THERMAL PROCESSES

EBNER®

EED

Gautschi®

HAZELETT

HPI

GNA

CRC

TPS®

EQMS

EBNER®

Emission-free solutions for continuous and batch type heat-treatment.

IWCC Technical Seminar 2025 Dallas

Anton Oppermann, Sascha Eppensteiner

4&5 March, 2025

EBNER® GROUP >> Driving Green Technologies

The purpose of this presentation is to guide programs benefiting the copper industry and to provide attendees with information to make independent business decisions.

Agenda

- EBNER company introduction
- Follow up: vertical bright annealing line (**GREENCAL®**): new tension control system, high-performance cooling
- Simulation of Continuous Annealing Lines (SIMCAL)
- Next generation of Bell Annealer Furnaces (**GREENBAFx®**)
- conclusion + Q & A

Steel

Focus: Heat Treatment

- Batch Annealing
- Bright Annealing
- Hardening/Tempering
- Continuous Annealing

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Aluminum

Focus: Melting/Casting & Heat Treatment

- Top/Side Charge Furnace
- Holding Furnaces
- Ingot Casting
- Horizontal/Vertical Casting
- Continuous Casting
- Pusher/Floater/Chamber

Gautschi HPI GNA

HAZELETT

EED EBNER®

Copper base metals

Focus: Heat Treatment & Casting

- Batch Annealing
- Bright Annealing
- Continuous Casting

EBNER®

HAZELETT

Automotive

Focus: High Strengths Heat Treatment

- Steel Press Hardening
- Aluminum Hot Forming

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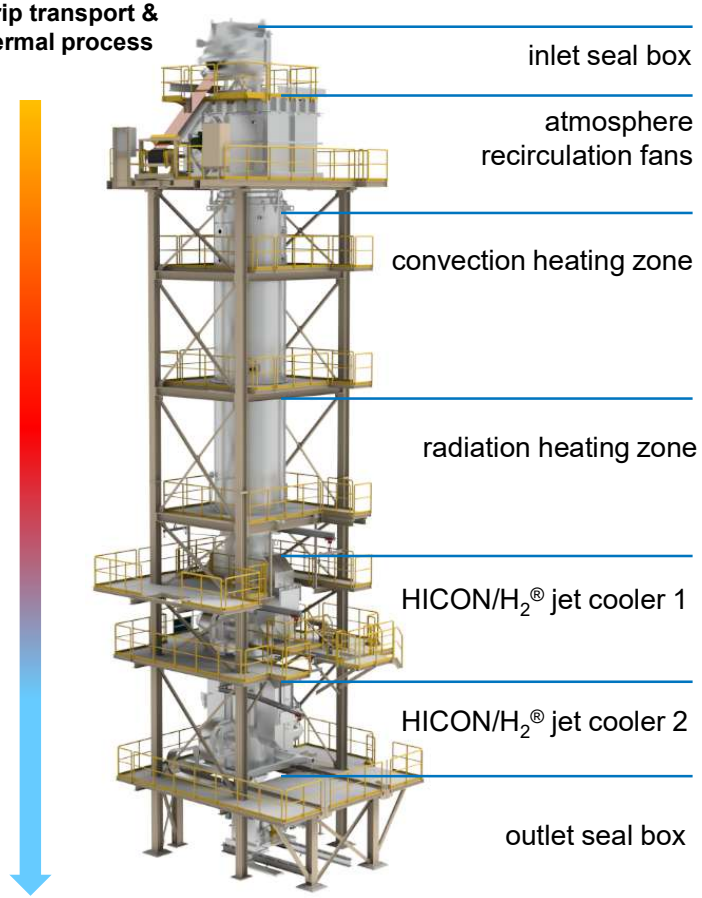
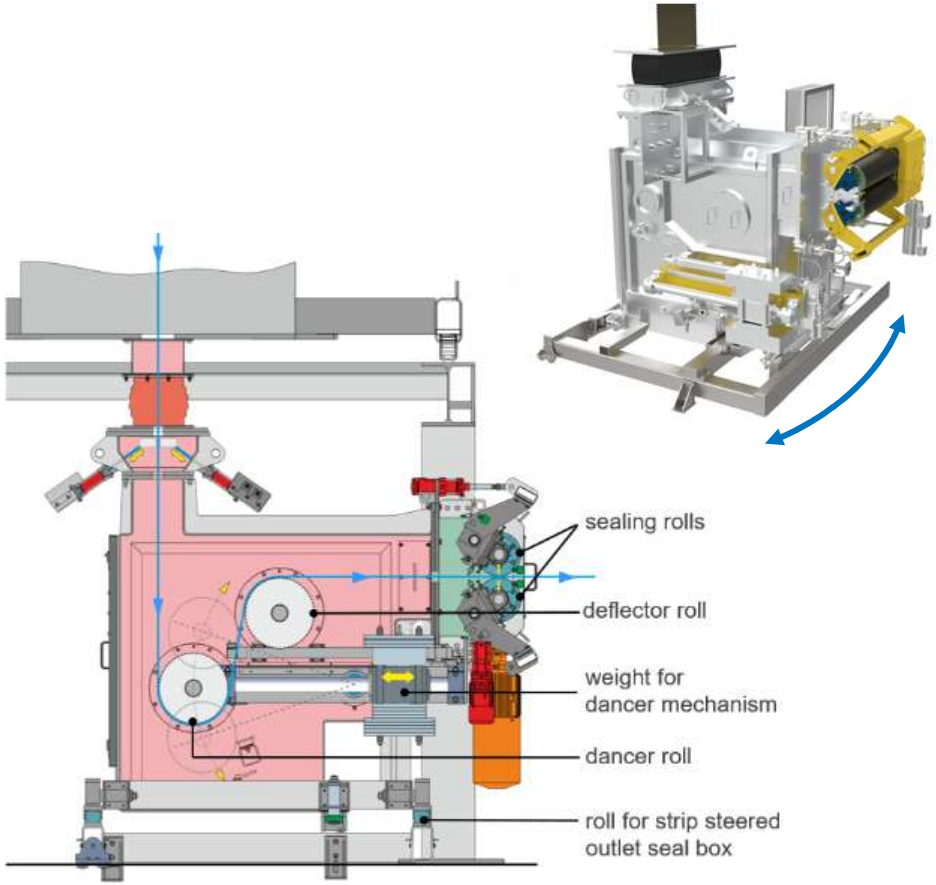
- HICON/H_2 Bell Annealing
  Inner Cover, Heating Bell, Cooling Bell

