Delayed coking availability improving by means of ceramic coatings

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TUBACOAT

KEY FACTS

- Worldwide leading supplier of Seamless Stainless Steel Products with the widest portfolio in the market
- 12 mills, commercial presence and own stocks and service centers worldwide.
- Fully integrated manufacturing process.
- More than 300 customers in over 100 countries.
- 2300 professionals.

TUBACEX INDIA · AWAJI STAINLESS · TTA · TSS · TTI · ACERALAVA · SALEM TUBE · SCHOELLER BLECKMANN · IBF

Worldwide leading supplier of Seamless Stainless Steel Tubes

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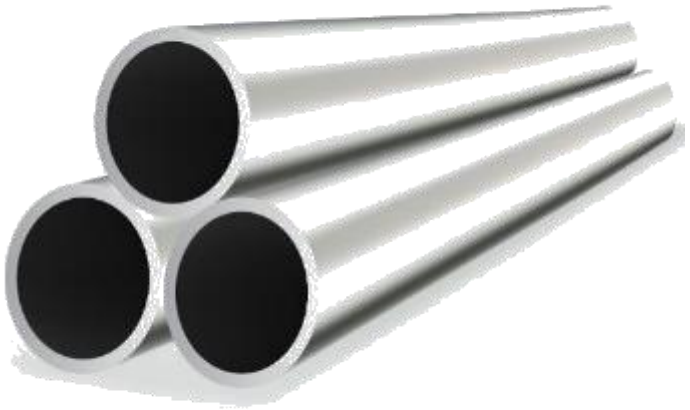
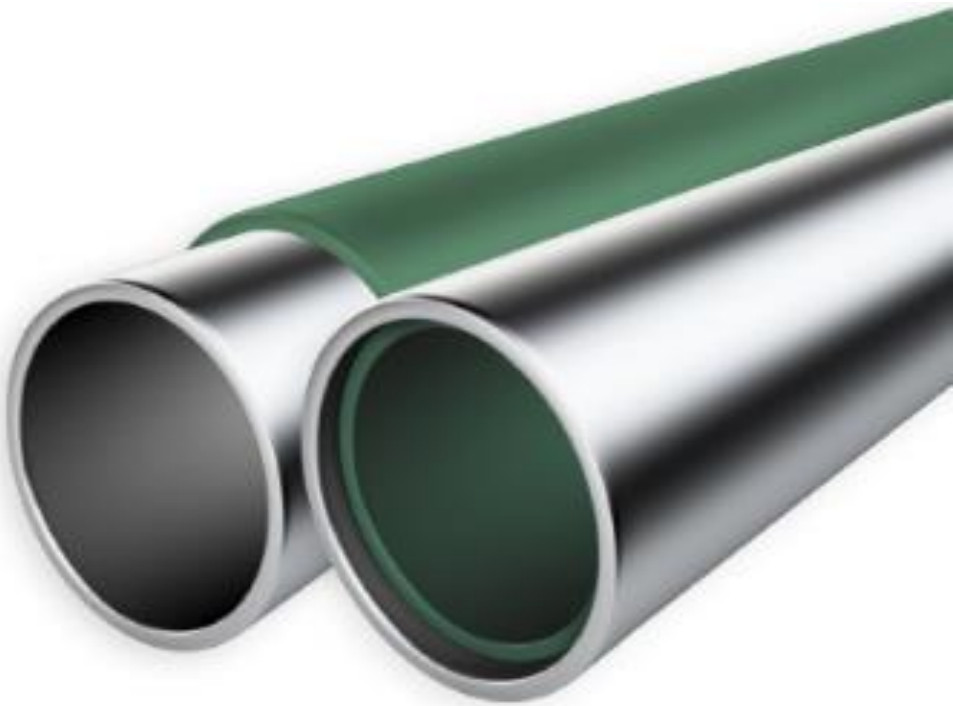




