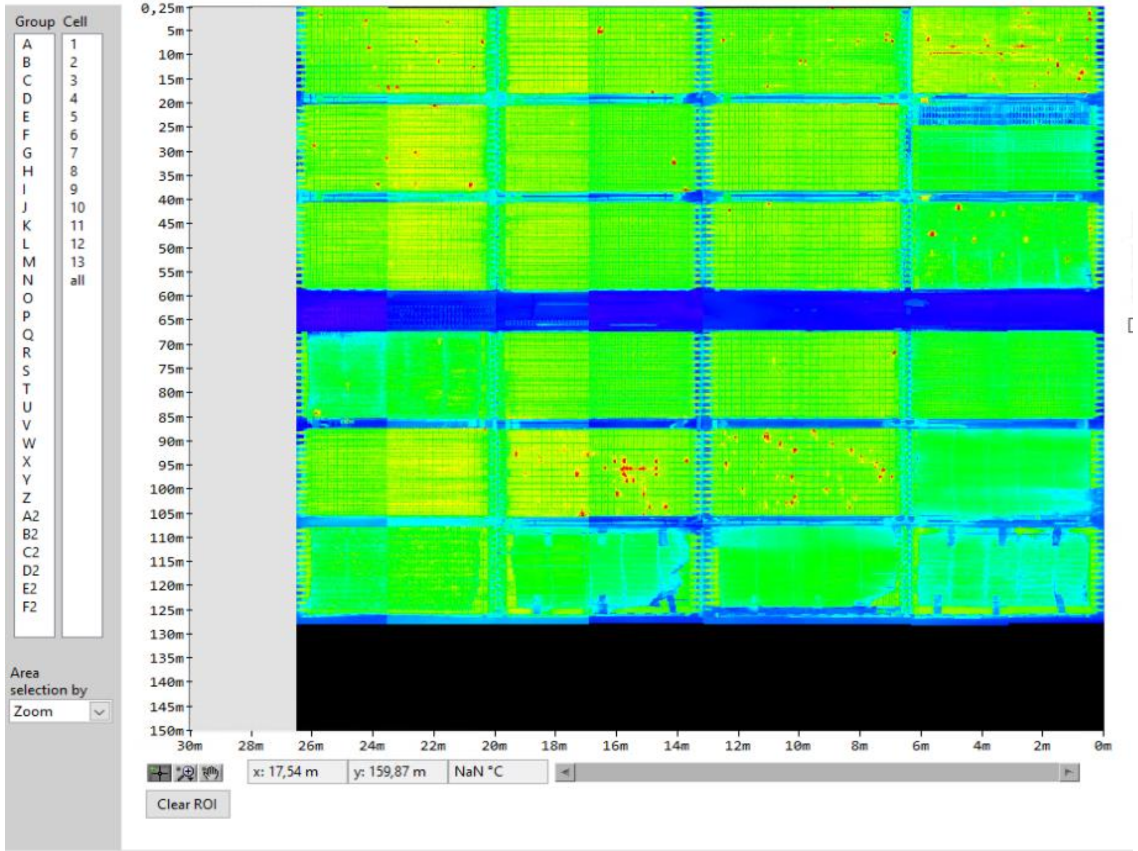
Display of short circuits in the tankhouse

- Shock resistant displays
- Variable screen size
- Acid resistant
- IP65 certified



