Low Energy Direct Contact Condenser Designs for Claus TGTUs in Desert Environments

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Introduction

- **Tail Gas Unit :**
  - Hydrogenate Claus tail gas to H_2S
  - Cool hydrogenated tail gas in a Direct-Contact Condenser (DCC)
  - Remove H_2S in a solvent (e.g. amine) contactor
  - Regenerate the solvent and re-run the acid gas in the Claus unit

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- **Typical DCC Design:**
  - Single pumparound (PA) with 50% air cooling & 50% trim cooling
  - Hot, arid regions require refrigeration for trim cooling
  - High power and capital cost

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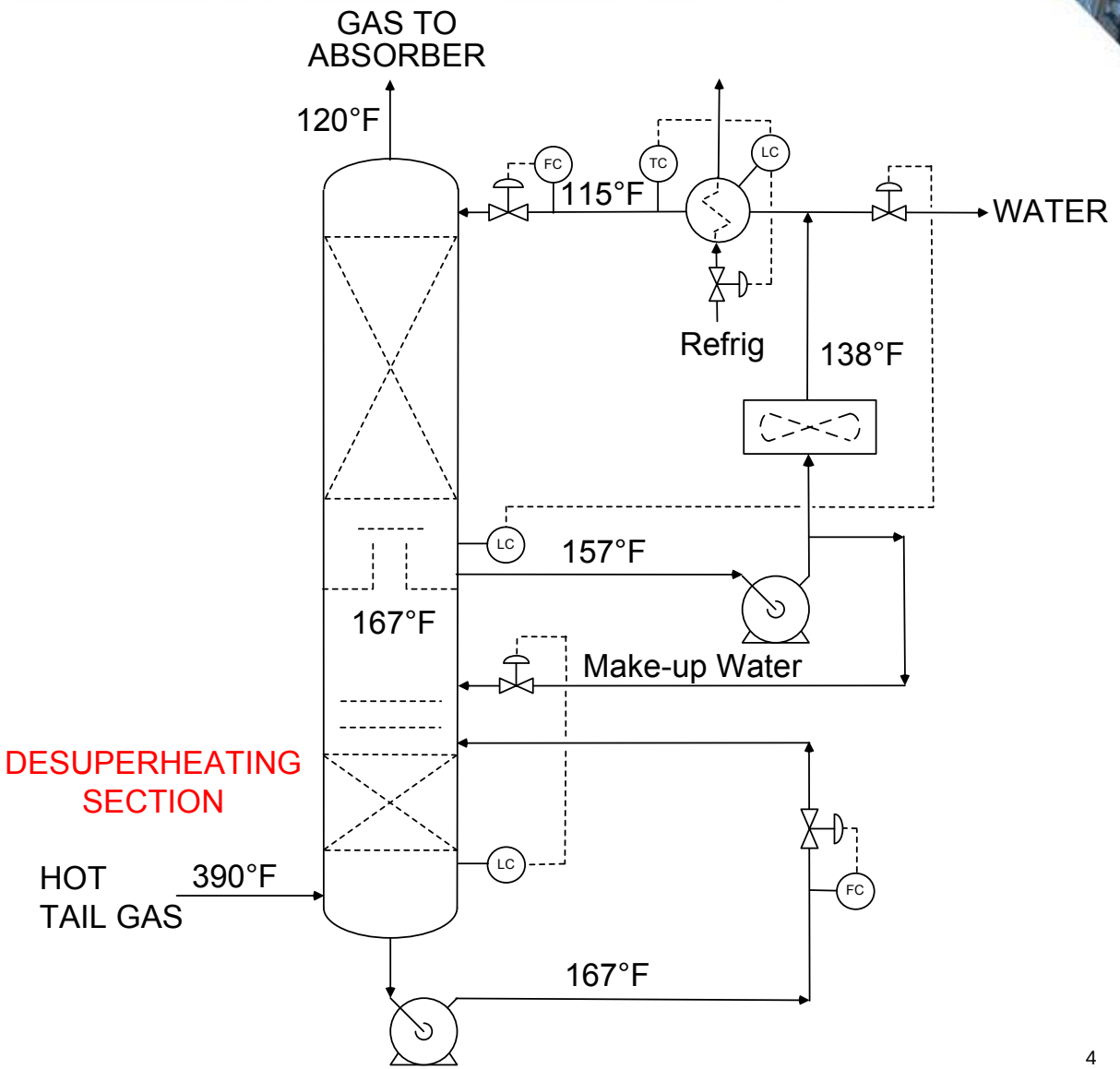
Conventional DCC Process

