Compact and Efficient Solutions with Enhanced Heat transfer Surfaces

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I-ThERM Workshop

Brunel University London

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Outline

1. About Wieland Thermal Solutions
2. Wieland Enhanced Heat Transfer Tubes
3. Selected Case Studies
4. Production Qualification Test (PQT) for Duplex 2205

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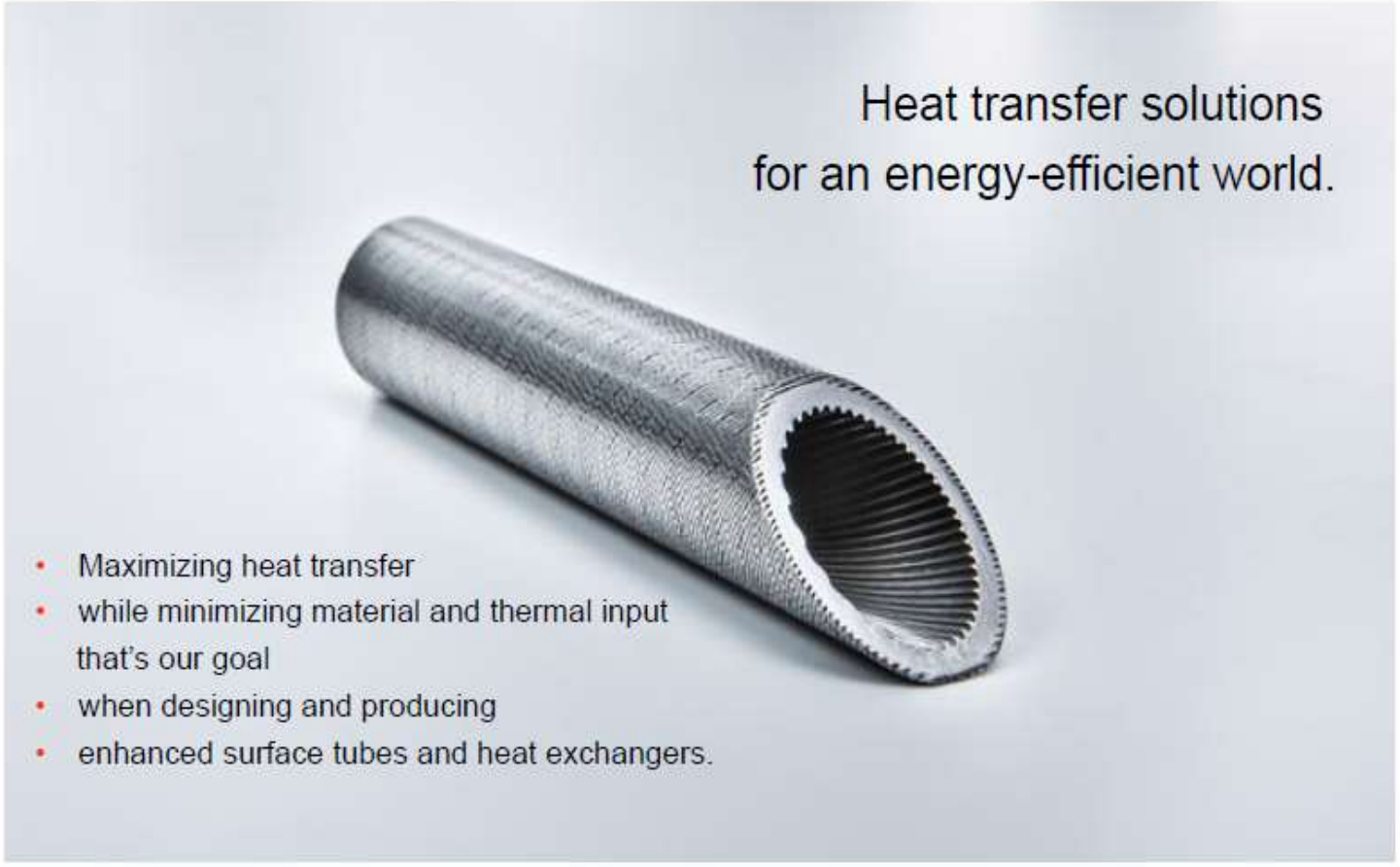
Short Overview of the Wieland Group

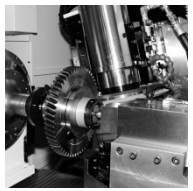
A global leader in heat transfer and forming technologies …



About us

- The World Market Leader for Technical Tubes for Air Conditioning, Refrigeration and Process Technology Applications.
- A Leading Supplier of Enhanced Surface Tubes and Heat Exchangers for Heating Technology and Machinery & Plant Technology Applications.
- 487 People, 4 Manufacturing Locations (U.S., China, Germany, Portugal).
- 2 Research Centers (Ulm/Germany, Shanghai/China).
- State-of-the-Art Technology, Largest IP Portfolio in the Industry.



Production Sites

487 dedicated EMPLOYEES

4 PRODUCTION SITES:

Ulm | Germany • Esposende | Portugal • Wheeling | USA • Shanghai | China

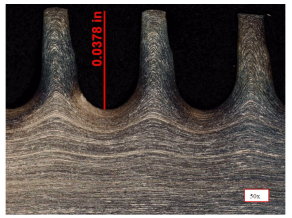
R &D

- Two research centers: Ulm/Germany, Shanghai/China
- Development of enhanced tubular surfaces
- Test rigs for safety refrigerants and hydrocarbons
- Singe tube testing
- Bundle simulations
- CFD, Data collection / reduction / correlations
- Software for Heat Transfer Applications

2

DEVELOPMENT CENTERS:

Ulm, Germany · Shanghai, China



in — out

IN THE BEGINNING, IT'S AN IDEA
IN THE HEADS OF OUR ENGINEERS.