Symbol image

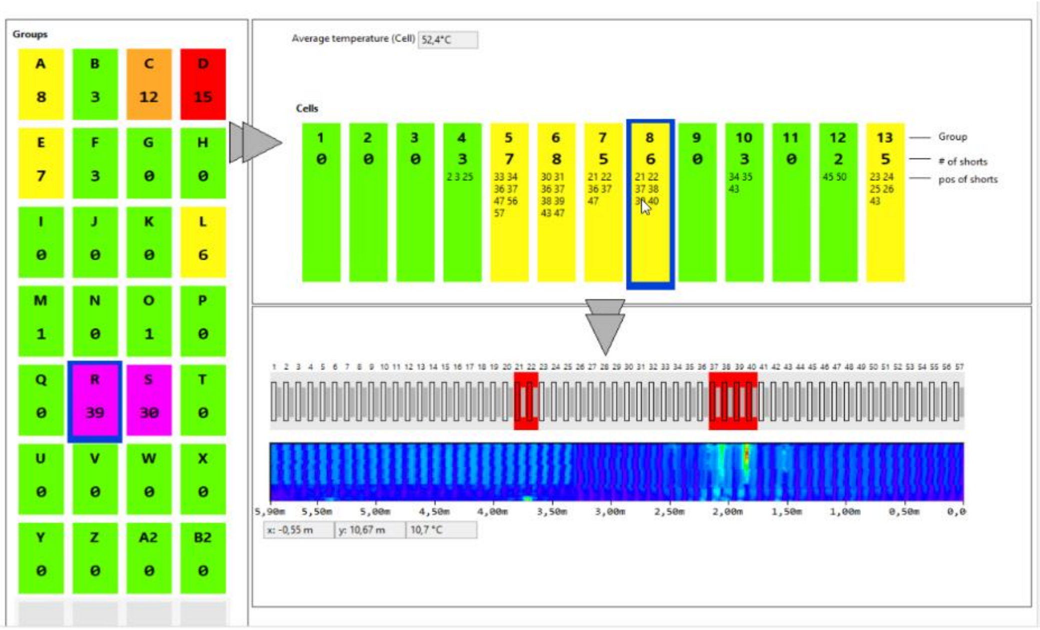
DigMet-Software



Symbol image

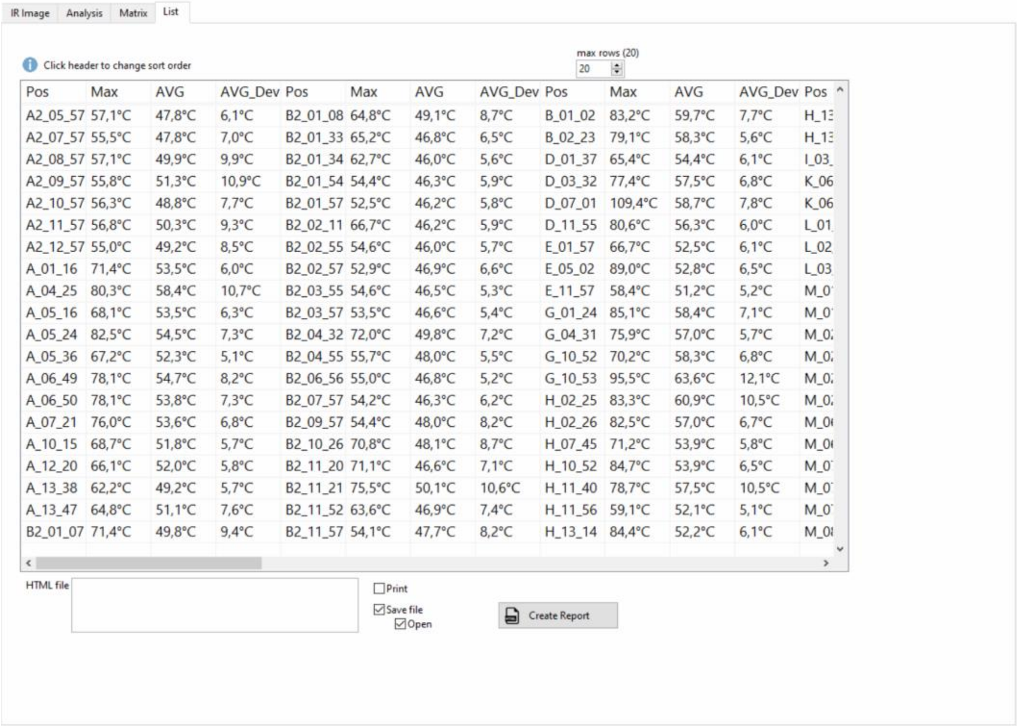
DigMet-Software

- Visualization of the tankhouse
    - With all groups and cells
    - Display of highly affected groups
    - Number of short circuits per group and cell