- HICON/H_2 Continuous Bright Annealing

Vertical bright annealing line: tension control

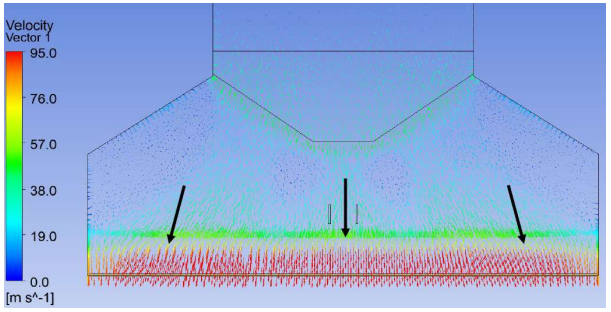
Strip transport & thermal process

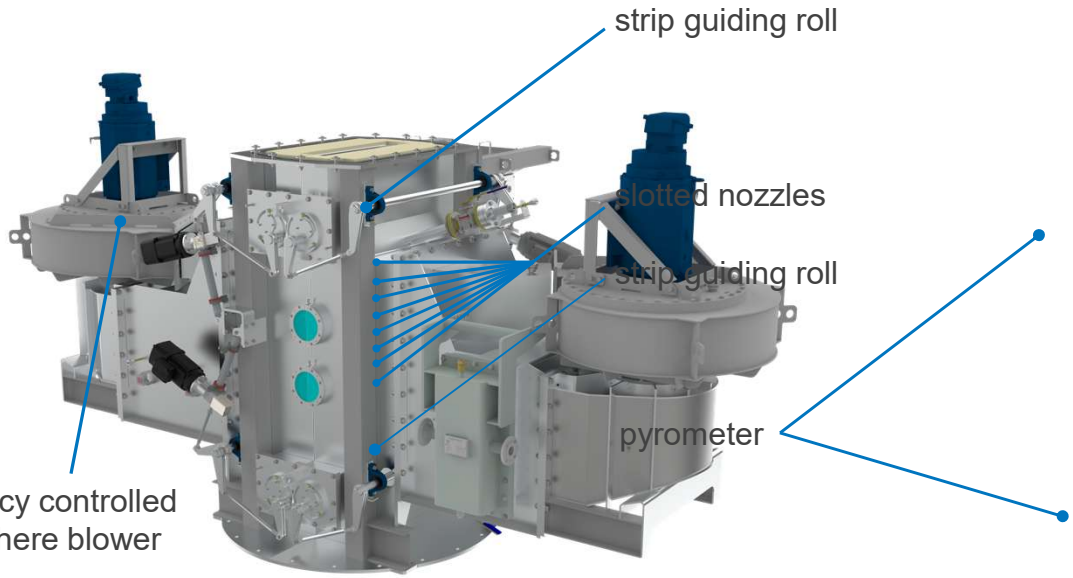


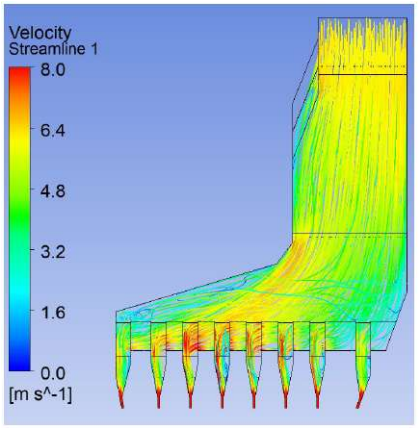


Vertical bright annealing line: High-performance cooler

- Optimized design for high-performance alloys
- CFD-Simulation optimized fluid flow
- Compact design for highest cooling rates:
  - cooling rates > 100K/s*mm





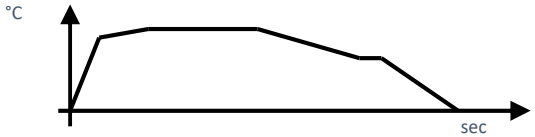


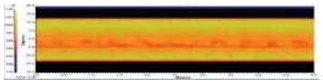
Simulation of Continuous Annealing Lines (SIMCAL)

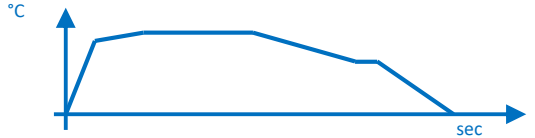
EBNER®

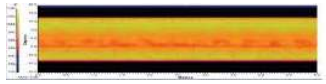
... find a match between ...

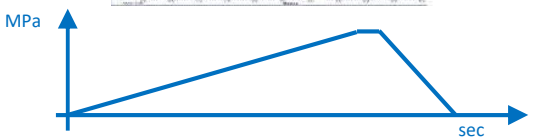
- same strip thickness
- same atmosphere
- same temperature curves
- same temperature uniformity
- same strip tension curves
- **same material properties**