- Hot tail gas desuperheated



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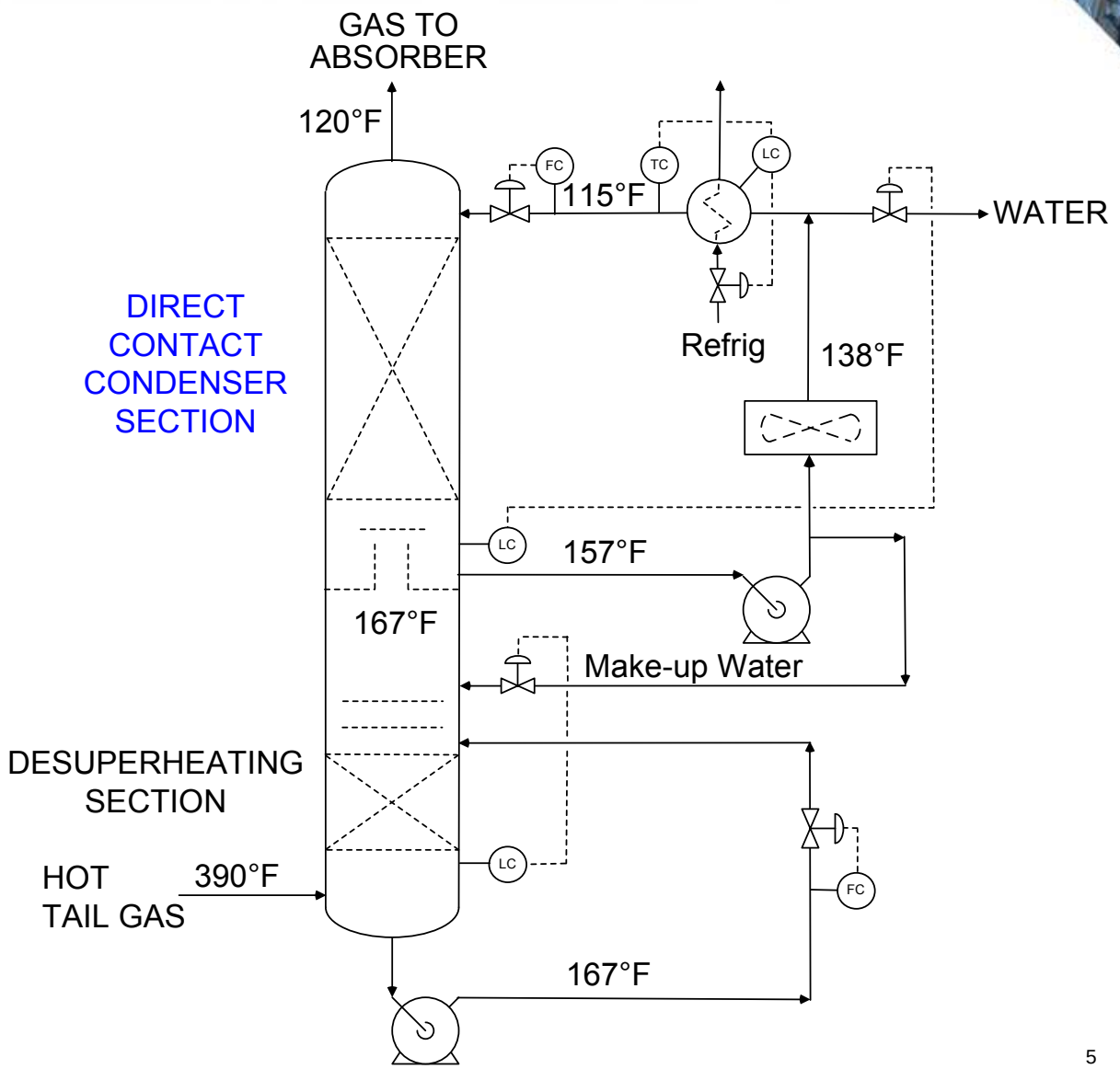
Conventional DCC Process