DigMet-Software

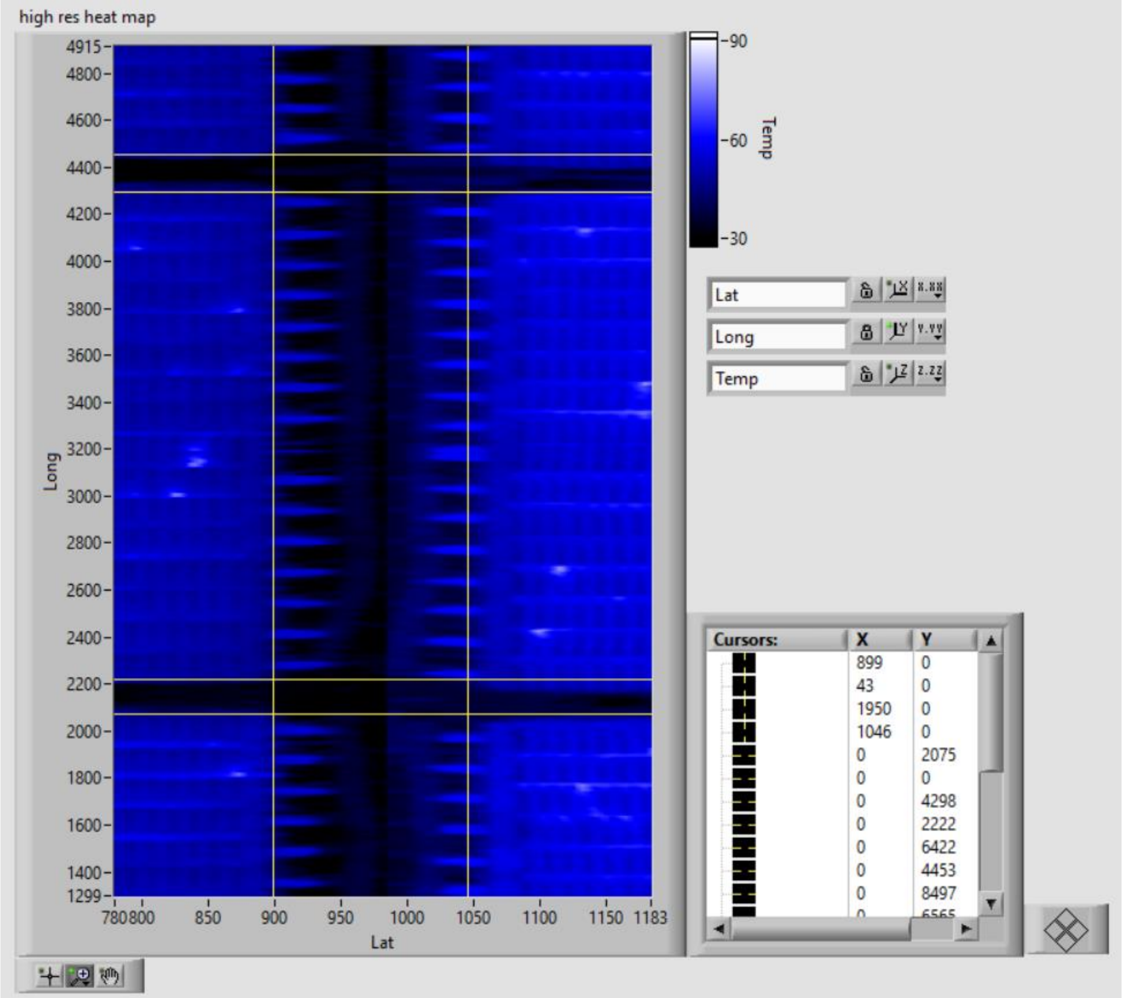
- Export and Visualization of
  - Short-circuits
  - Anode/Cathode temperatures
  - Busbar temperature
  - Electrolyte outlet temperature



