Wieland Thermal Solutions®

PROVIDING EFFICIENCY

AHR New Product & Technology Theater

Optimization of Copper Tubes for ACR Fin Coil Heat Exchangers

Steffen Rieger
Wieland-Werke AG
Technical Marketing
Industrial Tubes

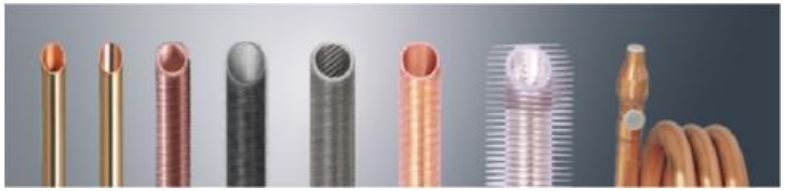
Dallas, TX
01/29/2013

Agenda

- Introduction of Wieland
- Inner-grooved copper tubes for fin coil heat exchangers:
  - Why using copper?
  - Why using inner-grooved tubes?
- Correlation of tube unit weight and inside surface enhancement
- Potential of high performance inner-grooved tubes
- Reduction of tube unit weight
  - Light weight tube design
  - Thinner bottom wall
- Miniaturization: Effect of reducing tube outside diameter
- Development of inner-grooved tubes on customer demand

Wieland

About Wieland



Manufacturer of
semi-finished products

Headquartered
in Germany

2 manufacturing sites
in the US (NC and IL)

Founded in 1820

> 30 locations
worldwide

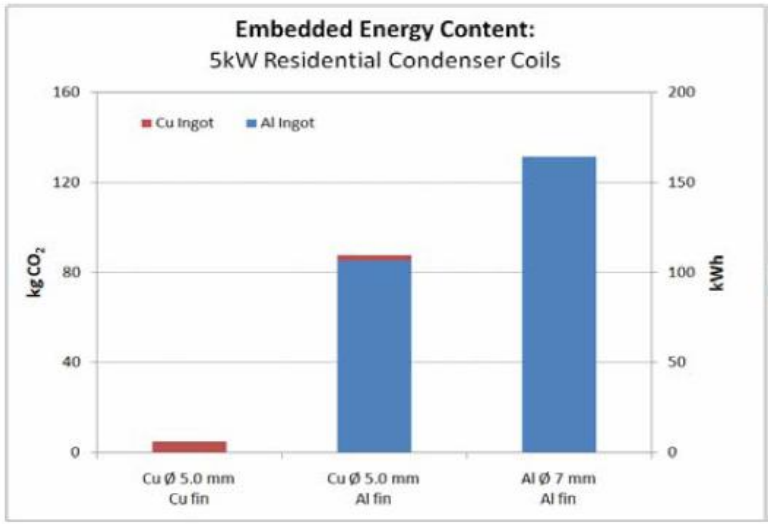
Specialized in copper and copper
alloys

Wieland

Why using copper tubes for fin coil heat exchangers?

Ø **Corrosion and durability** –
Copper coils feature superior and **reliable long-term performance.** Aluminum fin and tube combinations must be carefully matched and tested to provide sufficient corrosion protection and to maintain performance level long-term

Ø **Environmental impact** –
Carbon footprint of copper is extremely low. Energy consumption to produce aluminum is extremely high.



Source: IBIS

Ø **Optimized tube technology** can be implemented into existing heat exchanger facilities immediately and **with only slight investments** into new equipment

Ø **Installation and assembly** (brazing) is very easy and safe

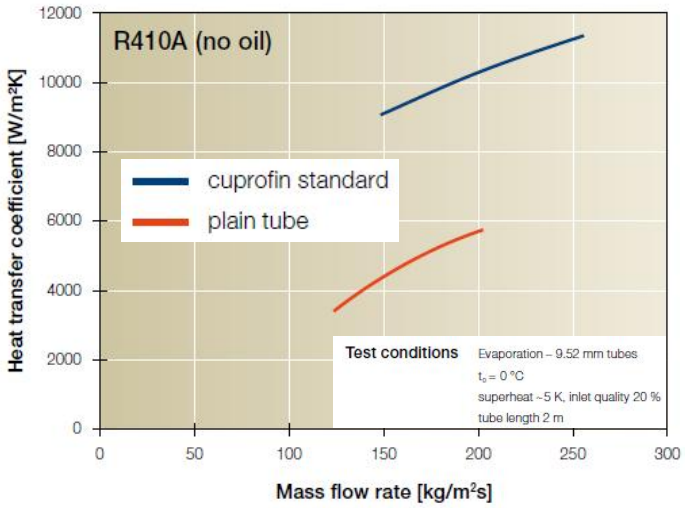
Ø **Ease of service and** reliable **repair** opportunity in the field

Ø **High flexibility** to modify heat exchanger size / capacity very easily and quickly

Wieland

Why using inner-grooved copper tubes?

