REFCOMM®
VALENCIA
1-5 October, 2018

Maximize performance of your FCC unit, using unconventional solutions

RefComm® Valencia, October 2018

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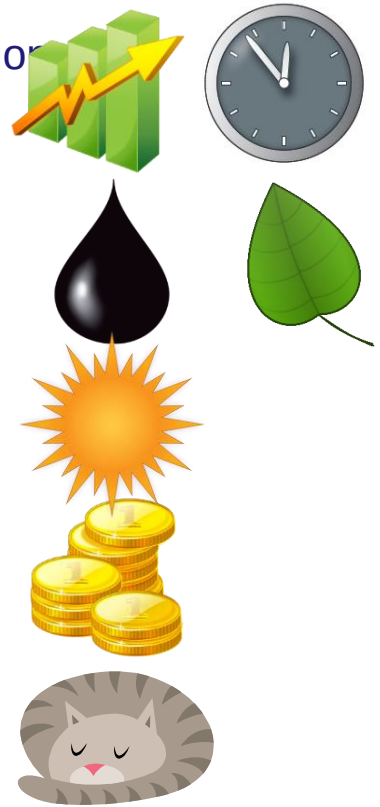
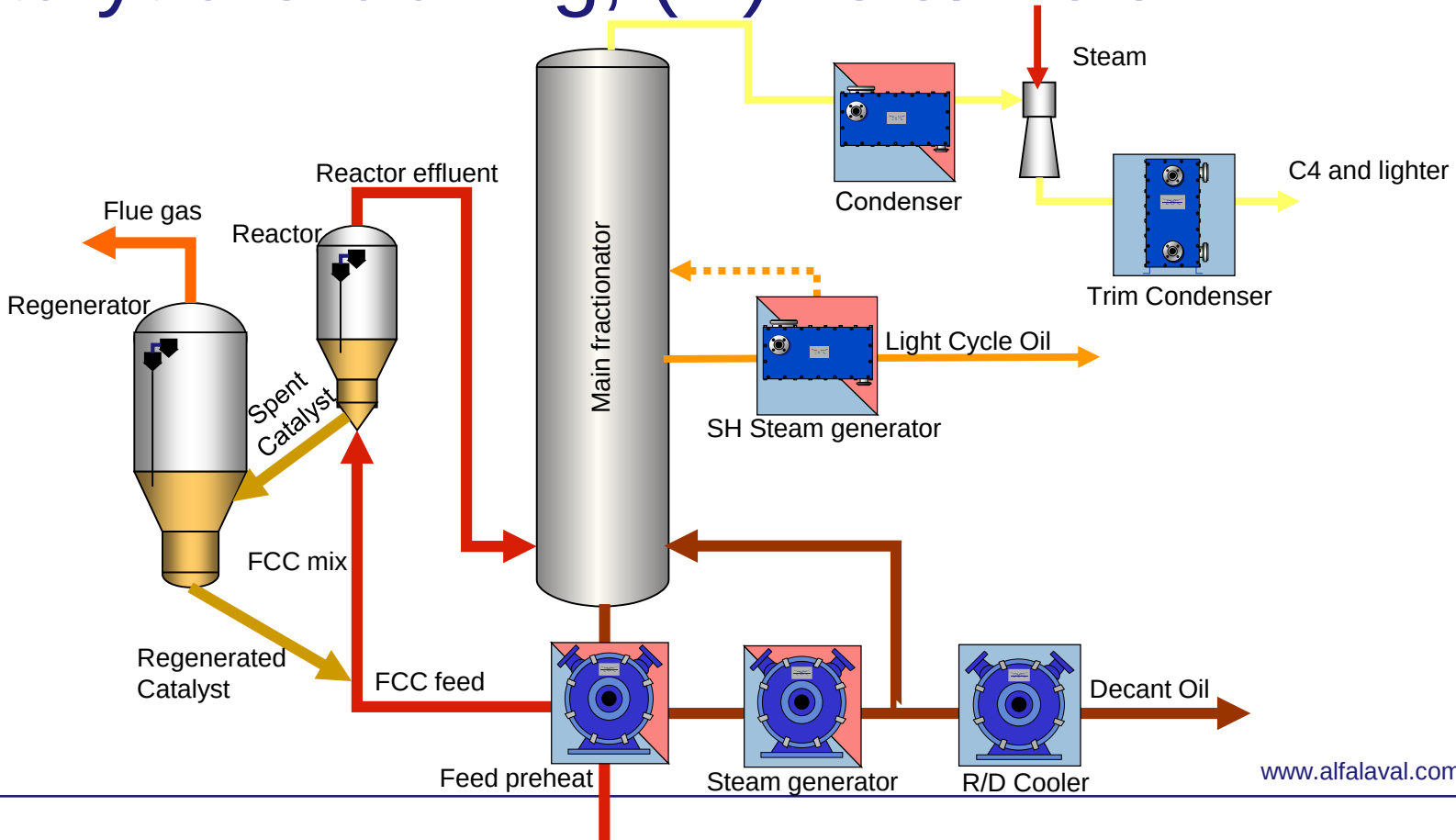
CONTENT

- Maximize performance of your FCC unit, using unconventional solutio

* Uptime & Availability
  - In your most fouling services – choose the right solution!
* Energy Efficiency
  - If it can be recovered, why waste it?
* Yield Improvements
  - When the rays of the sun make your assets sweat
* CAPEX Reduction
  - The best solution does not have to cost more….
* Reliability
  - In your most critical services, don’t take any risks!



