IMPROVE DISTILLATION EFFICIENCY BY UOP EQUIPMENT

Optimize Distillation Unit by using UOP High Performance Tray & Tube

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Community of Practice

TIChE

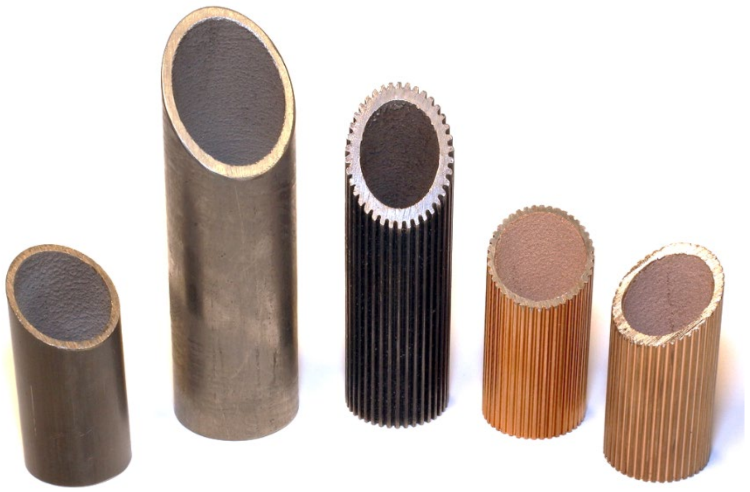
UOP HIGH PERFORMANCE TRAY & TUBE

Maximized Production Rates

Improved Product Purities

Improved Produce Recoveries

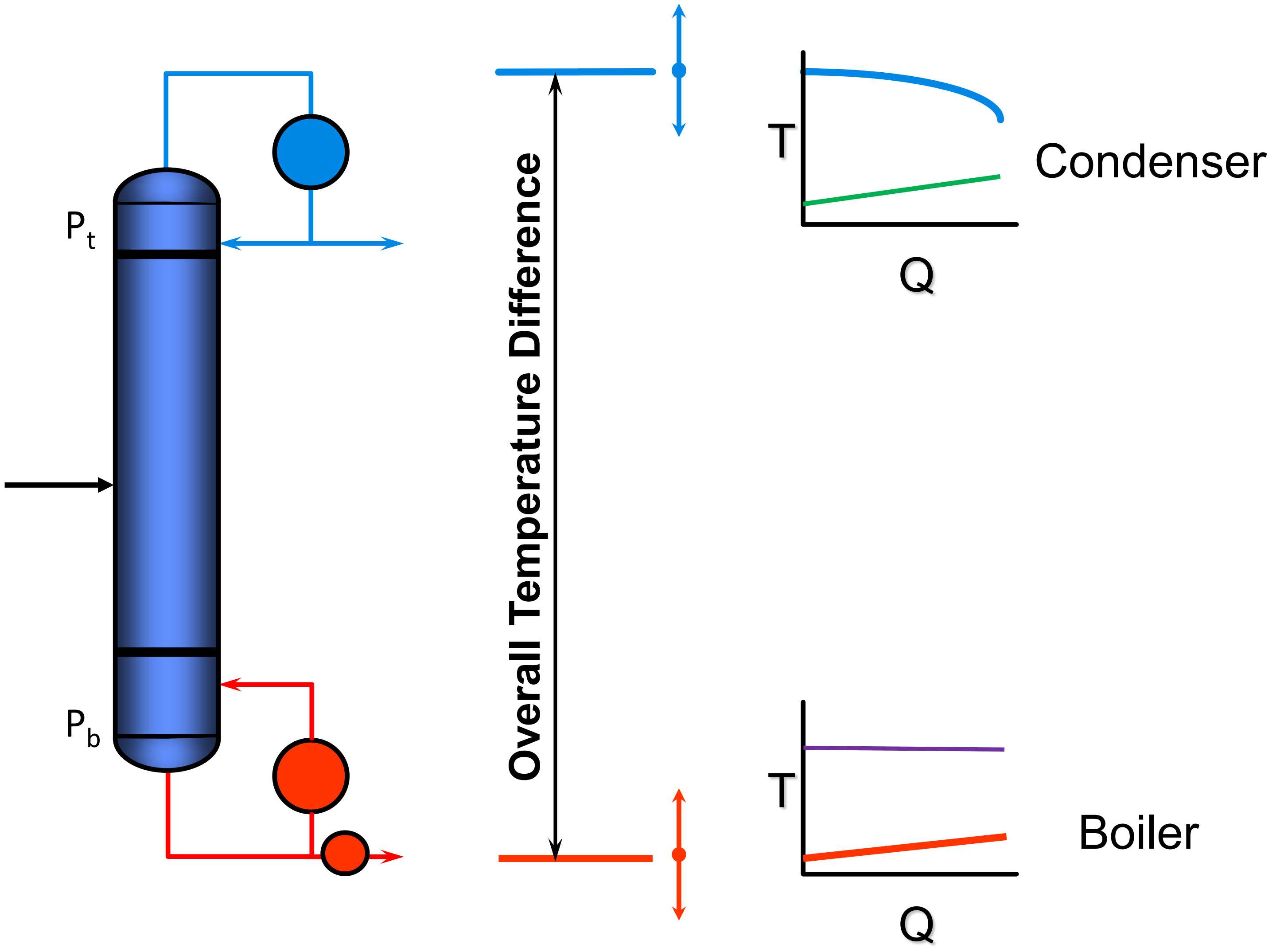
Minimum CAPEX



SIMPLE DISTILLATION SYSTEM

- **Unit Operating Pressure**
  - Condensing Medium
  - Boiling Medium

- **Reboiler & Condenser Duties**
  - Desired Separation
  - Number of Theoretical Trays Generated