1

MORPHOLOGICAL

- Continuous coating layer
  Thickness control based on suspension parameters & rheological properties
- Roughness, decrease ≈ 97% minimizing particle adhesion
- Good chemical bonding between metal substrate and ceramic coating

MECHANICAL

- Hardness & Elasticity
  Coating is harder than substrate but less elastic
- Abrasion resistance
  ≈ 94% decrease in mass loss
- Good adherence. Impact test: No coating detachments at medium loads

CHEMICAL

- High corrosion resistance compared to base material

THERMAL

Thermal resistance
Good performance under thermal cycling
No delamination – No cracks

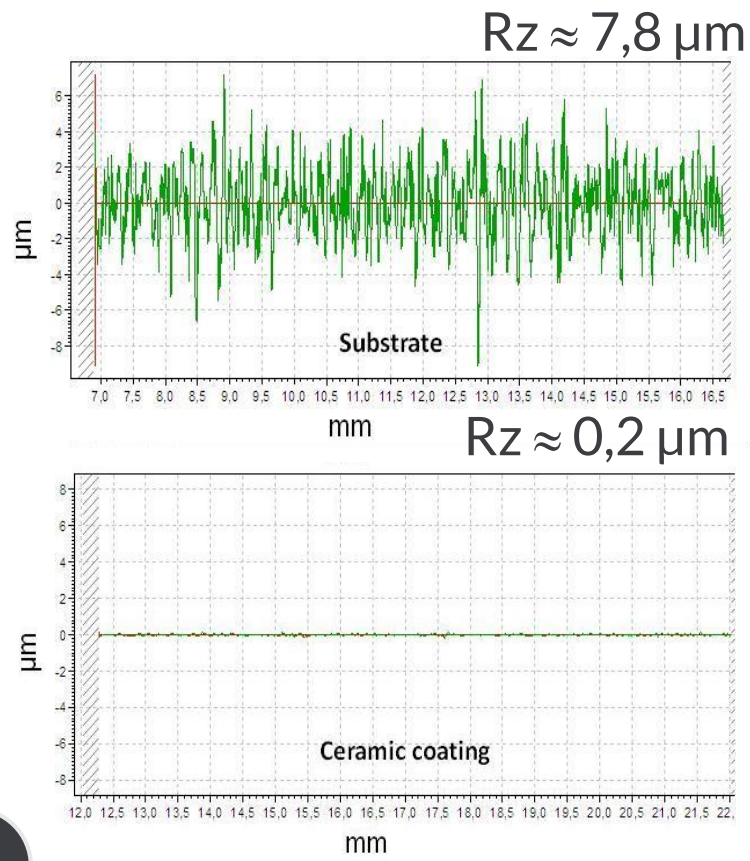
Thermal conductivity
Thermal conductivity range ≈ 5-8 W/mK = f(T) Average (reference) 6 W/mK

Morphologycal

1

Continuous coating layer

Thickness control based on suspension parameters & rheological properties



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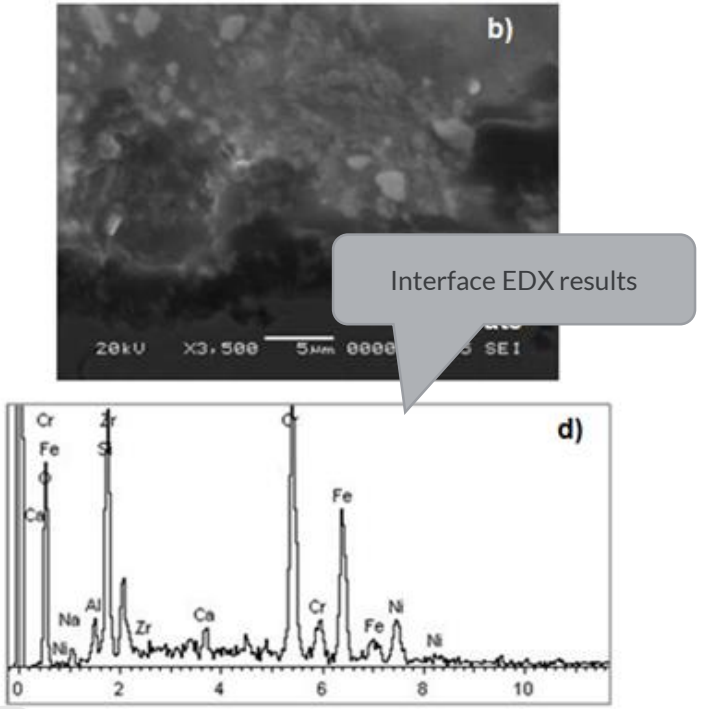
Roughness, decrease ≈ 97% minimizing particle adhesion



