

**EBNER**

**HEAT TREATMENT FOR  
THE STEEL INDUSTRY**

**HICON/H<sub>2</sub>**

**RECOTEB**

**BURNER SYSTEMS**

---

**VACUUM LOCK**

---

**1960**

First time a vacuum lock is used in a roller-hearth furnace facility to save process atmosphere.

---

**PROCESS ATMOSPHERE GENERATORS AND BURNER SYSTEMS**

---

**1965**

These systems are developed in our own laboratory to round off our product range.

---

**QUENCHING IN MOLTEN METAL**

---

**1970**

First time molten metal instead of oil is used as quenchant to bright-martemper steel strip.

---

**BRIGHT ANNEALING TECHNOLOGY**

---

**1972**

This process for semi-finished products was developed and patented for the bell annealer and becomes famous worldwide under the name HICON/H<sub>2</sub>®.

---

**HICON/H<sub>2</sub>® FOR STRIP AND WIRE**

---

**1983**

Innovative HICON/H<sub>2</sub>® technology is marketed and implemented worldwide for heat treatment in the steel industry.

---

**INTEGRATED COOLER**

---

**2004**

Integrated cooler is successfully fitted to HICON/H<sub>2</sub>® workbase and patented.

---

**HYDROGEN QUENCH COOLER H<sub>2</sub>Q**

---

**2005**

First time a cooler of this design is applied to harden and temper of martensitic steel strip.

---

**PATENTED HICON® JET COOLER**

---

**2006**

This cooler is developed and patented for use with wide strip in bright annealing lines and galvanizing lines.

---

**PATENTED RESOURCE SAVINGS**

---

**2011**

World first application of a heat exchanging bell plus hydrogen recycling system for bell annealer facility.



**HICON / H<sub>2</sub>® bell annealer facility**  
with patented heat and hydrogen  
recycling system to anneal steel strip  
coils on 6 workbases. (2011)



BRIGHT ANNEALING LINES  
STAINLESS STEEL

1

CONTINUOUS  
ANNEALING LINES

2

BELL ANNEALER  
FACILITIES

3

HARDENING AND  
TEMPERING LINES

4

06 | 13

14 | 23

24 | 35

36 | 43

ROLLER-HEARTH  
FURNACES

5

44 | 51

PRESS HARDENING  
FURNACES

6

52 | 55

MODERNIZATION

7

56 | 59

BURNER SYSTEMS

8

60 | 67

## HIGHEST QUALITY, GREATEST EFFICIENCY AND BEST PERFORMANCE FOR STAINLESS STEEL STRIP.

These factors define our bright annealing lines and are the basis for global success. Today, more than 50 bright annealing lines produce material to the strictest quality standards in 15 countries.

1



### ThyssenKrupp Mexinox / Mexico

throughput: max. 12 t/h Cr/CrNi strip  
strip thickness: 0.25 – 1.3 mm  
strip width: 1350 mm

**S.C. Otelinox / Romania**

throughput: 7.7 t/h Cr/CrNi strip  
strip width: max. 1300 mm  
strip thickness: 0.1 – 1.5 mm



## BRIGHT ANNEALING LINES FOR STAINLESS STEEL STRIP

These furnaces are designed in vertical or horizontal form with the proven muffle concept to make use of the advantages of 100% hydrogen with the lowest possible dewpoint when bright annealing these oxygen-sensitive alloys to achieve the optimum surface finish. The economical combustion system is fitted with open burners.

Vertical single-muffle furnaces are built up to a muffle length of 30 m and achieve a throughput of approx. 19 t/h with a strip width of 1600 mm.

Ebner also supplies a patented design of double-muffle furnace, which, with a heated length of 40 m, can bright-anneal 1600-mm-wide strip at up to 25t/h.

For lower capacities and narrower strip, the horizontal configuration is ideal: 1.8 t/h with a strip width of 520 mm.

### Design features of EBNER muffle concept:

- 1 100% hydrogen and -60°C dewpoint for best oxide-free bright surface thanks to tight construction
- 2 Lowest tension in strip thanks to integrated dancer roll in hydrogen with preceding sealing rolls
- 3 No nitriding of steels with Cr content because 100% hydrogen can be used
- 4 HICON/H<sub>2</sub><sup>®</sup> jet cooler with adjustable flow over whole strip width
- 5 Strip temperatures up to max. 1180°C
- 6 Low hydrogen consumption thanks to hydrogen regeneration
- 7 Increasing throughput capacity with additional heat recycling (patented)
- 8 Lowest energy savings for fuel gas and electricity



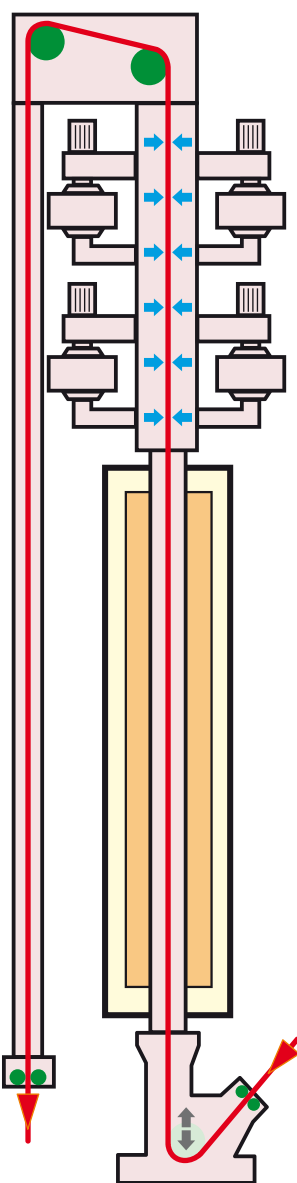


08 | 09

Double-muffle furnaces (patented) are available for higher production capacities with both vertical and horizontal configurations. All processing lines are supplied complete with strip handling gear and electrical equipment.

## HICON/H<sub>2</sub><sup>®</sup> VERTICAL BRIGHT ANNEALING LINES

The strip passes through sealing rolls into an integrated dancer box and then up through the furnace, the HICON/H<sub>2</sub><sup>®</sup> cooler, top deflector box and return duct to the outlet sealing rolls.



strip dimensions	
strip width [mm]	300 to 1600
strip thickness [mm]	0.025 to 5.0

This diagram shows the strip path inside a HICON/H<sub>2</sub><sup>®</sup> vertical processing line. Strip tension is just 1 to 3 N/mm<sup>2</sup>

muffle heating	gas-fired or electric heated
temperature range [°C]	up to 1180 at strip
process atmosphere	100% hydrogen, cracked ammonia, argon

Process atmosphere consumption is kept to a minimum thanks to the sealing rolls applied to the strip at the inlet and outlet. A liquid seal for the muffle guarantees clean process atmosphere and lowest dewpoint.

### EXAMPLES FOR AISI 304

max. throughput	heated furnace length	
strip width [mm]	single muffle furnace	double muffle furnace
650	up to 6.2 t/h	
1300	up to 15.5 t/h	up to 20.5 t/h
1600	up to 19.0 t/h	up to 25.5 t/h

An additional increase in performance is made possible by the patented energy recycling system.

**ARINOX S.p.A. / Italy**

throughput: max. 5.6 t/h  
strip thickness: 0.08 – 1.2 mm  
strip width: 1260 mm



## HICON/H<sub>2</sub>® HORIZONTAL BRIGHT ANNEALING LINES AND TENSION ANNEALING LINES

The strip passes through the furnace in a controlled catenary. Strip tension is regulated by the dancer at the inlet (2-4 N/mm<sup>2</sup> strip tension).

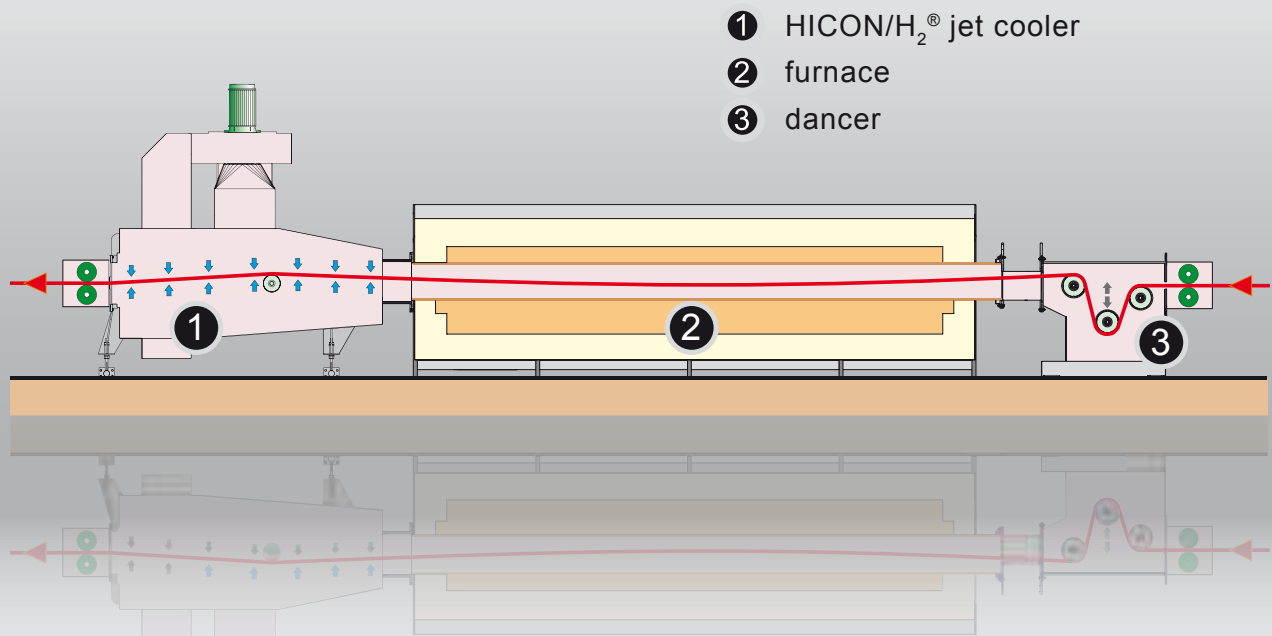
For tension annealing, the dancer is moved out of the line so that tensions of 150 N/mm<sup>2</sup> (for example) can be applied by multiple-roll bridles upstream and downstream of the furnace.

Layout with heated muffle length of 6 m or 12 m and HICON/H<sub>2</sub>® jet cooler.

muffle heating	gas-fired or electric heated
temperature range [°C]	up to 1150 at strip
process atmosphere	100% hydrogen, cracked ammonia, argon

strip dimensions	
strip width [mm]	up to 520
strip thickness [mm]	0.02

### Contact-free through the furnace



**MK Metallfolien GmbH, Hagen / Germany**

throughput: max. 0.6 t/h  
strip thickness: 0.03 – 0.5 mm  
strip width: 450 mm



12 | 13



**KORINOX Co., Ltd., Busan / Korea**

throughput: max. 0.9 t/h  
strip thickness: 0.03 – 0.6 mm  
strip width: 520 mm

## FLEXIBILITY AND INNOVATIVE SOLUTIONS FOR GALVANIZING, GALVANNEALING AND TINPLATING USING CONTINUOUS STRIP ANNEALING LINES.

EBNER's specialists work tirelessly when it comes to creating innovative solutions to complex customer requests, often resulting in completely new technologies.