With inner-grooved tubes (IGT), the inside heat transfer performance can be increased considerably.

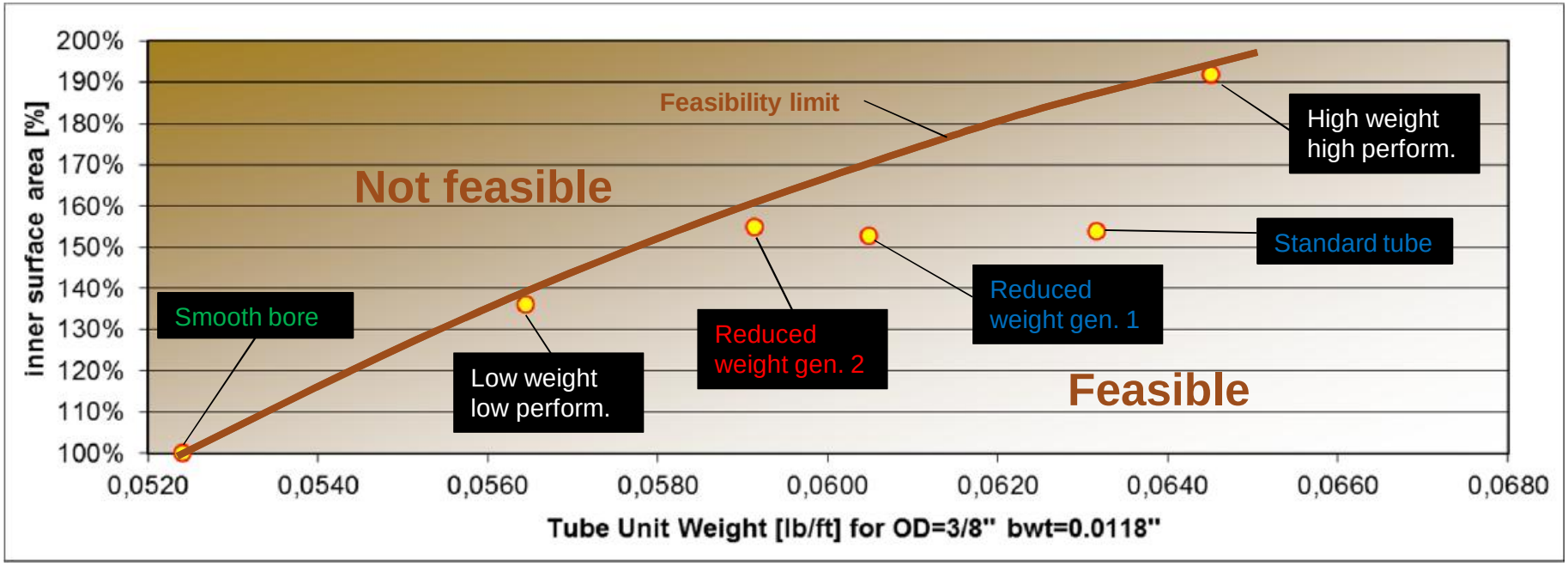


Results:

- **Higher capacity** of heat exchanger (HEX)
- **Improved energy efficiency**
- **Reduced size** of heat exchanger possible
  - → smaller footprint
  - → **less material costs**