UOP DISTILLATION TRAYS

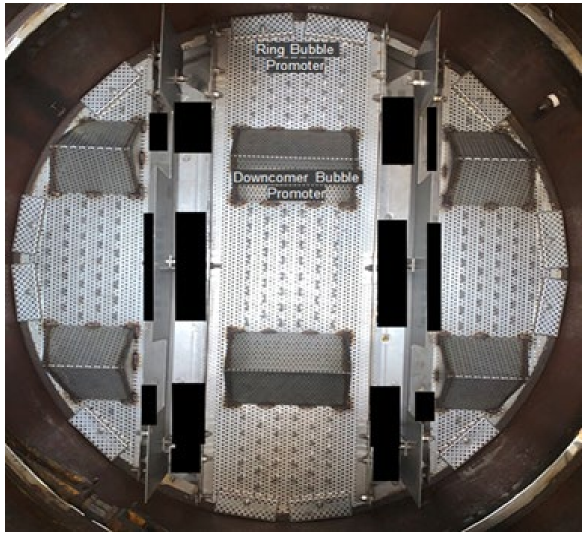
- **Low Tray Pressure Drop**
  - Maximize capacity
  - Installation at low tray spacings

- **Fully Active Area**
  - Maximize capacity
  - Less prone to fouling
  - Less prone to foams

MD™ / ECMD Trays

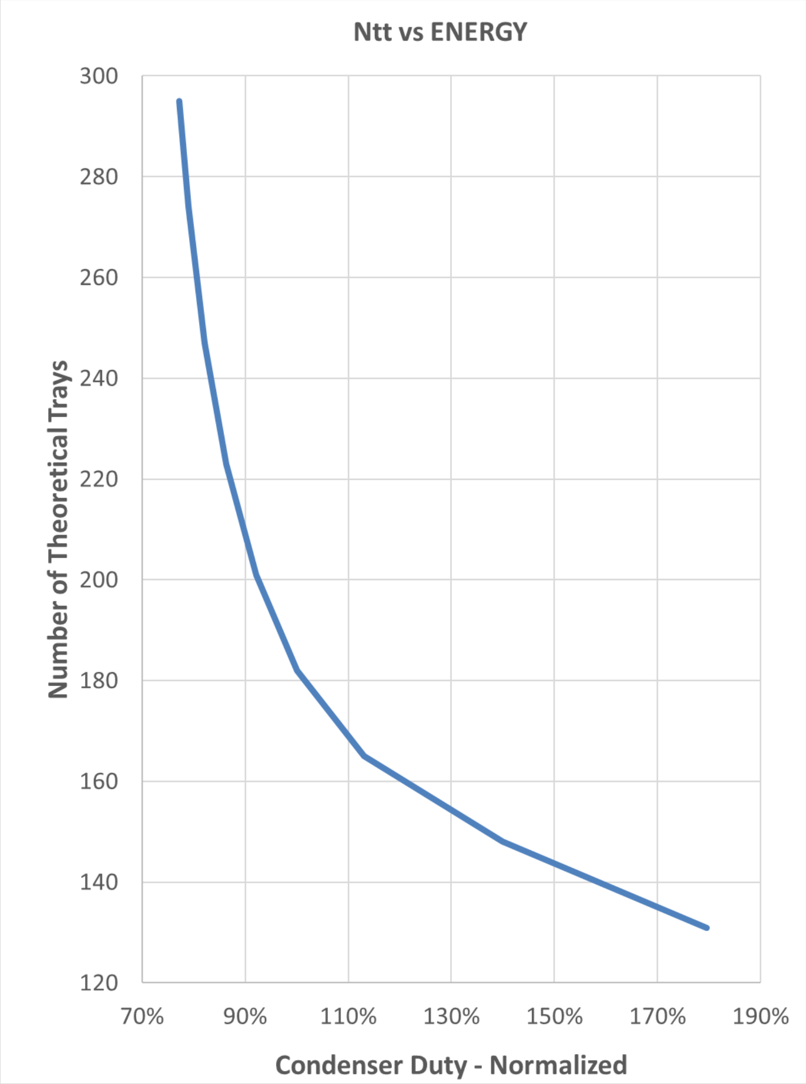
Slotted Sieve

ECMD+ Trays



PFMD Trays

OPTIMIZING CAPACITY AND ENERGY



ECMD Revamp Scheme	1-for-1	5-for-4	4-for-3
Impact on Energy Requirement	100%	-14%	-16%
Number of Theoretical Trays	180	220	235
Tray spacings, mm	450	360	338