2



**ArcelorMittal Eisenhüttenstadt / Germany**

throughput: 500,000 t/y  
line speed: 50 – 165 m/min




## CONTINUOUS ANNEALING LINES FOR UNCOATED AND COATED STEEL STRIPS

These furnaces are implemented in continuous galvanizing lines (CGL) and continuous annealing lines (CAL). Well-established technology has been refined by EBNER for the annealing furnaces as well as for the coolers – e.g. HICON® jet cooler (patented).

The objective of each furnace supplied by EBNER is to deliver the best surface finish and uniform mechanical properties for the annealed material and maximize the service life of the radiant tubes.

All furnace types feature components manufactured or approved by EBNER. These components include burners, radiant tubes, control valves for the combustion system, heat-resistant material for muffles, hot bridles, insulating materials etc.

### Vertical processing lines:

- 
- 1 Furnaces for continuous galvanizing lines (CGL) for car body sheet up to 2100 mm wide
  - 2 Continuous annealing lines (CAL) for car body sheet up to 2100 mm wide
  - 3 MINI CAL for deep drawing grades, poly-phase grades and metallically coated strips up to 700 mm wide

### Horizontal processing lines:

- 1 Decarburization lines for grain-orientated electrical strip (silicon steel) up to 1050 mm wide with a thickness of e.g. 0.65 mm
- 2 Annealing lines for non-grain-orientated electrical strip up to 1200°C
- 3 Furnaces for continuous galvanizing lines (CGL)

Strip handling gear and electrical systems are supplied with all facilities.

**HICON® JET COOLER**

for a galvanizing line (patented)  
with adjustable cooling over strip width.

## Vertical radiant tube-heated furnaces for galvannealing and continuous annealing lines

### Features:

- highly-efficient RECOTEB® heating systems featuring recuperative burners in combination with double P and U radiant tubes
- HICON® jet cooler for steep gradients e.g. 150K/s,mm
- the EBNER APC ensures virtually oscillation-free transport of the strip through the cooler after the zinc pot
- strip widths of up to 2100 mm

An EBNER radiant tube-heated furnace is equipped with an inlet seal at the furnace inlet to reduce process atmosphere consumption and a proven combination of burners and radiant tubes; the RECOTEB concept that delivers high performance and long service life.

The HICON® jet cooler for steep cooling gradients can be adjusted to individual material qualities and strip dimensions and can be operated with a high hydrogen content thanks to a special seal system ahead of and beyond the coolers.

## Vertical direct gas-fired furnaces with muffles for galvanizing lines

### Features:

- heating up section as muffle furnace or combination of direct-fired furnace (DGF) and muffle furnace
- range of process atmosphere compositions inside muffles
- rapid exchange of process atmosphere inside the muffle
- straightforward replacement of burners without interrupting operation
- HICON® jet cooler for steep gradients e.g. 150K/s,mm
- the EBNER APC ensures oscillation-free transport of the strip through the cooler after the zinc pot
- strip widths of up to 2100 mm

EBNER muffle furnaces are equipped with an inlet seal to reduce process atmosphere loss at the furnace inlet.

The muffle furnace can be operated with different levels of hydrogen content and dewpoint.

High combustion efficiency is achieved by using the hot exhaust gas in the first muffle (patented) and using several recuperators.



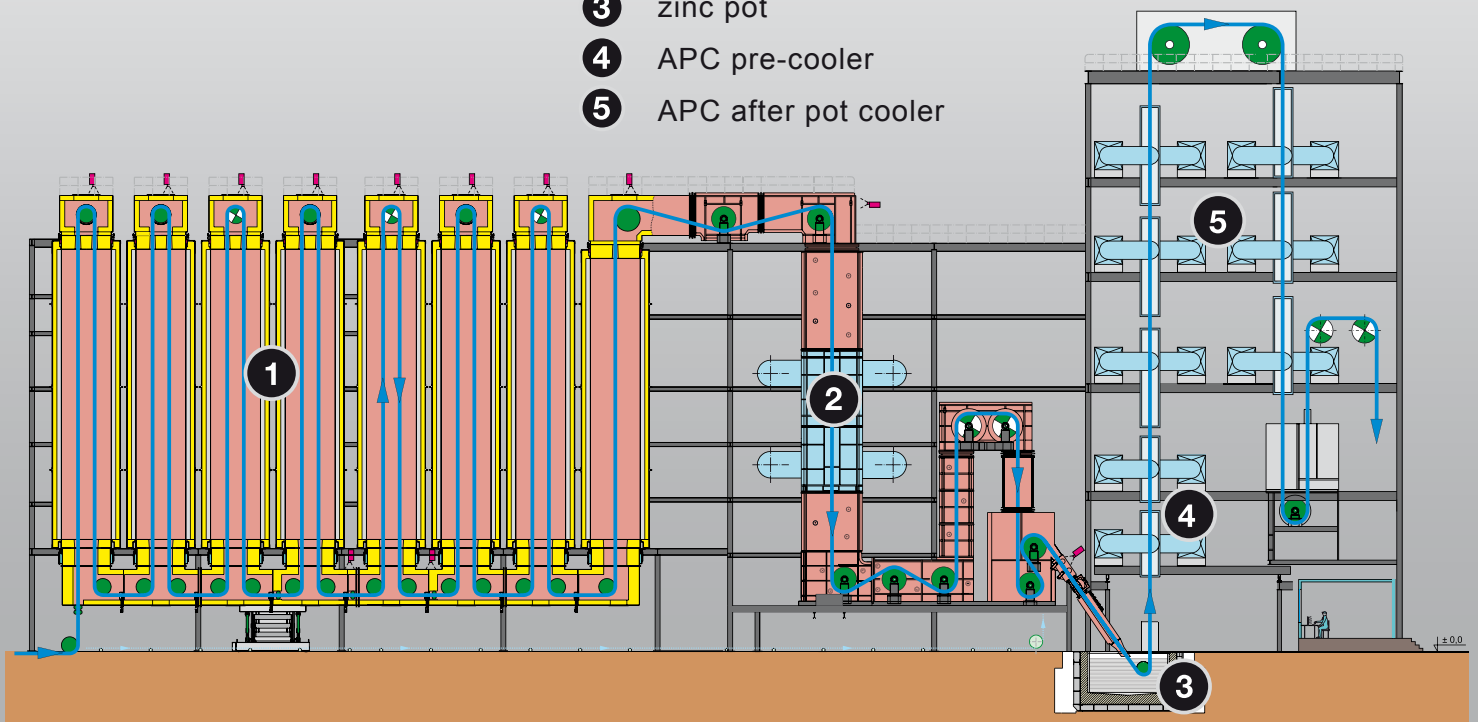


ArcelorMittal Eisenhüttenstadt / Germany

throughput: 500,000 t/y  
strip thickness: 0.6 – 2.2 mm

18 | 19

- 1 muffle furnace
- 2 HICON® jet cooler
- 3 zinc pot
- 4 APC pre-cooler
- 5 APC after pot cooler



HIGHEST QUALITY HIGHEST DEGREE OF  
AUTOMATION HIGHEST THROUGHPUT  
HIGHEST COMBUSTION EFFICIENCY  
EFFICIENT INSULATION INNOVATION  
ANNEAL LOGISTICS DELIVERY EXPERTISE  
COST EFFECTIVENESS CUSTOMER  
SPECIFIC LOW NOISE DURABILITY SAFE  
MARKET-SPECIFIC FEWER OPERATING  
PERSONNEL AUTOMATION LOW PRICES

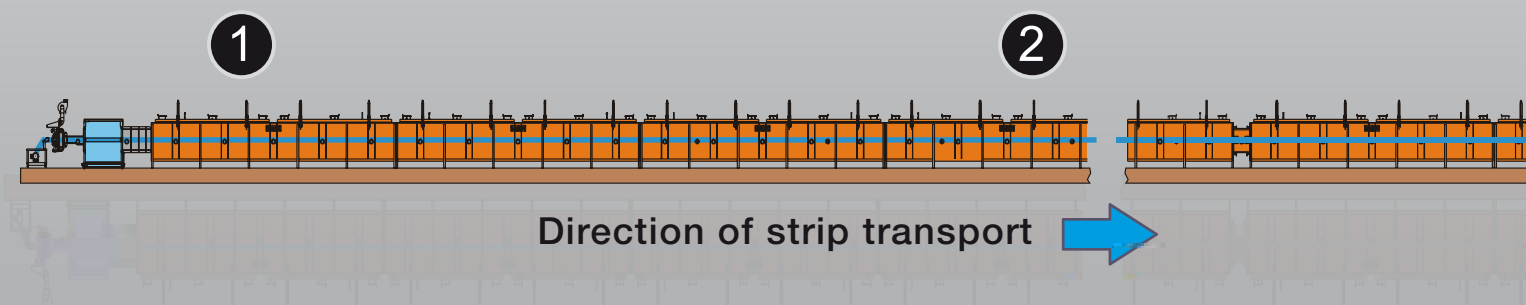
## Decarburization lines for producing grain-oriented electrical strip

Horizontal lines to decarburize electrical strip to less than 0.0015% carbon. Excellent decarburization results achieved in reproducible quality thanks to the following special design features:

- optimized process atmosphere humidification and supply system
- best process technology for atmosphere recirculation and separation
- latest burner/radiant tube technology for rapid heating up gradients and high throughputs
- advanced sealing systems at inlet and outlet

2

actual values measured					
strip thickness	strip width	dewpoint	hydrogen	C content before	C content after
0.65 mm	1005 mm	+40°C	22 %	0.030 %	21 ppm
0.60 mm	1005 mm	+40°C	22 %	0.032 %	24 ppm



**ArcelorMittal Frydek Mistek / Czech Republic**

decarb annealing to 0.003%

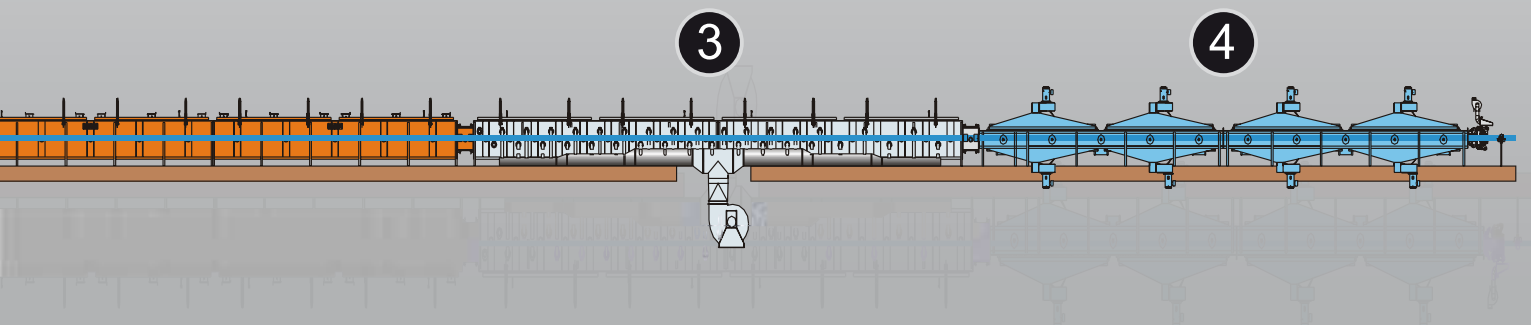
throughput: 6.9 t/h

strip thickness: 0.65 mm



20 | 21

- ❶ heating up zone
- ❷ decarburization furnace
- ❸ slow cooling zone
- ❹ jet cooling zone



## MINI CAL (horizontal) to anneal deep-drawing grades, polyphase steels and special grades

### 1 annealing line – 3 technologies

#### MINI CAL:

- horizontal configuration
- strip width of up to 800 mm
- throughput up to 1.3 t/h
- cooling gradient up to 100K/sec with 5% H<sub>2</sub> in N<sub>2</sub>
- temperature range up to 750°C

Thanks to hydrogen cooling technology, cooling gradients of 100 to 150 K/s are achieved while heat treating polyphase steels and IF grades. Strip can be annealed for various applications, such as white goods, consumer electronics and the automotive industry.