Wieland

Correlation of tube unit weight and inside surface enhancement of IGT

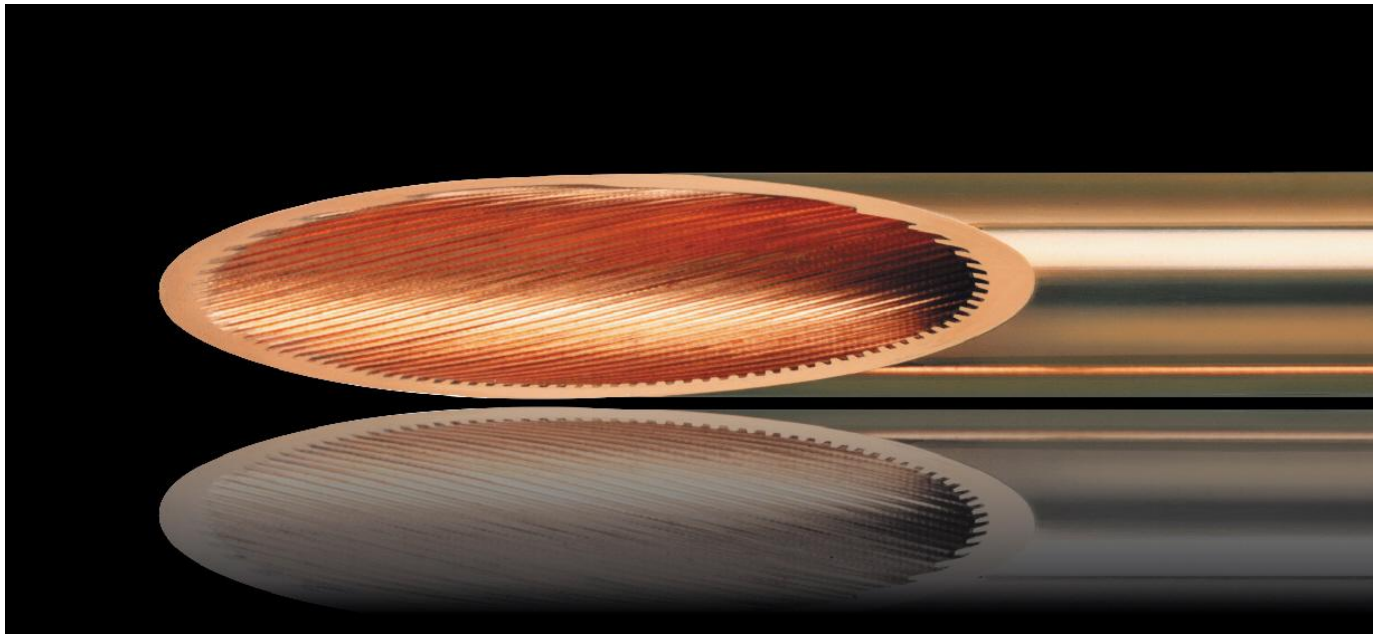


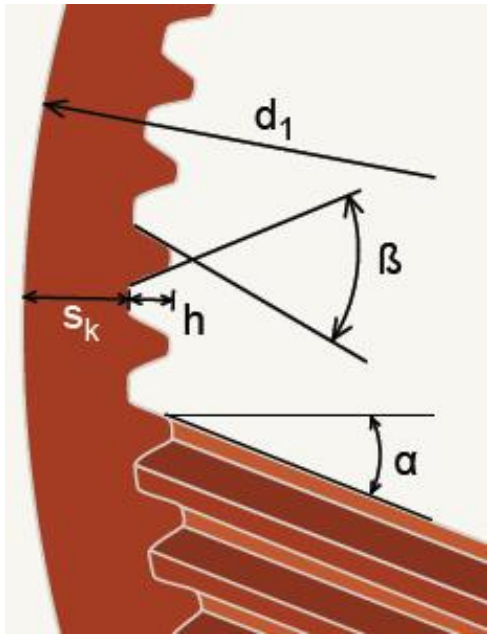
- Lower inside surface results in lower unit weight
- High performing tubes are heavier

Result: Tube type should be customized to achieve optimum unit weight at required performance level

Wieland

Parameters of fin patterns





h… fin height

n… number of fins

α… lead angle (helical angle)