- Hot tail gas desuperheated
- Tail gas further cooled



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Conventional DCC Process

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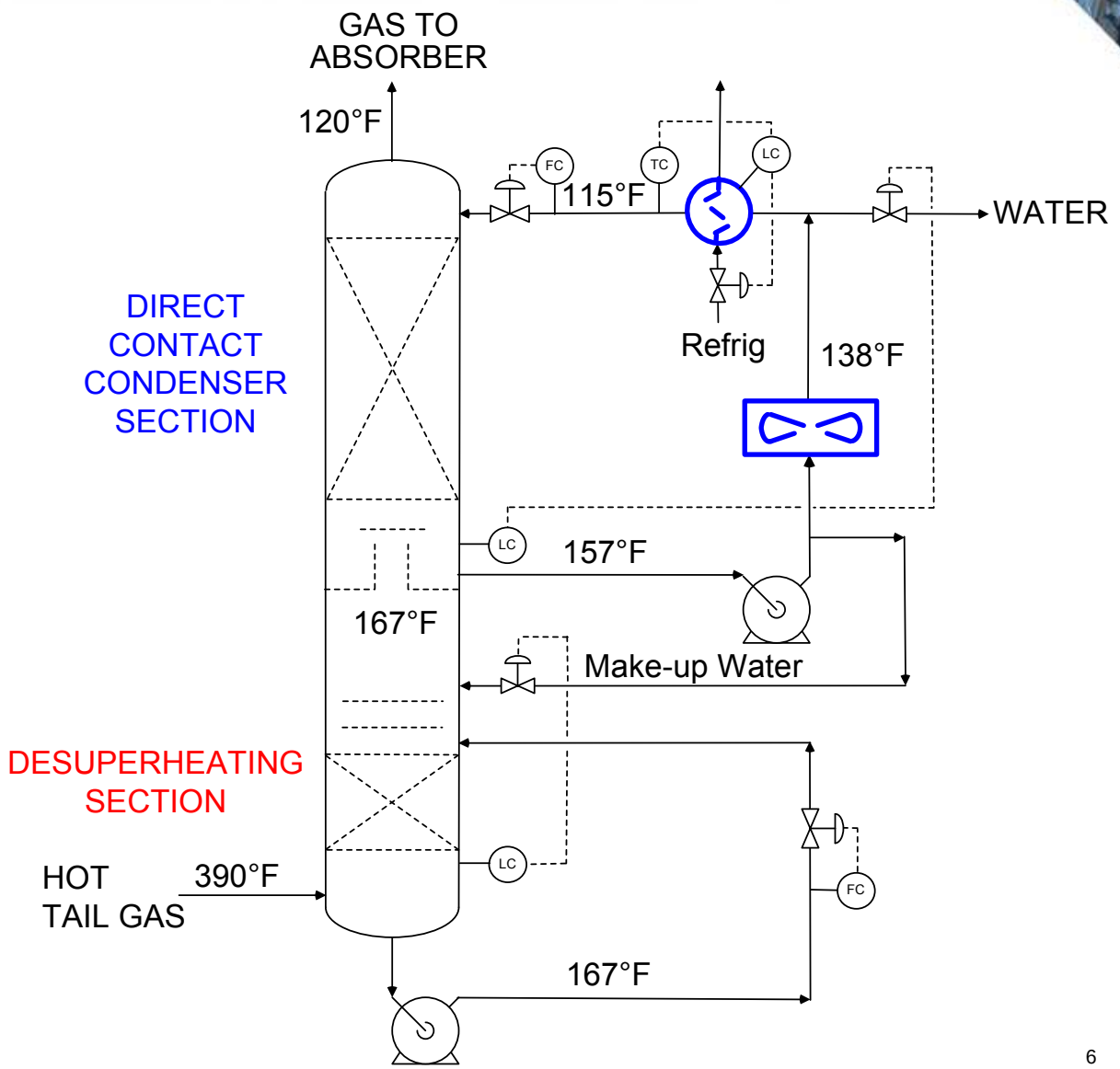
- Excess water rejected
- PA cooled by air, then trim cooling
- Cooled gas to absorber