Pos	Max	AVG	AVG_Dev	Pos	Max	AVG	AVG_Dev	Pos	Max	AVG	AVG_Dev	Pos
A2_05_57	57,1°C	47,8°C	6,1°C	B2_01_08	64,8°C	49,1°C	8,7°C	B_01_02	83,2°C	59,7°C	7,7°C	H_13
A2_07_57	55,5°C	47,8°C	7,0°C	B2_01_33	65,2°C	46,8°C	6,5°C	B_02_23	79,1°C	58,3°C	5,6°C	H_13
A2_08_57	57,1°C	49,9°C	9,9°C	B2_01_34	62,7°C	46,0°C	5,6°C	D_01_37	65,4°C	54,4°C	6,1°C	I_03_
A2_09_57	55,8°C	51,3°C	10,9°C	B2_01_54	54,4°C	46,3°C	5,9°C	D_03_32	77,4°C	57,5°C	6,8°C	K_06
A2_10_57	56,3°C	48,8°C	7,7°C	B2_01_57	52,5°C	46,2°C	5,8°C	D_07_01	109,4°C	58,7°C	7,8°C	K_06
A2_11_57	56,8°C	50,3°C	9,3°C	B2_02_11	66,7°C	46,2°C	5,9°C	D_11_55	80,6°C	56,3°C	6,0°C	L_01
A2_12_57	55,0°C	49,2°C	8,5°C	B2_02_55	54,6°C	46,0°C	5,7°C	E_01_57	66,7°C	52,5°C	6,1°C	L_02
A_01_16	71,4°C	53,5°C	6,0°C	B2_02_57	52,9°C	46,9°C	6,6°C	E_05_02	89,0°C	52,8°C	6,5°C	L_03
A_04_25	80,3°C	58,4°C	10,7°C	B2_03_55	54,6°C	46,5°C	5,3°C	E_11_57	58,4°C	51,2°C	5,2°C	M_0
A_05_16	68,1°C	53,5°C	6,3°C	B2_03_57	53,5°C	46,6°C	5,4°C	G_01_24	85,1°C	58,4°C	7,1°C	M_0
A_05_24	82,5°C	54,5°C	7,3°C	B2_04_32	72,0°C	49,8°C	7,2°C	G_04_31	75,9°C	57,0°C	5,7°C	M_0
A_05_36	67,2°C	52,3°C	5,1°C	B2_04_55	55,7°C	48,0°C	5,5°C	G_10_52	70,2°C	58,3°C	6,8°C	M_0
A_06_49	78,1°C	54,7°C	8,2°C	B2_06_56	55,0°C	46,8°C	5,2°C	G_10_53	95,5°C	63,6°C	12,1°C	M_0
A_06_50	78,1°C	53,8°C	7,3°C	B2_07_57	54,2°C	46,3°C	6,2°C	H_02_25	83,3°C	60,9°C	10,5°C	M_0
A_07_21	76,0°C	53,6°C	6,8°C	B2_09_57	54,4°C	48,0°C	8,2°C	H_02_26	82,5°C	57,0°C	6,7°C	M_0
A_10_15	68,7°C	51,8°C	5,7°C	B2_10_26	70,8°C	48,1°C	8,7°C	H_07_45	71,2°C	53,9°C	5,8°C	M_0
A_12_20	66,1°C	52,0°C	5,8°C	B2_11_20	71,1°C	46,6°C	7,1°C	H_10_52	84,7°C	53,9°C	6,5°C	M_0
A_13_38	62,2°C	49,2°C	5,7°C	B2_11_21	75,5°C	50,1°C	10,6°C	H_11_40	78,7°C	57,5°C	10,5°C	M_0
A_13_47	64,8°C	51,1°C	7,6°C	B2_11_52	63,6°C	46,9°C	7,4°C	H_11_56	59,1°C	52,1°C	5,1°C	M_0
B2_01_07	71,4°C	49,8°C	9,4°C	B2_11_57	54,1°C	47,7°C	8,2°C	H_13_14	84,4°C	52,2°C	6,1°C	M_0

