Enhancing Heat Exchanger Performance, Optimising Production, and Reducing Energy

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Lead Technical Engineer

10th June 2026

Global Consulting Engineers for Heat Transfer Solutions

- CALGAVIN established 1980
- Head Office: Alcester, Birmingham, UK
- Manufacturing of technology carried out in UK

Extensive Research and Development in Hardware & Software

Work carried out at In-house Test Laboratory collaborating with 10+ Universities across Europe.

CENTRE FOR FLOW PROCESSING

HARNESSING THE SCIENCE OF FLUID DYNAMICS

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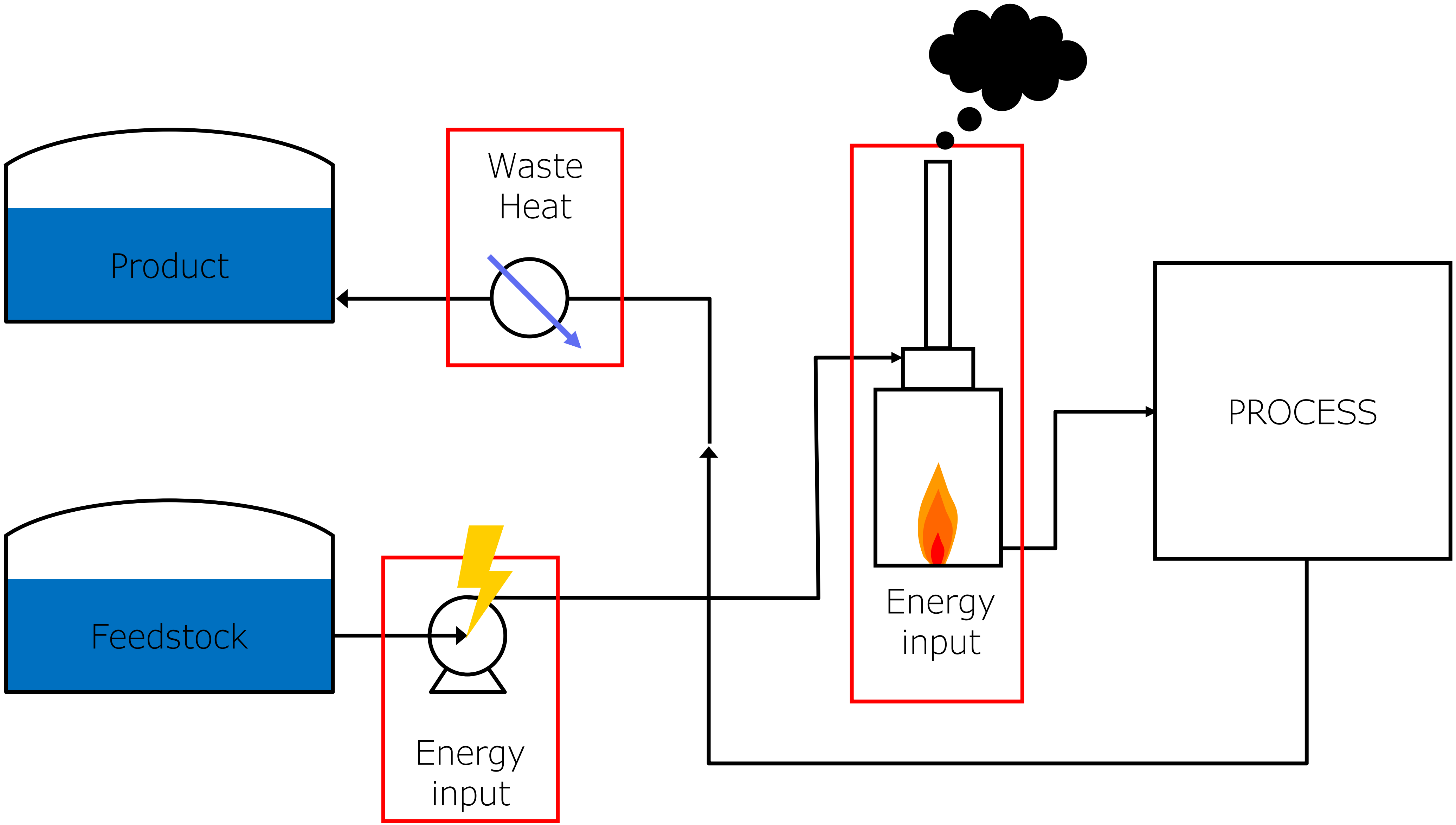
The Problem

Decarbonisation projects may struggle to attract funding because the rate of return is too low

- New technologies and alternative energy sources may be difficult & expensive to implement
- Improving energy efficiency can be more cost effective
    - Traditional "pinch" analysis leads to increased plant complexity and requirements for new heat exchangers
    - Avoid new equipment, improve performance of installed assets instead