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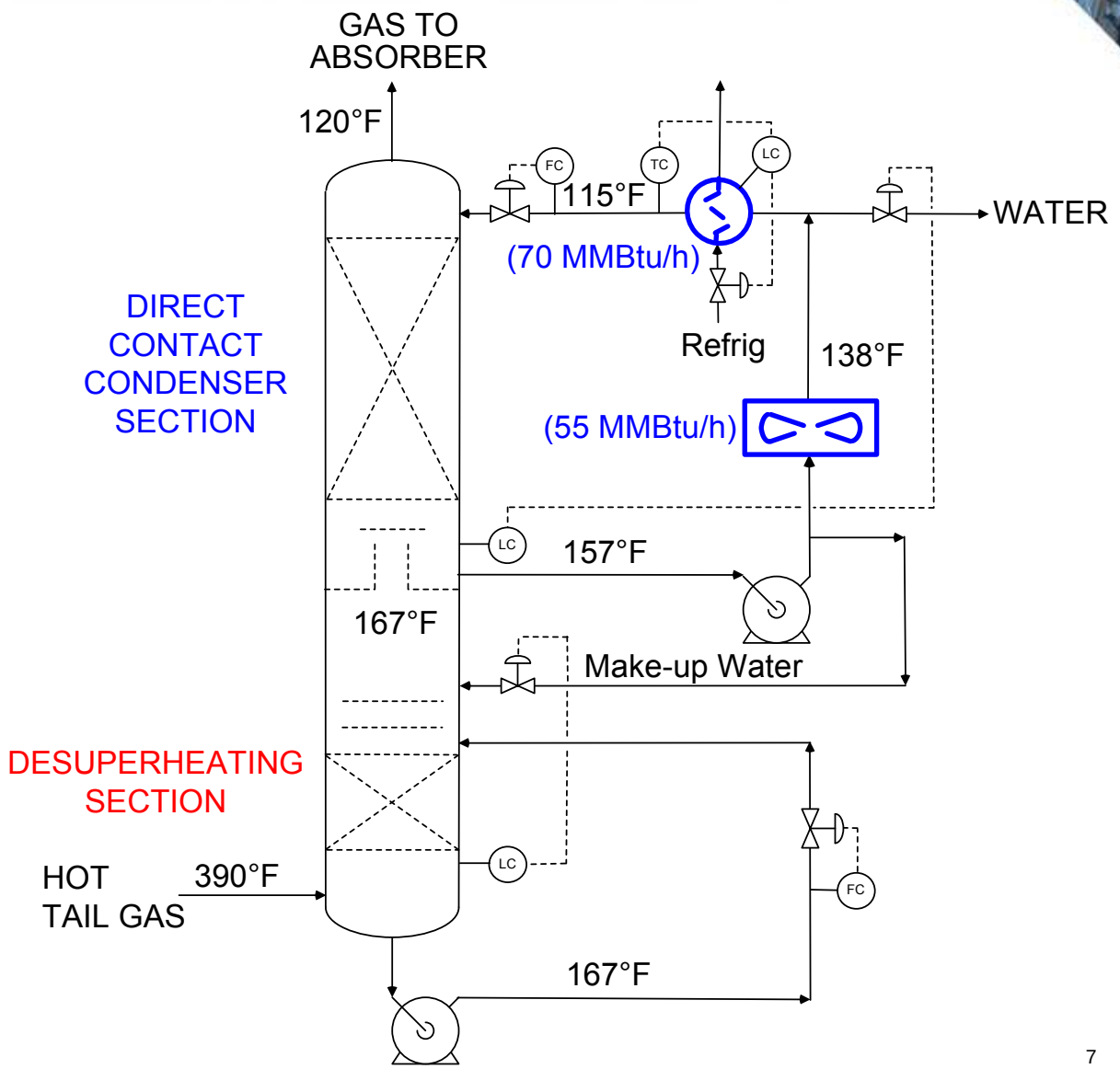

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Economic Incentive to Minimize Effluent Gas Temp.