- **Curve shape dependent on desired separation**
- **Project objectives will drive best revamp option**
  - **Energy savings vs capacity**

CASE: C2 SPLITTER TRAY REVAMP

Mass Transfer: UOP MD^{TM} Trays Designed to minimize energy consumption with increased capacity

Customer Needs

- **Column revamped in 1997 with 118 high capacity valve trays**
- **Revamp failed on capacity and purity**
- **Customer needed 10% higher capacity, higher purity & recovery**
- **Minimize energy requirements**

UOP MD^{TM} Tray revamp resulted in:

- **12% ethylene production increase**
- **Improved purity & recovery**
- **Reflux ratio reduced by 9%**
- **Energy requirements for separation minimized**

	Before Revamp	After Revamp	Change
Number of Trays	118	147	**+24.6%**
Tray Type	HC Valve Tray	MD^{TM}	
Tray Spacing, mm**	600/450	600/338	
Feed Rate, ton/hr	96.0	102.6	**6.9%**
Ethylene Product Rate*	75.5	84.8	**+12.3%**
Ethylene Purity, mol%	99.93	99.96	
Ethylene in Ethane, mol%	5.90	1.32	**-77.6%**
Reflux rate, ton/hr	345	352	**2.0%**
Reflux ratio	4.57	4.15	**-9%**

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CASE: NAPHTHA STABILIZER REVAMP

UOP ECMD+/ECMD™ Trays Designed to optimize capacity and energy efficiency

Customer Goal:

- **Sharper LPG & Naphtha split needed**
- **Reduce heavies in top LPG product**
- **Minimize C4's in FRN (Min. IBP)**
- **Maximize FRN feed to Platforming Unit**
- **Optimize the bottleneck reboiler/condenser**

UOP ECMD+™ Multi-Tray revamp resulted in:

- **Improved purity & recovery**
- **Energy requirements for separation minimized (10% lower reflux ratio)**
- **Extra capacity +10-15% after revamp**

	Before Revamp	After Revamp
Tray type	Valve	ECMD+/ECMD
No. of trays	15(top) 17(btm)	18(top) 25(btm)
Tray Spacing, mm	610	488/407
Diameter, mm	1500/2600	1500/2600
Feed rate, m3/hr	240-250	255 x 110%
C5+ in top LPG, mol%	3~5	1.5
C4- in btm FRN, wt%	1.7~2.0	1.2
Reflux/Feed Ratio	0.25	0.23
Reboiler Steam, t/hr	16.1	16.3*
Reflux, m3/hr	63.0	58.4

* Feed temperature lowered to optimize interna loadings

UOP HIGH PERFORMANCE TUBES:
HIGH FLUX™ TUBE / HIGH COND™ TUBE

- Engineered Surfaces
- Enhancing Performance
- Boiling & Condensation

- Reduce CAPEX & OPEX
- 60 Years Experience
- 1900+ Installed Worldwide
- 440+ Revamp Projects