Product
Waste
Heat
PROCESS
Feedstock
Energy
input
Energy
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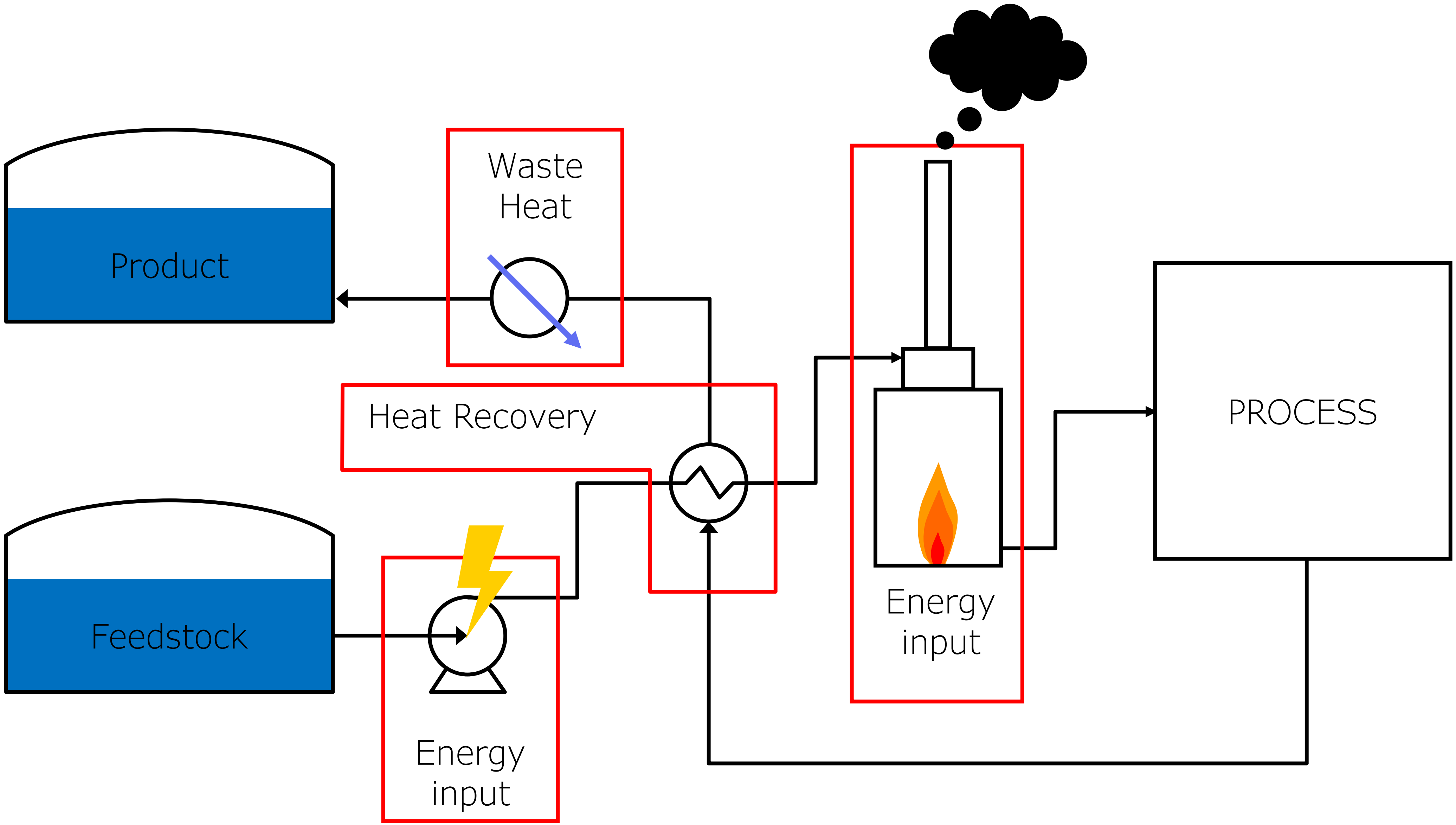
Waste
Heat
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Heat Recovery
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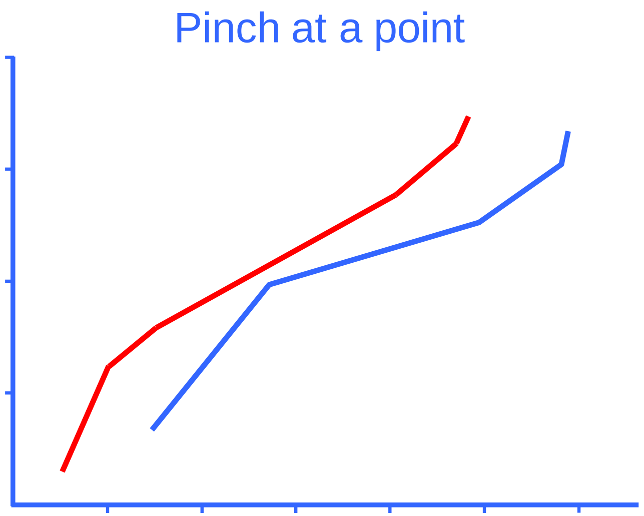
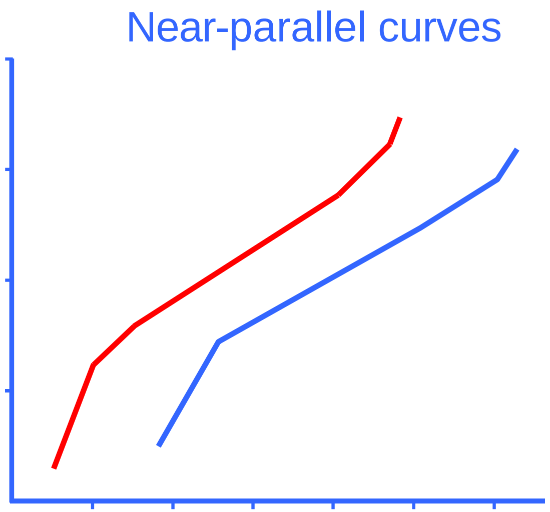
Pinch Analysis - Limitations





A few plants have a clearly-defined pinch:

- Modest network modifications near pinch point will yield energy savings at low cost

For many plants composite curves are near-parallel:

- To achieve energy savings, modifications will be required across the majority of the network – high cost