#### RECRYSTALLIZING

Low carbon steels cold-rolled from 1 to 0.1 mm are recrystallized at 700°C, cooled in a high-performance cooler to overaging temperature and then overaged. Carbon diffusion is prevented as a result.

#### DUAL-PHASE CYCLES

A similar process is used to produce dual-phase steels. Carbon goes into solution in the intercritical alpha/gamma region at around 850°C. In the downstream high-performance cooler, partial formation of martensite takes place – depending on the composition of the material - at cooling gradients in excess of 100 K/s. The martensite with enriched carbon content is embedded in the ductile, carbon-deficient ferritic base matrix, forming a dual-phase structure. The martensite component gives the material increased strength, while the base matrix provides ductility.

#### NORMALIZING

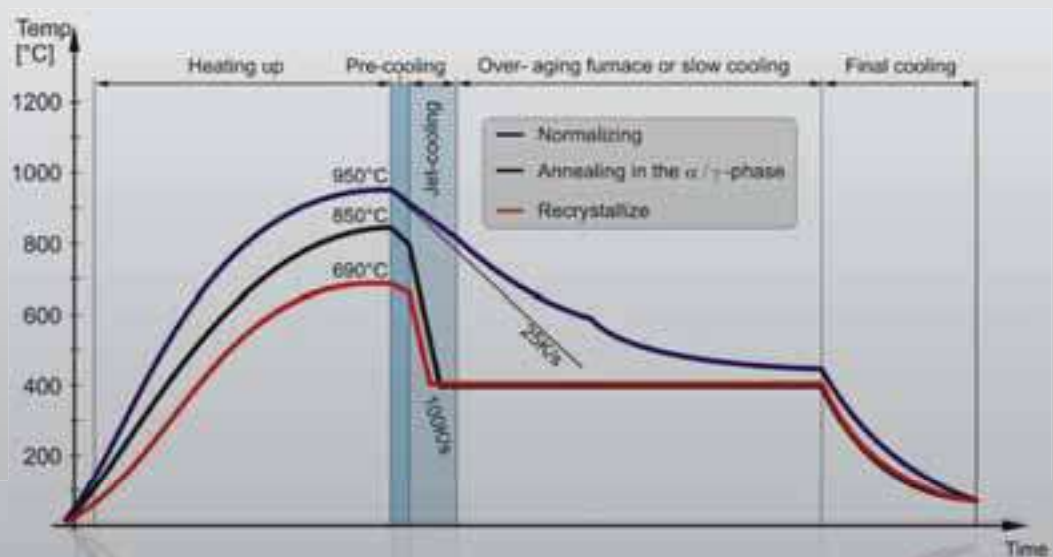
The third process technology offered by this heat treatment line is completely different to the two described above. Material that needs to be earing-free during subsequent deep drawing (e.g. battery sleeve strip) is normalized. The microstructure is homogenized in the austenitic region at 950°C. During subsequent controlled cooling the ramp needs to be lower than 25 K/s in order to achieve the required microstructure.



**CORUS Special Strip Hille & Müller / Germany**  
bright annealing metallic-coated and cold-rolled strips



22 | 23



## HICON/H<sub>2</sub><sup>®</sup> BELL ANNEALER FACILITIES THE TECHNOLOGY THAT REVOLUTIONIZED THE HEAT TREATMENT OF STRIP STRIP AND WIRE COILS.

Today, HICON/H<sub>2</sub><sup>®</sup> is internationally known as a synonym for excellence in quality, productivity and lowest production costs. It is the exceptional quality of steel coils annealed in 100% hydrogen which has provided the cornerstone for the lasting success of HICON/H<sub>2</sub><sup>®</sup>.

3



Dongbei Special Steel Group Co., Ltd.  
China


**ArcelorMittal Vega / Brazil**

net charge: 145 t  
coil diameter: max. 2100 mm  
stack height: max. 5900 mm



## BELL ANNEALERS FOR STRIP AND WIRE COILS

In the 70s EBNER developed HICON/H<sub>2</sub><sup>®</sup> and HICON<sup>®</sup> technology for the bell annealer. The smallest possible temperature scatter in the charge is achieved during the anneal to deliver uniform mechanical properties and the best possible quality material for further processing.

- 
- 1 The metallically-tight workload space enables safe use of process atmospheres like hydrogen. The low dewpoints achievable during the heating and cooling phase keep surfaces bright, even on high-alloyed cold-rolled strip.
  - 2 Other process atmospheres such as nitrogen, argon and mixed gases can be used, depending on the material being processed. Nitrogen is used for hot-rolled, unpickled cold heading grades to prevent decarburization.
  - 3 Shortest possible heating and cooling times are achieved at annealing temperatures up to 900°C by combining high convection (HICON) and hydrogen (H<sub>2</sub>).
  - 4 Energy can be saved thanks to the development of the new heat exchanging bell; hydrogen can be saved using the recycling system (both patented).
  - 5 For high-temperature facilities between 900°C and 1200°C the charge is heated by radiant systems.
  - 6 Patented load-bearing system inside workbase.
  - 7 Complete electrical equipment with VISUAL FURNACES<sup>®</sup> 6 process control system.



## HICON/H<sub>2</sub><sup>®</sup> bell annealers for strip coils

Hydrogen annealing technology uses pyrolysis to break down residual lubricant (hydrocarbon compounds) on the surface of the cold-rolled strip and purge it out of the furnace. The result is a surface with the lowest carbon residues. Tin plate and ultra-thin strip are degreased before annealing to remove residual lubricant.

### Suitable for:

- cold-rolled unalloyed grades such as DC01 (St12, CQ) to DC05 (St15, EDDQ), IF steels, etc.
- cold-rolled low-alloyed carbon steels like C60 to C100
- high-alloyed cold-rolled and hot-rolled ferritic and martensitic grades such as AISI 430, 410, 420, etc.
- low-alloyed silicon steel strip (max. 3% Si)
- tin plate T1-T4 (TS 230 – TS 415)

charge dimensions	
coil diameter [mm]	between 1400 and 2700
charging height [mm]	between 1600 and 7000 (incl. convector plates)
heating system	gas-fired / electric heated / oil-fired
maximum process temperature	900°C

### Advantages:

- strip edge protection with 100% load-bearing surface for coil at bottom of stack
- economic and environmentally friendly burnout burner that uses waste hydrogen atmosphere bearing with rolling lubricant vapor
- integrated cooler (patented) enables rapid cooling of charge to skin-pass temperature
- recycling thermal energy in stack gas and waste process atmosphere to maximize efficiency (see page 3)



**voestalpine / Austria**

HICON/H<sub>2</sub>® base with integrated cooler to  
recrystallize deep drawing grades (750°C max.)  
using integrated cooler technology  
stack height: 5200 mm



**JSW Steel Limited / India**

net charge: 112.5 t

coil diameter: max. 1900 mm

stack height: max. 6700 mm



## HICON/H<sub>2</sub>® bell annealers for wire coils, wire rod coils and wire spools

HICON/H<sub>2</sub>® technology is used for drawn wire to achieve the best possible surface. Scaled wire is annealed decarb-free using HICON® technology with nitrogen as process atmosphere.

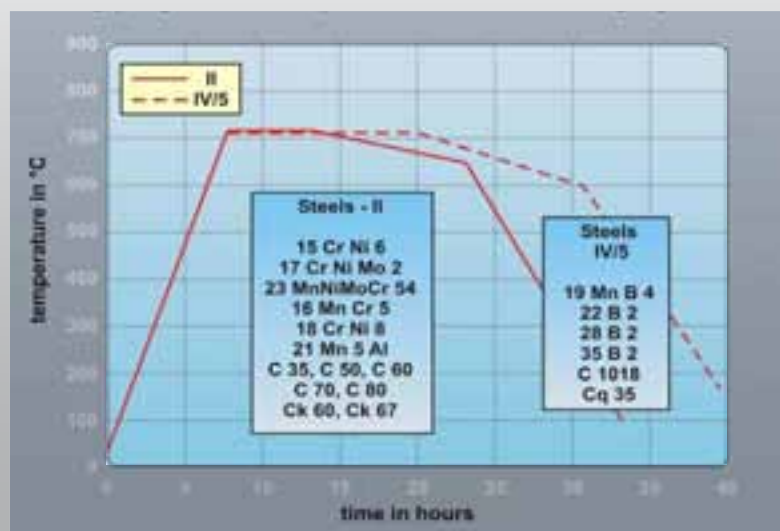
### Applications

#### Cold-drawn wire or hot-rolled wire rod:

- non-alloyed and low-alloyed grades cold-heading grades
- high-alloy tool steels, ball bearing steels and high-speed steels (HSS).
- high-alloy Cr steels and nickel or titanium alloys

3

Able to anneal different grades in a single charge



#### Design features:

- A heated vent line (patented) draws evaporated drawing lubricant out of the workload space to achieve the cleanest surfaces and reduce hydrogen consumption.
- Burnout burner powered by waste hydrogen for economy.
- Automatic process atmosphere purging system controlled by CO<sub>2</sub> analyzers to reduce atmosphere consumption (depending on material being annealed).

**OVAKO WIRE b.v. / Holland**

HICON® bell annealer facility with 6 bases  
to anneal steel wire for ball bearings



## HICON/H<sub>2</sub><sup>®</sup> bell annealers for OPEN COIL strip coils

Decarburized steel is used for enamel grades and shadow mask material. These can be processed effectively and uniformly using HICON/H<sub>2</sub><sup>®</sup> bell annealers.

The humidity needed for the decarburization phase at approx. 700 °C is created by admixing water to the process atmosphere at the workbase (approx. 10% H<sub>2</sub> / 90% N<sub>2</sub>). Decarburization reduces carbon from around 0.04% to between 0.002% and 0.001%.

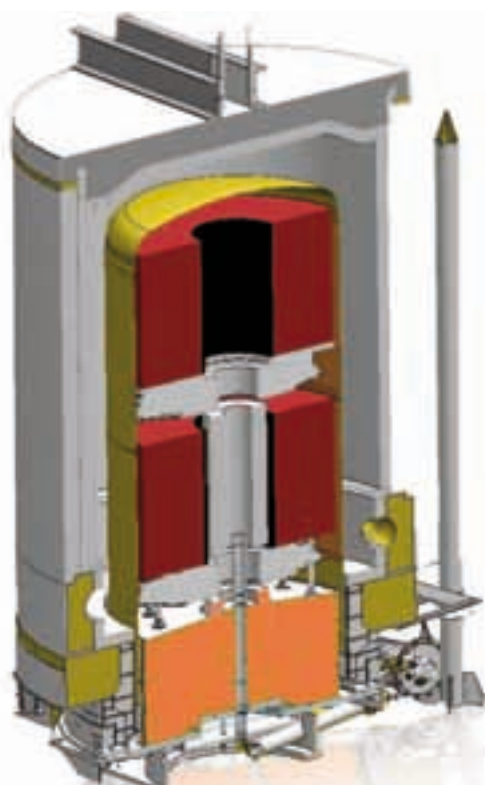
### Design features:

- Open-type load plate and plenum chamber for optimized process atmosphere flow through the charge.
- Typical dimensions: coil diameter 3000 mm, stack height 3000 mm.
- Process temperature range: up to approx. 750°C



## HITT<sup>®</sup> high temperature bell annealer facilities

HITT<sup>®</sup> bell annealers (High Temperature and Tight) are available with gas-fired or electric-heated systems for heat treating grain-oriented electrical strip and other materials and components. The safety concept for processing in hydrogen has been adopted from HICON/H<sub>2</sub><sup>®</sup> bell annealers. The charge is heated by thermal energy radiating from the heating bell and inner cover. Cooling bells are used to cool the charge down to below the ignition threshold of the hydrogen atmosphere - possible thanks to the metallically-tight workload space.