3

Good **chemical bonding** between metal substrate and ceramic coating

Product characterization

Mechanical

	Base Material	Ceramic coating
Hardness (HV)	220	840
Elastic Modulus EIT (GPa)	140	87

Elongation ≈ 1,2-1,5%

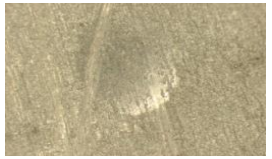
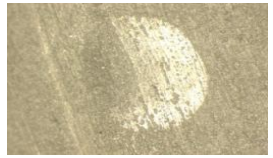
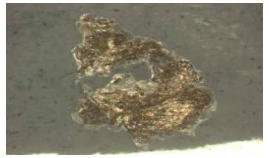
1

Hardness & Elasticity
Coating is harder than substrate but less elastic

10000 cycles

2

Taber test **Abrasion resistance** ≈ 94% decrease in mass loss

Height	Stainless Steel	Ceramic coating
5 cm		
10 cm		
15 cm		

3

Good performance. Impact test: No coating detachments at medium loads

Chemical

High corrosion resistance compared to base material

- **Pitting Corrosion Resistance** Solution: 5% NaCl, 25 ºC and electrode potential to 1 mA/cm2
- **Pitting Corrosion Resistance** Method A-Ferric Chloride
- **Seawater corrosion test Solution**: 3,5% NaCl at 22ºC
- **Acid corrosion test Solution**: 10% HCl at 22ºC
- **Molten salt corrosion test** NaNO3 + KNO3 (60/40)

Field applications & Experience CASE 1

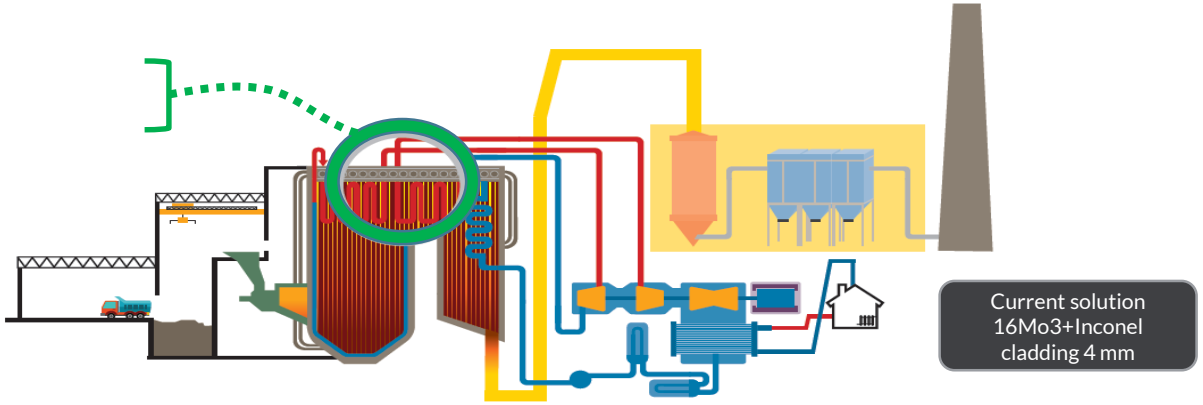
Steam reheater & Thermocouple sheath

Working conditions

Steam temperature	Pressure	Furnes termperature	Inner fluid media	Outter fluid media	Other
300 °C	170 bar	850 °C	Steam	W to E fumes	Alkaline ashes