IN THE END, IT'S A COMPETITIVE
ADVANTAGE IN YOUR PRODUCT.

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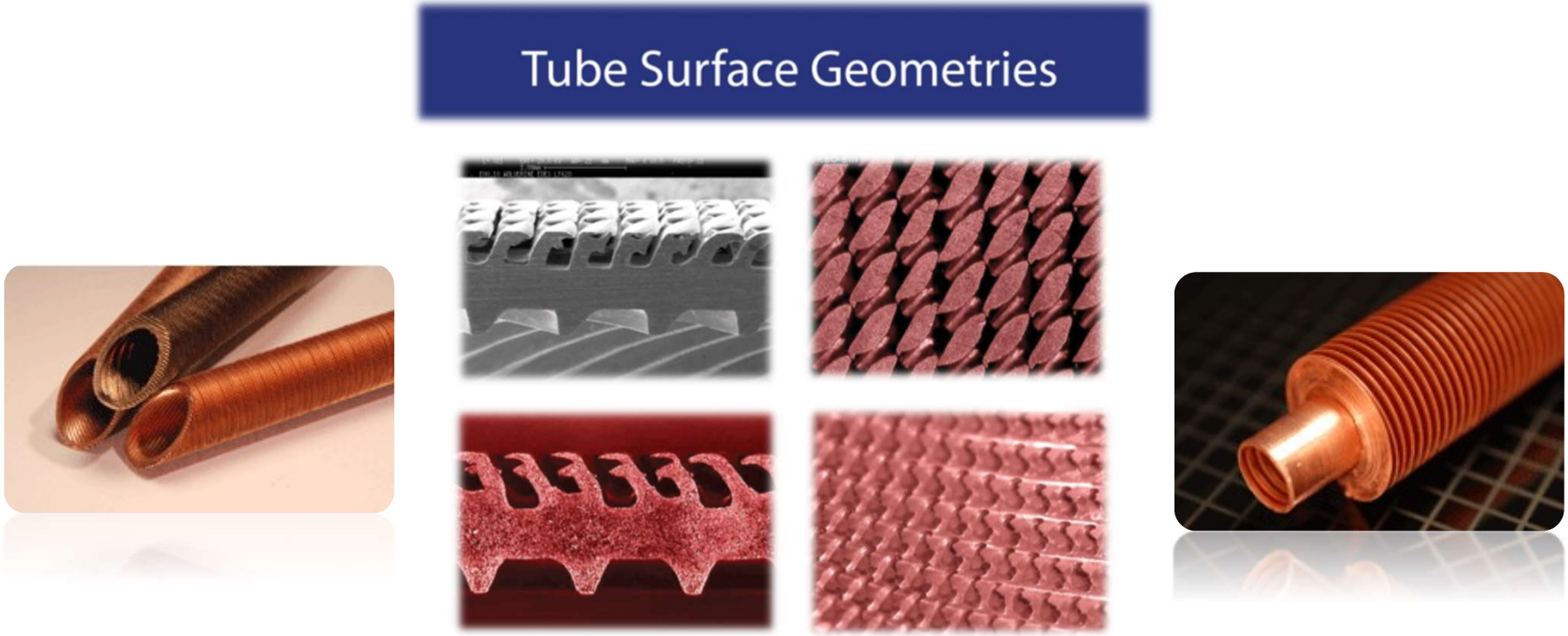
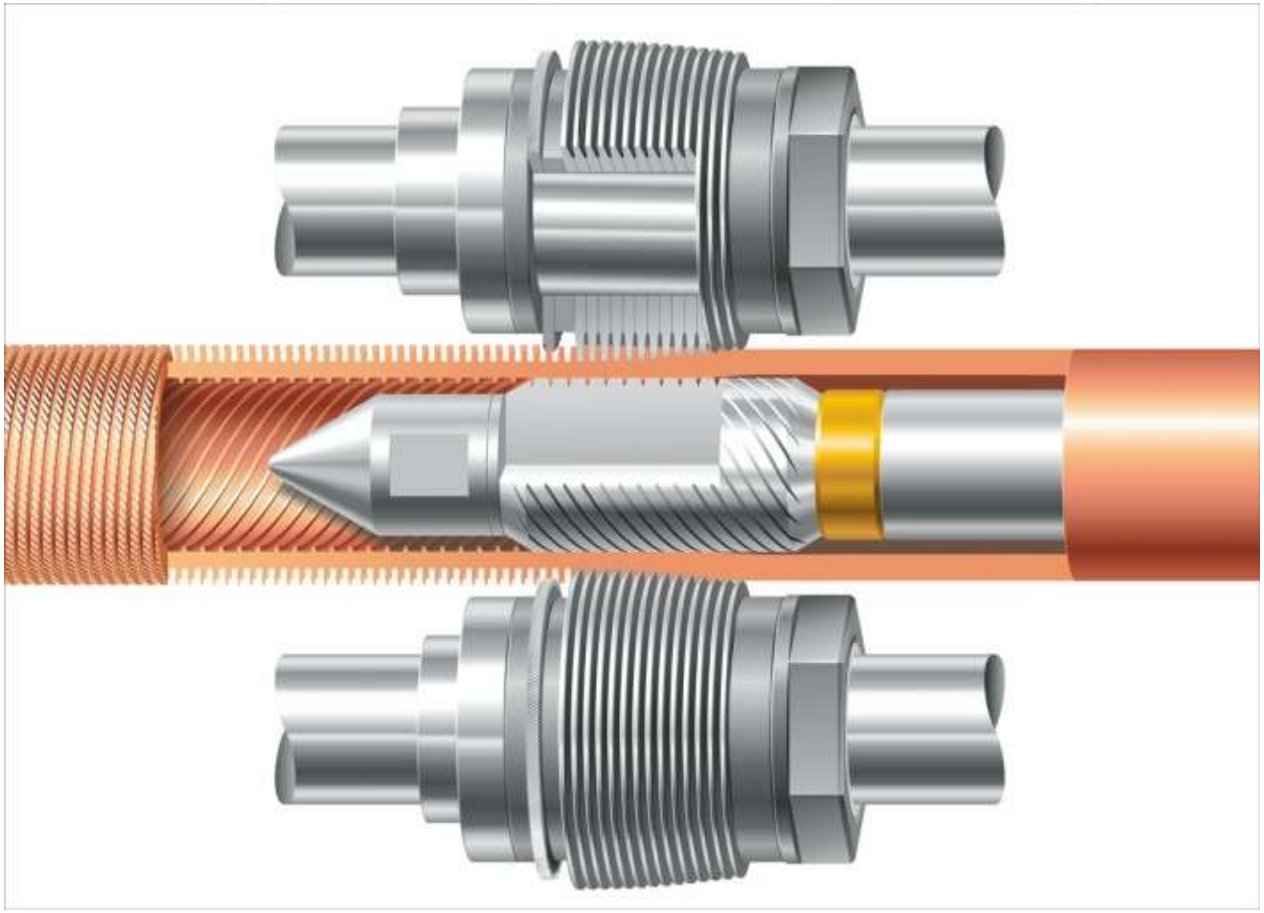
Expertise: Proprietary Heat Transfer Technology for Enhanced Performance