HIGHER GAS EFFLUENT TEMPERATURE…

- Reduces H_2S removal by solvent
- Often requires expensive solvent
- Carries more water that dilutes the solvent

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TO MINIMIZE…

- Target 5℉ approach between effluent gas and proces s water inlet
- Target 95 - 115℉ for process water inlet

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DCC Optimization: Maximize Air Cooling

- Maximize air cooler size, duty
- But limited by air/process water approach, target 14 - 20℉
- For 122℉ air, process water cooled to 138℉
- Rest of cooling by water
- But in arid areas, there is often no water!
- Need refrigeration for trim cooling ----- **Expensive!**
- Smaller approaches escalate air cooler size and cost with diminishing benefits

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DCC Optimization: Minimizing PA Rates

- Hotter process water
- Higher portion of duty can be removed by air

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DCC Optimization: Minimizing PA Rates

- Hotter process water
- Higher portion of duty can be removed by air
- Water T out of bed gets closer to gas T in
- Requires taller bed, expensive distributors
- More prone to maldistribution !
- Good practice: Keep (gas in) – (water out) >10℉

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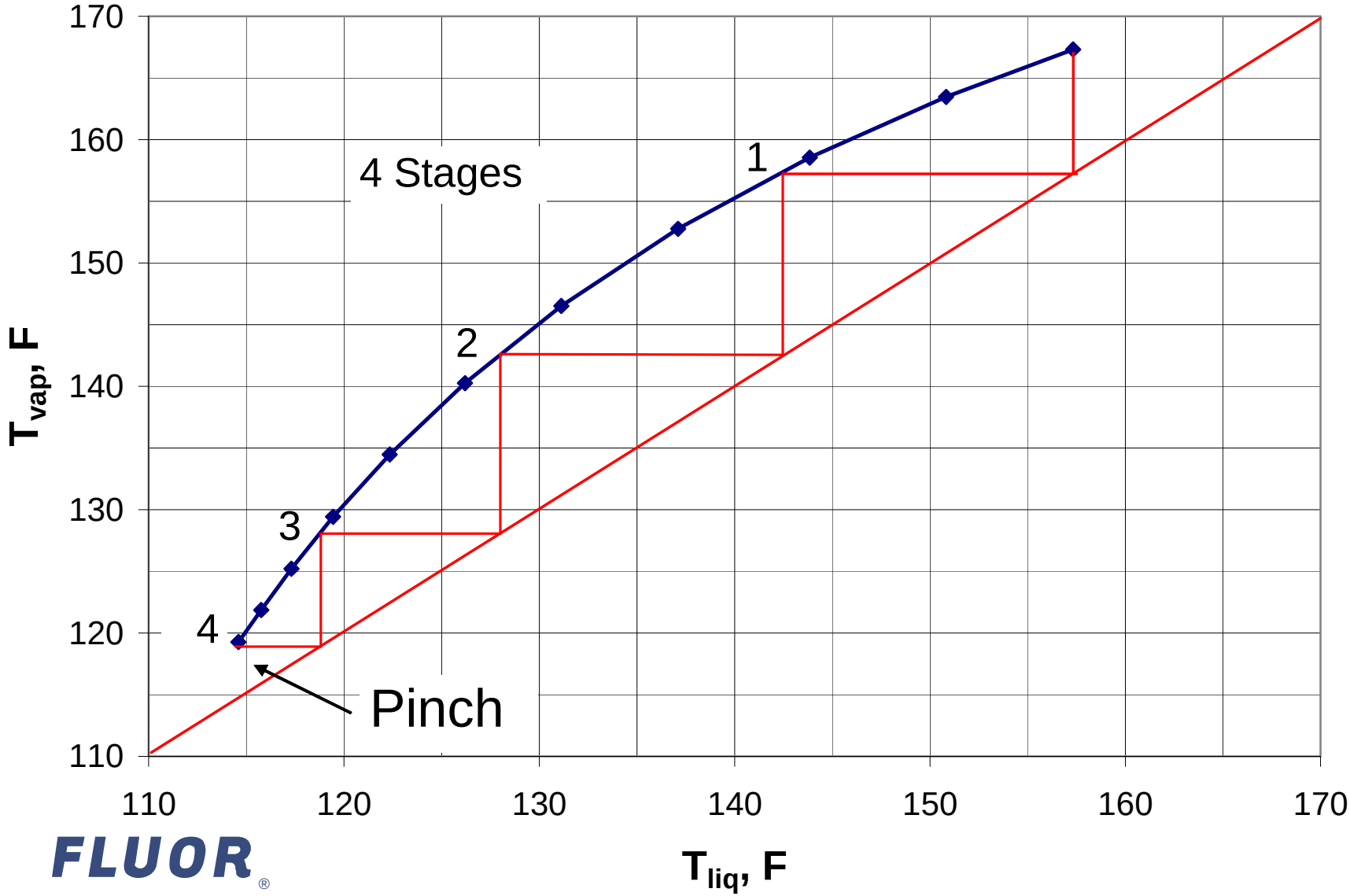
Condenser Packed Bed Operation