Applications

- Steam reheater
- **Thermocouple sheath**



Chemical corrosion | Efficiency loss | High OPEX

Field applications & Experience CASE 1

Steam reheater

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TP310H outer coated tubes
vs 16Mo3 + Inconel overlay

Results

- Low ash adherence
- Glossy surface after 2 years in operation
- Negligible loss of mass

Conclusions

- **Longer tube life expectation**
- Improved thermal efficiency
- **Possibility to increase thermal cycle temperature**

Air preheater Coke calciner

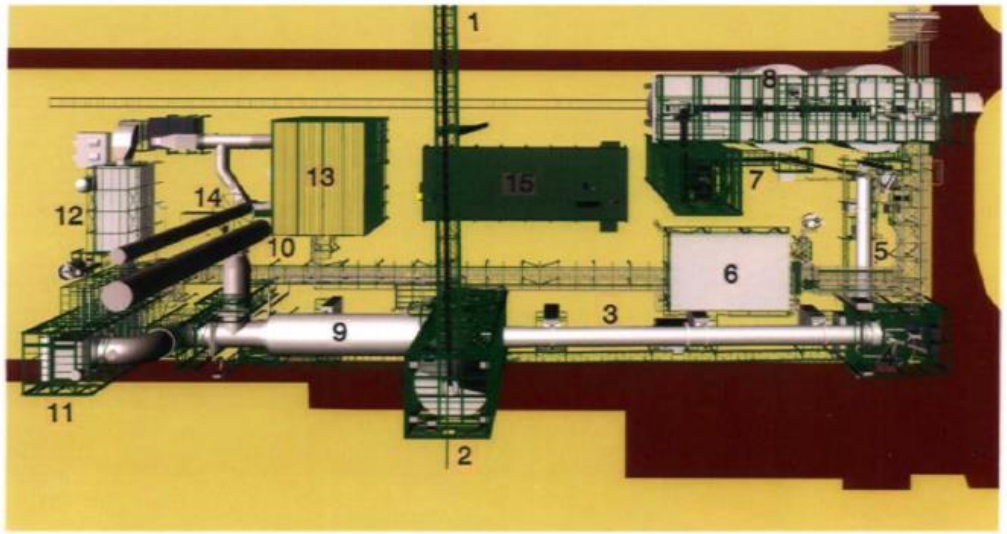
Application

- Coke Calciner Recuperator

Working Conditions

- Oil **fumes rich in vanadates at 850ºC**
- Metal surface 570ºC
- Low pressure (welded tube)

Current solution **TP310 (bare)**



1 Green coke conveying belt *)
2 Green coke feed bin
3 Rotary kiln
4 Kiln firing building
5 (Indirect) coke cooler
6 Air cooler
7 Product conveying system
8 Product storage silos
9 Incinerator
10 Emergency or By-pass Stack
11 Waste heat boiler
12 Baghouse dust filter
13 Desulphurisation unit
14 Stack
15 Control - / MCC Room