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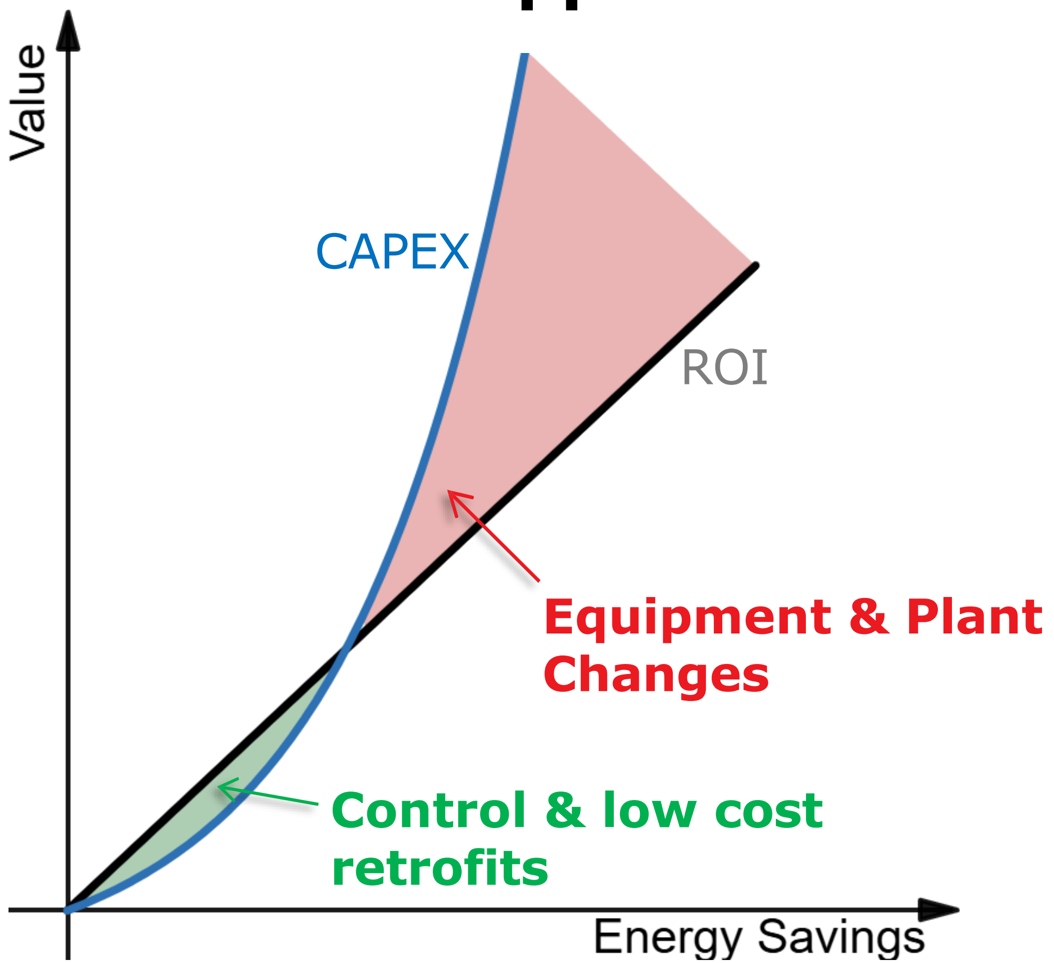
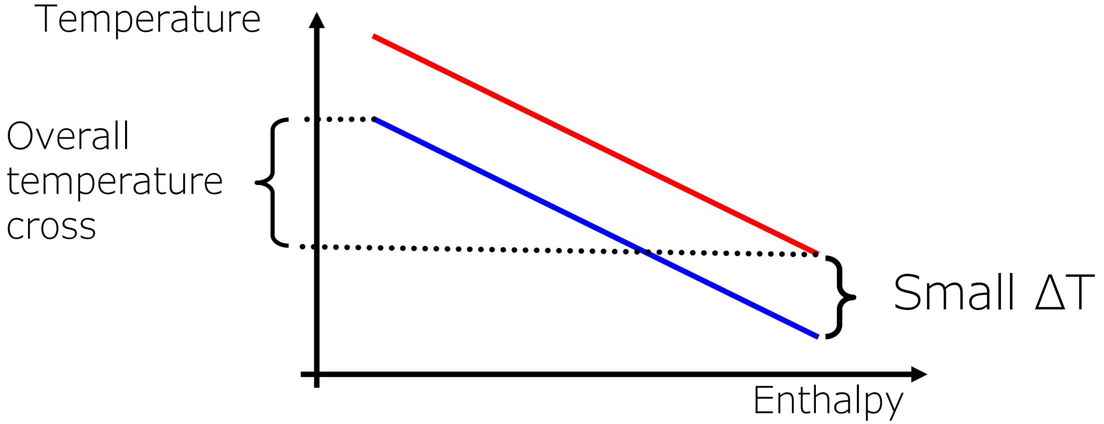
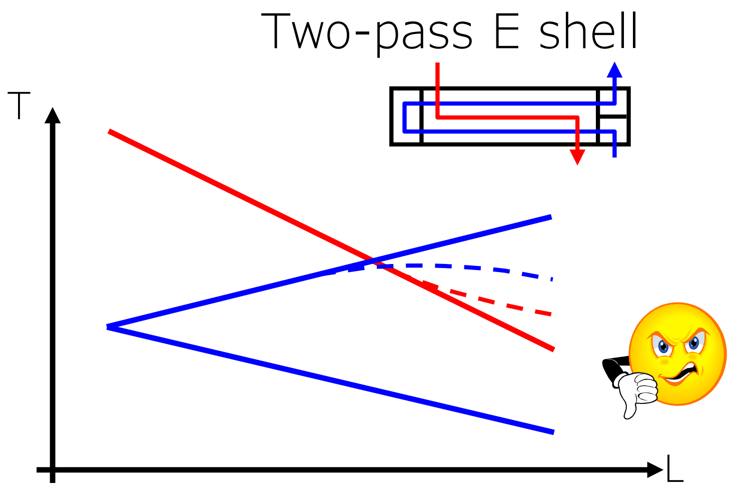
Project Costs vs. Energy Savings