### Design features:

- Workload space dimensions:

workload space	
diameter [mm]	2200
charging height [mm]	3000
charge weight [t]	36

- Patented support construction for coils for improved temperature uniformity and shorter annealing times.
- Encapsulated workload space for low atmosphere consumption.
- Processing temperature range up to 1200°C

**ILVA / Italy**

coil diameter: 3000 mm

decarburization using open coil process



## HARDENING AND TEMPERING LINES FOR STRIP

EBNER's innovative and future-safe developments in continuous hardening and tempering technology are recognized worldwide and set new standards in maximizing product quality and cost effectiveness while minimizing environmental impact.

4



**HUNG SHUH / Taiwan**

Hardening and tempering lines with decarb system for bainite strip

**INAC S.p.a., Lecco / Italy**

throughput: 1550 kg/h  
strip width: max. 650 mm  
strip thickness: 0.2 – 3.2 mm

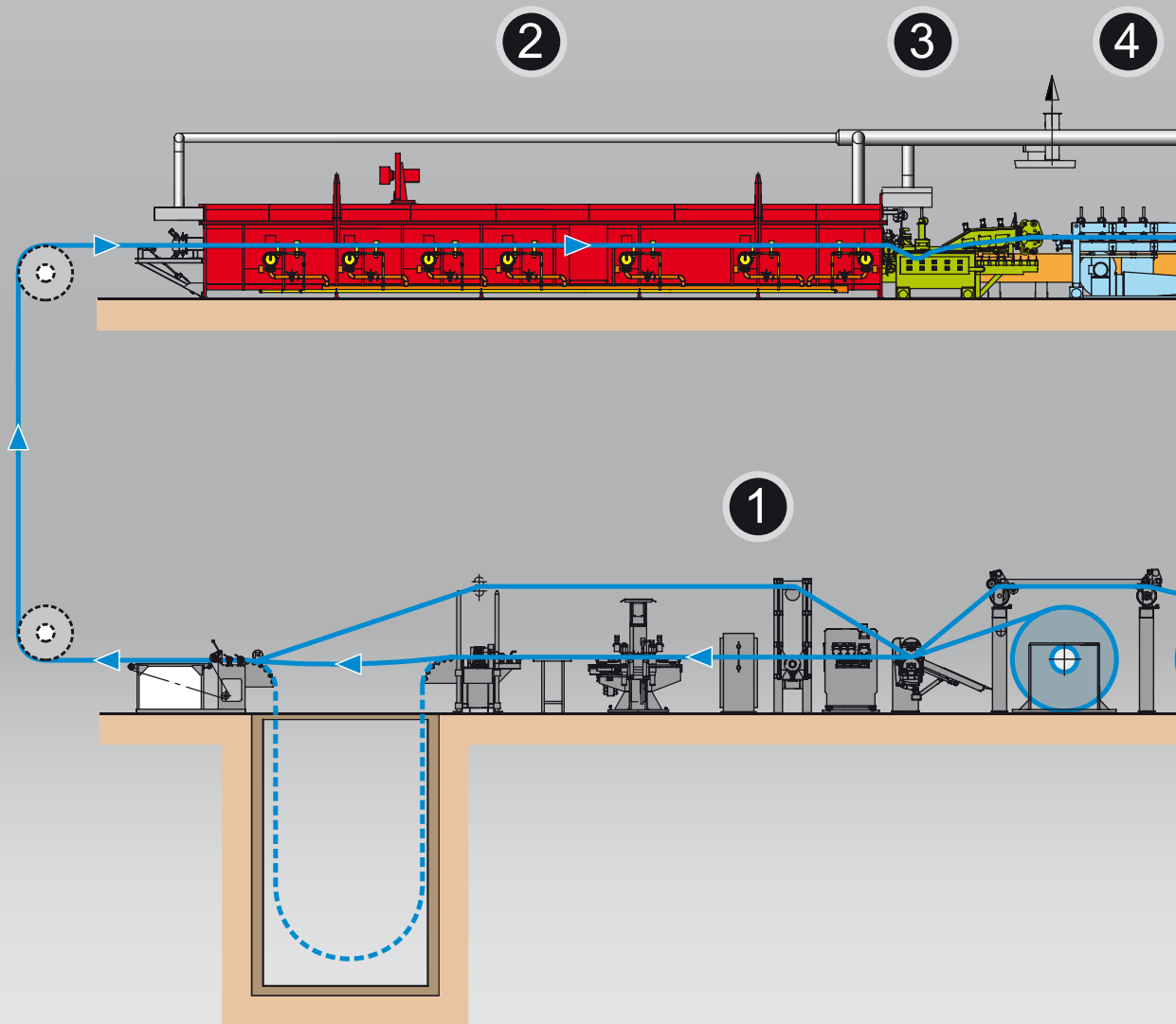
## HARDENING AND TEMPERING LINES FOR UNALLOYED AND ALLOYED CARBON STEEL STRIP

Continuous inline hardening and tempering of low-alloy carbon steel strip using molten metal quench technology with cooling gradients of up to 600 K/s is a process that has won worldwide acceptance.

EBNER 3-technology H/T lines enable non-alloyed and low-alloy carbon steel strips to be transformed into one of the following final microstructures following austenitization:

- 1 Martensite with leveling and tempering (martempering)**  
for band saws, high performance circular saws, tools, springs, etc.
- 2 Bainite with mid-stage leveling (austempering)**  
for punching and bending lines plus formable components
- 3 Pearlite/sorbite (patenting)**  
for seat belt springs, cable drum springs etc.

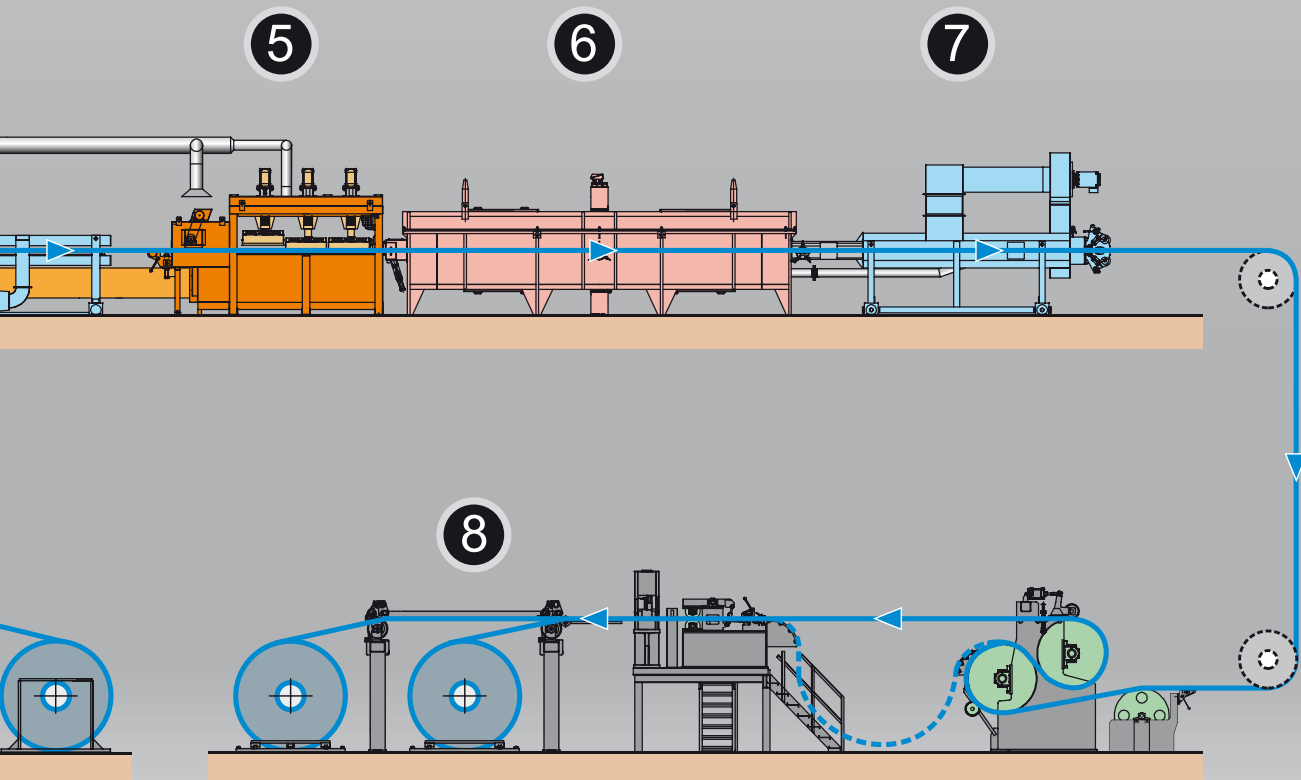
4



Quenching in molten metal followed by transformation to martensite in an air cooler has considerable advantages over quenching in oil, particularly with regard to strip flatness and surface finish.

Isothermal transformation (austempering and patenting) - and thus the combination of all 3 processes in a single line - is possible only with a molten-metal quench.

- 1 pay-off section
- 2 austenitizing furnace
- 3 molten metal quench
- 4 air cooler with leveling system
- 5 bright leveling furnace
- 6 convection tempering furnace
- 7 process atmosphere jet cooler
- 8 recoiling section



INCREASE EFFICIENCY SAFE OPERATION  
AUTOMATION DURABILITY INNOVATIVE  
ECONOMICAL ENERGY-SAVING ENERGY  
EFFICIENCY DEVELOPMENT ADDED VALUE  
LOWEST EMISSIONS EXCELLENT SERVICE  
MATERIALS AND HEAT TREATMENT HEAT  
TREATMENT FACILITIES HIGHEST QUALITY  
HIGHEST DEGREE OF AUTOMATION  
HIGHEST THROUGHPUT EFFICIENT

## Hardening and tempering lines for carbon steel strip (martempering, austempering and patenting)

H&T lines	C steel strip
martempering	C75, C80, C75Cr1, C95, SAE1078
austempering	C60, C70, SAE1070
patenting	C80, SK5

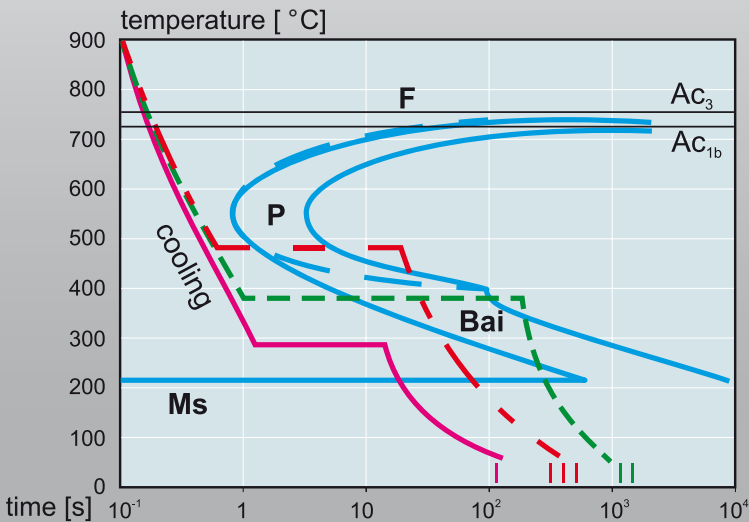
charge dimensions	
strip width [mm]	up to 700
strip thickness [mm]	between 0.1 and 4.0
throughput [kg/h]	up to 2000

4

## Combination lines for martempering, austempering and patenting

The additional cost is relatively low, while this combination of technologies ensures cost-effective utilization of large processing lines.