Source: Technip Germany. Coke Calcining Plants June 2008

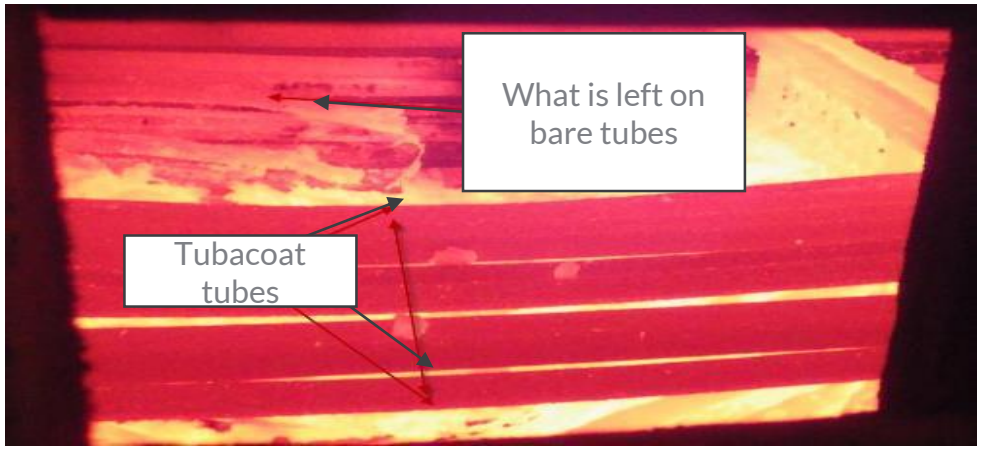
Chemical corrosion

Efficiency loss

Field applications & Experience CASE 2

Coke calciner

10 months working



8 months working

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TUBACOAT Anti corrosion/erosion proposal

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5000 mm, OD 30, WT 2,5

Refinery sector
OUTER COATING

Overhead Condenser Crude distillation (corrosion/erosion)

2

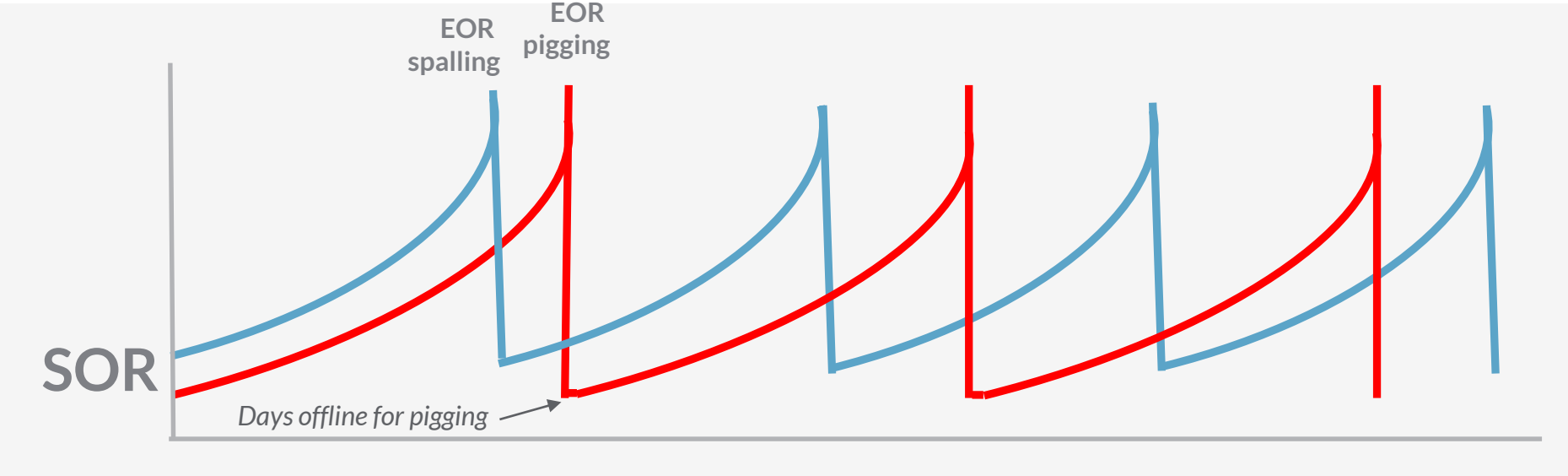
Why does the coke stick to the tube in the furnaces?

What are the consequences?

Have you ever thought about increasing the availability?