Pinch Approach

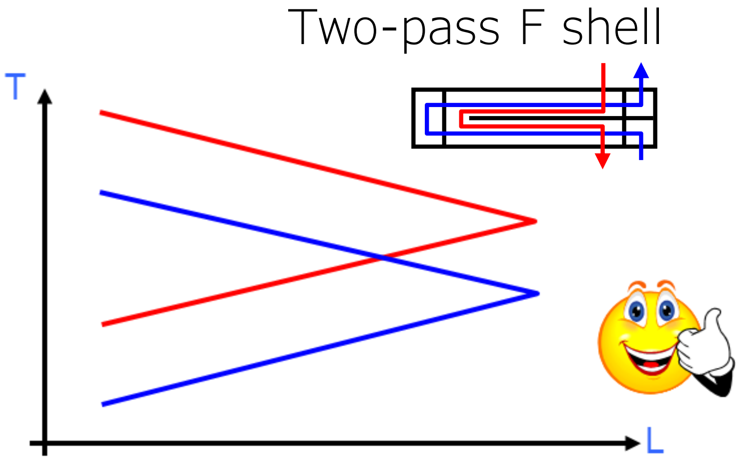


Typical Temperature Profile in Heat Recovery Services

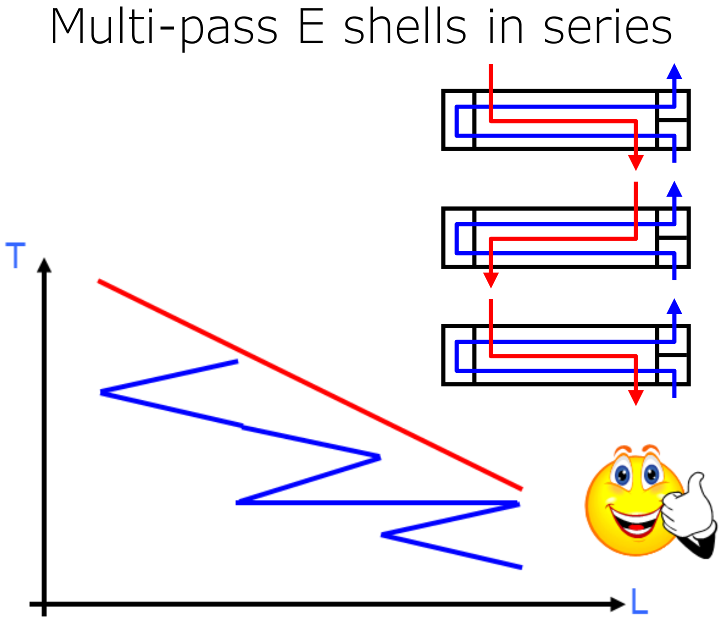




Local heat flow reversal and poor performance



Functional, but F-shells can have problems



Requires multiple units at higher overall cost

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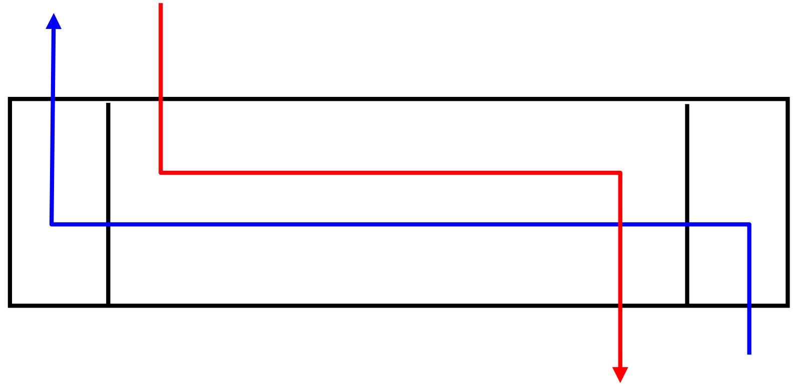
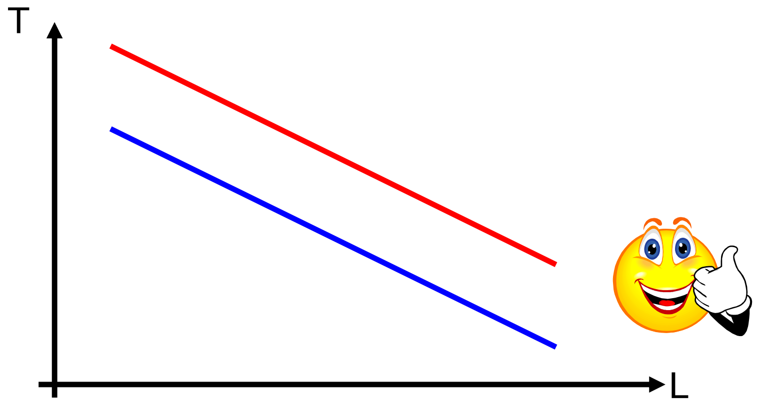
General Solution For Temperature Cross Applications

Single-pass E shell



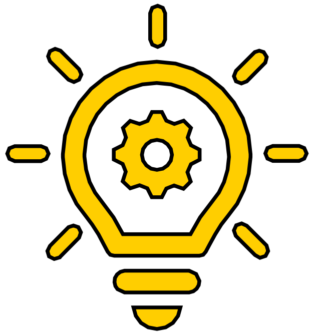


Low flow velocities

Poor tube side heat transfer

Bundle flow maldistribution

Temperature stratification



Case Study

Feed / Effluent Heat Recovery

Feed / Effluent Scholven BP refinery

Shell-and-Tube Type AES

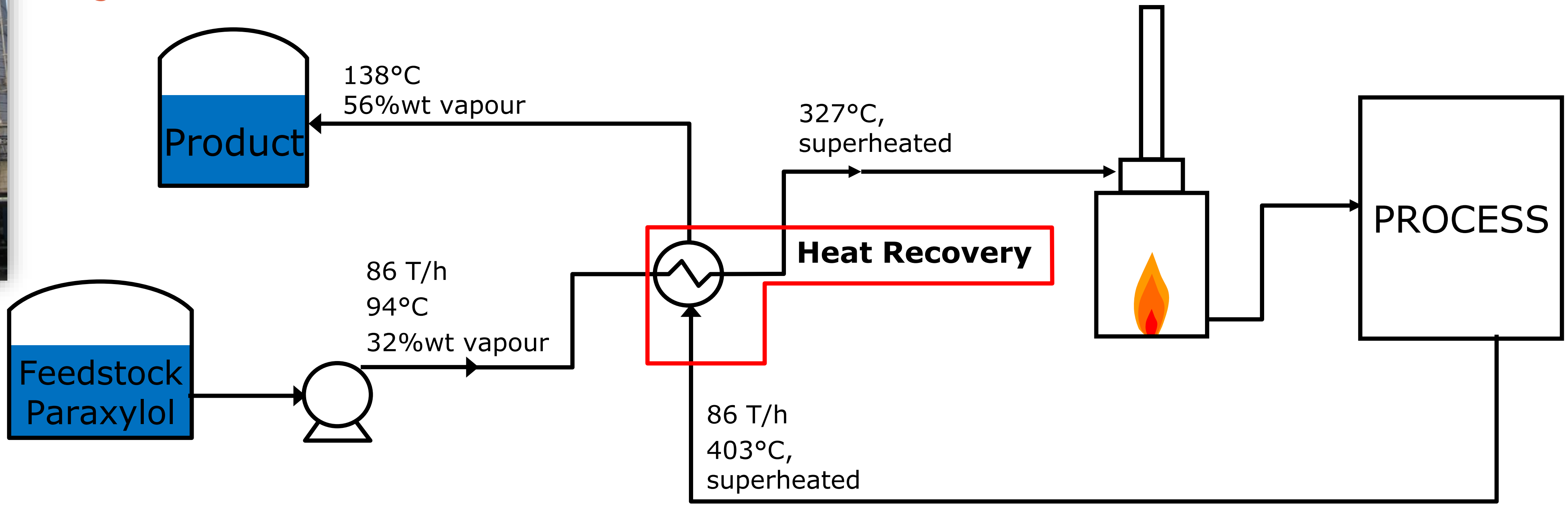
Duty: 19.7 MW

1734 tubes: 20mm x 2mm x 12m

Single Pass

REVAMP TARGETS:

- Upgrade – **15%** plant capacity increase
- Texas Tower acting as the **bottleneck** - key equipment unable to meet increase
- **Energy & carbon savings on Fired Heater**