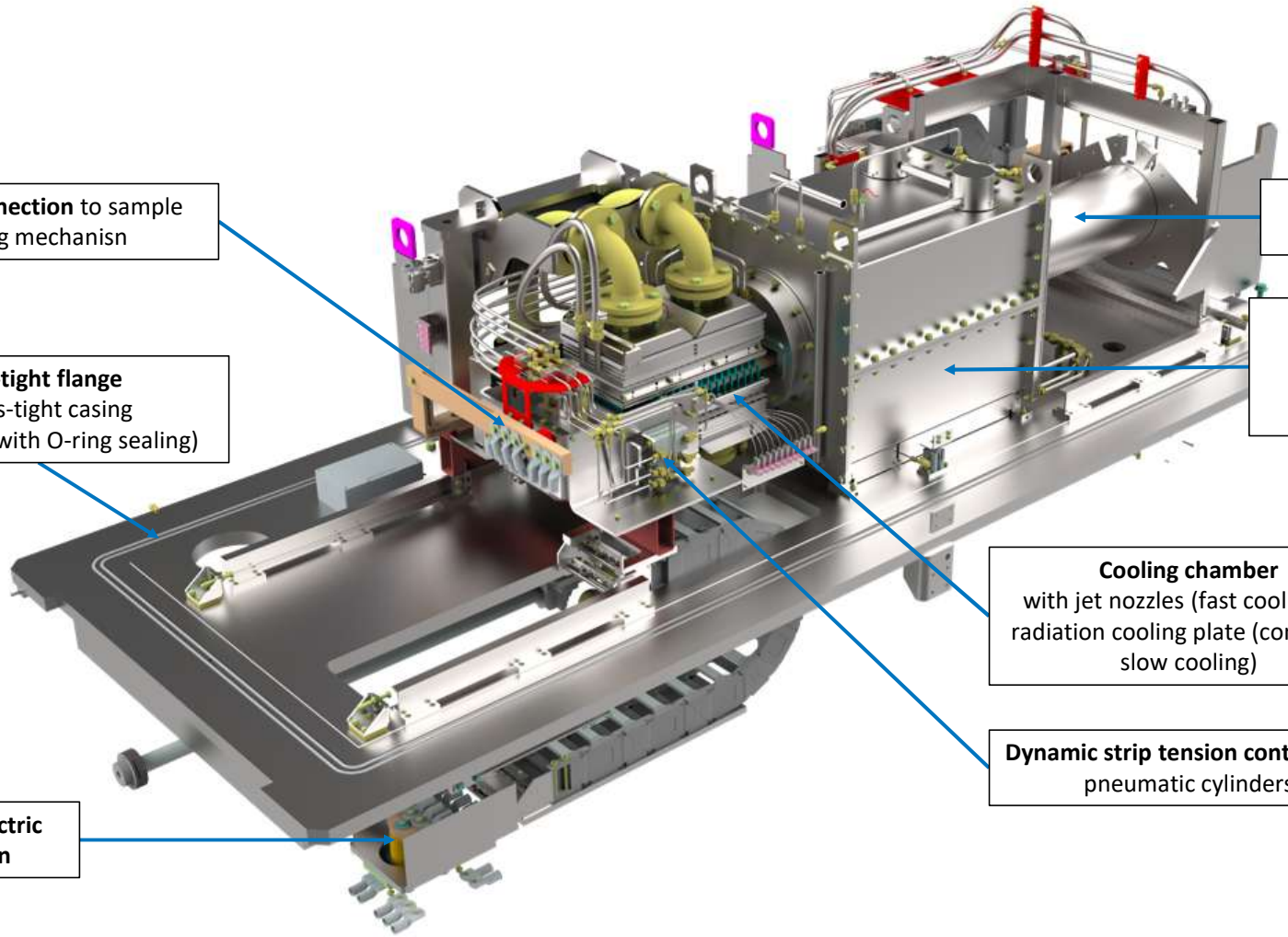








SimCAL GEN. 5 – Detailed View



Electric connection to sample claming mechanisn

Gas-tight flange
to gas-tight casing
(machined with O-ring sealing)

Gas-tight electric connection

Fast sample transfer mechanism
between heating-/cooling chamber

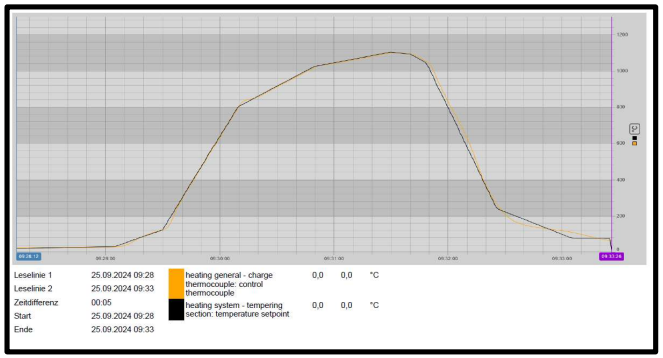
Process chamber
with hybrid-heating system
muffle (radiation heating) and conductive heating (clamps)