β… apex angle (fin angle)

d_1… outside diameter

s_k… bottom wall thickness

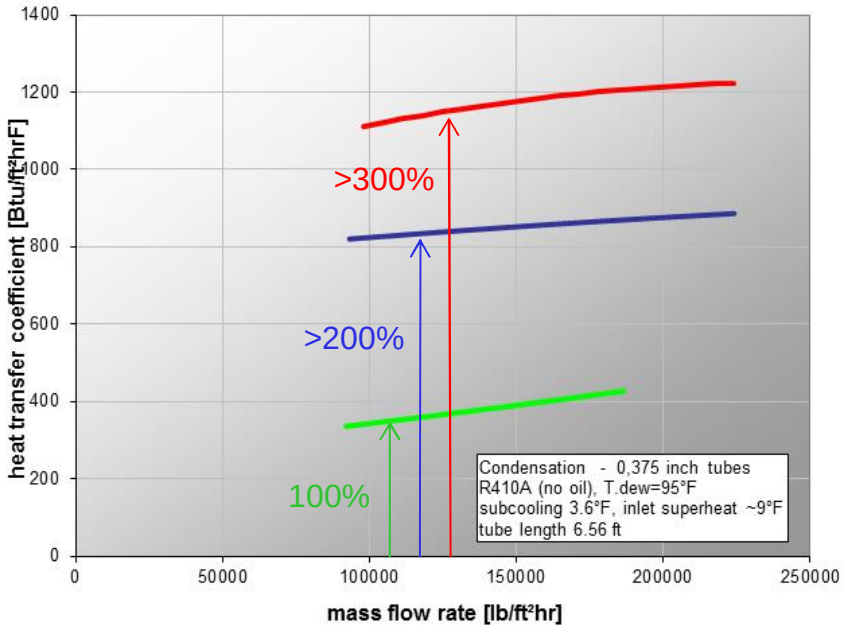
Wieland

Optimized tube design for increased tube side performance

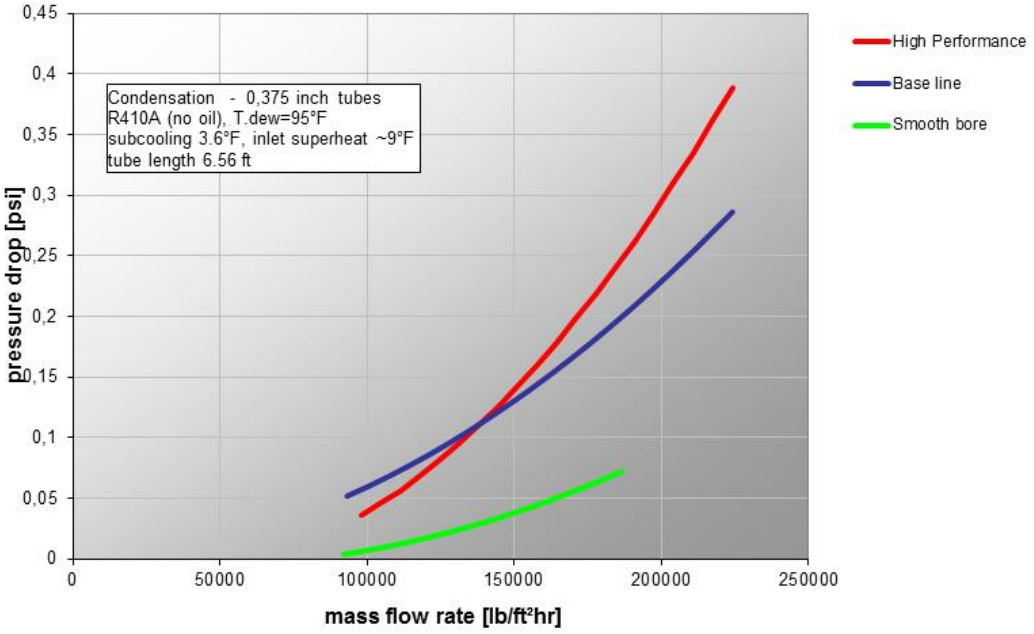
Example: Condensation of R410A in 3/8“ diameter tubes

Description	Outside Diam. [inch]	Bottom wall [inch]	Fin height [inch]	Number of fins	Lead angle [deg]	Unit weight increase	Surface increase
Plain tube - Reference	3/8	0,0118	0,0000	0	0	100%	100%
Industry standard - Base line	3/8	0,0118	0,0079	60	18	120%	154%
High performance config.	3/8	0,0118	0,0079	85	30	123%	192%