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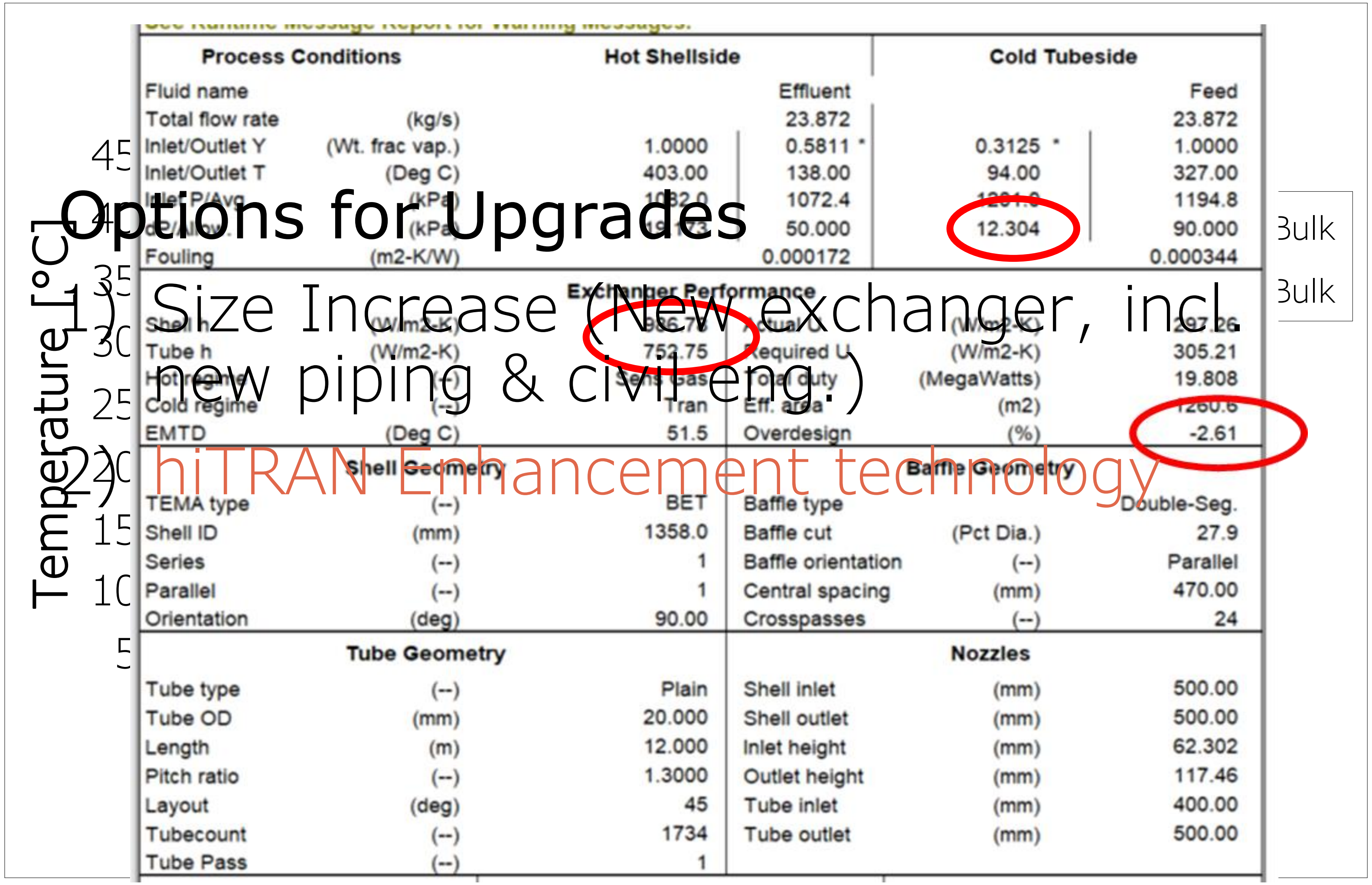
Problems with Current Design

- Temperature cross; single tube pass only
- Low tube-side heat transfer
- 1 bar pressure drop allowable, only 0.1 bar used



Process Conditions		Hot Shellside		Cold Tubeside	
Fluid name			Effluent		Feed
Total flow rate	(kg/s)		23.872		23.872
Inlet/Outlet Y	(Wt. frac vap.)	1.0000	0.5811 *	0.3125 *	1.0000
Inlet/Outlet T	(Deg C)	403.00	138.00	94.00	327.00
Inlet P/Avg	(kPa)	1082.0	1072.4	[illegible]	1194.8
dP/Allow.	(kPa)	[illegible]	50.000	12.304	90.000
Fouling	(m2-K/W)		0.000172		0.000344

Exchanger Performance					
Shell h	(W/m2-K)	[illegible]	Actual U	(W/m2-K)	297.26
Tube h	(W/m2-K)	752.75	Required U	(W/m2-K)	305.21
Hot regime	(--)	Sens. Gas	Total duty	(MegaWatts)	19.808
Cold regime	(--)	Tran	Eff. area	(m2)	1260.6
EMTD	(Deg C)	51.5	Overdesign	(%)	-2.61

Shell Geometry			Baffle Geometry		
TEMA type	(--)	BET	Baffle type		Double-Seg.
Shell ID	(mm)	1358.0	Baffle cut	(Pct Dia.)	27.9
Series	(--)	1	Baffle orientation	(--)	Parallel
Parallel	(--)	1	Central spacing	(mm)	470.00
Orientation	(deg)	90.00	Crosspasses	(--)	24

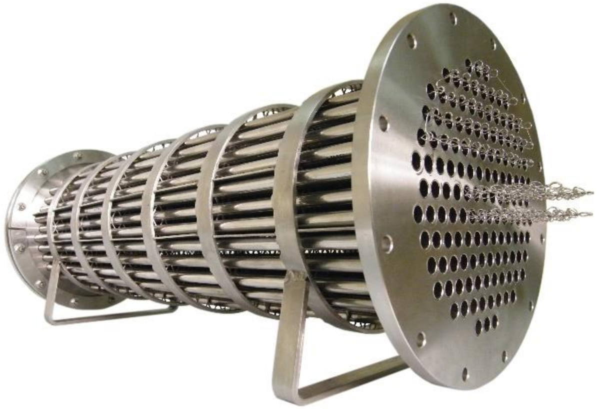
Tube Geometry			Nozzles		
Tube type	(--)	Plain	Shell inlet	(mm)	500.00
Tube OD	(mm)	20.000	Shell outlet	(mm)	500.00
Length	(m)	12.000	Inlet height	(mm)	62.302
Pitch ratio	(--)	1.3000	Outlet height	(mm)	117.46
Layout	(deg)	45	Tube inlet	(mm)	400.00
Tubecount	(--)	1734	Tube outlet	(mm)	500.00
Tube Pass	(--)	1			