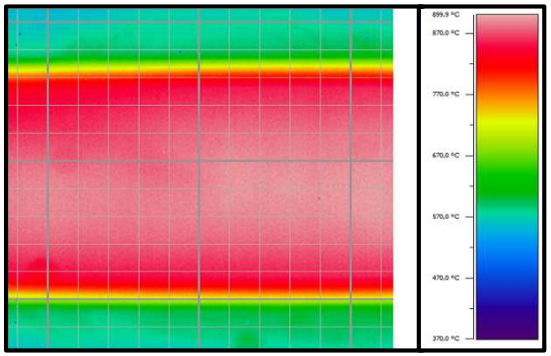
Cooling chamber
with jet nozzles (fast cooling) or radiation cooling plate (controlled slow cooling)

Dynamic strip tension control with pneumatic cylinders

SimCAL Gen. 5 simulates the conditions of a real continuous annealing line

- **Hybrid heating chamber** with electric-heated muffle furnace (heating and/or temperature homogenization) in combination with electric-/conductive heating of the sample
- **Gas-tight** process chamber
- **Temperature uniformity** in the range of ±5 to ±10°C
- **Dewpoint adjustable** in the range of +20°C to -55°C
- **Process atmosphere adjustable** H_2/N_2 mixtures (0-100%) and 100% Ar
- Annealing temperatures **up to 1260°C**
- **Dynamic strip tension control** throughout the whole annealing cycle (up to 3900 N)
- **Rapid heating** (up to ~ 100 K/s) as well as **Controlled heating** possible
- **Fast Cooling** (up to 200 K/s.mm) as well as **Slow/Controlled cooling** possible (5 – 25 K/s)





The Next Generation of
Bell Annealer Furnaces

GREENBAFx®

- Emission-free process (CO_2/NO_x)
- Innovative Electric Heating System integrated into the workbase
- New Process Bell replaces traditional Inner Cover, Heating Bell and Cooling Bell

GREENBAFx Basic Case: Direct Heating System

Heating Bell
for Hybrid-heating mode

- ECOBURN natural gas (NG) burner
- ECOBURN FLEX burner for NG / H_2

or

Insulation Bell
with low heat losses:

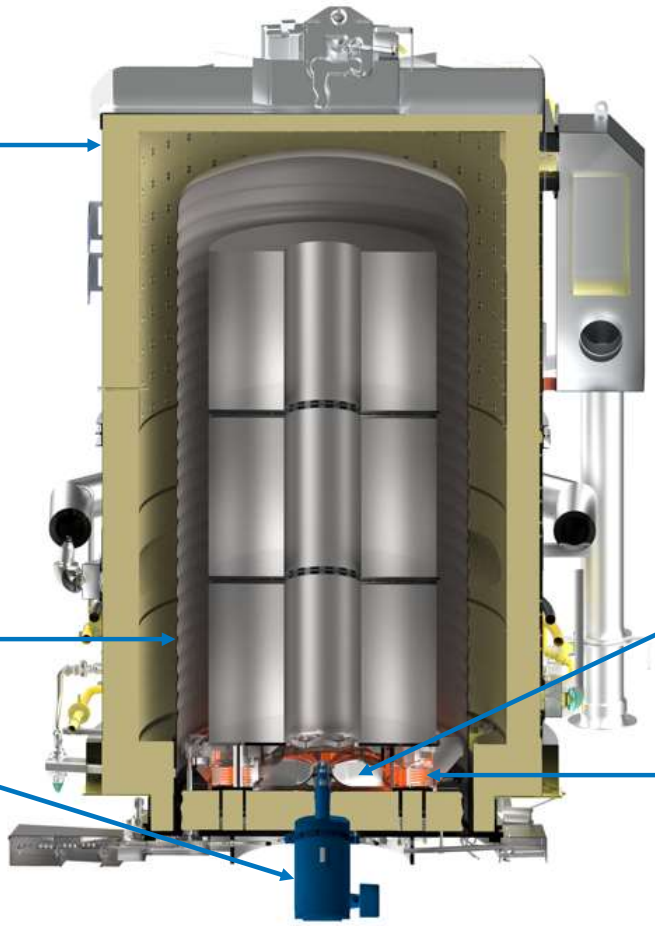
- smaller outer surface
- no overshoot temperature required (no outer heating chamber)

resp.