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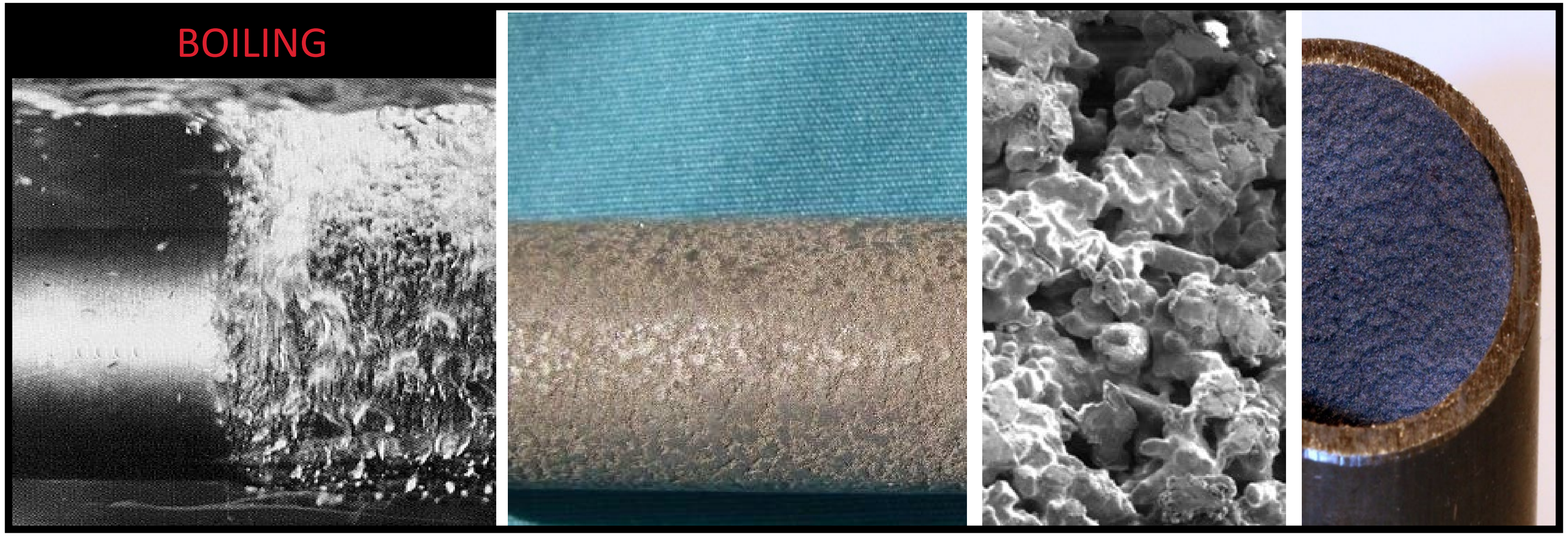
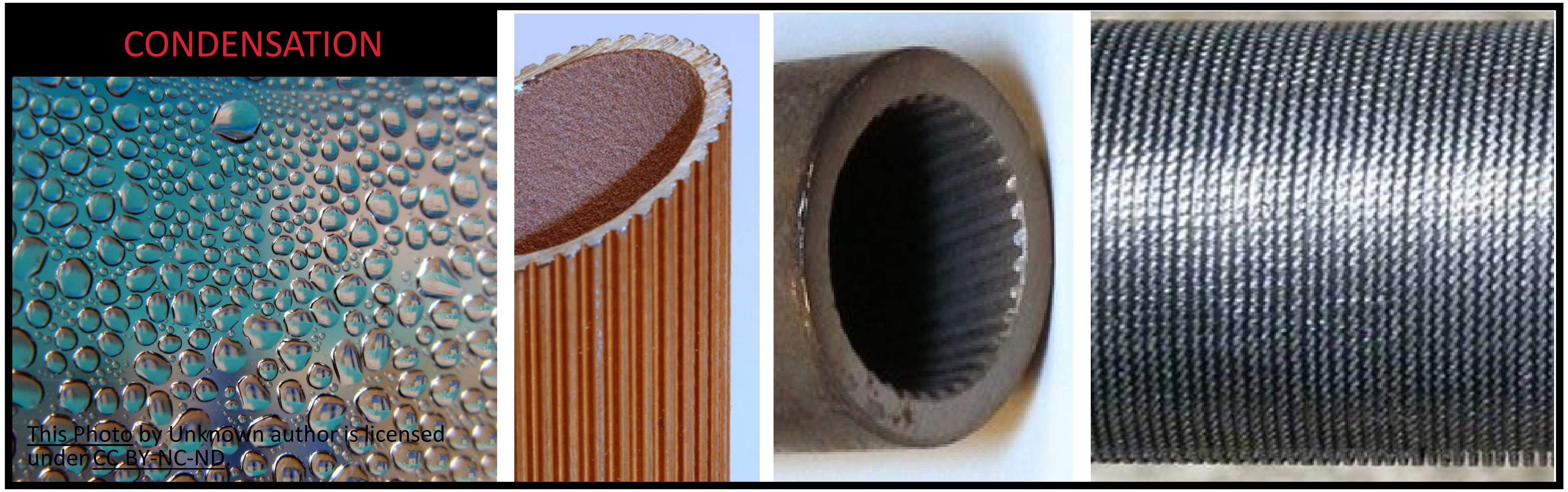
ENGINEERED SURFACES FOR BOILING AND CONDENSATION

BOILING



CONDENSATION



CASE: BENZENE COLUMN REBOILER REVAMP

	Original Design Bare Tube	*High Flux Tube Revamp*	*Change*
	MP Steam (16 KG)	**LP Steam (3.85 KG)**	
Duty *(MMKcal/hr)*	**2.63**	**2.63**	**-**
Area *(m^2)*	**103**	**114**	**+11%**
MTD *(°C)*	**54.7**	**12.8**	**-74%**
U-value *(Kcal/hr.m^2.°C)*	**467**	**1,802**	**+286%**
Hot Side Tin | Tout	**191.0 | 191.0**	**150.0 | 149.3**	
Cold Side Tin | Tout	**135.0 | 136.0**	**135.0 | 136.0**	
Steam Flow, *kg/hr*	**5,580**	**5,110**	**-8%**

CASE: NGL PLANT REBOILER REVAMP

Heat Transfer: UOP High Cond Tubes Enabled Column Pressure Reduction PLUS Energy Savings

Customer Needs:

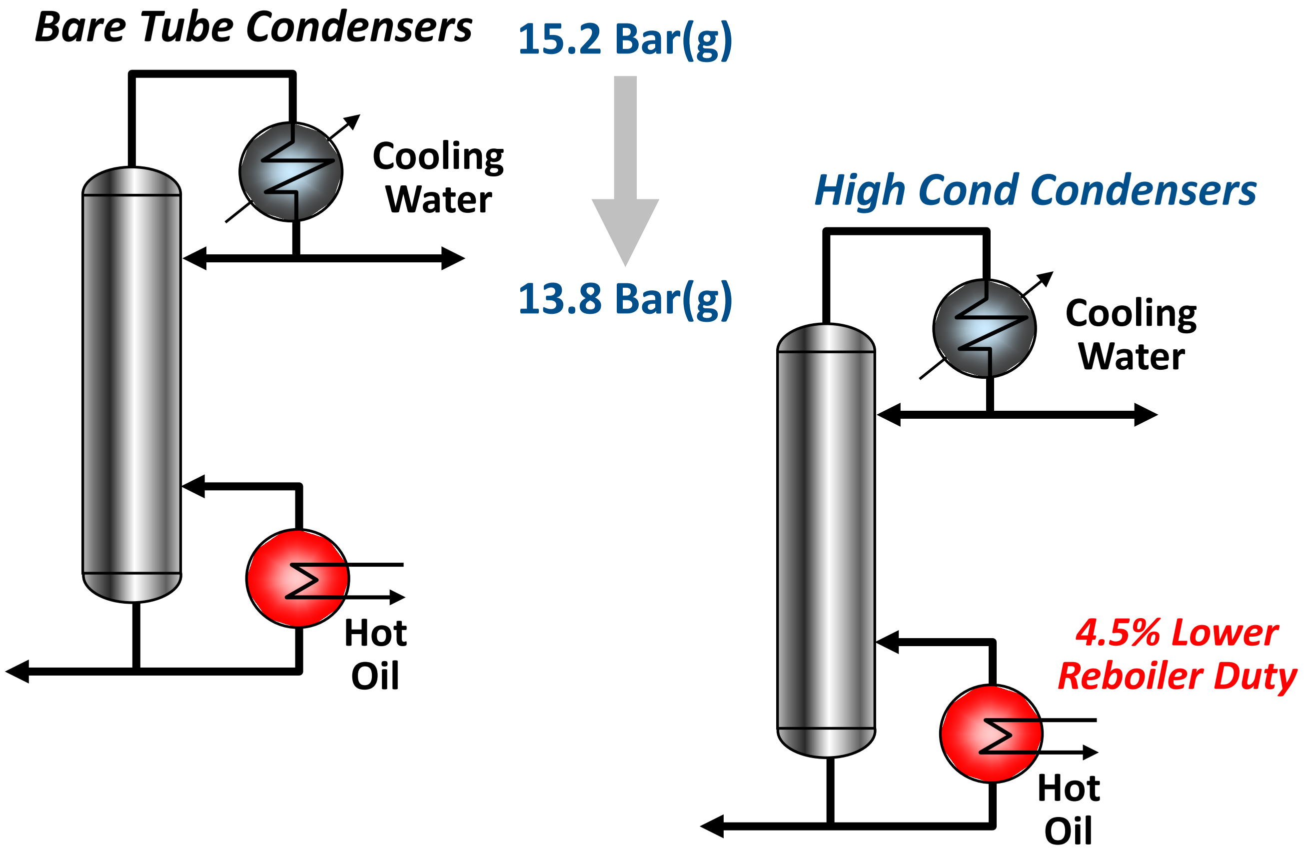
Maintenance Revamp

- Existing exchanger at end of life
- Investment Upgrade
- Summertime Water Temp Limit

UOP High Cond revamp results:

- **Maintained Existing Footprint**
- **Lower energy consumption**
  - Overhead Pressure Reduced 1.4 Bar(g)
  - Reduced Cooling Water Usage
  - 4.5% reduction in reboiler duty
- **Stable operation year round**