Thermal Innovation

- Global leader in the development and manufacture of integral finned tubes
- The tubes are mechanically deformed to obtain integrals fins on the outside and integral ridges on the inside, significantly improving heat transfer between the two fluids
- Improvement is from a combination of extended surfaces areas (up to 3 times) and proprietary technology to promote nucleate boiling or condensing

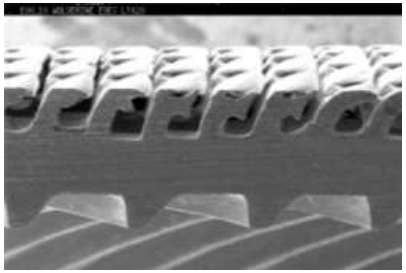
Finning Process

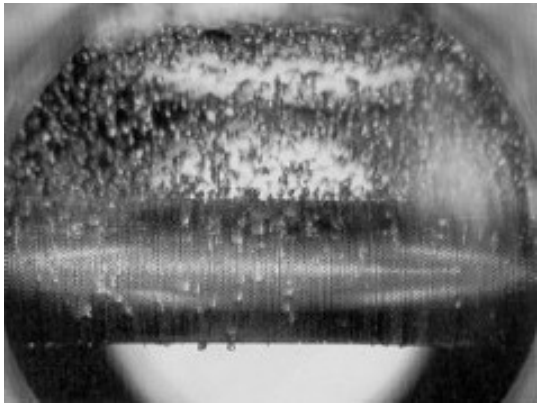


Boiling and Condensing Processes

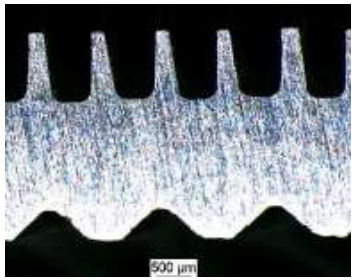
Highly complex designs to optimize heat flux, pressure drop and ΔT