DigMet-Software

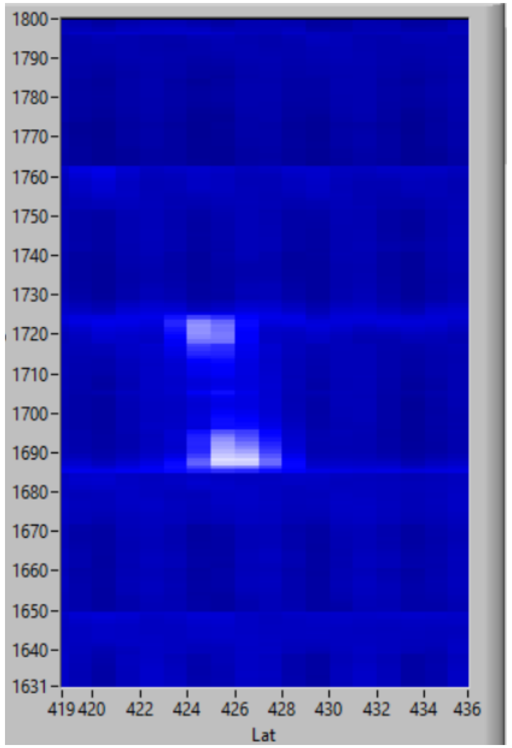
- Advanced Cell Detection
  - Automatic calibration
  - For easy calibration of the system
  - In the case of a camera exchange, the calibration is omitted
  - No need of crane positioning system



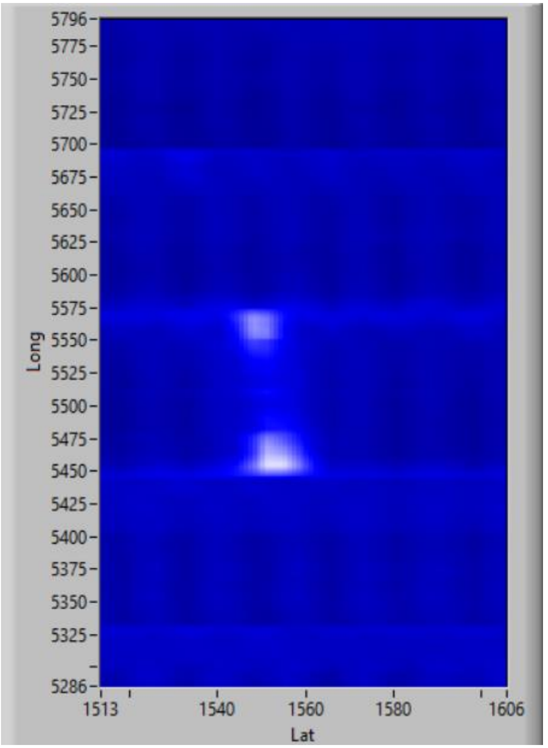
DigMet-Software

- Innovative Image Resampling Technology
  - Better short-circuit detection
  - More precise position
  - Accuracy of up to ±0 anodes/cathodes

Standard thermal image



Resampled Image



Mounting options

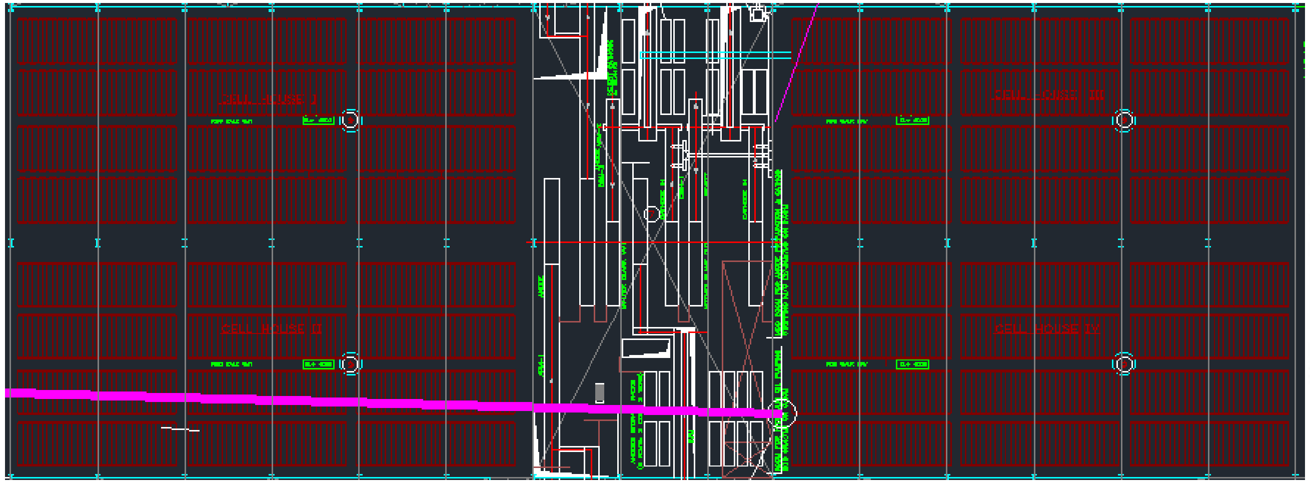
- Fixed cameras
- Crane
- Sliding rail
- …