DeC3 Condenser *OVHD Pressure Reduction*



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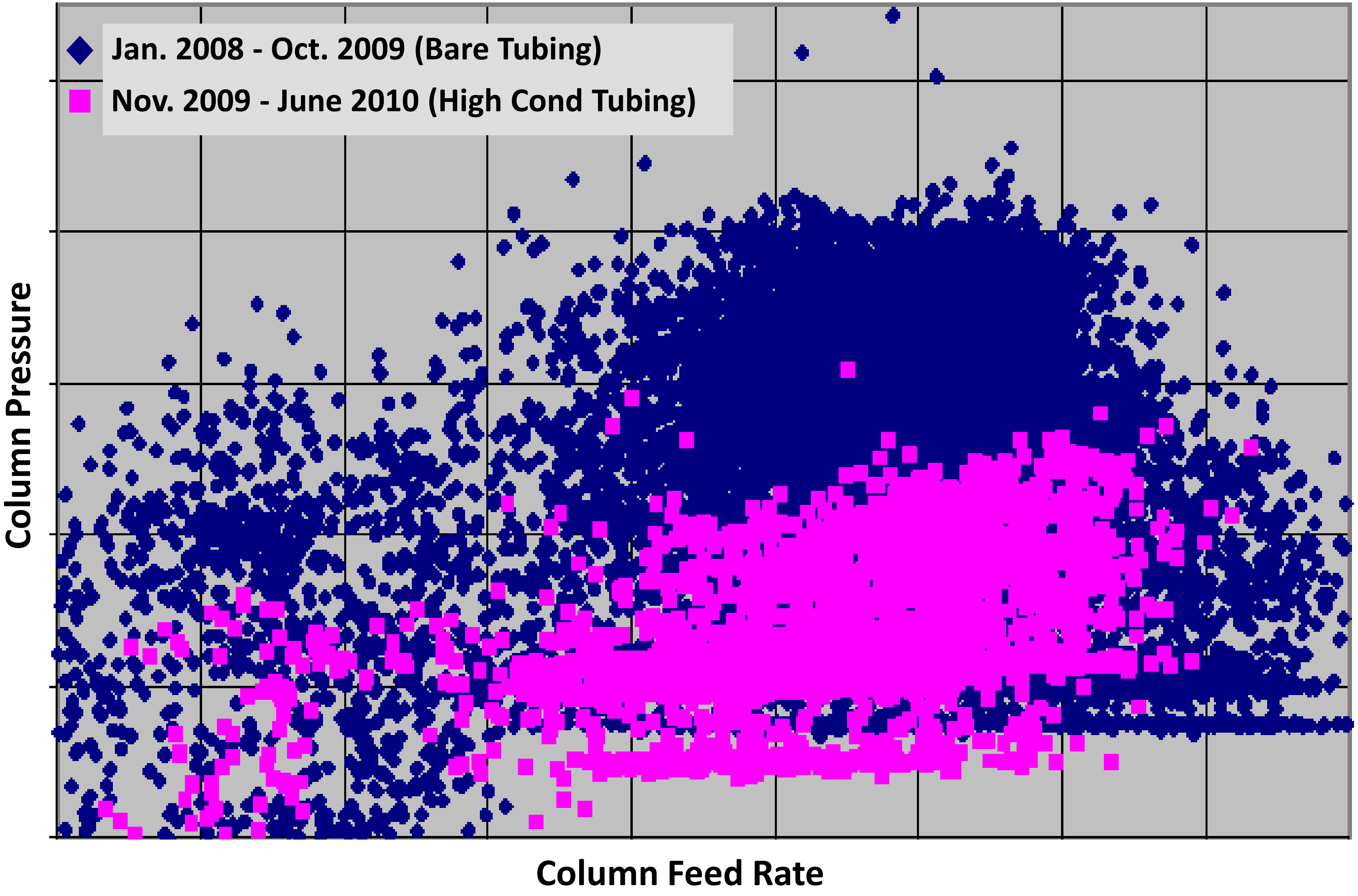
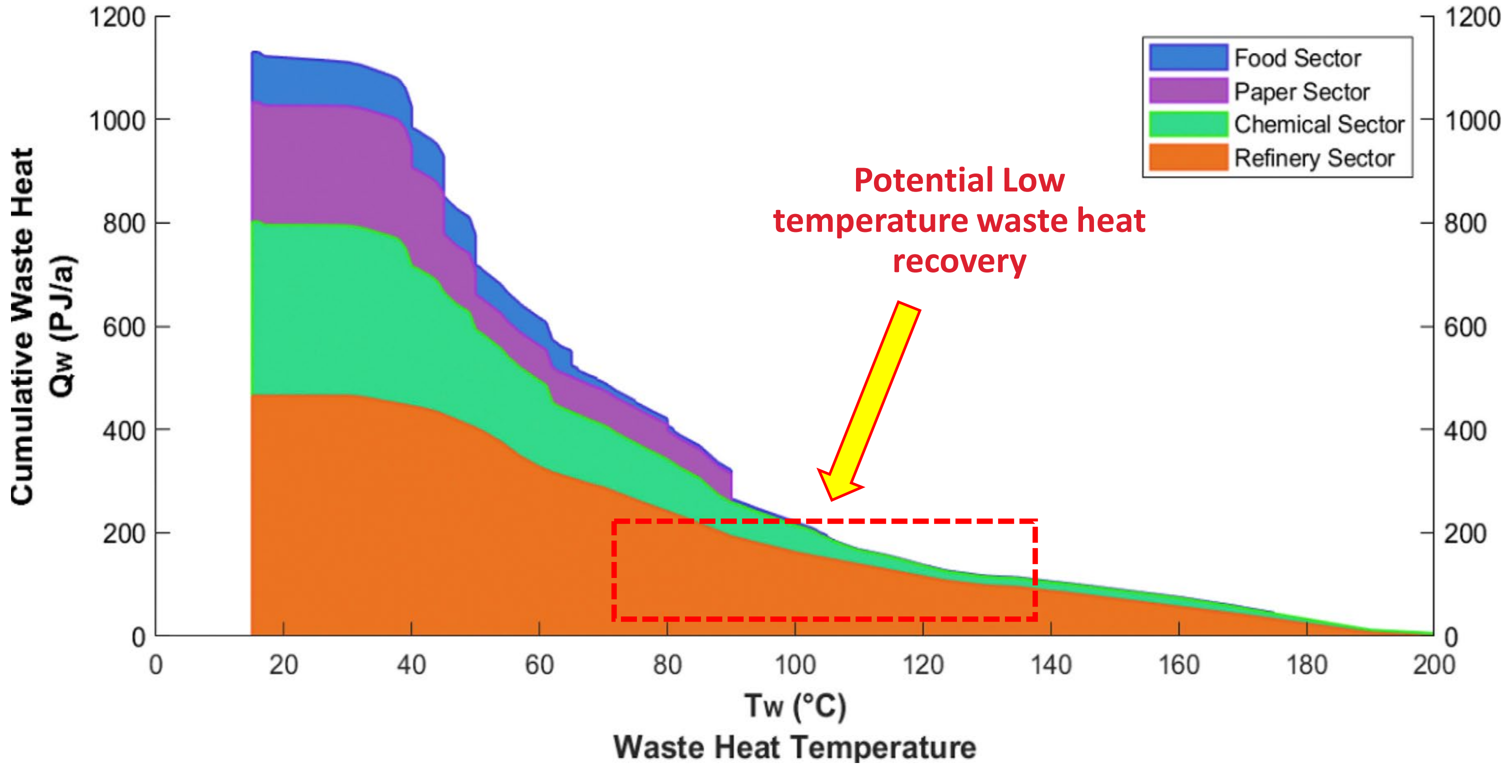
CASE : NGL PLANT REBOILER REVAMP