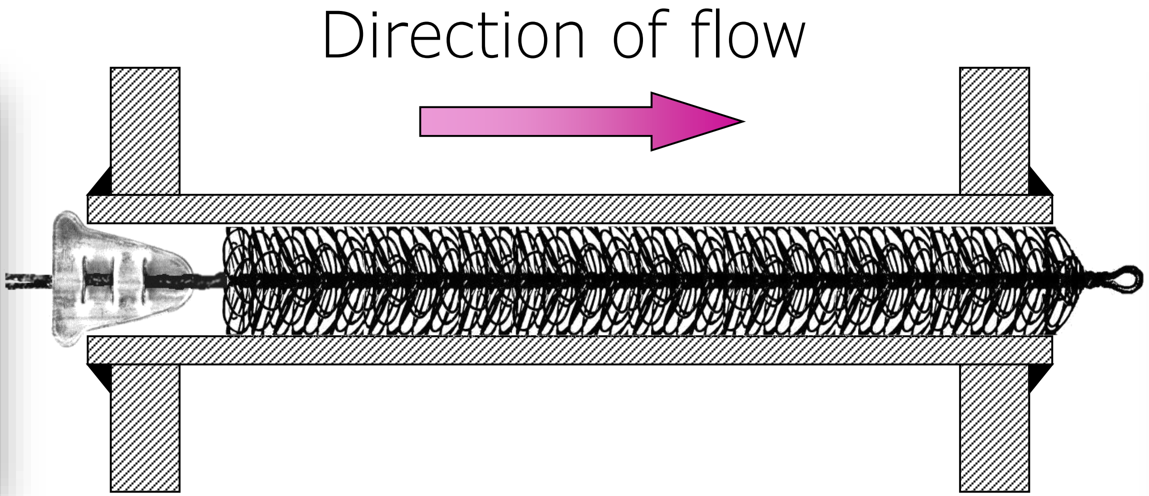
Options for Upgrades

1) Size Increase (New exchanger, incl. new piping & civil eng.)

2) hiTRAN Enhancement technology

hiTRAN
THERMAL SYSTEMS





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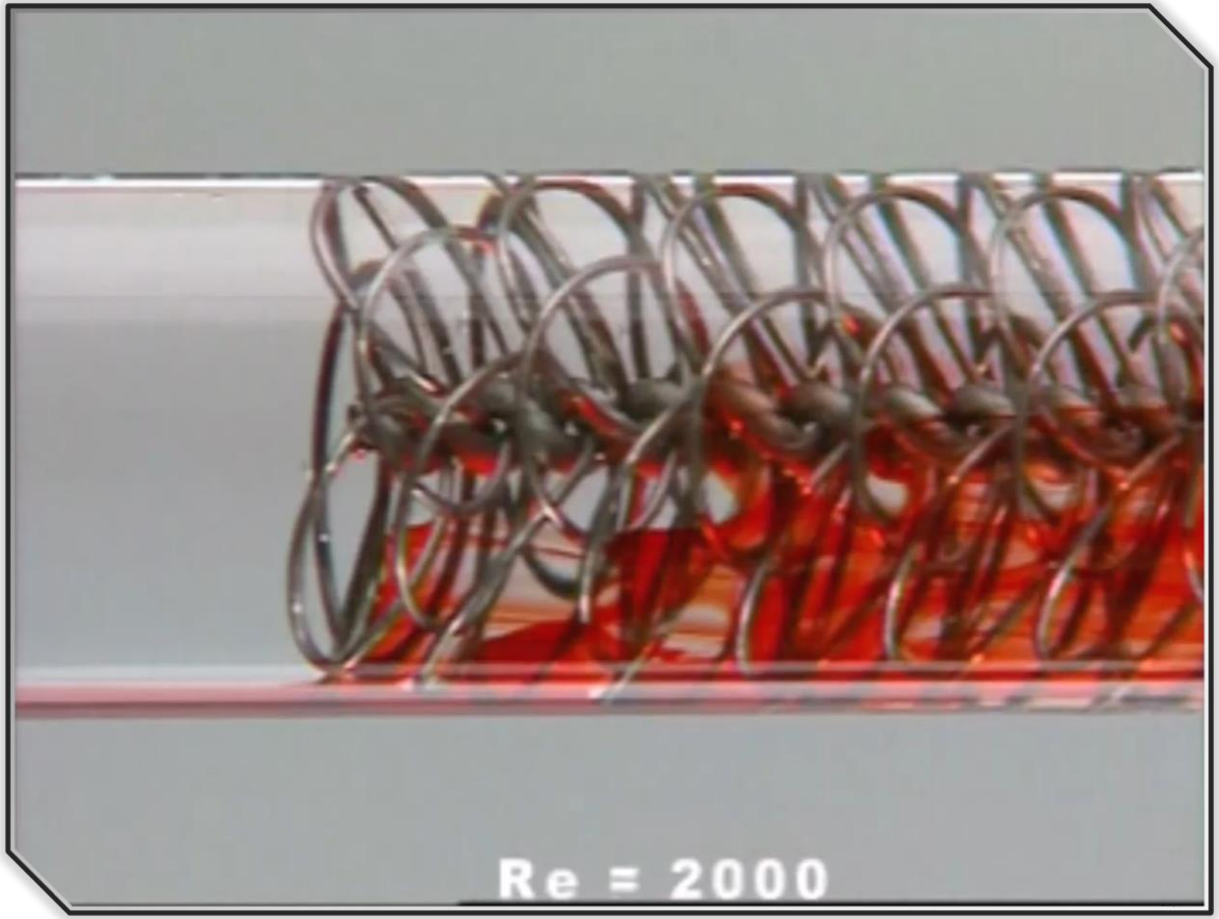
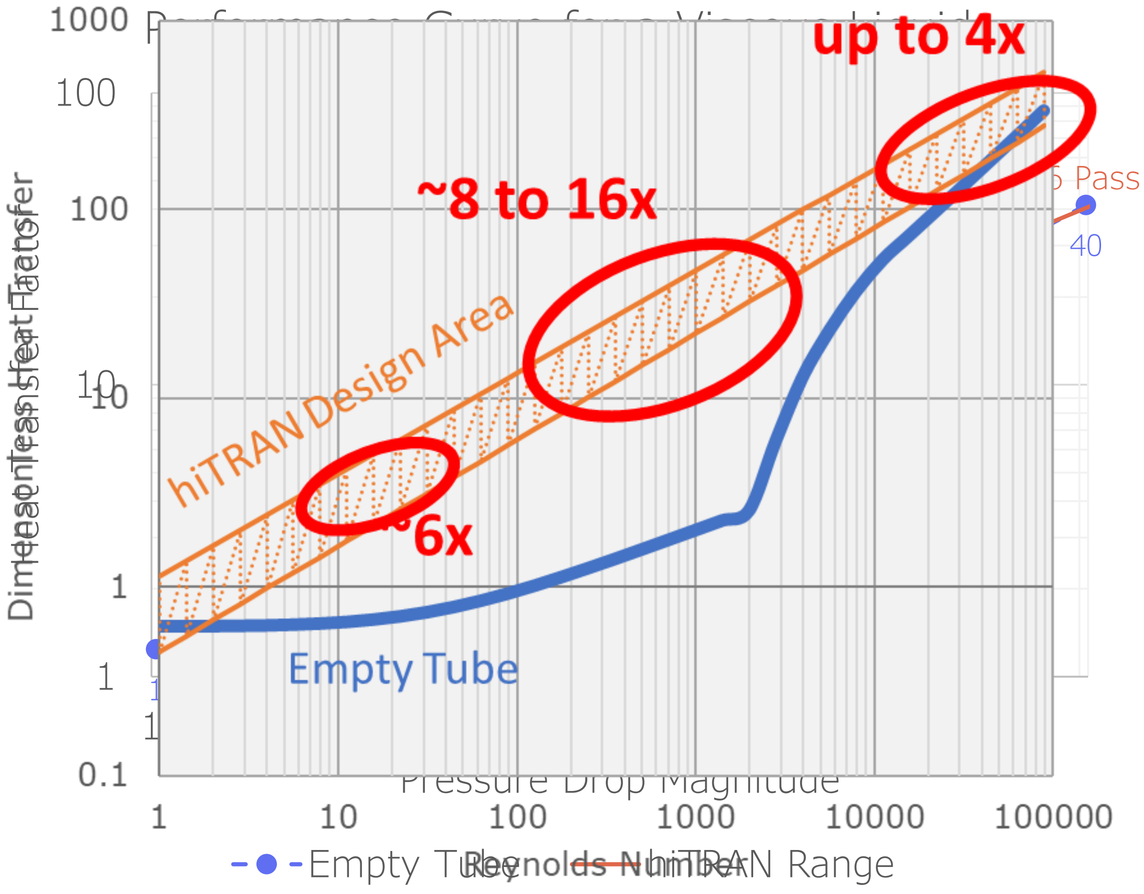
Enhanced Heat Transfer