Thanks to inline surface decarburization, processed strip remains free of cracks when bent over a 0.5 mm radius edge. These facilities are supplied including strip handling gear to meet each customer's requirements.



Isothermal diagram showing the transformation of Ck75 steel using the 3 processes.



**Risse + Wilke Kaltband / Germany**

throughput: 1550 kg/h  
 strip width: 650 mm  
 strip thickness: 0.2 - 4.0 mm  
 processes: martempering and austempering

40 | 41



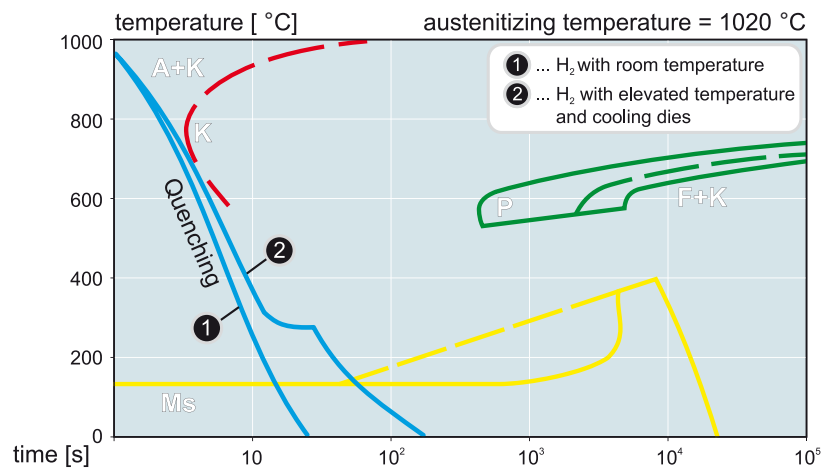
**NASTECH CO. LTD. / Korea**

throughput: 1000 kg/h  
 strip width: 550 mm  
 strip thickness: 0.3 - 3.2 mm  
 processes: martempering and patenting

## Martempering Cr grades

Various stainless steel components, knives, tools and parts for the cutlery industry are made from steels with 13% chromium and between 0.2 and 0.4 % carbon. Since these products are usually polished to provide the best resistance to oxidation, the aim of the heat treatment process is not just to achieve a good microstructure and flatness, but also a clean, flaw-free surface, so that the amount of polishing required is kept to a minimum.

The isothermal transformation diagram for X40Cr13 steel shows that a cooling gradient of 50 K/s is sufficient to avoid preliminary precipitation. This cooling gradient can be achieved using the atmosphere jet cooler. Using hydrogen for quenching prevents such steels from oxidizing in spite of chromium's high affinity for oxygen.



## Martempering Cr and C steels with H<sub>2</sub>Q

The extremely powerful H<sub>2</sub>Q hydrogen quench has been designed specifically for these combined applications. This means that wide carbon steel strip such as grade C67 can be martempered on this combination line. H<sub>2</sub>Q, or hydrogen quench, delivers flexibility, economy, best microstructure and strip geometry, without using a molten metal quench or bright leveling system.

## Strapping band

A heat treatment system featuring conductive heating has been developed for this special steel strip hardening application.

The process uses a 50 or 60 Hz transformer to heat the strip to austenitizing temperature, and recycles the heat dissipated during quenching to transformation temperature to be used for preheating the incoming strip.

Material: e.g. 34Mn5 (1.1166), 30Mn5

High-tensile strapping band with a strength of 1000 to 1200 N/mm<sup>2</sup> and 10% elongation.

Our recommendation: heat treat wide strip which is then slitted.



**Paturle Aciers / France**

hardening and tempering Cr and C steel strips  
with 2-stage H<sub>2</sub>Q jet quench system

42 | 43



**GARIBALDI S.A. / Chile**

throughput: 3 t/h  
strip width: up to 32 mm  
strip thickness: up to 1.5 mm

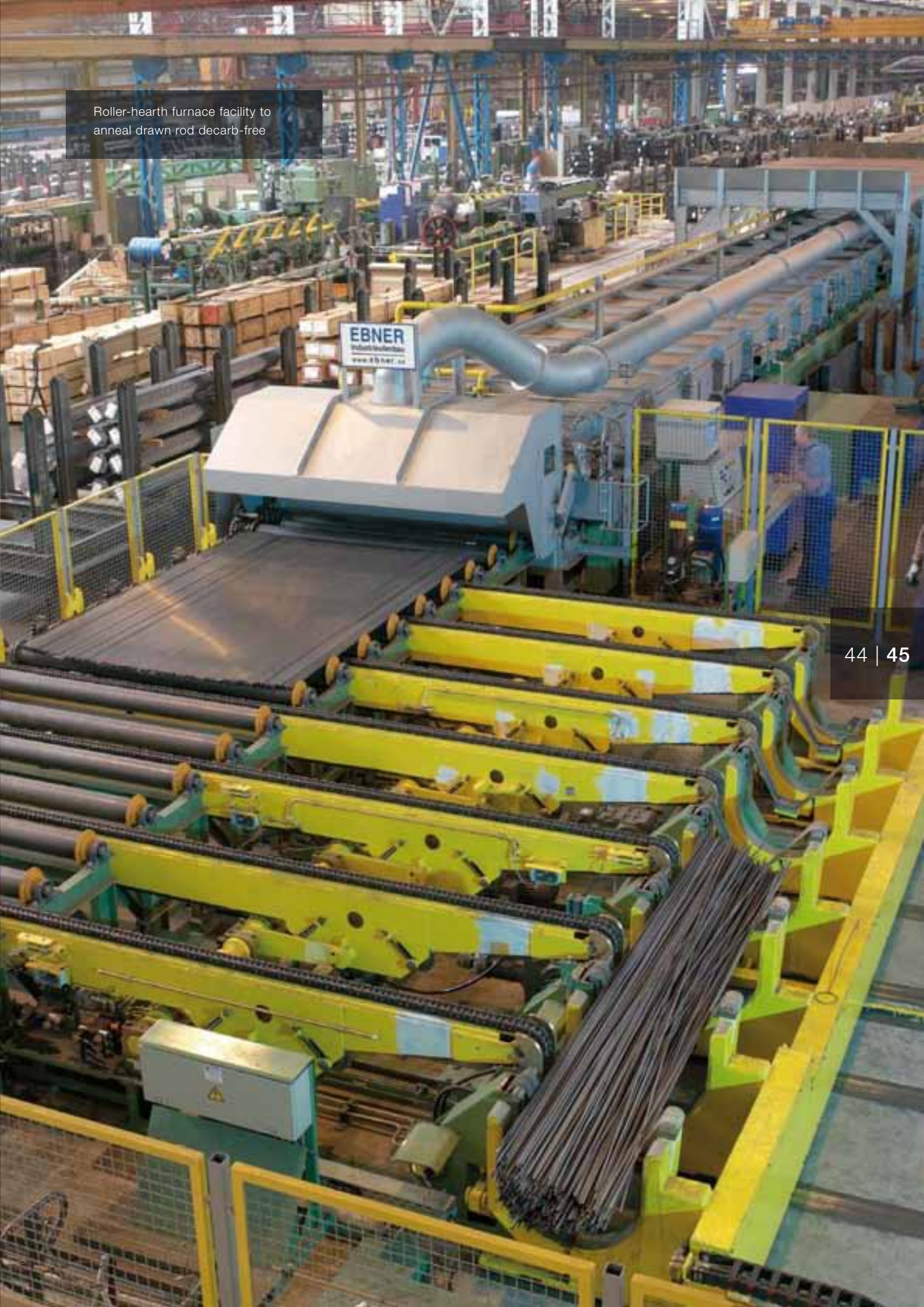
**IN 1960 EBNER BUILT THE FIRST ROLLER-HEARTH FURNACE FACILITY IN THE WORLD EQUIPPED WITH A VACUUM LOCK.**

This type of furnace was specially developed for soft annealing to achieve globular cementite in medium and high-alloyed tool steels, high speed steels, cold heading and bearing steels.

5



Roller-hearth furnace facility to  
anneal drawn rod decarb-free



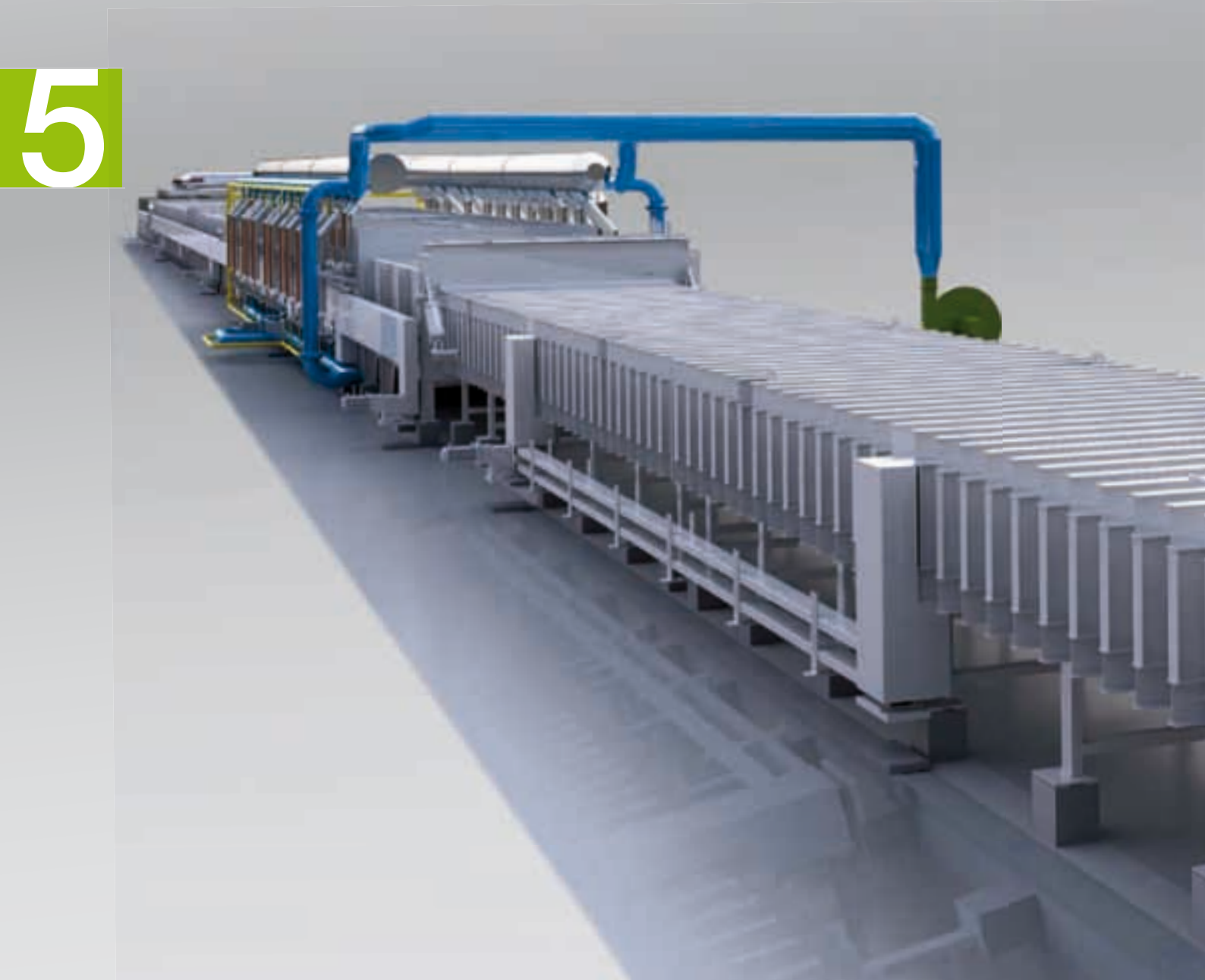
## Roller-hearth furnaces to normalize, spheroidize and recrystallize non-alloyed and alloyed steel tubes and rods

As well as taking care of the as-annealed quality factors (purging air out of the inside of tubes, for example), this design of furnace also minimizes process atmosphere consumption inline with the economic demands placed on a state-of-the-art furnace facility. A vacuum lock is located at the furnace inlet for this purpose.