Cooling Bell
to cool down the charge

Inner Cover

high-performance fan motor
to recirculate process atmosphere



liftable bell

optimized impeller
to recirculate process atmosphere

integrated Electric Heating System
in workbase
for direct heating of process atmosphere

GREENBAFx Advanced Case: Direct Heating System with HICON® Process Bell

HICON® Process Bell
with integrated inner cover
ensures lowest heat losses:
- small outer surface
- no losses through gaps
- no overshoot temperature required
- reduced tara weight

Electric power connection to workbase
with gas-tight leadthrough into workbase

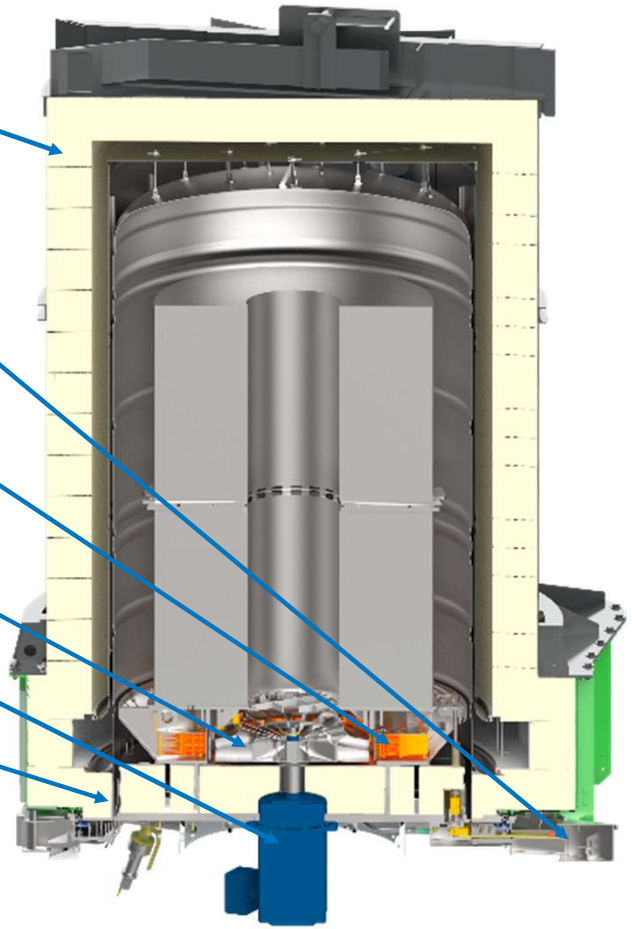
Integrated electric heating system
- inside the workbase
- for direct heating of atmosphere