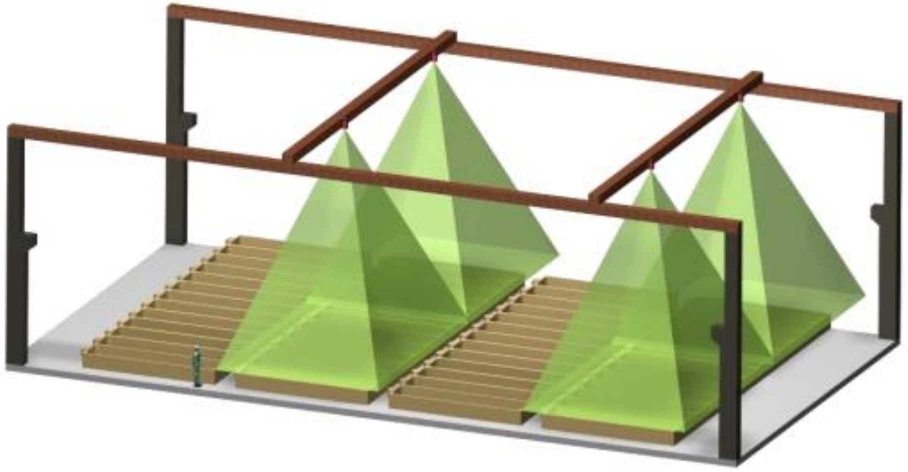
Mounting

Fixed cameras

- Permanent monitoring
- Independent of the crane
- Fast response times

- Cameras needed:
  - Per group: ~1



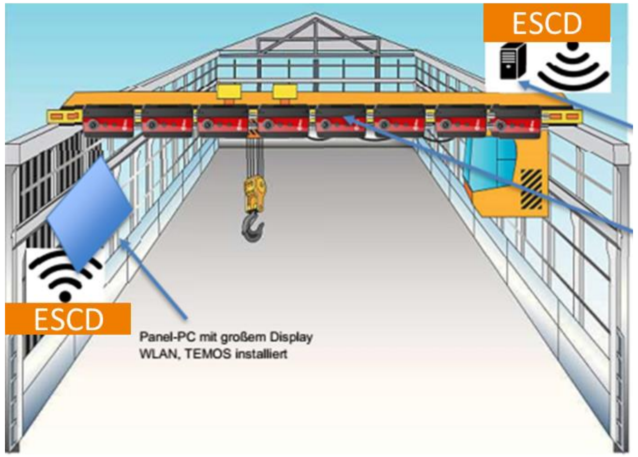


Mounting

Crane

- Break times for crane are needed
- Monitoring only when crane in “scan mode”
- Small installation effort
- Crane positioning system not needed