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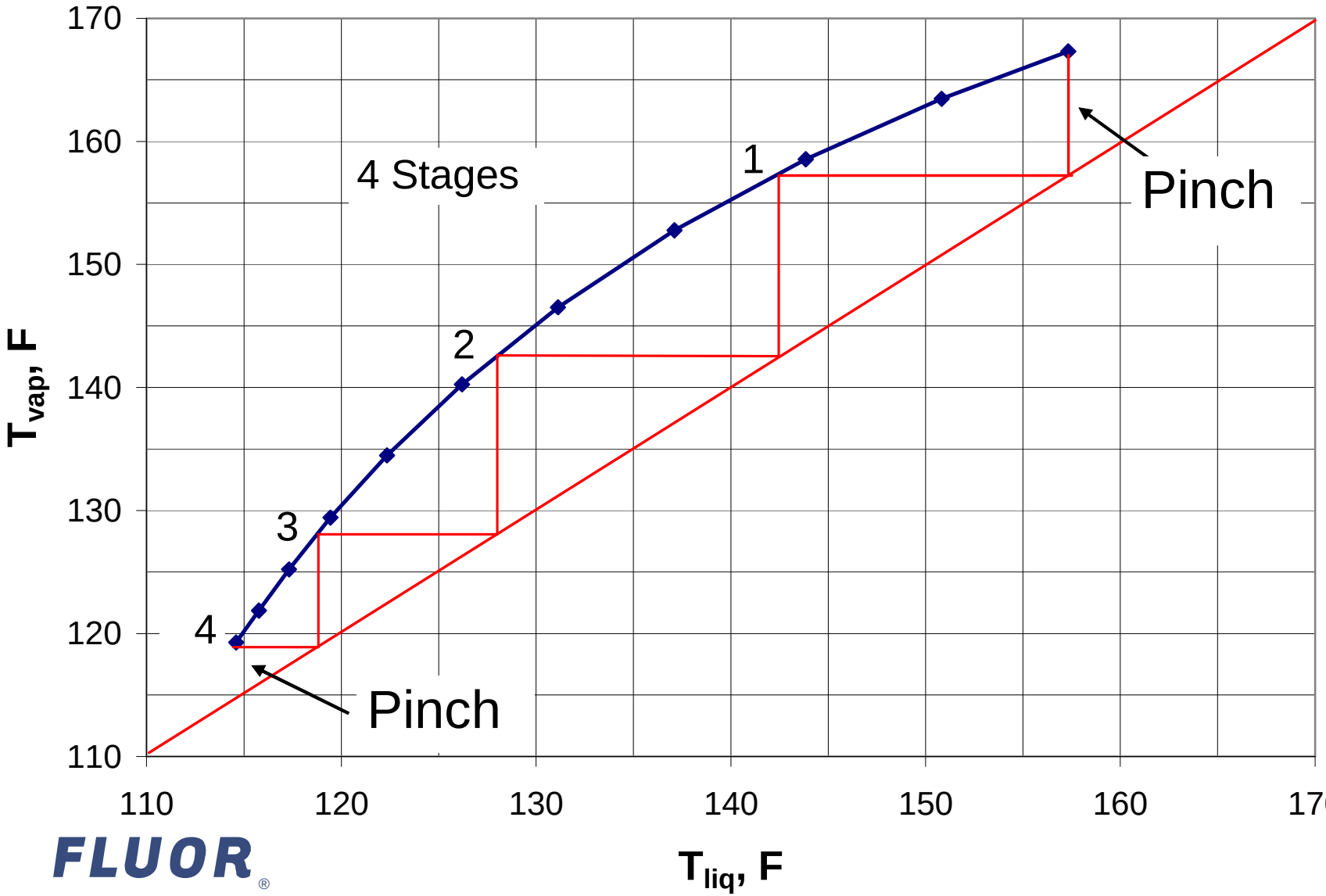

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In One Project.....