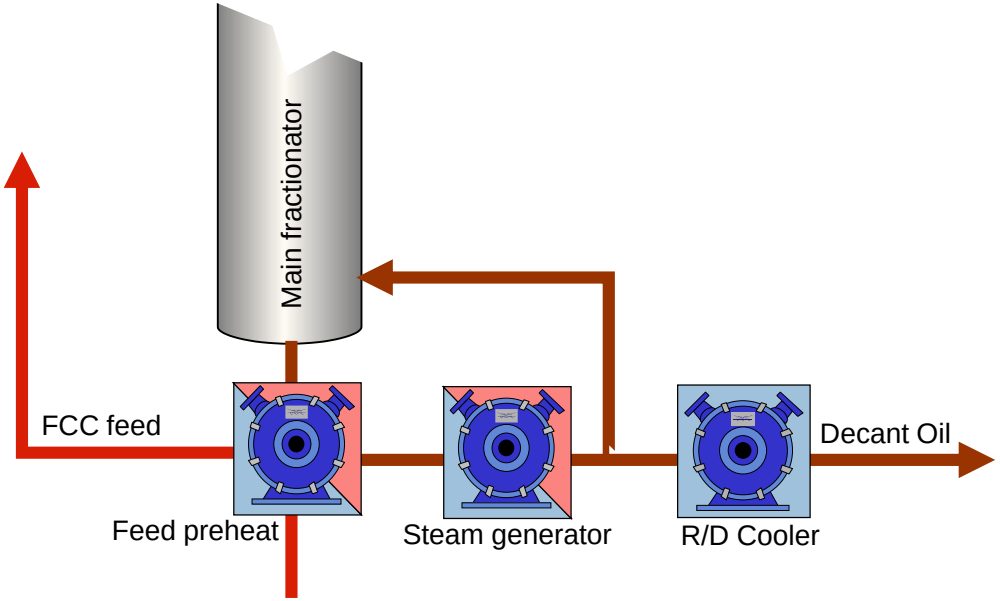
Catalytic Cracking, (R)FCC/DCC



UPTIME & AVAILABILITY

- In your most high-fouling services, choose the right solution!

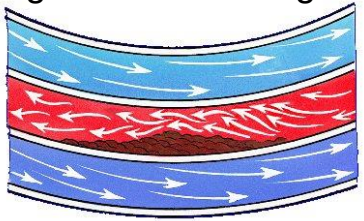
* Slurry exchangers
  - Feed preheaters
  - Steam generators
  - Run Down Coolers
* Heavy fouling
  - Bottleneck
  - Frequent cleaning & repair
  - Downtime
  - Stand-by equipment
  - HSE issues

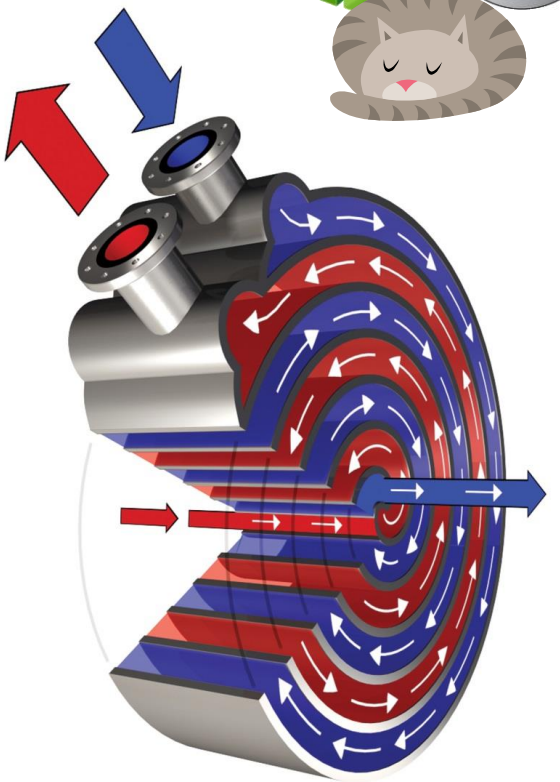


UPTIME & AVAILABILITY

- Spiral Heat Exchangers (SHEs)

* High Heat Transfer Efficiency
  - 2-3 times higher than S&Ts -> 2-3 times less HTA
  - Fully Counter-current flow with temperature approach of 5°C -> Single exchanger solution
* Self-Cleaning Design
  - Short hold-up time
  - No dead zones & uniform velocity
  - Single channel design





UPTIME & AVAILABILITY

- Slurry run-down cooler, Total Mider, Leuna, Germany (UOP license)

Duty:

FCC Bottoms, 10-15 tph	180 → 75 °C
Warm water loop	65 ← 45 °C

Heat load: 0,9 MW

Original installation:
Two double-pipe exchangers, cleaned 40 times during first year

Replaced by:
Two spiral heat exchangers, one in operation and one in stand-by,

Start-up: Beginning 1999.
2001 & 2002 – catalyst carry-over into MF. Spirals cleaned by flushing AGO.
2004 – internal inspection by TUV. No remarks.
No mechanical cleaning required.