Flow-optimized impeller
to recirculate process atmosphere

High-performance fan motor
to recirculate process atmosphere

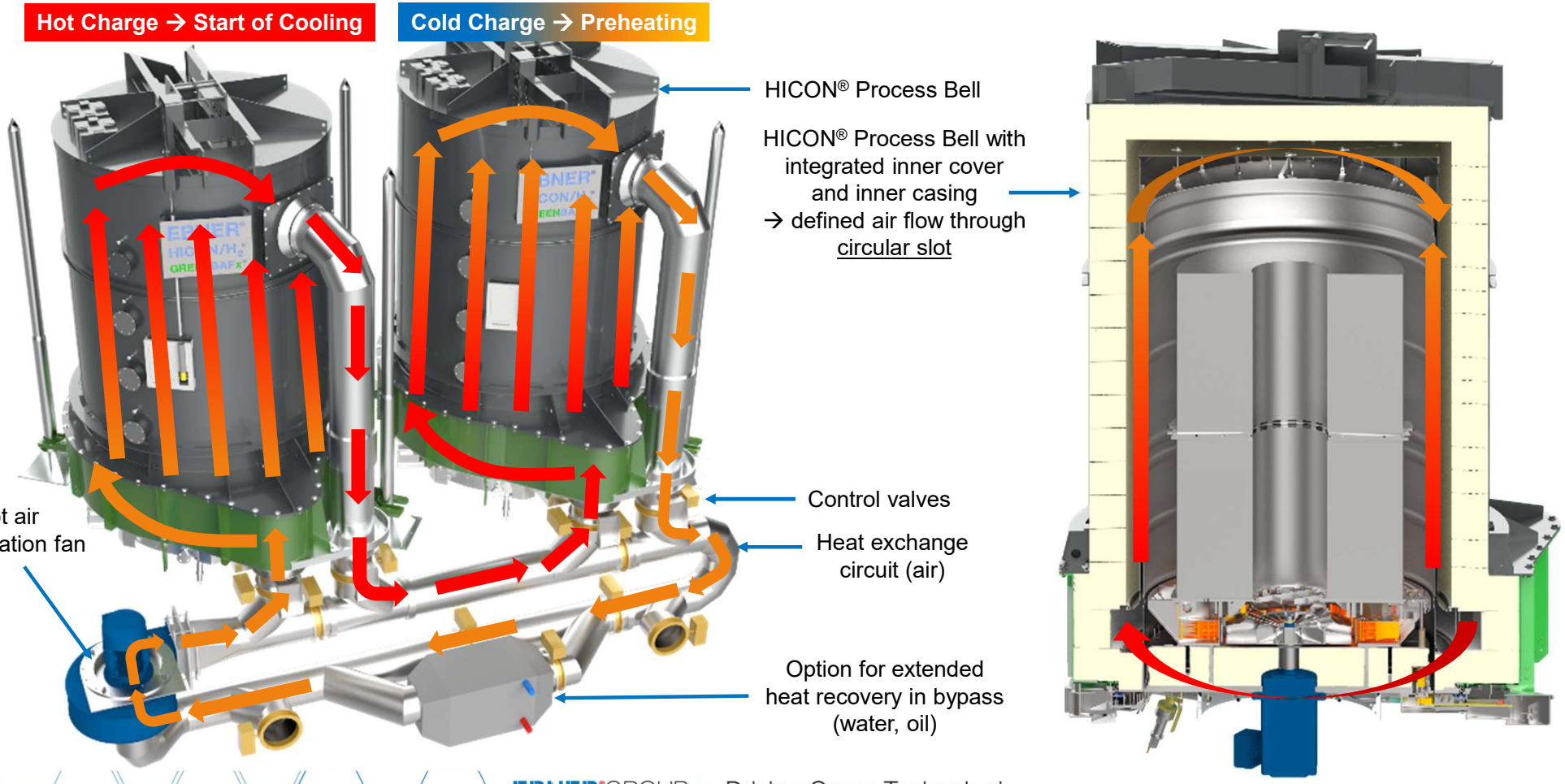
Fully insulated „furnace-throat“
no gap between Inner cover and insulation