LOW TEMP HEAT RECOVERY POTENTIAL



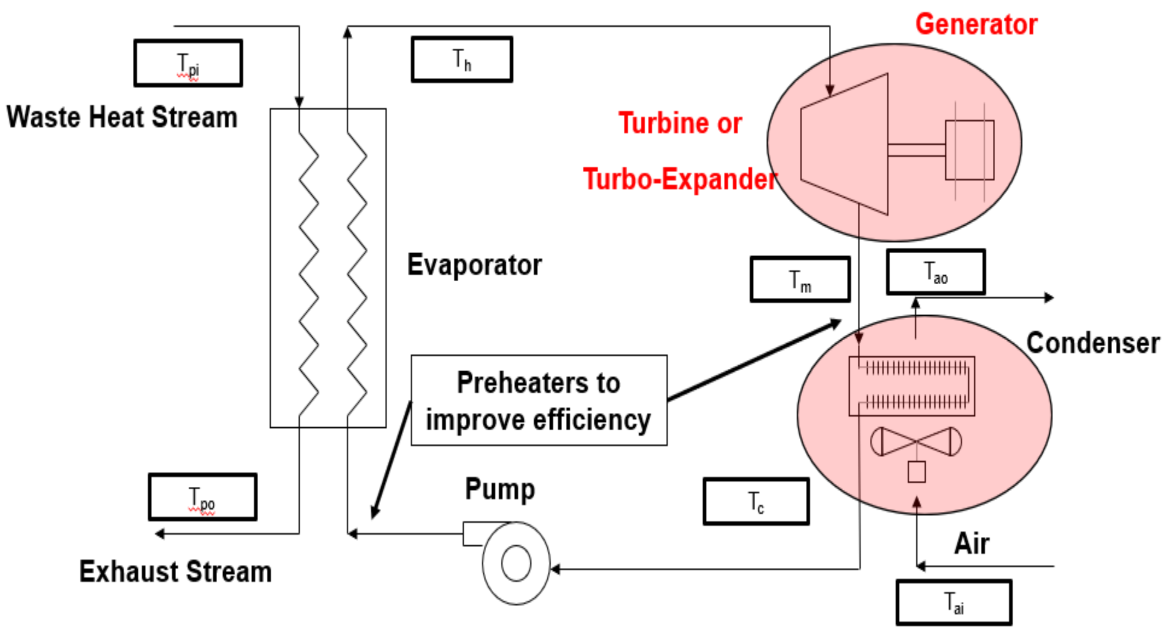
***Source:** An estimate of European Heat Pump Market Potential (2021) – Marina et al*

Significant untapped potential for low temperature heat recovery in Refinery sector

LOW TEMP HEAT RECOVERY
ORGANIC RANKIN CYCLE (ORC)

ORC for Low grade waste heat recovery

- A system to recover low grade waste energy from the process streams that cannot be recovered by conventional heat integrations
- Focus on large energy lost in Air coolers from fractionation overhead and Product condensers
- ~10% conversion efficiency