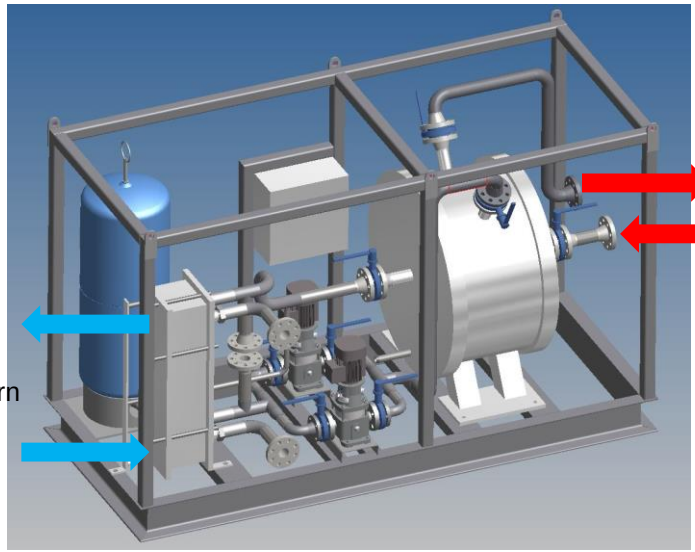
Installed Cost = 360 kEUR
Annual savings in maintenance = 180 kEUR

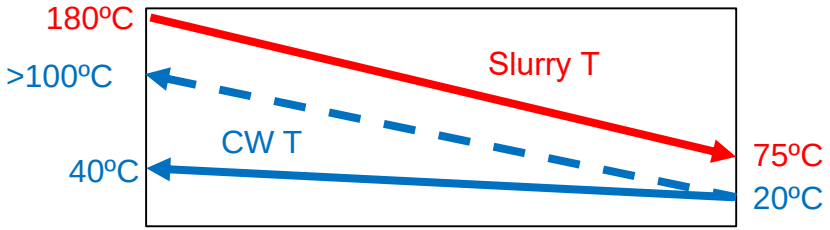
TOTAL

UPTIME & AVAILABILITY

- Optimized performance control with closed loop cooling system module

* Optimize temperature of closed loop cooling media
  - Minimize size/cost of Spiral exchanger
* Keep constant temperature of closed loop cooling media
  - Avoid ”over cooling” of Slurry oil
  - Avoid capacity issues
  - Avoid corrosion issues due to CW control (see below)





Corrosion risk when controling duty on CW flow

UPTIME & AVAILABILITY

- References – MF Bottom Slurry Coolers

Country	Licensor	Equipment	Year
Austria	UOP	1 SHE	1992
Belgium	UOP	1 SHE	2012
Colombia		2 SHE	2018
Germany		2 SHE	92
Germany		1 SHE	2016
Germany	UOP	2 SHE	1998
Ghana	UOP	2 SHE	2000
India	UOP	5 SHE	04 & 06
Korea	UOP	3 SHE	96 & 04
Korea	UOP	3 SHE	2009
Korea	Axens	3 SHE	2017
Nigeria	UOP	2 SHE	2018
Russia		2 SHE	2011
S Africa		2 SHE	2011
Taiwan	UOP	4 SHE	1997
USA		1 SHE	2014
USA		4 SHE	2011
USA		1 SHE	2018

UPTIME & AVAILABILITY

- Slurry / Feed heat recovery, European Refinery, (KBR license)

Duty:

FCC Slurry, 285 tph	337 → 215 °C
FCC Feed (UCO+VGO), 200 tph	288 ← 135 °C

Total recovered heat: 23 MW

Original installation:
Two S&Ts, plugging on slurry side of solids from reactor, cleaning needed every 3-4 months, causing capacity bottleneck.

Replaced by:
Two spiral heat exchangers, 2 * 50%.
Plant capacity increase of 10%:
- Increased feed preheating with 20°C
- Increased cooling of main fractionator bottoms
- Increased cooling of finished products

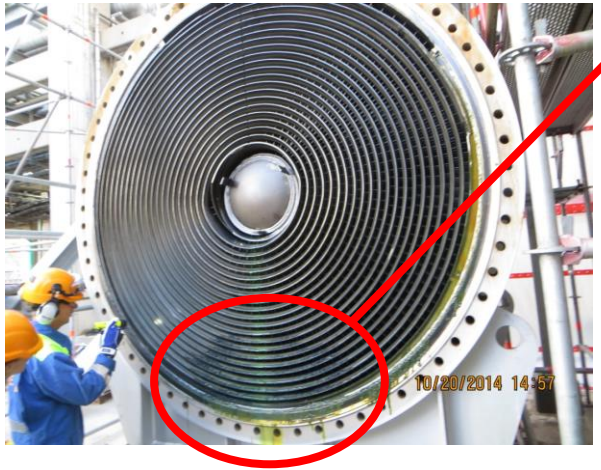
Eliminate capacity loss during cleaning
Reduced cleaning cost

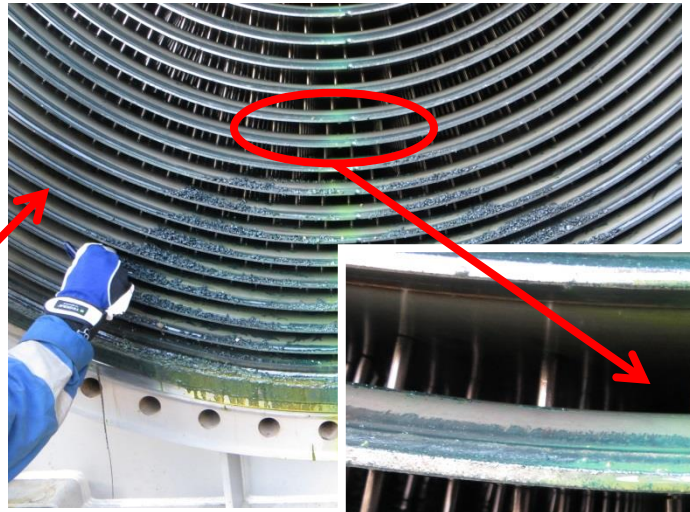
Start-up: November 2013.