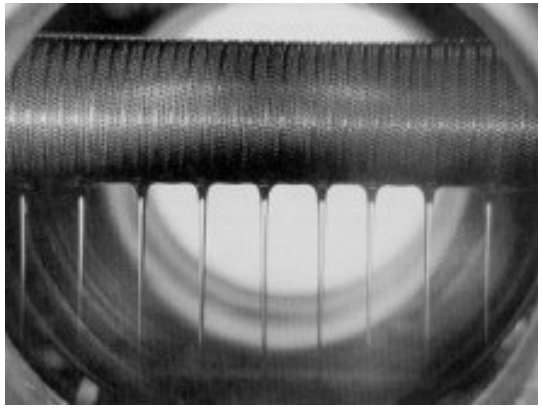
Boiling



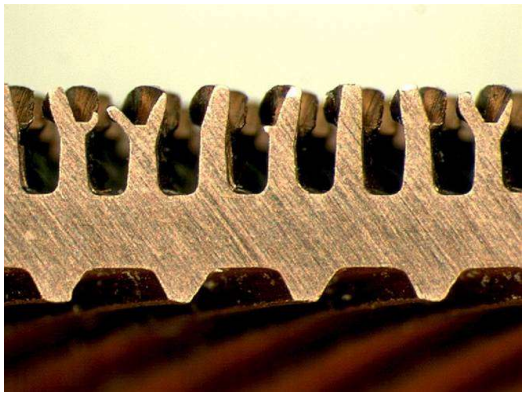
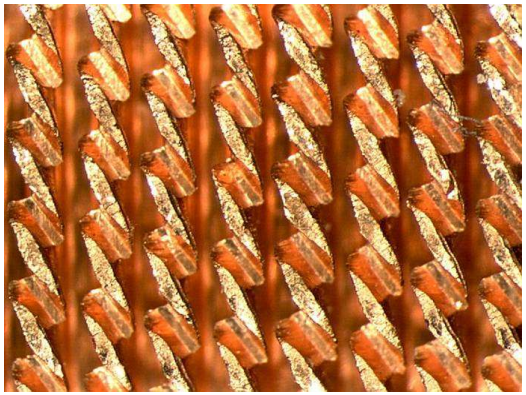
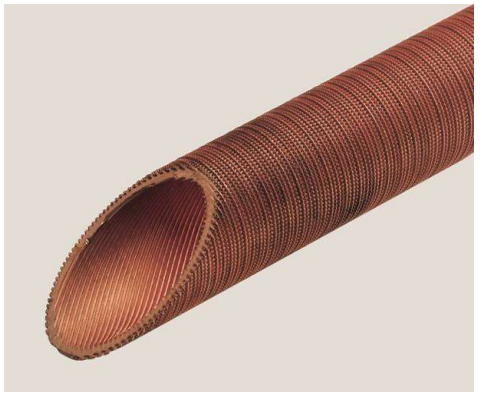
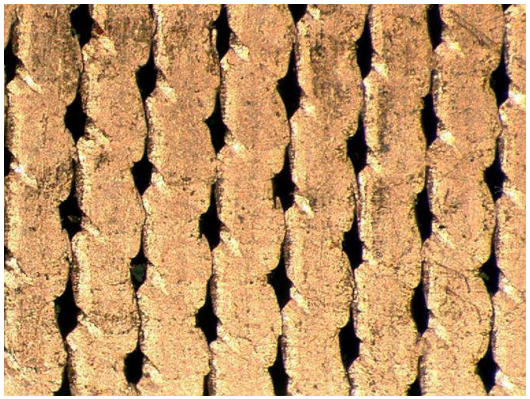


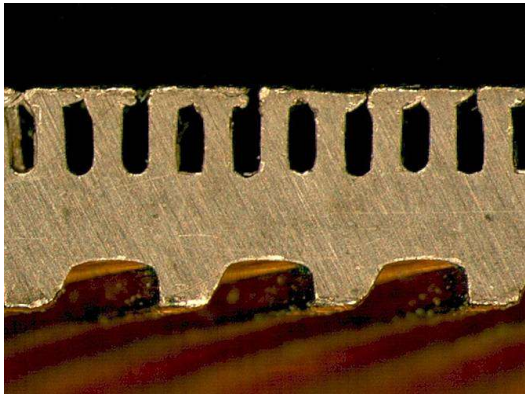
Condensation





High Performance Boiling and Condensing Surfaces



Benefits of Double Enhanced Tubes

- Broad heat transfer knowledge in evaporating and condensing fluids
- Maximum performance in any application
- Uses in low, medium, high and temperature sources
- Largest global supplier of high-performance finned tube for commercial chillers
- Co-development of application specific solutions with each customer

Considering Dual Enhanced Tubes

- Smaller Investment/Reduce capital cost as less tubing required for the same duty
- Reduced foot print and weight which results into a more compact design
- Structural savings because of the more compact design. Less shells, heads, nozzles, piping, connections and supports
- Debottlenecking. Performances of an existing equipment can be increased without changing the original design

Materials

- Carbon Steel
- Stainless Steel
- Duplex Stainless Steel
- Titanium
- Copper
- Copper Nickel Alloy (90/10 & 70/30)

Mature Technology

Markets

- Air conditioning & refrigeration
- Petrochemical / Chemical Process
- Power Generation
- Oil & Gas production and processing
- Hydrocarbon processing: Polypropylene, ethylene and LNG plants

Applications

- Refrigerant condensers & evaporators
- Compressor intercoolers
- Oil coolers
- Pre-heaters
- Overhead condensers
- Reboilers
- …and more

S/T Trufin / GEWA K

S/T Trufin / GEWA K – OD enhancement

Integral helical fins on the outside of the tube provide increase in the outside surface area
Designed for boiling and condensing of hydrocarbons or other liquids

S/T Turbo-Chil / GEWA KS

S/T Turbo-Chil – OD & ID enhancement

Integral finned with an internal surface enhancement of internal ridging. Heat transfer process is added by turbulation of the tube-side fluid. Designed for boiling and condensing of hydrocarbons or other liquids

Enhanced Tubes

Manufacturing Capabiliites

- Tube Diameter – 1/2” to 1” OD
- Internal & External fin enhancement
- Fins per inch (FPI) – from 11 to 60
- Max Tube Length – up to 21 m long
- U-Bent capabilities
- Non Destructive Test (NDT) Equipment –

  Eddy current, pneumatic pressure testing and air-underwater pressure testing
- ISO 9001 & ISO 14001 plants

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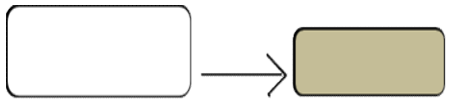
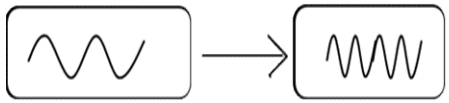
Levels of Optimization with Enhanced Tubes

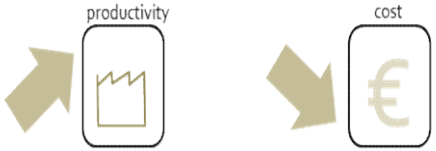


- **Reduce size of heat exchanger**
  - 30 to 100 % or more
  - Applied in case of critical unit sizes



- **Increase capacity**
  - Quick and simple
  - Low cost option
  - Often only choice due to limited plot space and piping alternatives