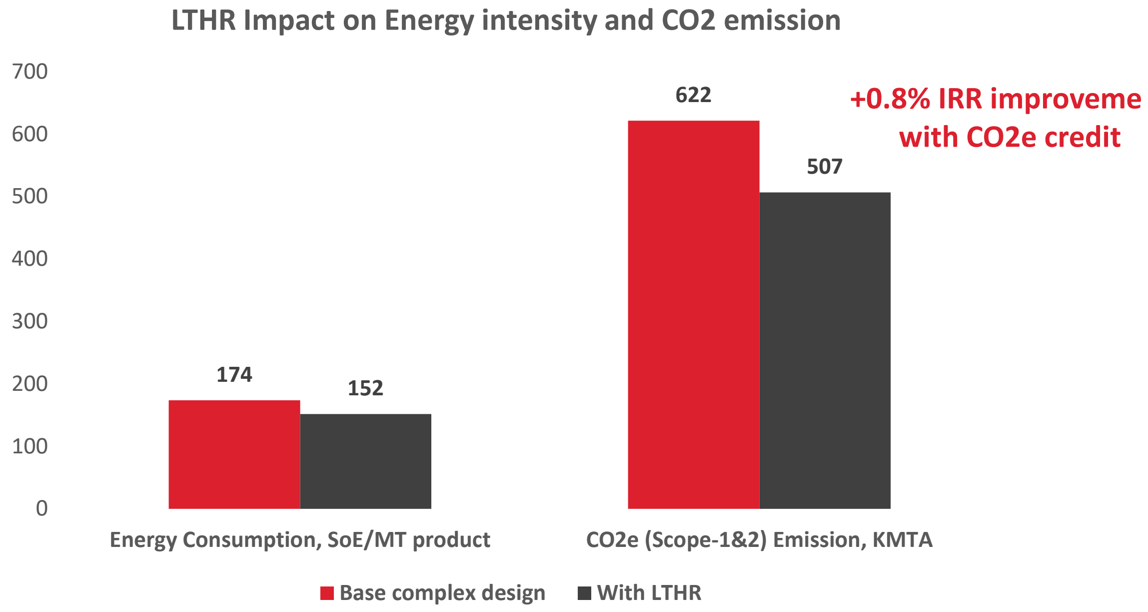
Advantages

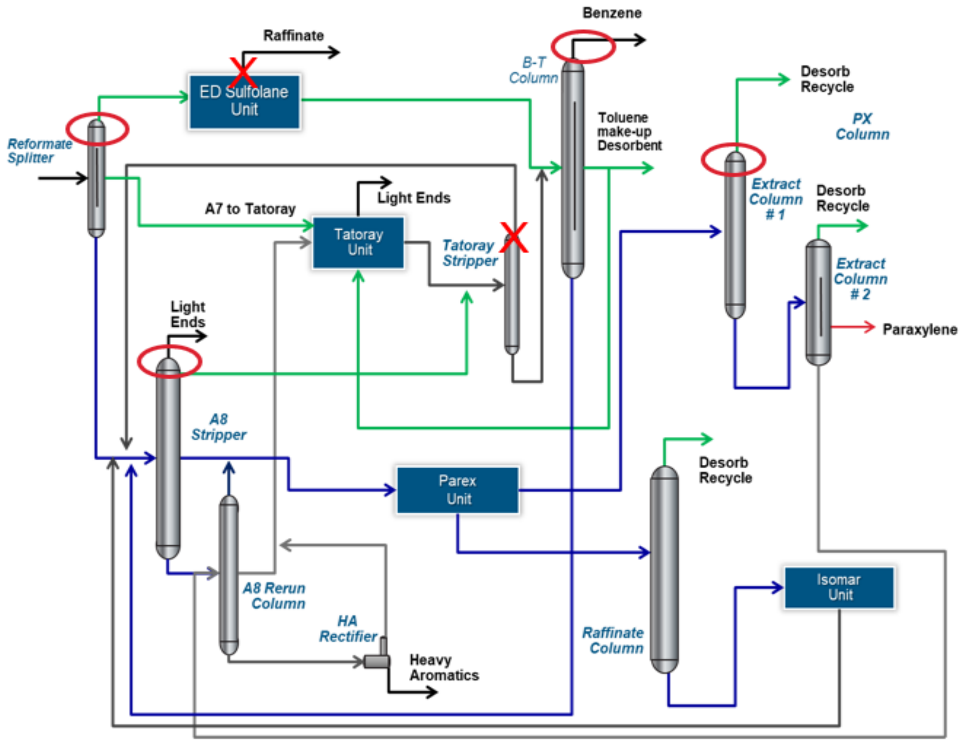
- Reduces Opex, Cash Cost of Production (CCOP) and CO2 emission
- Improve project economics and capital financing
- Help to achieve cost competitiveness to older units/assets
- Can be applied across the refinery complex
- Uses proven components

Significant potential to improve the energy efficiency and reduce CO2 emission

CASE STUDY: 1500KTA AROMATIC COMPLEX

- 17-18 MW Electricity generation from the waste heat recovery
- 4 years Simple Payback with $30-35M Capex investment
- +0.6% Project IRR improvement from waste heat recovery
- >100 kmta Scope-2 CO_2e reduction potential





Potential Applications In an Aromatics Complex
Extract Col #1
Reformate Splt
A8 Stripper
BT Frac
Naphtha Splt
Platforming Rx condenser

NOTE: *CO2e numbers represented here are estimated based on UOP internal tool and on the basis of electric grid mix of Asia Pacific region*

Aromatics Complex is One of Several R&P ORC Integration Options

THANK YOU
FOR YOUR PARTICIPATION

Q&A

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