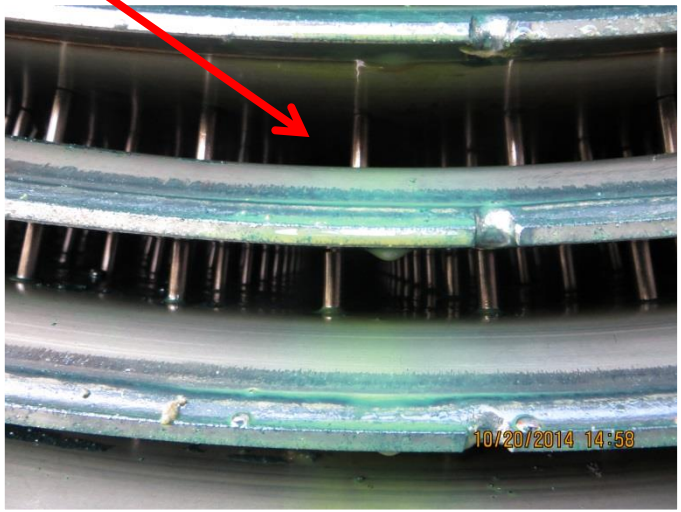
UPTIME & AVAILABILITY

- Slurry / Feed heat recovery, European Refinery, (KBR license)

* Decant side opened once for inspection after 1 year operation -> No fouling







UPTIME & AVAILABILITY

- References – MF Bottom Slurry/Feed Interchangers

Country	Licensor	Equipment	Year
Japan	UOP	2 SHE	2006
Russia		2 SHE	2012
Sweden	KBR	2 SHE	2013

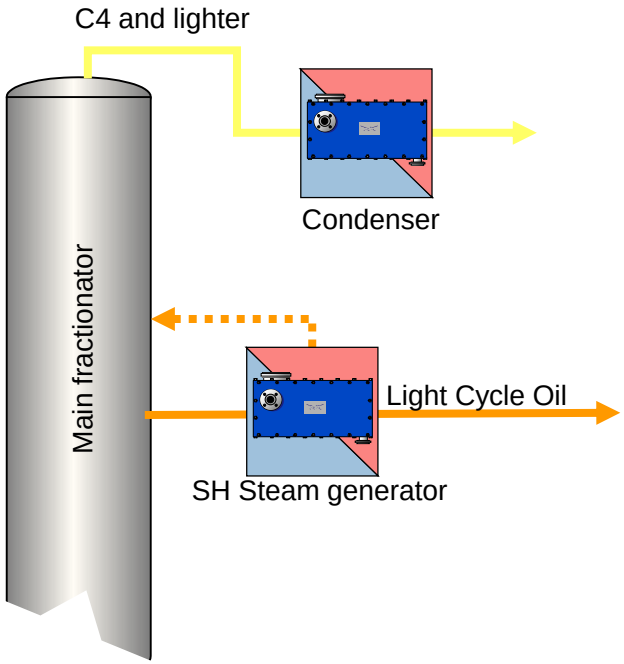
ENERGY EFFICIENCY

- If it can be recovered, why waste it?

* Low grade energy CAN be efficiently recovered

  - OVHD vapour -> Boiler Feed or District Heating Water pre-heating

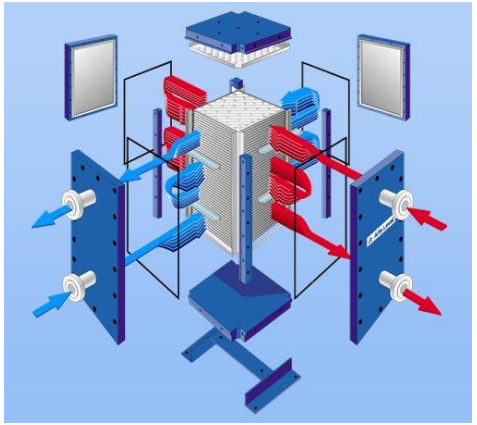
  - Hot run-downs & PAs -> Superheated steam



ENERGY EFFICIENCY

- Welded Plate Heat Exchangers (WPHEs)

  - Maximal Energy Recovery
    - 3-5 x higher heat transfer efficiency
    - Temperature approach of 3-5 deg C
  - Compact & Light Weight
    - 4000 m2 S&T HTA* fits in 3 m2 plate space
    - 5-10 x less flooded weight
  - Low Fouling Tendency & Easy to Clean
    - 3 x longer operating period in-between maintenance
    - 1-3 days down-time for cleaning
  - Cost-efficient in Corrosion-free Materials



* Equals 850 m2 WPHE area

ENERGY EFFICIENCY

- MF OVHD condensers, Shell Sarnia, Canada (UOP license)

1st Stage – Heat recovery:

Overhead vapour	141 → 87°C
BFW	128 ← 43°C

Total recovered heat: 14 MW

Preheating of BFW required to de-bottleneck boiler to provide energy for a new diesel hydrotreater to produce ULSD.
Plant energy foot print not allowed to increase.