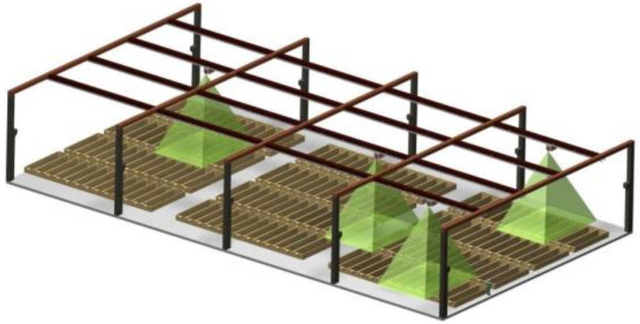
- Cameras needed:
  - Per line: 1

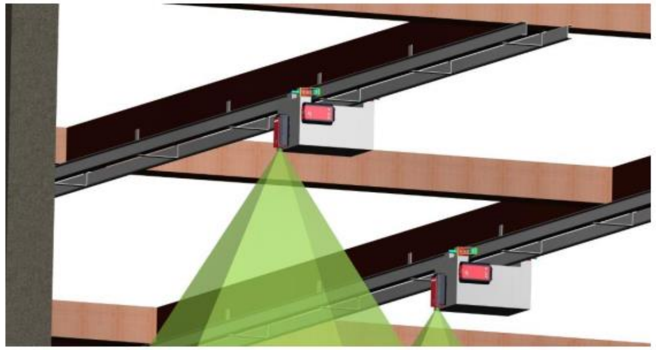


Mounting

Sliding rail

- Semi-Permanent monitoring
- Independent of the crane
- Higher installation effort





- Cameras needed:
  - Per line: 1

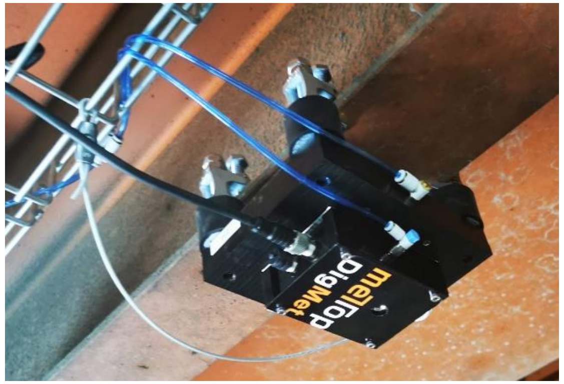
ESCD

Must be clarified

- Mounting options
- Hall dimensions
- Crane positions
- Crane specification
- Network infrastructure

Study

- 30 days test with one or more fixed cameras
- Report of occuring short-circuits and time
- Self installation on beam on the roof of the hall
- Online-Support
- Test system incl.:
  - 1x Thermal camera incl. cooling solutions
  - 1x Evaluation computer
  - Network components



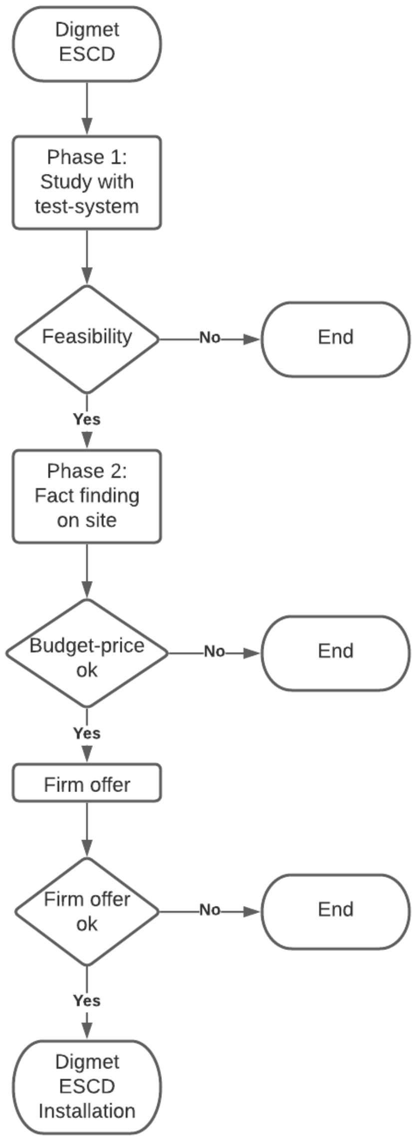
Phases

Phase 1: Study with test system, online support and report

Phase 2: Fact finding on site, defining mounting option and budget price

Phase 3: Firm offer

Phase 4: Installation of ESCD



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