- **Minimise the number of shells per unit**
  - Cost and operation optimisation (e.g. for large units)



- **Optimize the process**
  - Operation cost optimisation
  - Maximisation of production capacity

Selected Case Studies

- Case 1 – Maximizing heat transfer rate

  Cooling Water Systems/Electrical Power Station

  Water/Water Heat Exchangers

- Case 2 – Enhancement for improved boiling

  Geothermal Power Plant based on ORC – Cycle

  Butane/Brine Evaporator

Case 1

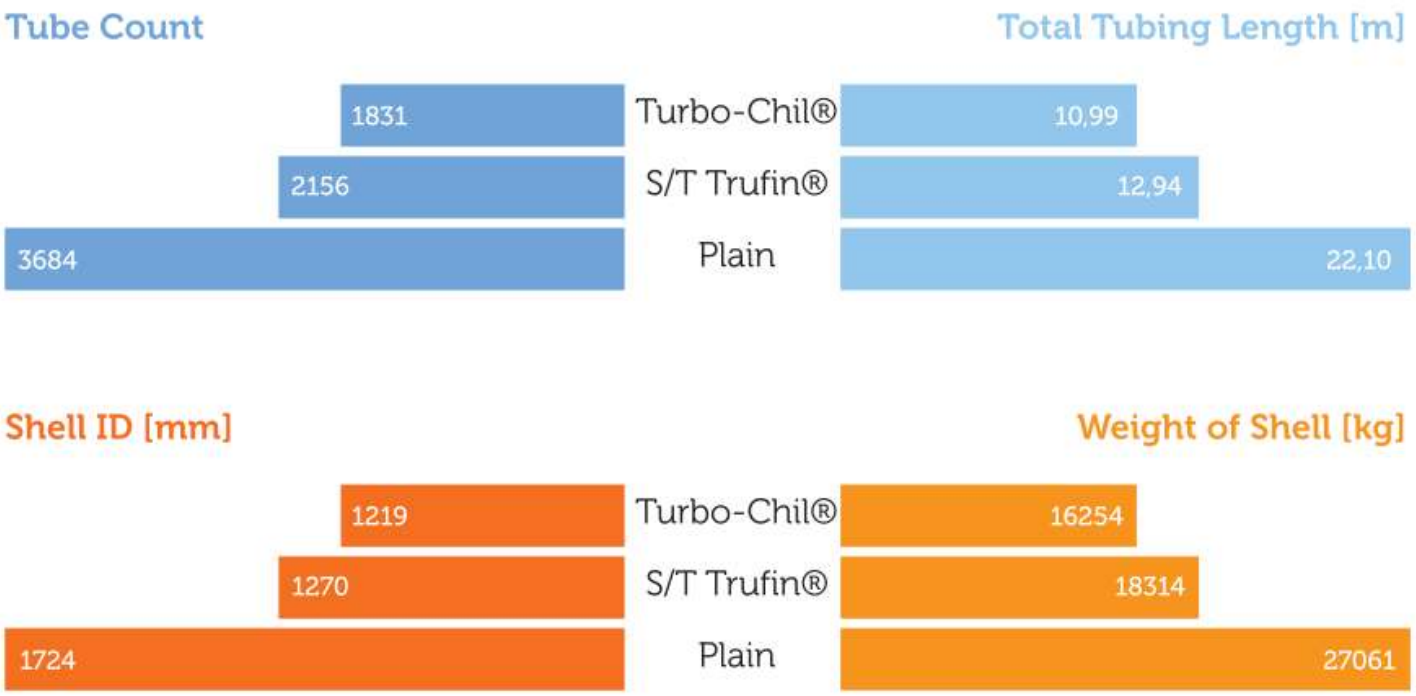
WATER/WATER HEAT EXCHANGER

Cooling Water System / Electrical PowerStation

Duty: 6.82 MW
Shell: TEMA BEM, 1 pass
Tubes: Carbon Steel, 3/4", Length= 6 m

Shell Side Fluid: Demin Water, T_{in}/T_{out}= 40/29.5 °C
Tube Side Fluid: Cooling Water, T_{in}/T_{out}= 22/32.5 °C
Design constrain: Max equipment length 6 m