2nd Stage – Trim Cooling:

Overhead vapour	87 → 29°C
Cooling water	45 ← 24°C

Original installation:
4 S&Ts in CS, without energy recovery, suffered from corrosion of bisulphides, cyanides and chloride salts.

Replaced by: 8 WPHEs in Hastelloy C276

Start-up: January 2003

ENERGY EFFICIENCY

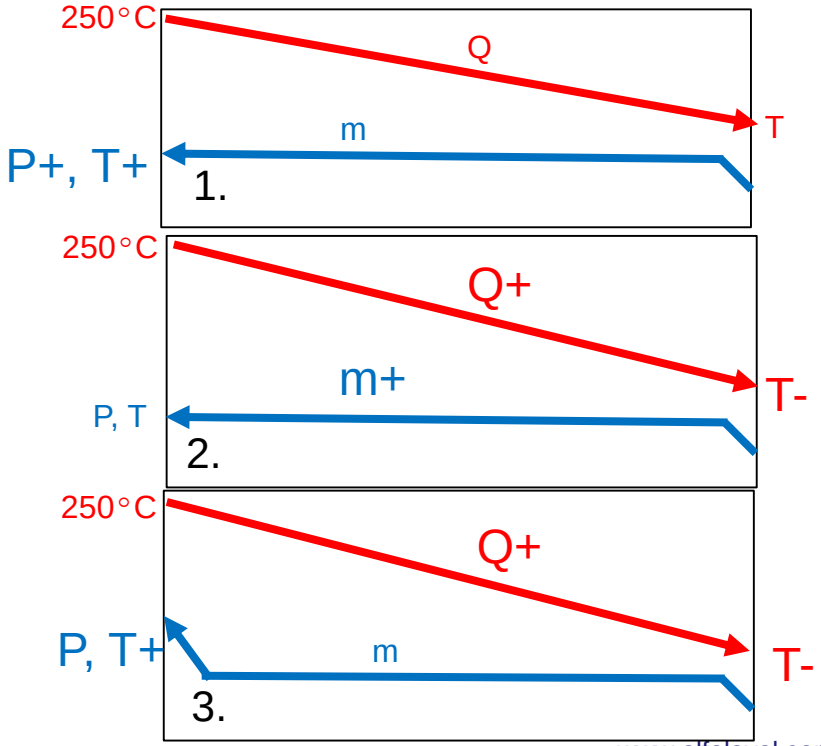
- Steam generation from hot PAs and RDs

When WPHEs are used as steam generators, they can operate with a much closer temperature approach. This means that

1. Same amount of saturated steam can be generated at higher pressure

2. More saturated steam can be generated at same pressure

3. Same amount of Superheated steam can be generated



ENERGY EFFICIENCY

- SH Steam generation from fractionator MPA, European Refinery

Duty:

MPA, 330 tph	221 → 181 °C
SH Steam, 15 tph	215 ← 120 °C @ 11 bar (30°C SH)

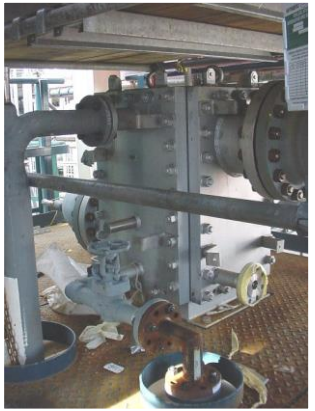
Total recovered heat: 8,2 MW

Steam generations system comprises:
- BFW preheater
- Steam generator
- Separation vessel
- Steam superheater

Start up: 2002

Pay-back around 6 months, based on a steam cost of 10 USD/ton

Steam superheater



Steam generator

ENERGY EFFICIENCY

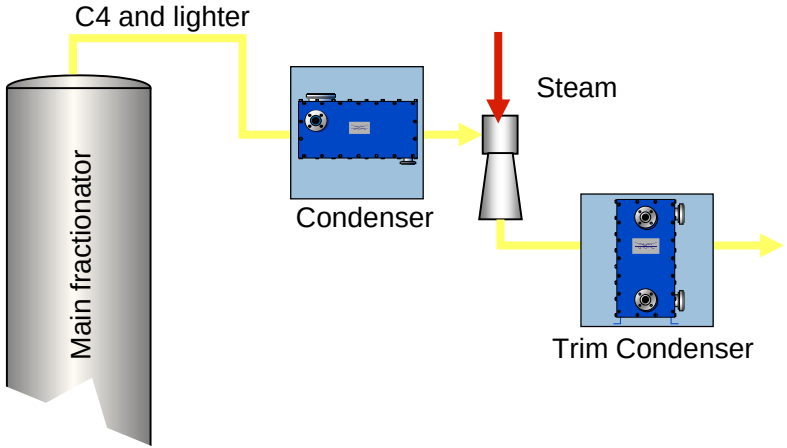
- References – Steam Generators from hot PAs and RDs