Process temperature ranges are between 400 °C and 1050 °C. Net throughputs of between 2,000 kg/h and 10,000 kg/h can be achieved depending on the size of the facility and the heat treatment program selected.

These furnaces are built with a standardized hearth width (charge width) of 1750 mm or 2250 mm. Other widths are available on request.

Cooling gradients of up to 300 K/min can be achieved with the HICON® jet cooling system.



## Advantages of the EBNER concept

- 1 optimum spheroidization of the microstructure up to 100% and/or formation of a perlite/ferrite microstructure with jet cooler and isothermal transformation
- 2 vacuum lock at inlet
- 3 gas-tight furnace and cooler
- 4 no decarburization of charge
- 5 perfect bright annealing of cold-forming products
- 6 lowest consumption of fuel gas and process atmosphere
- 7 automatic process control and charge tracking



ECONOMICALTEMPERATUREACCURACY  
TEMPERATUREUNIFORMITYTRADITION  
TURNKEYENVIRONMENTALCOMPATIBILITY  
DURABILITYCOMPLIANCEWITHREGULATIONS  
RELIABILITYQUALITYSTANDARDTRADITION  
RELIABLEADDEDVALUECOREVALUESDESIGN  
PRIORITYCOOPERATIONCONSTRUCTION

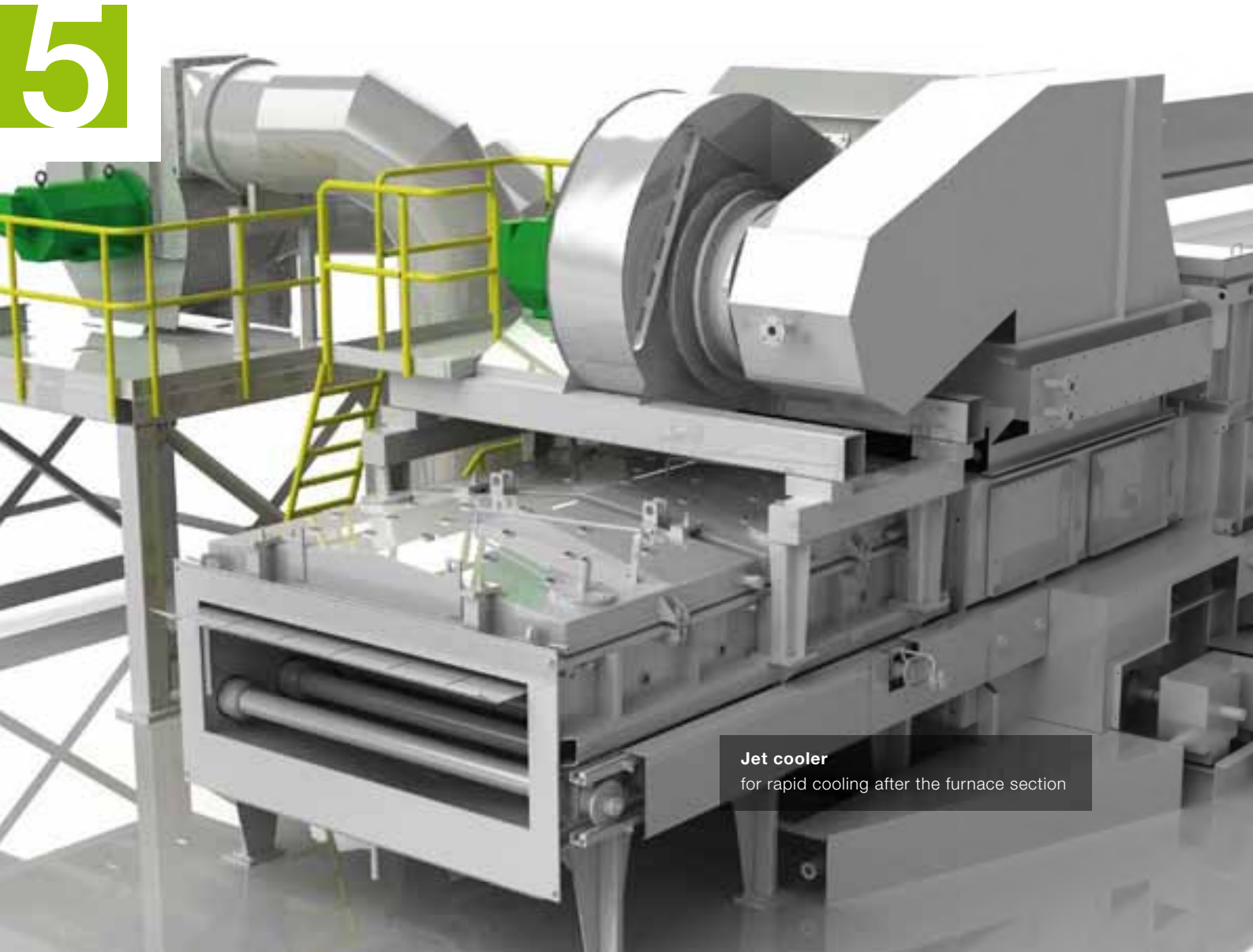
## Hot-rolled long products

In addition to complying with the primary objective of optimizing the material's mechanical properties, the EBNER design of roller-hearth furnace also avoids surface decarburization.

To minimize surface decarburization during heat treatment the anneal is carried out in technical grade nitrogen. The furnace itself is completely gas-tight.

The roller-hearth furnace features several heating groups that can be controlled individually plus additional cooling zones integrated into the heating section in order to rapidly adapt the heat treatment temperature to each type of steel being processed. The cooling section can be short since black material can tolerate discharging temperatures of between 250 and 300°C.

Extremely low atmosphere consumption is achieved due to the gas-tight implementation of the inlet vacuum lock and the outlet door at the end of the cooler, plus the optimum design of the process atmosphere system.



### Jet cooler

for rapid cooling after the furnace section

### **Metal Ravne / Slovenia**

Decarb-free annealing of rod and flat bar,  
max. 3500 kg/h



## Cold-formed long products

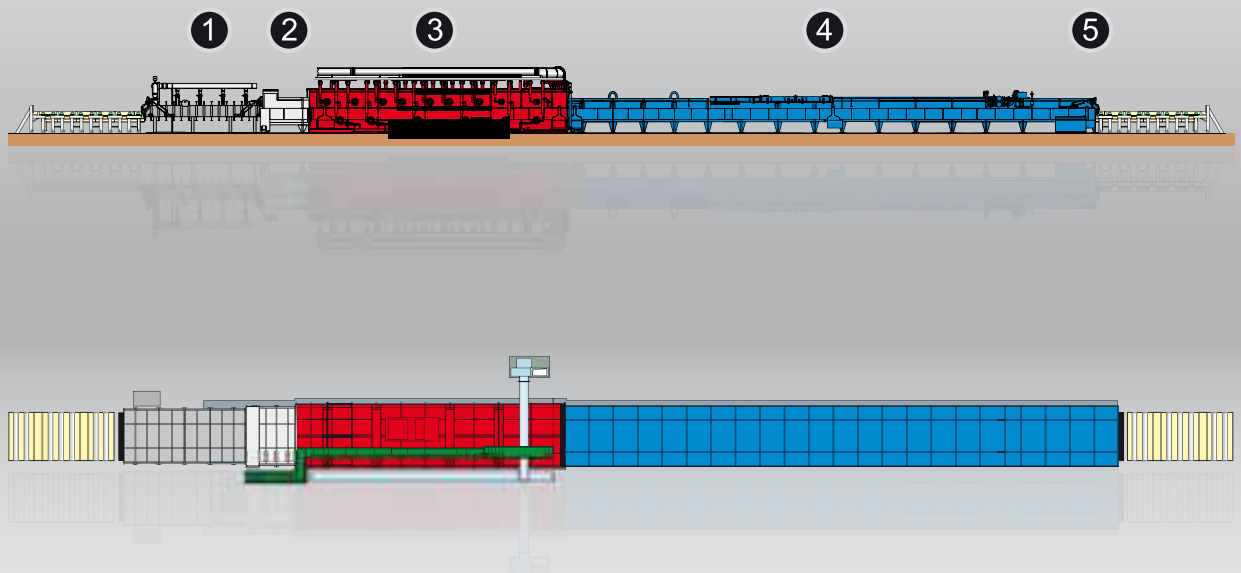
In this EBNER roller-hearth furnace all annealing programs - including normalizing, recrystallizing, stress-relieving and soft annealing - are carried out in process atmosphere completely bright and free of decarburization.

The pre-condition for successful bright annealing is the use of lubricant that evaporates without leaving residues.

The main difference between this roller-hearth furnace and the one described above is that the heated section is shorter due to the more straightforward annealing programs used and the cooling section is much longer due to the lower discharging temperature required (approx. 150°C).