Case 1 – Thermal Simulations



Case 1 – Relative Reductions

Case 2

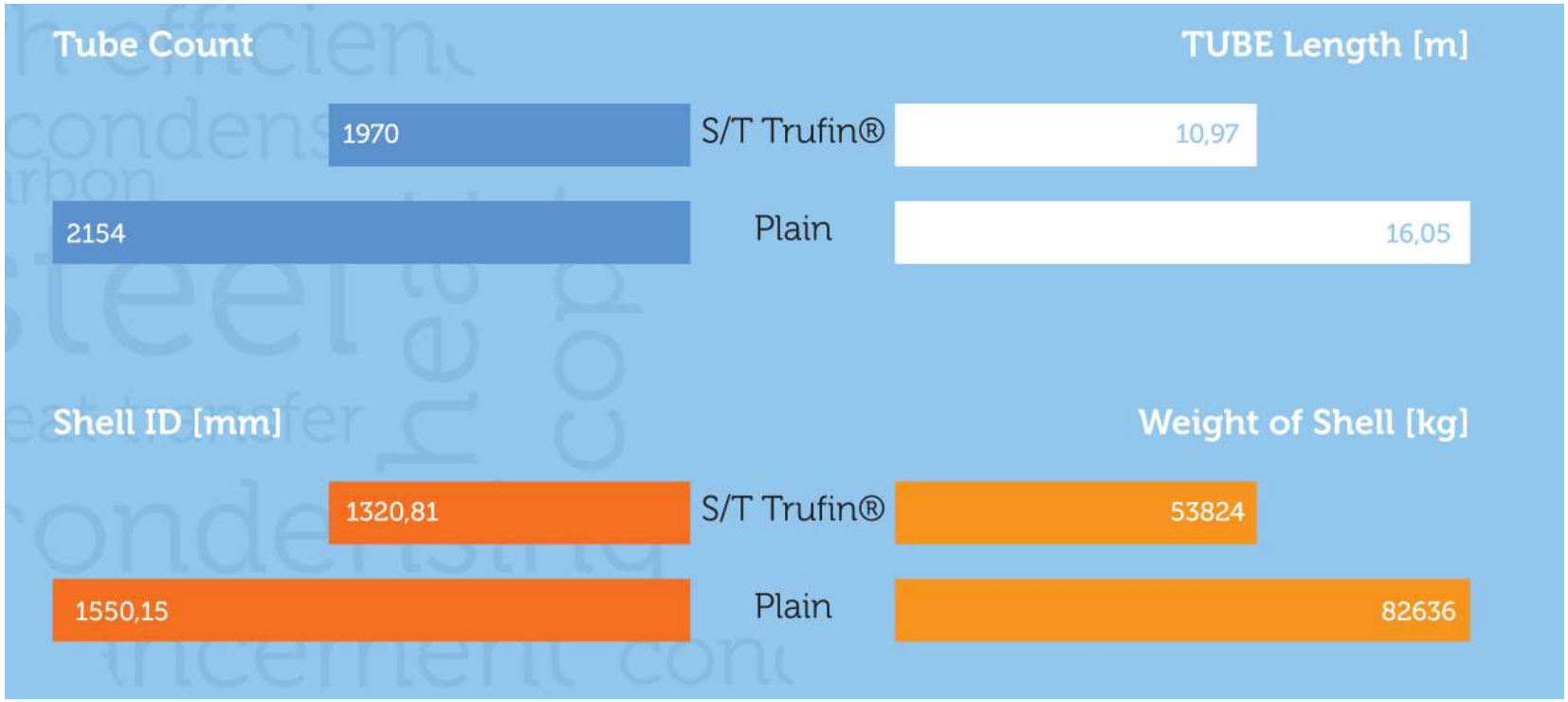
BUTANE/BRINE EVAPORATOR

Butane Evaporator / Geothermal Power Plant based on ORC-Cycle

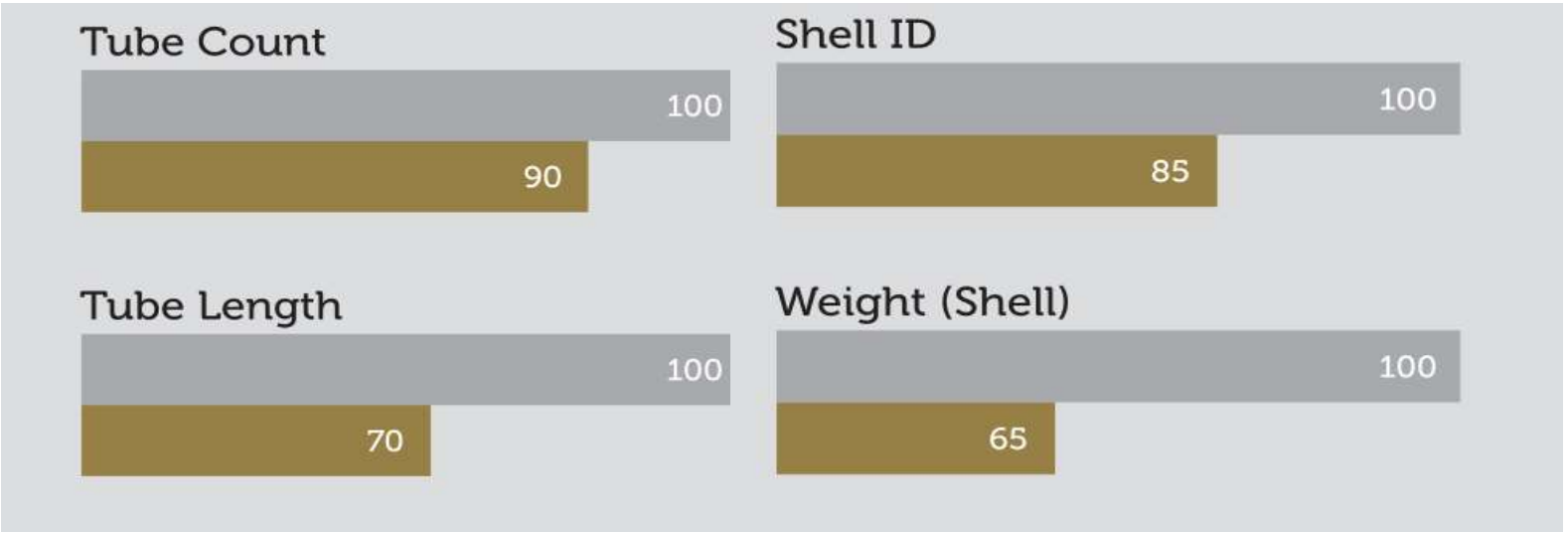
Duty: 55.33 MW
Shell: TEMA NKN, 1 pass
Tubes: Carbon Steel, 3/4“

Shell Side Fluid: Butane, T_{in}/T_{out}= 124.80/127.10 °C
Tube Side Fluid: Brine, T_{in}/T_{out}= 161.70/130.96 °C