Country	Hot media	SH	Equipment	Year
Australia	Jet Fuel	No	2 WPHEs	2017
China	VGO	No	1 WPHE	2015
China	HVGO	No	1 WPHE	2015
Italy	VR/VBR	No	1 WPHE	2013
Netherlands	HCK MPA	Yes	4 WPHEs	2002
Netherlands	ADU HGO	Yes	3 WPHEs	2010
Turkey	HCK Kero	Yes	3 WPHEs	2012
Turkey	HCK Diesel	Yes	3 WPHEs	2017
Turkery	HCK BPA	Yes	3 WPHEs	2017
USA	VR	No	2 WPHEs	2005
USA	VR	No	1 WPHE	2009

YIELD IMPROVEMENTS

- When the rays of sun make your assets sweat

* Maximal cooling
  - De-bottleneck of processes/improve yield
  - Reduce size/cost of ejector/compressor system



YIELD IMPROVEMENT

- FCC OVHD vapour cooling, South American refinery

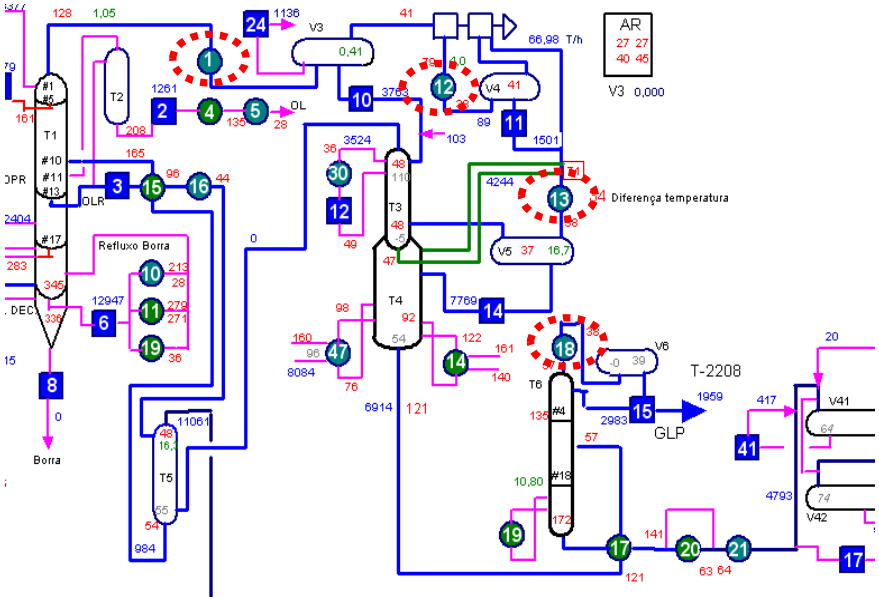
4 WPHEs were installed in a revamping/de-bottlenecking of FCC unit in Petrobras REPLAN

1. 1 WPHE in parallel to existing 8 S&Ts, providing 25% additional cooling capacity (10,5 MW)

12. 1 WPHE in parallel to existing 4 S&T, providing 5,1 MW additional cooling capacity, reducing compressor load

13. 1 WPHE replaced 2 S&Ts, providing 8,3 MW cooling capacity

18. 1 WPHE in parallel to existing S&T, providing additional cooling capacity



YIELD IMPROVEMENT

- FCC OVHD vapour cooling, South American refinery

	S&T	CP
TOTAL WEIGHT (kg, flooded)	136.000	17.500
TOTAL HTA (m2)	2960	320

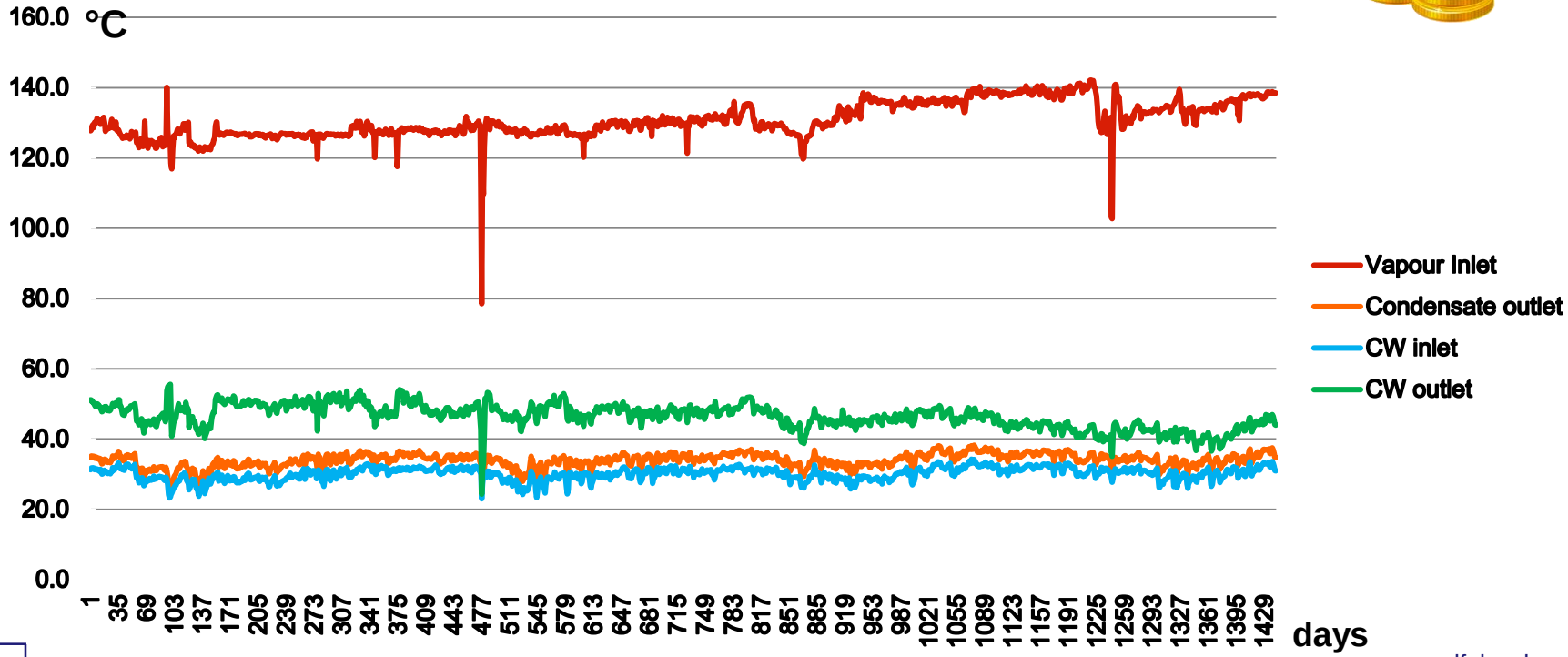
Pos 1: Main Fractionator condensers,
WPHE = 10,5 MW,
start-up 2009