How much availability is lost in a coker annually

DCU on-line spalling and offline pigging



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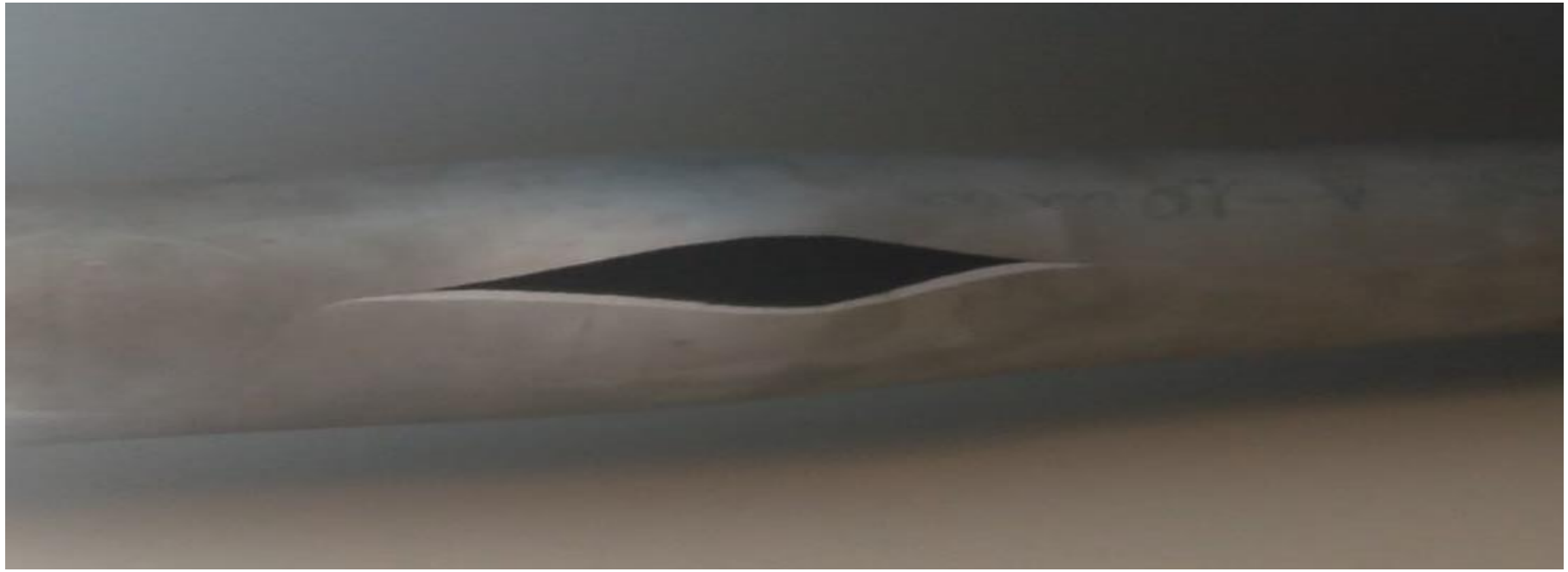
Did anyone observe a skin overheating Did anybody detect, in the shutdowns, warped tubes