Heat transfer performance



Total pressure drop

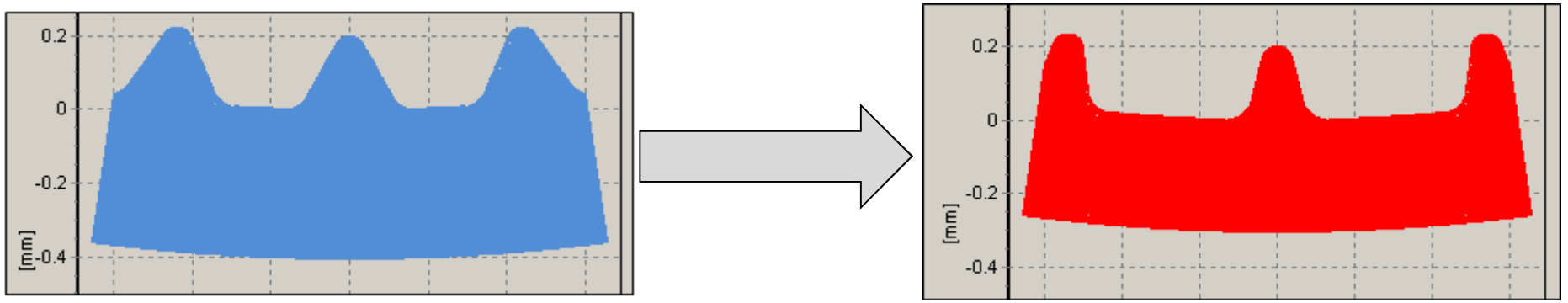


Wieland

Optimized tube design for reduced unit weight

Example cuprolite®: Light weight drop-in for 3/8“ diameter IGTs

Description	Outside Diam. [inch]	Bottom wall [inch]	Fin height [inch]	Number of fins	Lead angle [deg]	Apex angle [deg]	Unit weight increase
Plain tube - Reference	3/8	0,0118	0,0000	0	0	0	100%
Industry standard - Base line	3/8	0,0118	0,0079	60	18	53	120%
Light weight - cuprolite	3/8	0,0118	0,0079	50	25	25	113%



- Slimmer fin, decreased number of fins, higher lead angle
- Comparable performance level
- Fin height unchanged → Drop-in

Result: Unit weight reduction of **> 6%**

Wieland

Reduction of bottom wall thickness

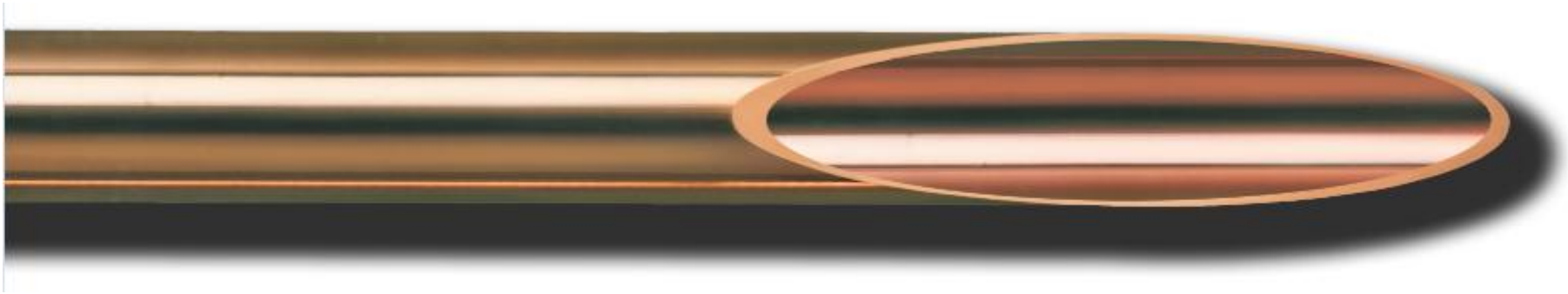
Example: 3/8“ x 0.0118“ reduced to 0.011“ bottom wall thickness

Description	Outside diam. [inch]	Bottom wall [inch]	Unit weight factor
Base line	3/8	0,0118	100%
Reduced wall	3/8	0,0110	93%

Issues to be considered when reducing the wall thickness:

- Ø Tools for bending & expansion may have to be replaced
- Ø Pressure level requirements must be checked