Pos 12: Compressor interstage condensers,
WPHE = 5,1 MW,
start-up 2009

Pos 13: Post compressor condenser,
WPHE = 8,3 MW
start-up 2005

YIELD IMPROVEMENT

- FCC OVHD vapour cooling, South American refinery



CAPEX SAVINGS

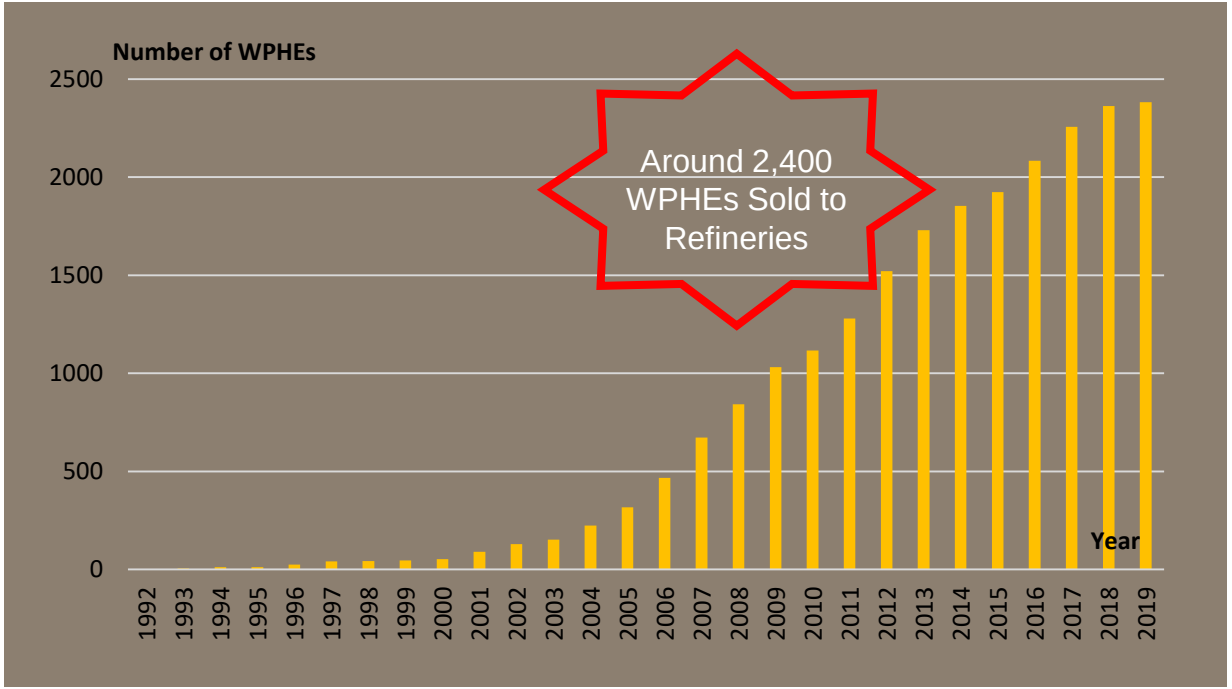
- A better solution does not have to cost more….

- When Welded PHEs will save a bundle!
  - When 2 or more CS S&Ts are needed for one service
  - Any time high grade MOC is needed
  - When installation is on structure
  - When CAPEX can be saved in fired heaters, boilers and/or coolers due to better heat recovery
  - When CAPEX can be saved in compressor/ejectors due to reduced vapour flow and/or lower pressure drop