Case 2 – Thermal Simulations



Case 2 – Relative Reductions



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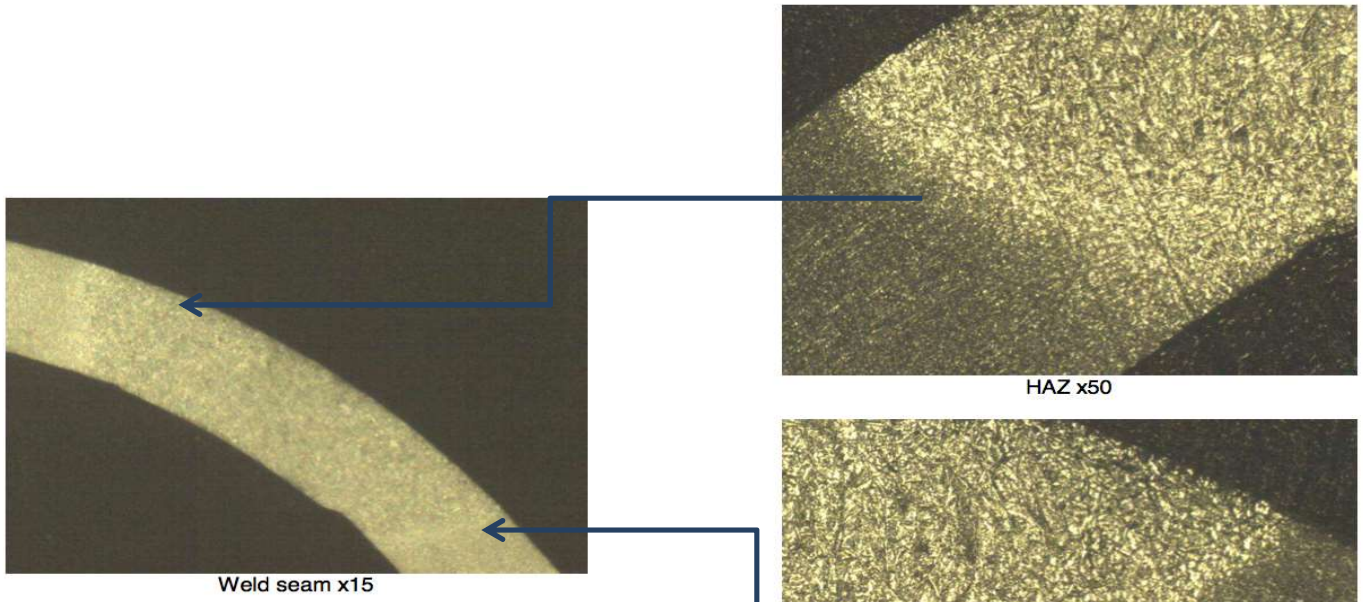
Chemical Analysis

Product : Longitudinally welded stainless steel tubes
Dimensions : Ø25.4 x 1.65 mm
Standard : ASTM A789M
Grade : UNS S31803 - Duplex 2205

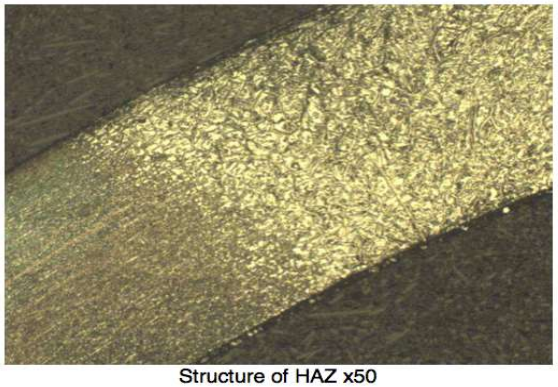
Heat N°		C	Si	Mn	P	S	Cr	Mo	Ni
504121	Original	0.022	0.34	1.62	0.020	0.001	22.75	3.11	5.63
	Product	0.028	0.30	1.55	0.014	0.002	22.60	3.30	5.66