Connection to air circuit
for heat exchange between stacks and for cooling

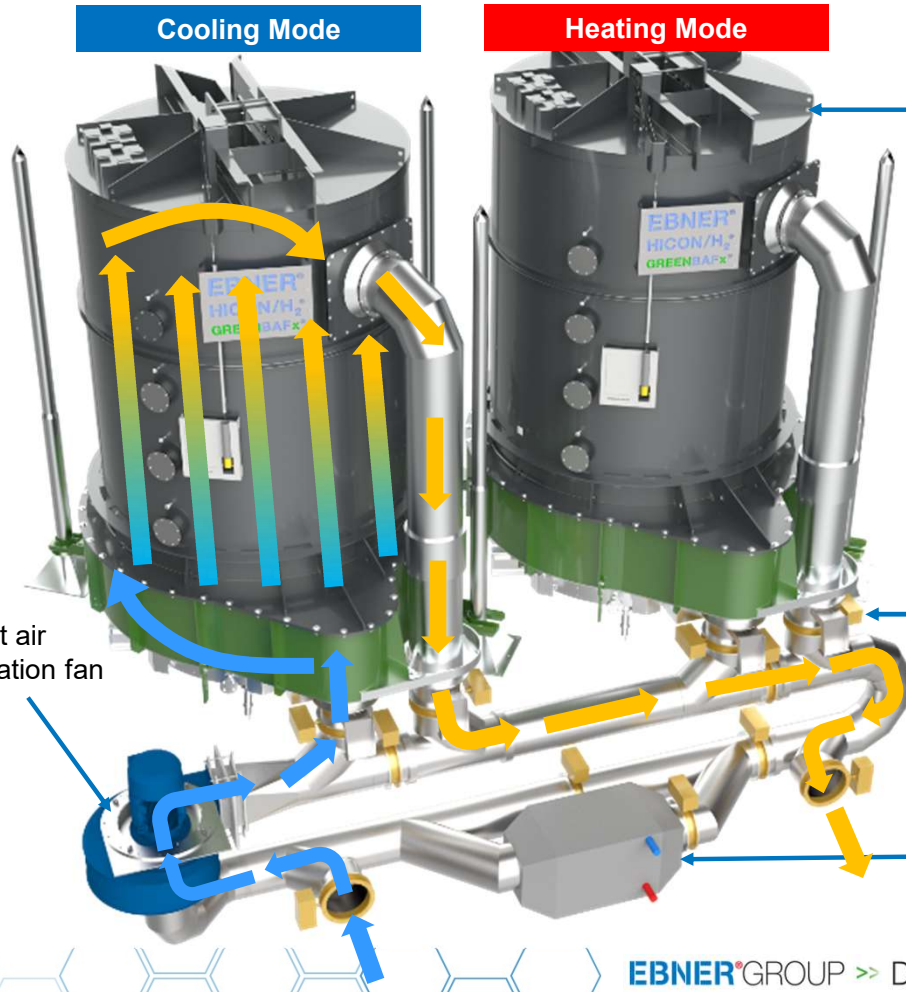


GREENBAFx Advanced Case: Direct Heating System with Process Bell & Heat Exchange

EBNER®

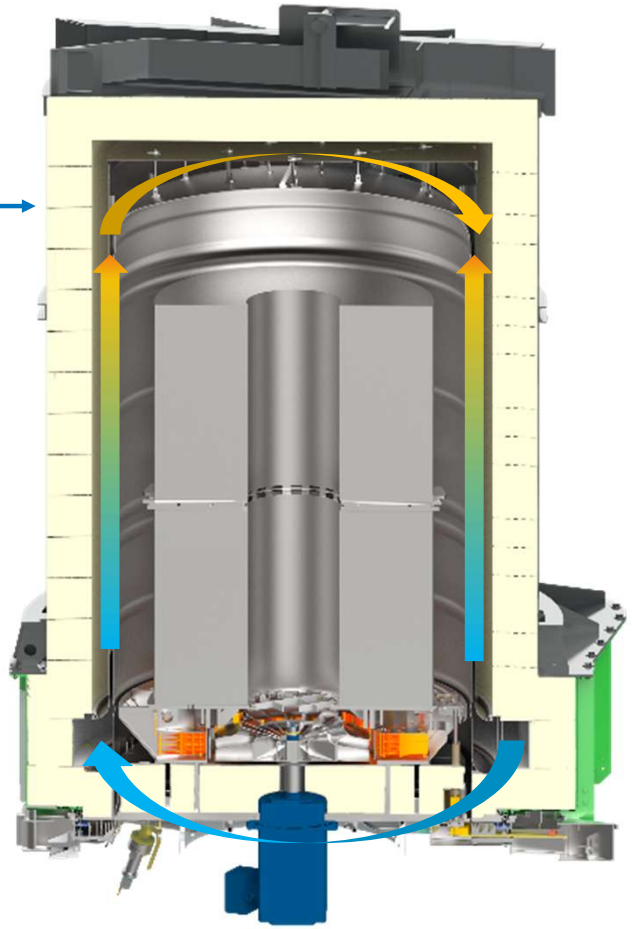


GREENBAFx Advanced Case: Direct Heating System with Process Bell and Air cooling



HICON® Process Bell

HICON® Process Bell with integrated inner cover and inner casing → defined air flow through circular slot



Hot air recirculation fan

Control valves

Heat exchange circuit (air)

Option for extended heat recovery in bypass (water, oil)

- Vertical bright annealing for copper alloys
  - Emission-free annealing in particular for high-performance alloys
  - Innovative strip tension control concept
  - High-performance Cooling for high-performance copper alloys
- SIMCAL
  - Delevop annealing cycles to meet specific material specifications
  - Optimize annealing process and material properties
  - Evaluate existing processes
  - Improve productivity and profitability
- GREENBAFx
  - Emission-free process without CO_2 & NO_x emissions from facility
  - „Passive“ process bell replaces heating-/cooling bell & inner cover
  - Less space requirements, retrofitting capability
  - Hybrid-heating (gas/electric) possibility with add. heating bell
  - Cooling via Cooling Bell or Internal Cooler

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