- ① vacuum lock
- ② vestibule
- ③ annealing furnace
- ④ cooler
- ⑤ door with nitrogen knife



**Zeleziarne Podbrezova / Slovakia**

Roller-hearth furnace facility with HICON® jet cooler  
for seamless tube  
throughput: max. 5.3 t/h



50 | 51



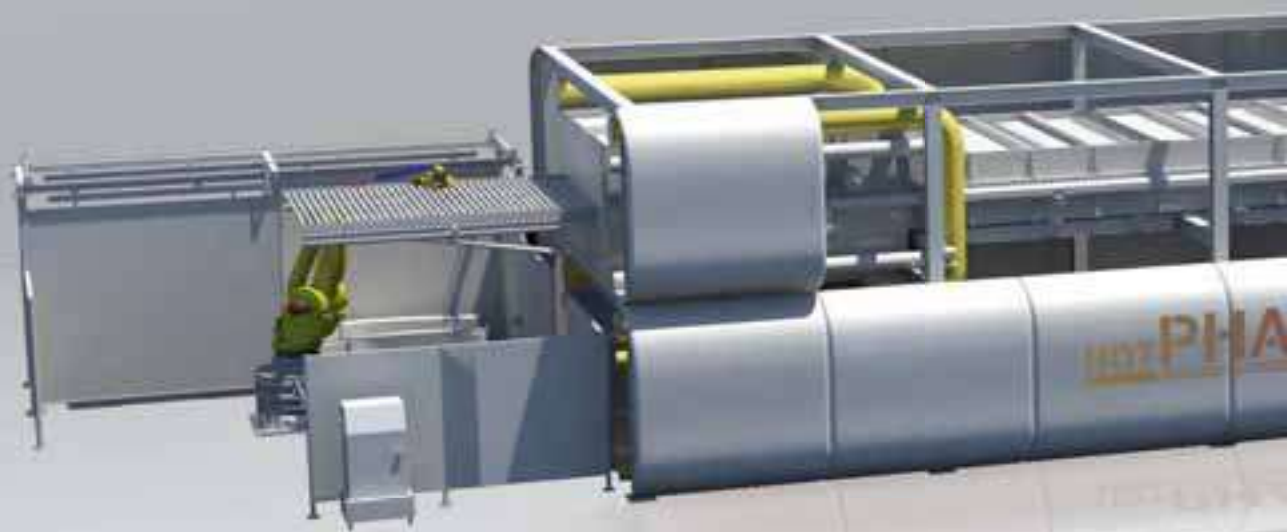
**OAO SinTZ / Russia**

Roller-hearth furnace to bright anneal and  
normalize steel tube  
throughput: max. 8 t/h

## HOTPHASE® – EBNER FURNACE FACILITY FOR PRESS HARDENING

Energy costs and safety requirements are increasing worldwide. At the same time the automotive industry is subject to lower emission regulations and falling production costs. The implementation of press-hardened parts in the body panels of modern cars fulfills these requirements. The latest strategy is to develop car panel parts that possess function-controlled properties for complex shapes.

6



EBNER has taken up this challenge and manufactures both heat treatment furnaces for press hardening on a production scale as well as smaller furnaces for press-hardening trials. The objective is to support the automotive industry with the very latest furnace technology.



## THE EBNER HOTPHASE® ROLLER-HEARTH FURNACE FOR HOT-FORMING PROCESSES

Press-hardening is the technology of the future in the manufacture of lightweight cars. This process enables the safety of the vehicles to be improved and the number of components to be reduced at the same time as saving on vehicle weight. A considerable contribution is made to reducing CO<sub>2</sub> emissions as a result.

EBNER implements press-hardening technology using the hotPHASE® roller-hearth furnace, which is equipped with a gas-fired radiant tube heating system and a special electric heating system.

EBNER hotPHASE® press hardening furnaces bring together

- 1 the very latest furnace technology
- 2 individually adjustable temperature distribution across the width of the rolls (patented)
- 3 high flexibility
- 4 lowest operating and maintenance costs
- 5 easy maintenance
- 6 less complex robotic manipulator needed





**Braun CarTec / Germany**

HOTPHASE® double-deck roller-hearth furnace  
system to tailor-temper press hardening blanks  
max. throughput: 5.4 t/h

54 | 55



**Braun CarTec / Germany**

HOTPHASE® double-deck roller-hearth furnace  
system to tailor-temper press hardening blanks  
view of charging roller-table on lower deck

## MODERNIZATION – KEEPING PRODUCTION STANDARDS AT THE HIGHEST LEVEL.

There are many situations where it is worth modernizing a heat treatment facility before considering investment in new equipment. The main objective is usually to increase production capacity using the space available. That said, modernization is just as often used to increase the quality of the as-annealed material. Ebner can often achieve both objectives and at the same time provide a new control center and comply with up-to-date safety regulations. The facility components are preassembled as far as possible prior to installation and work is performed in shifts to reduce downtime.





**Relocation and modernization**  
of a HICON/H<sub>2</sub>® bell annealer  
to anneal steel wire.

## MODERNIZING EXISTING FURNACE FACILITIES INCLUDING NON-EBNER FURNACES

Apart from quality and production capacity, other reasons for modernization include outdated heating systems and worn rotating parts. Electrical systems also become obsolete due to short product cycles meaning spares are in short supply. Upgrading or modification to future-safe systems is a prerequisite for operational reliability.

### Why MODERNIZATION?

- 
- 1 implementation of newly-developed software packages  
e.g. to increase productivity and improve stores management
  - 2 applying the latest safety standards
  - 3 minimizing emissions, e.g. CO<sub>2</sub>, NO<sub>x</sub>
  - 4 simplifying operation
  - 5 reducing process gas consumption
  - 6 reducing running costs, e.g. for CH<sub>4</sub>, electricity etc.
  - 7 increasing performance with additional enhancements  
in high convection

### Examples of successful modernization projects include

- 1 fitting a jet cooling system to a roller-hearth furnace facility for boiler tubes,  
in order to increase mechanical strength
- 2 increasing performance of a galvanizing line by 20 % to 500,000 t/y by installing  
additional heating zones and a HICON® jet cooler
- 3 modernizing the entire control system and implementing the latest software  
for a HICON/H<sub>2</sub>® bell annealer facility
- 4 apps - intelligent computing model for shortest possible heat treatment cycles and  
lowest energy consumption
- 5 HICON/H<sub>2</sub>® recirculation fan speed increased from 85Hz to 100Hz (3000 rpm)  
for higher throughput



**STATE-OF-THE-ART BURNER SYSTEMS  
SUPERIOR TECHNOLOGY COMBINED WITH  
A PASSION FOR PERFECTION**

Striving for perfected functionality and quality is one of the most important elements of EBNER's lasting success and a major factor in ensuring the higher productivity and more economical operation of EBNER's heat treatment facilities.



## BURNER SYSTEMS

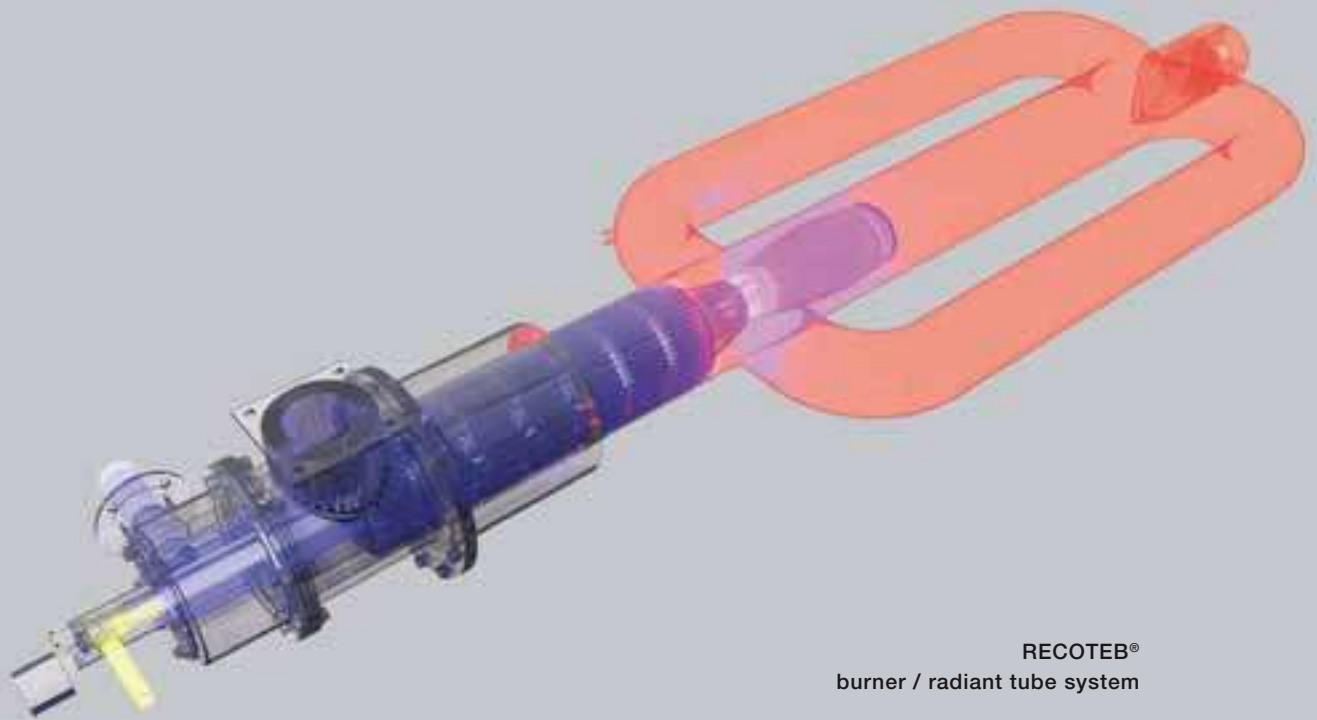
The development of direct-fired or indirect-heated systems contributes greatly to the economy and durability of individual components and furnace facilities as a whole.

EBNER is in the enviable position of being able to develop burner systems for industrial furnaces or process-specific applications in its own research and development laboratory.

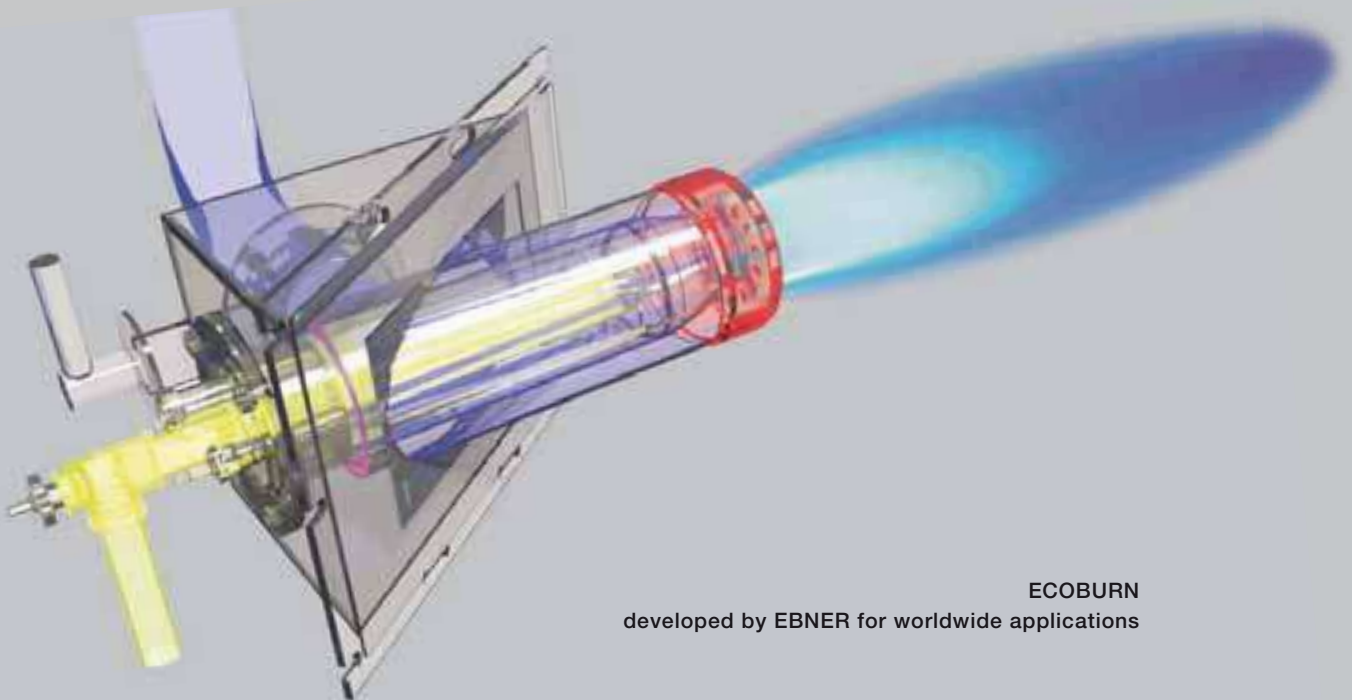
### HIGHLIGHTS

- 1 all-metal 2-stage burner
- 2 suitable for all standard fuel gases
- 3 direct ignition
- 4 variable power output range
- 5 combustion air preheating up to 700°C
- 6 lowest exhaust gas temperatures
- 7 best combustion efficiency
- 8 lowest NO<sub>x</sub> values
- 9 suitable for furnace temperatures of up to 1200°C





RECOTEB®  
burner / radiant tube system



ECOBURN  
developed by EBNER for worldwide applications

## ECOBURN - ADVANTAGES at a glance

### All-metal - long service life

The burner is constructed with an all-metal casing. The burner head is insulated by a vacuum-formed insulating component. The outer burner tube (1st combustion phase) is also cooled by the secondary combustion air supply, which contributes to exceptional durability.