RELIABILITY

- Welded PHEs in the refinery market

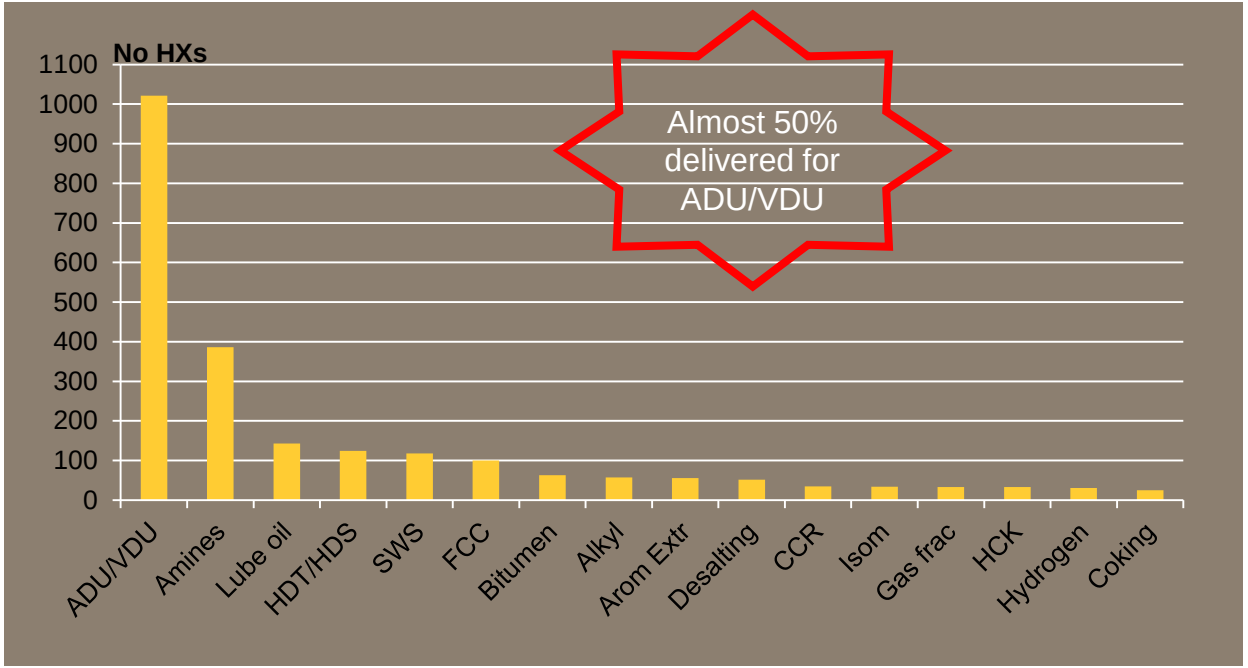
- A well-proven solution
- Introduced to refineries in early 1990's
- Gaining market share since beginning of 2000
- Around 2400 WPHEs sold to refineries world-wide



RELIABILITY

- Welded PHEs to Refinery processes

- Used in all refinery processes
- Mainly used for heat recovery services, such as
  - ADU/VDU PHT
  - Amine & SWS F/B
  - Fractionator F/B
  - Fractionator OVHD to feed or BFW
  - Steam generation

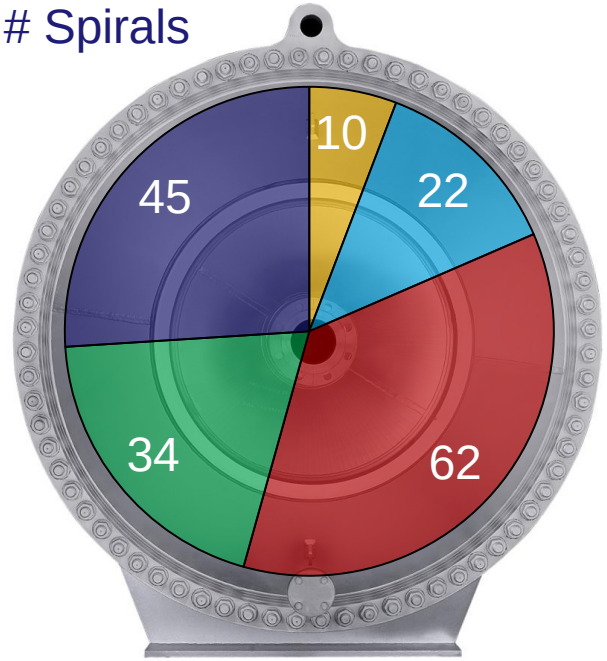


RELIABILITY

- Spirals to heavy oil processing

- Tailor-made for high-fouling services
- A well-proven solution
- Introduced to refineries in mid 80’s
- Over 300 Spirals delivered to refinery processes, out of which more than 170 are for heavy oil processes

Spirals



SUMMARY

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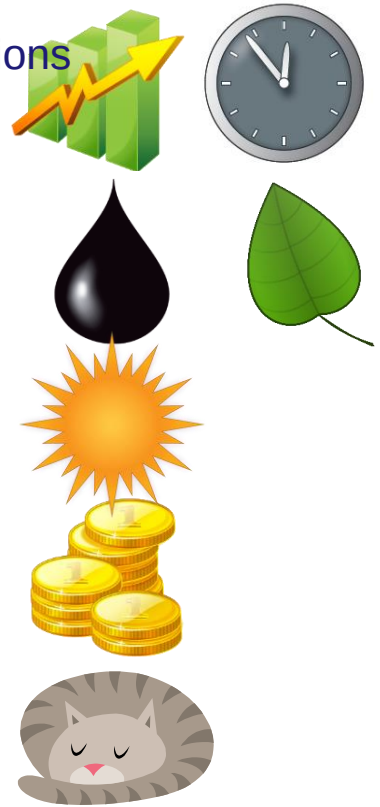

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