Result: metal cost savings of ~7%



Wieland

Miniaturization: Decreased outside diameter

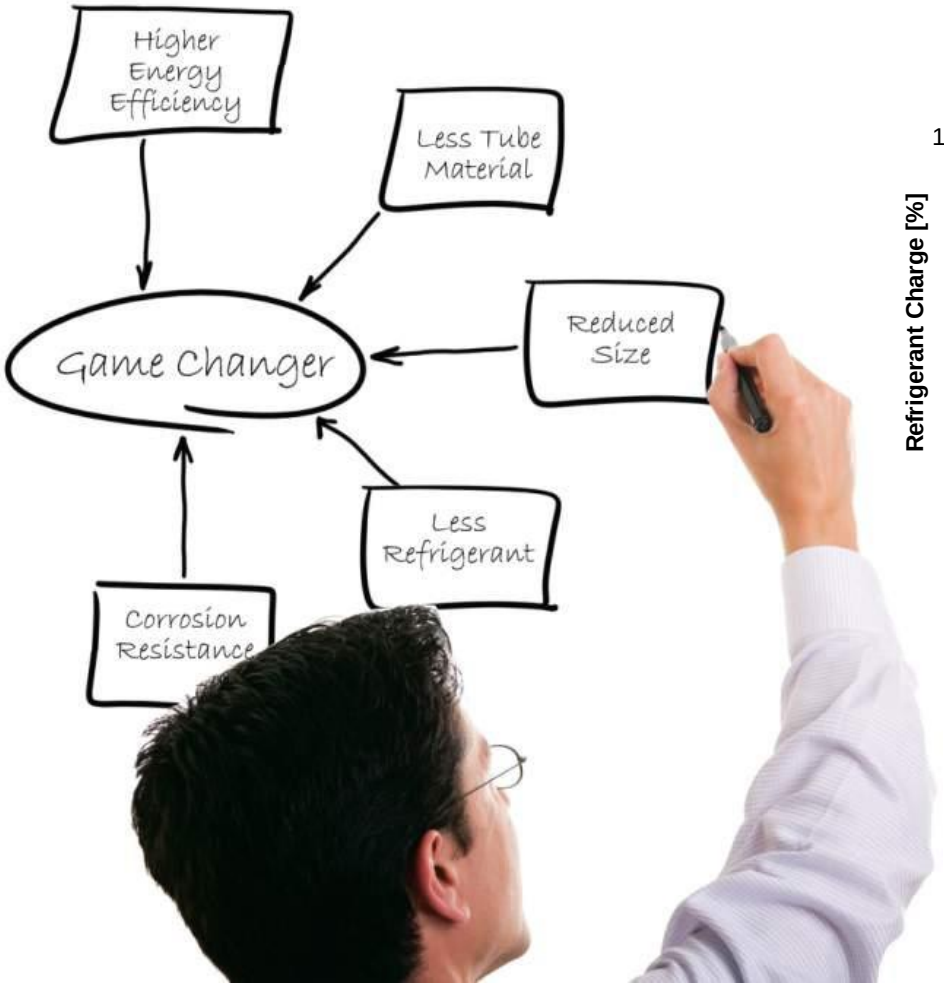
Example: Optimization of 5.7 ton condenser implementing microgroove technology