### Two-stage combustion - guaranteed NO<sub>x</sub> values

This burner is designed for two-stage combustion with air staging. In the primary combustion zone, sub-stoichiometric combustion lowers flame temperature and suppresses formation of NO<sub>x</sub> as a result. Complete combustion takes place in the secondary combustion zone.

### Identical electrodes - simple spares management

Ignition and supervision electrodes are identical and interchangeable - which is advantageous for stock-keeping and servicing.

fuel gas type		mean calorific value (kJ/m³)
CH <sub>4</sub>	natural gas	33,000 – 38,000
LPG	liquid petroleum gas (diluted with air to calorific value of natural gas)	92,000 – 122,000
COG	coke oven gas	15,000 – 19,000
MIG	mixed gas (direct ignition above 18% hydrogen, otherwise with pilot burners)	7,500 – 11,000



ECOBURN® burners manufactured in the EBNER workshop.

64 | 65



ECOBURN® burners in operation at a pusher-type furnace.

## **RECOTEB®**

### **INNOVATIVE BURNER / RADIANT TUBE SYSTEM**

The decision to introduce new ideas and EBNER's well-known quality to the market of continuous galvanizing and annealing lines brought with it extensive analysis of the weaknesses of existing facilities. Discussions with numerous operators in Europe and the US resulted in a number of issues which EBNER then investigated in-depth.

One major point was the burner/radiant tube system, especially the service life of the new double-P radiant tubes. Investigations soon revealed that the design of the burner has to be matched to the radiant tube.

### **THE SERVICE LIFE OF THE RADIANT TUBE DEPENDS ON THE BURNER**

In 2007, the modernization of galvanizing line 2 at ArcelorMittal Eisenhüttenstadt provided the first opportunity to install a burner/radiant tube system developed in EBNER's in-house R&D department. These industrial production conditions prove that a perfectly matched burner/radiant tube combination can significantly improve radiant tube service life.




## **HECOT burner**

### **HECOT - HIGH EFFICIENCY COMBUSTION TECHNOLOGY**

Increasing interest in reducing the emissions ( $\text{CO}_2$  and  $\text{NO}_x$ ) of heat treatment furnace facilities has resulted in special attention being paid to the burners. Based on years of experience and a simple, reliable design, EBNER decided on a recuperative combustion air preheating system. By optimizing thermal transfer from the stack gas to the combustion air, the preheated combustion air reaches temperatures of more than  $650^\circ\text{C}$ . As a result the temperature of the exhaust gas falls to below  $450^\circ\text{C}$ . This not only increases combustion efficiency, it also leaves just enough energy to heat water.

Compared to regenerative combustion air preheating systems, maintenance of recuperative preheating is much simpler. The higher combustion efficiency of regenerative designs has to be weighed against having to implement more valves, higher electrical consumption and high pressure drop of both the combustion air supply and the stack gas extraction due to the regenerative ceramic filler material.



Temperature comparison measurements  
on a DP radiant tube.

66 | 67



HECOT burner and DP radiant tubes in operation  
on a galvanizing line.

## HEAT TREATMENT FURNACE FACILITIES FOR THE ALUMINUM INDUSTRY

### reheating and homogenizing furnaces

- **HICON®** batch-type furnaces
- **HICON®** pusher furnaces
- **HICON®** soaking pit furnaces

### annealing furnaces

- **HICON®** floater furnaces
- **HICON®** batch-type furnaces
- **HICON®** single-coil overhead furnaces
- **HICON®** bell annealers for capacitor foil

### solution heat-treating and aging facilities

- **HICON®** roller-hearth furnaces for sheet, plate and profiled sections
- **HICON®** floater furnaces
- **HICON®** ageing furnaces for plates

## HEAT TREATMENT FACILITIES FOR THE COPPER BASE METAL INDUSTRY

### bright annealing facilities for strip

- **HICON|H<sub>2</sub>®** bell annealers for copper, brass and bronze strip coils
- **HICON|H<sub>2</sub>®** vertical annealing lines for copper, brass and bronze strip

### bright annealing facilities for tube and bar stock

- roller-hearth furnaces for straight copper tubes and copper tube pancake coils
- **HICON®** roller-hearth furnaces for copper tube coils
- **HICON|H<sub>2</sub>®** bell annealers for copper and brass tube coils

### bright annealing facilities for wire

- **HICON|H<sub>2</sub>®** bell annealers for copper, brass and bronze wire coils and spools

### bright annealing facilities for coinage alloys

- **HICON|H<sub>2</sub>®** muffle-type furnaces for coinage alloys

## ATMOSPHERE SYSTEMS

### generators

- exothermic generators
- nitrogen and hydrogen generators
- ammonia cracker with molecular sieve adsorber
- cracked ammonia and nitrogen mixer and adsorber facilities
- hydrogen and nitrogen mixers

### process atmosphere pressure vessels

- process atmosphere pressure vessel and tank filling units

### process atmosphere analyzers

- hydrogen analyzers
- CO<sub>2</sub>, CO and CH<sub>4</sub> analyzers
- dewpoint analyzers
- oxygen analyzers
- trace oxygen analyzers
- NOx analyzers

### hydrogen purification systems

### nitrogen purification systems

### ammonia storage facilities

- storage tanks for road and rail supply

## AUTOMATION

### basic automation systems

- power panel enclosures
- field-mounted units
- PLC control panels

## BURNER SYSTEMS

- RECOTEB® burner / radiant tube system
- ECOBURN burner

### VISUAL FURNACES® central operating and process control systems

- visualization and archiving
- expansions and retrofits
- programming of function-specific add-ons

Copyright by  
**EBNER** Industrieofenbau GmbH  
Leonding | Austria

subject to changes  
due to technical upgrades

# EBNER SERVICE - WORLDWIDE - AROUND THE CLOCK



1



## **EBNER** Industriofenbau GmbH

Ebner-Platz 1 (Ruflinger Straße 111)  
A 4060 Leonding / Österreich  
Tel: (+43) 732 6868, Fax: (+43) 732 6868 1000  
E-mail: [sales@ebner.cc](mailto:sales@ebner.cc), [www.ebner.cc](http://www.ebner.cc)

2



## **EBNER** Furnaces, Inc.

224 Quadral Drive, Wadsworth / Ohio 44281 / USA  
Tel: (+1) 330 335 1600, Fax: (+1) 330 335 1605  
E-mail: [sales@ebnerfurnaces.com](mailto:sales@ebnerfurnaces.com), [www.ebner.cc](http://www.ebner.cc)

3



## **EBNER** Industrial Furnaces (Taicang) Co., Ltd.

Beijing East Road 82, 215400 Taicang / Jiangsu / China  
Tel: (+86) 512 5357 6868, Fax: (+86) 512 5357 6867  
E-mail: [sales@ebner.cn](mailto:sales@ebner.cn), [www.ebner.cc](http://www.ebner.cc)

4



## **EBNER** India Pvt. Ltd.

A/310-311 Dynasty Business Park, J B Nagar / Andheri-Kurla Road  
Andheri East / Mumbai - 400059 / Indien  
Tel: (+91) 22 6139 3333, Fax: (+91) 22 6139 3311  
E-mail: [bti@ebner.cc](mailto:bti@ebner.cc), [www.ebner.cc](http://www.ebner.cc)

5

**EBNER** Service Center Brazil  
Uberlandia , MG, BRAZIL

6

**EBNER** Service Center Japan  
Chuo-ku, Tokyo 104, JAPAN

7

**EBNER** Service Center Taiwan / R.O.C.  
Kaohsiung / TAIWAN / R.O.C.

TRADITIONQUALITYSTANDARDADDEDVAL  
PRIORITYFUTURECORECOMPETENC  
DEVELOPMENTHEATTREATMENTFACILI  
ANNEALLOGISTICSCOOPERATIONLISTENIN  
TRUSTRESEARCHANDDEVELOPMENTCU  
ECONOMICALRELIABLESAFEENGINEERING  
HICON®ECOBURNRECOTEB®HOTPHASE®INC  
GLOBALPROFESSIONALSERVICESORIG  
INDEPENDENCEGLOBALPLAYEREXPERTISE  
PRICE/PERFORMANCERATIOCONTINU  
INNOVATIVETECHNOLOGIESSAFEOPERATION  
AUTOMATIONDURABILITYENERGYEFFICIEN  
OPTIONSLOWESTEMISSIONSLOWESTCONSUM  
EXCELLENTSERVICEHIGHESTQUALITY  
HIGHESTTHROUGHPUTHIGHESTCOMBU  
EFFICIENTINSULATIONINNOVATIONDELIVE  
CUSTOMER-SPECIFICLOWNOISERELIABL  
FEWEROPERATINGPERSONNELPRICE/P  
QUALITYSOUNDPROTECTIONSAFETYSA  
TEMPERATUREUNIFORMITYTURNKEYENV  
TRADITIONCOMPLIANCEWITHREGULATI  
CONSTRUCTIONQUALITYADDEDVALUEEC  
PRIORITYFUTURECORECOMPETENCEDESIG  
CUSTOMERSATISFACTIONCOREVALUESPR  
CONSTRUCTIONONGOINGDEVELOPMENTHEAT  
AUTOMATIONANNEALLOGISTICSCOOP  
TRUSTRESEARCHANDDEVELOPMENT  
TECHNOLOGICALLEADERSHIPRELIABLE  
HICON®ECOBURNRECOTEB®HOTPHASE®INC  
ORIGINALSPAREPARTSSERVICESINDEPEN  
GLOBALPLAYEREXPERTISETECHNO  
PRICE/PERFORMANCERATIOCONTINUOUSG  
TECHNOLOGIESSAFEOPERATIONGLOBAL  
DURABILITYENERGYEFFICIENCYFUTURE  
OPTIONSRELIABILITYLOWESTEMISSION  
EXCELLENT  
HIGHESTTHROUGHPUTHIGHESTC  
EFFICIENTINSULATIONINNOVATIONDELIVE  
CUSTOMER-SPECIFICLOWNOISERELIAB  
READYFEWEROPERATINGPERSON

160168B 2011-06 en

**EBNER.CC**