Macrographic/Micrographic - Plain

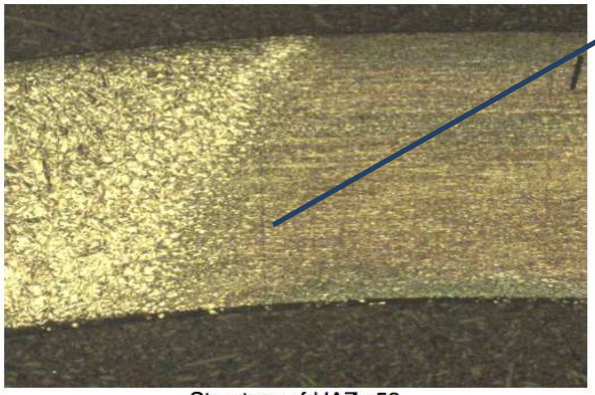


HAZ = Heat Affected Zone

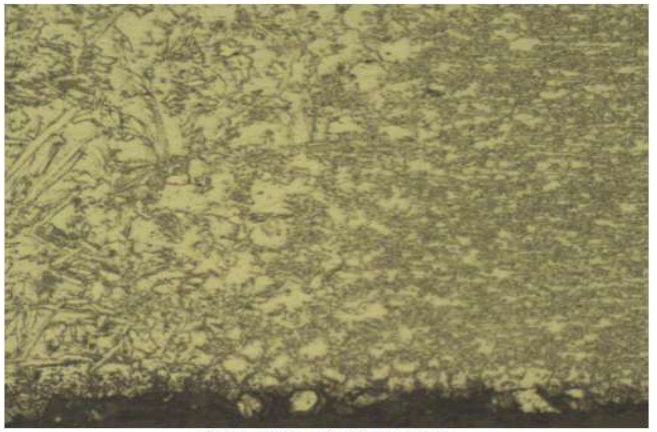
Macrographic/Micrographic - Finned



Structure of HAZ x50



Structure of HAZ x50

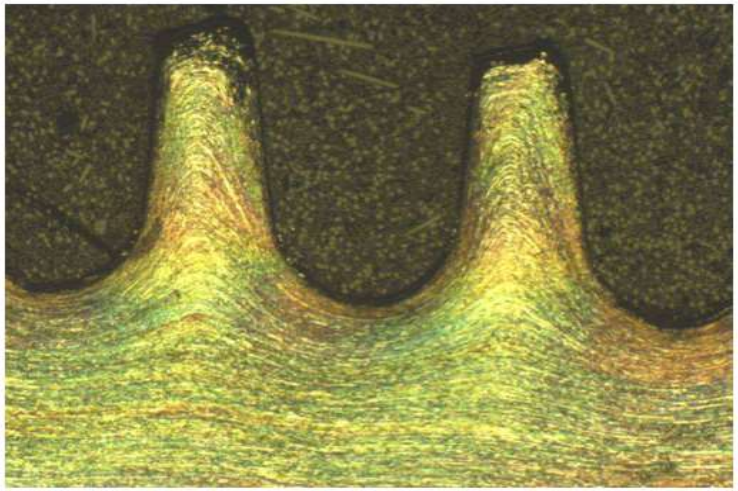


Structure of HAZ x200

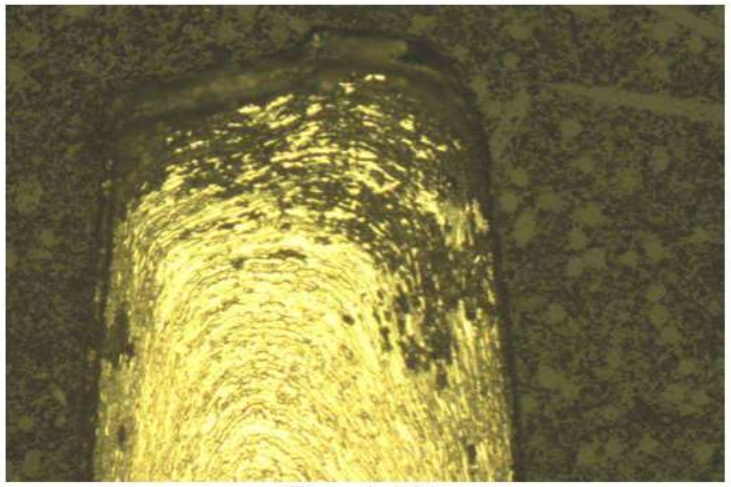
HAZ = Heat Affected Zone

Corrosion Test

Corrosion test according to G48 method A on the finned part (performed in $FeCl_3$ solution during 24h at 25ºC ±2ºC)



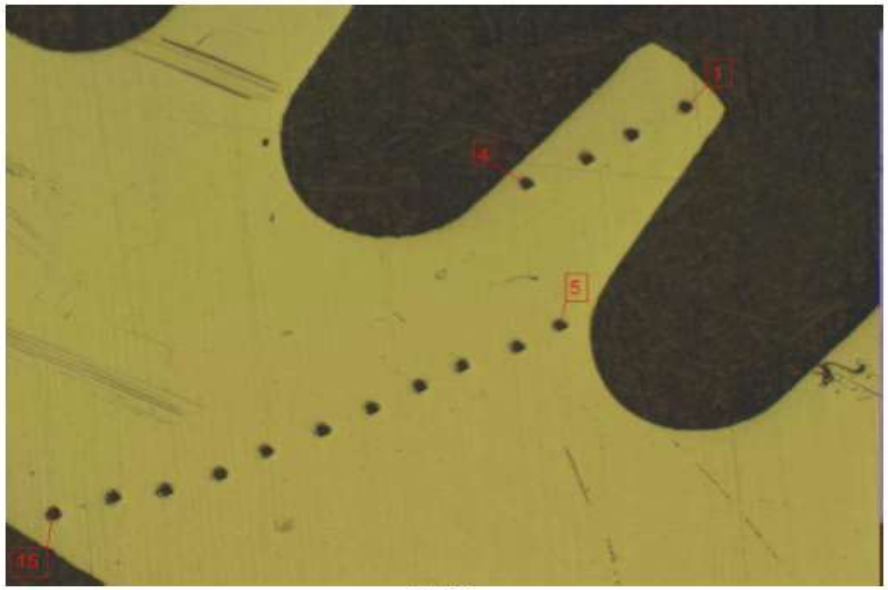
Finned x50



Finned x200

	Area (cm^2)	Weight (g)	Weight loss (g)	Corrosion rate (mg/cm^2)
Finned tube	76.73	40.733	0.015	**0.195**

Hardness Mesurements HV0.25



X50

	Hardness HV0.25
Plain tube	305

	Hardness HV0.25														
Point	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Finned tube	378	378	378	358	425	400	378	378	339	339	339	321	321	321	305

Conclusions

- **No grooves or cracks has been observed**
- **The microstructure of the HAZ and base material shows no evidence of intermetallic phases**
- **Expected hardness variation has been observed as a consequence of the cold deformation/finning process**
- **Sample analyzed passed the corrosion test**
  (Corrosion has been observed on micrographic pictures of the longitudinal cut on the edge of the finned tube although corrosion rate < 1 mg/cm^2)

Thank you !