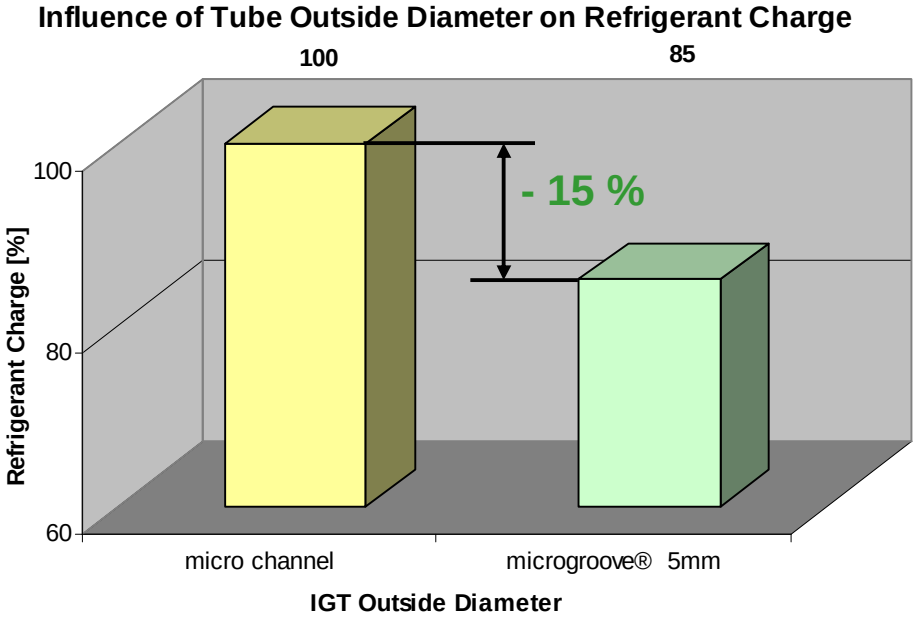
Description	Outside diameter	Bottom wall [inch]	Unit weight decrease	Required tube length	Material ratio	Refrigerant charge
Base line	3/8"	0,0118	100%	280 ft	100%	100%
microgroove	5 mm	0,0083	36%	420 ft	54%	44%

- **Cuts metal costs** nearly into half
- **Improves energy efficiency**
- Significantly **reduces** heat exchanger **weight**
- **Maintains** all **advantages of copper** tube based heat exchangers
- **Reduces refrigerant charge** by >50%

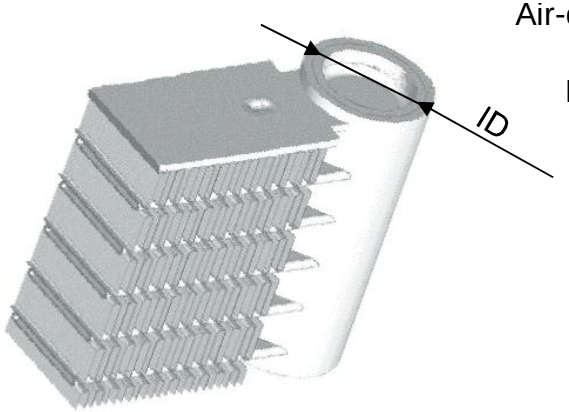
Wieland

microgroove® - Refrigerant Charge





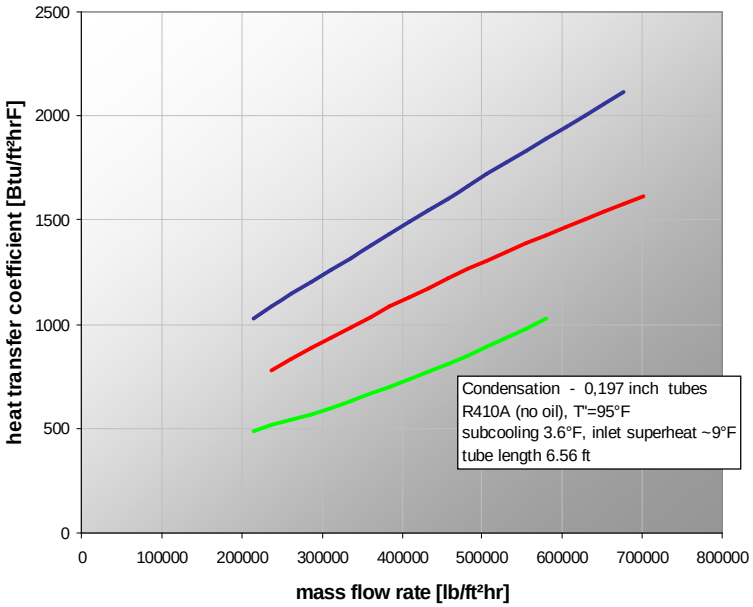
Air-cooled condenser
Capacity 20 KW
Equal frontal area
Equal fans