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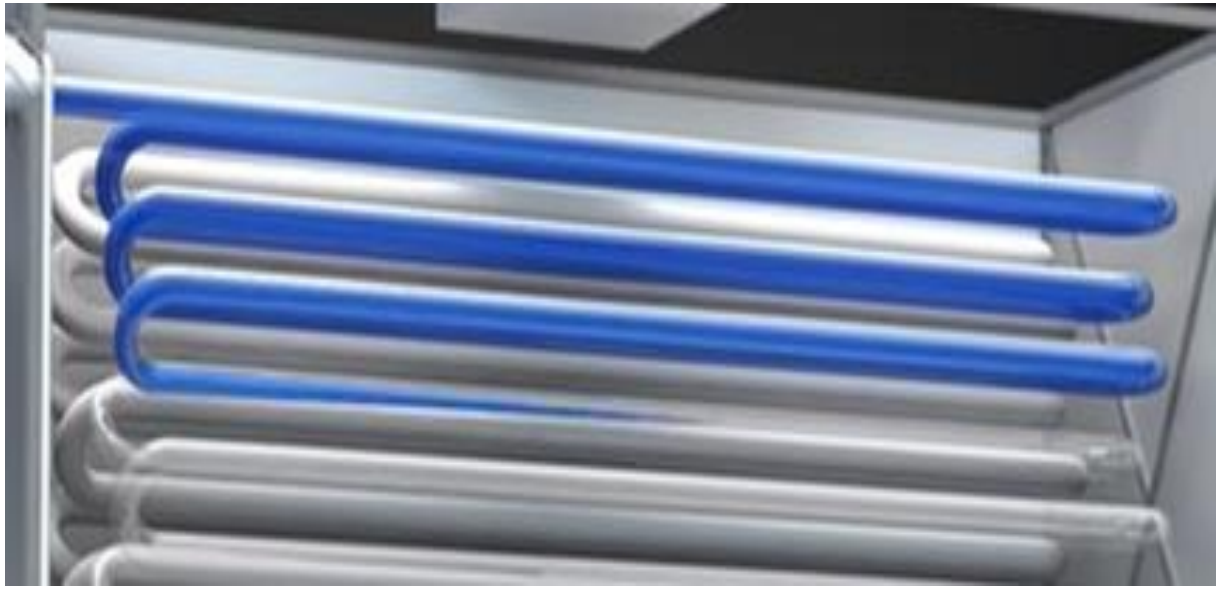
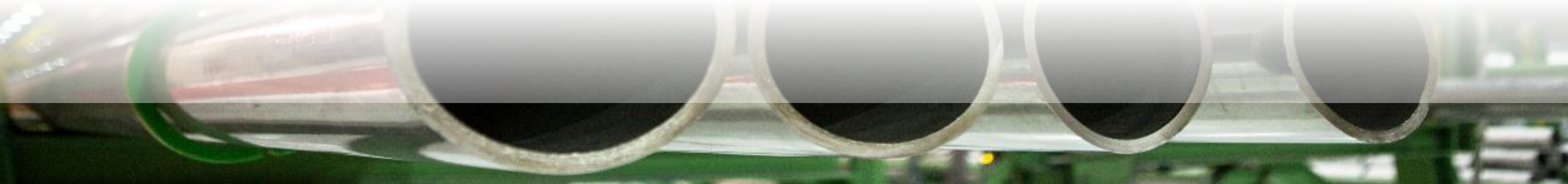
Could you imagine a furnace made up of tubes with inner ceramic coated ?



Opportunity for new designs

1. The residues fed to the DCU are cracked at 900 F (500 °C) or more.
2. The goal is to heat the residue in the DCU furnaces and to crack the residue in the coke drums and not in the furnace
3. Steam, velocity, tube metallurgy, advanced furnace designs are used to minimize carbon lay in furnace tubes.
4. However, carbon (coke) lay down does still occur in furnaces, so periodic decoking is necessary to recover DCU furnace capacity and efficiency

Will the ceramic avoid the adherence of coke particles



TUBACOAT Anti coke value proposal

- Coker (clogging)
- Visbreaker (clogging)
- Crude distillation (clogging)
- IGCC downstream lines (clogging)

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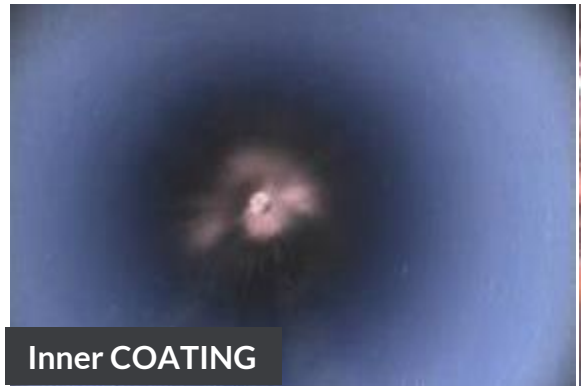
Vacuum Destillation Unit

Refinery sector



317 Grade
5500 mm, OD 141, WT 6,5

We are entering a stage of advanced design of furnaces with great efficiency and, above all, with great availability.

THANK YOU!

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