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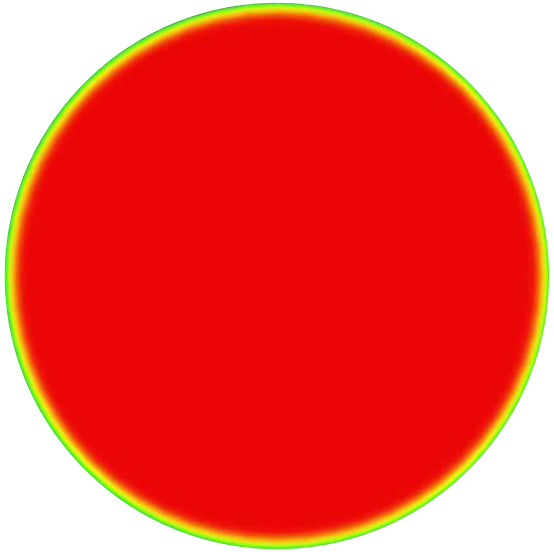
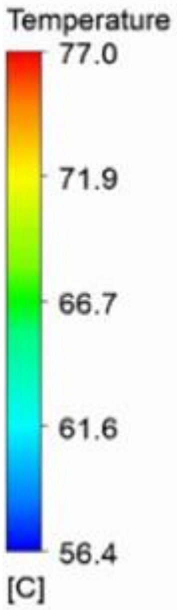
Reduced Temperature Stratification

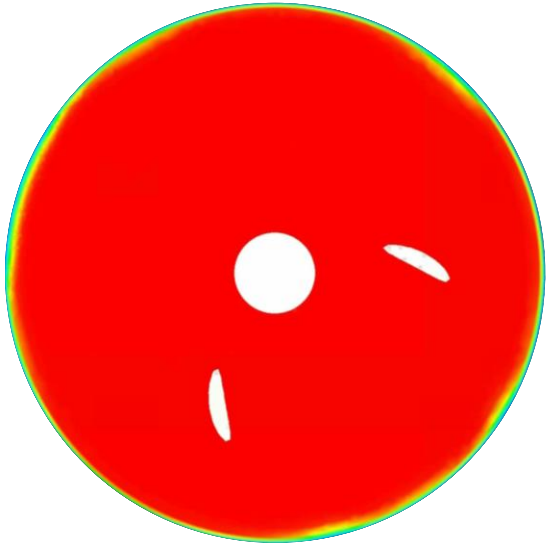
Plain Empty Tube
Stratified flow
Lower half of tube not effective



8m
Tube



Enhancement with hiTRAN Tube
Fully mixed flow
Common temperature across tube



3.5m
Tube

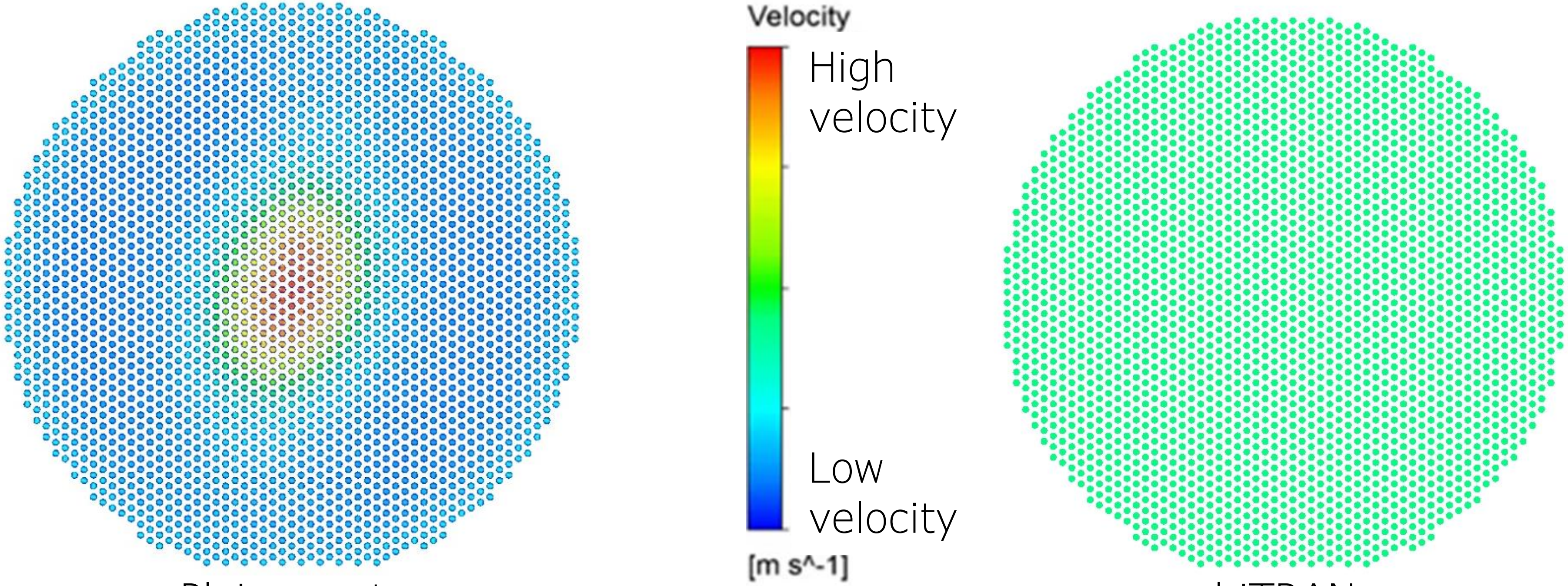
Natural convection:

- Cold, heavy fluid sinks to the bottom of the tube

- hiTRAN-enhanced flow delivers a reduced flow length by 56%

Improved Bundle Distribution with hiTRAN

	Empty Tubes	hiTRAN
Tube pressure drop	25mbar (>85% nozzles)	200mbar (~10% nozzles)



Plain empty hiTRAN

- hiTRAN balances pressure & flow between tubes in a bundle

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Installation

1700 tubes
12 metres, vertical

2 joined hiTRAN
Elements per tube

The installation was undertaken during shutdown within a timeframe of 5 days in situ.