Development of IGT on customer demand

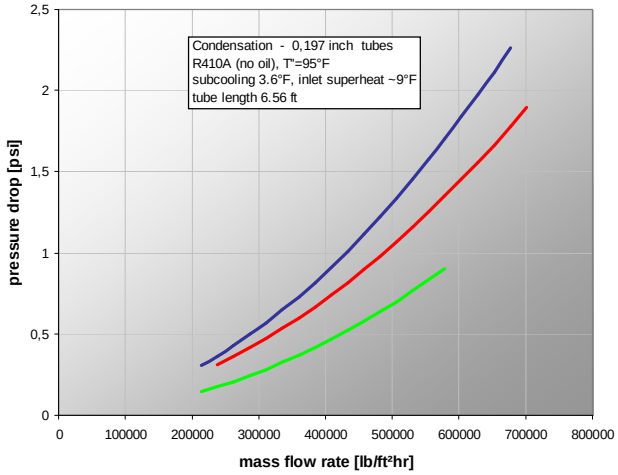
Example: Development task: Design optimized microgroove fin pattern for condensation of R410A

Heat transfer performance



Significant heat transfer enhancement in **condensation** mode was achieved.

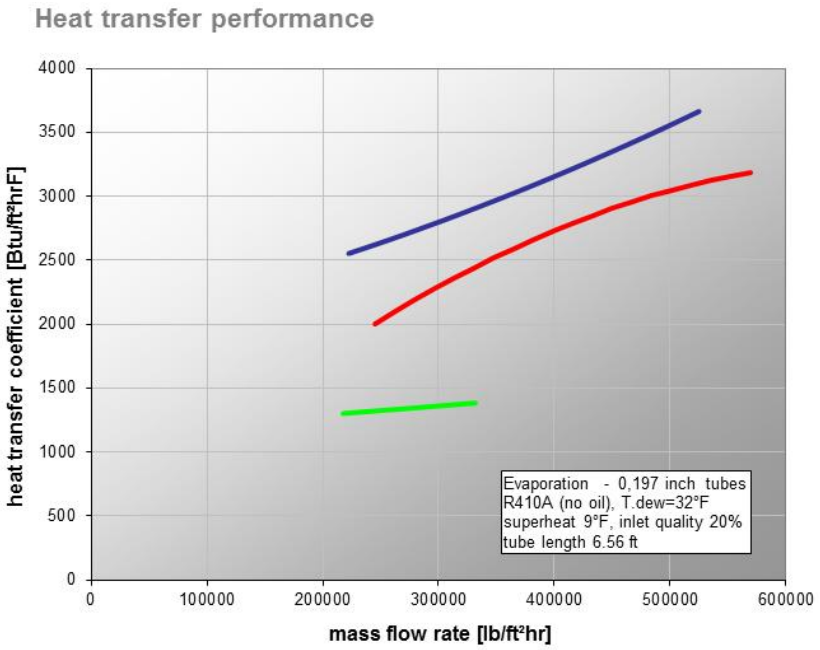
Pressure drop



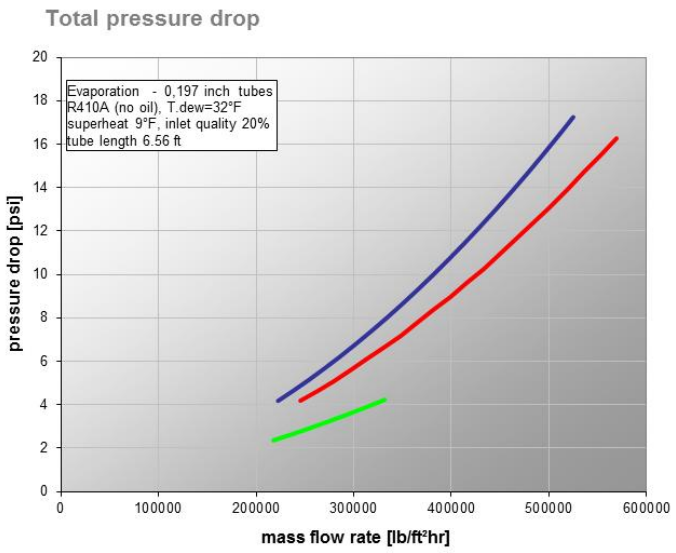
Wieland

Development of IGT on customer demand

Example: Development task: Design optimized microgroove fin pattern for condensation of R410A



Moderate enhancement for **evaporation** compared to standard microgroove, as this design favors condensation.



Wieland Thermal Solutions®

PROVIDING EFFICIENCY

Thank you for your attention!

For questions: steffen.rieger@wieland.de