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Installation

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The Benefits

3MW increase in duty, 18% higher throughput

- Negated need for larger unit, saving in CAPEX
- No additional civil engineering costs
- No additional piping costs

Reduction in Fired Heater duty

- Reduced energy use - $880,000 per year savings
- Reduced CO_2 output (306,000 T since installation in 2008)
- $6M+ savings since 2008 with a Carbon Credit price $20/T

Completed Orders
20,000+

Successful Retrofits
5,800+

Countries Supplied
50+

Number of Industries
15+

DOOSAN

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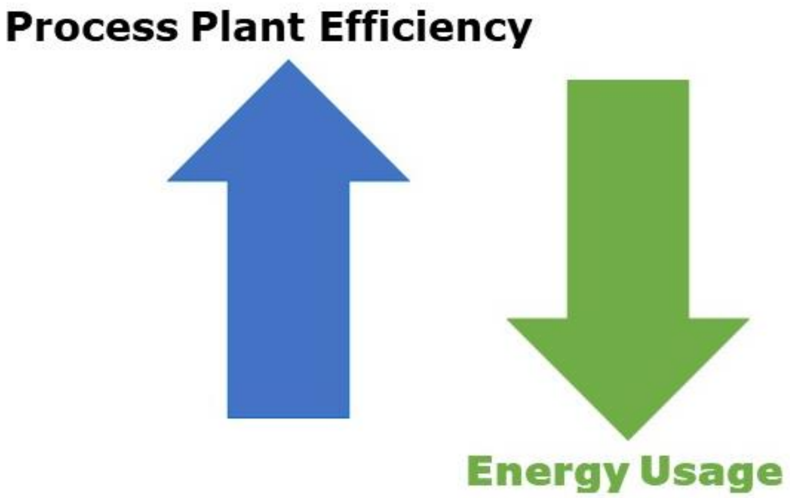
Cost and Energy Savings with Enhancement

Good return on investment – Increased heat transfer but at small CAPEX cost compared to the alternative of replacement equipment and re-piping.

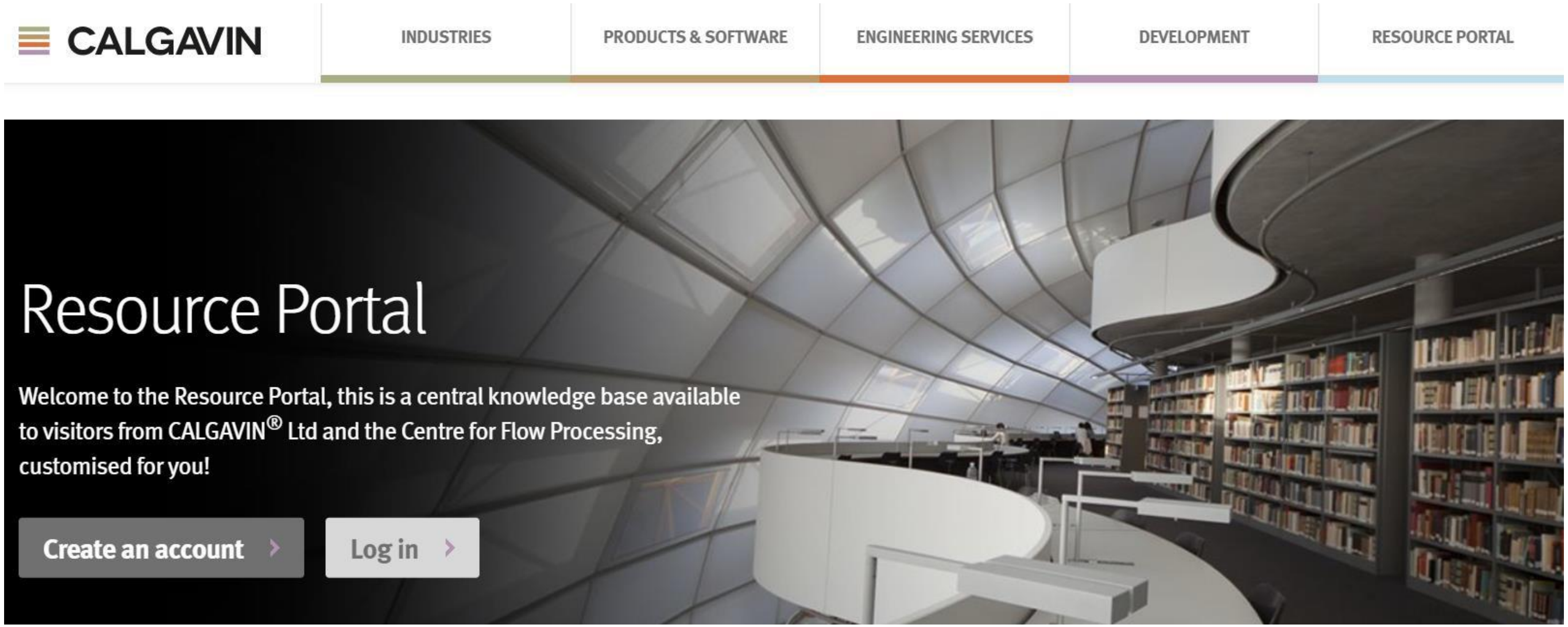
Reduced OPEX costs – Less cooling/heating utilities needed for required heat transfer duties.

Increased productivity – Increases the duty of an exchanger enabling increased flows to be processed and increase throughput.



CALGAVIN Resource Portal

https://www.calgavin.com/resource-portal



CALGAVIN has a protected customer resource portal and knowledge base to explore and learn!

- Case studies (Offshore, Refining, Petrochemicals & Chemicals)
- Academic papers, conference papers & magazine articles
- Over 20 webinars (Heat exchanger design, condensation, maldistribution, vaporisation etc.)

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Any questions?

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