- Need to minimize refrigeration duty
- Pinching was the constraint
- Give up?

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- Break into two pumparound circuits!

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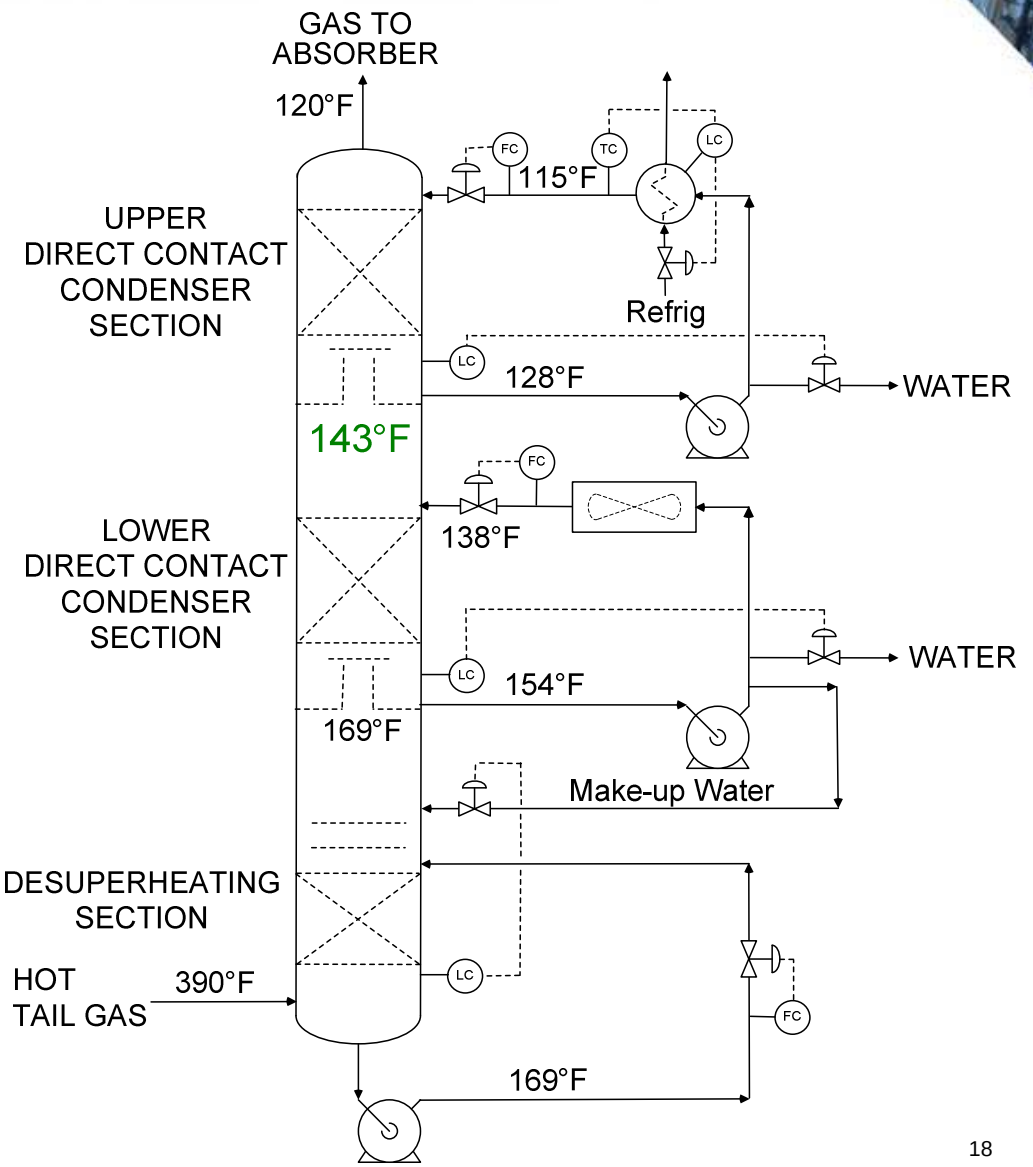
FLUOR Invention: Improved DCC Process

- **Improved DCC Process**
  - Splits DCC bed into two, with separate PA circuits
  - Bottom circuit air cooled
  - Top circuit refrigerant or water-cooled
- **Refrig duty minimized!**



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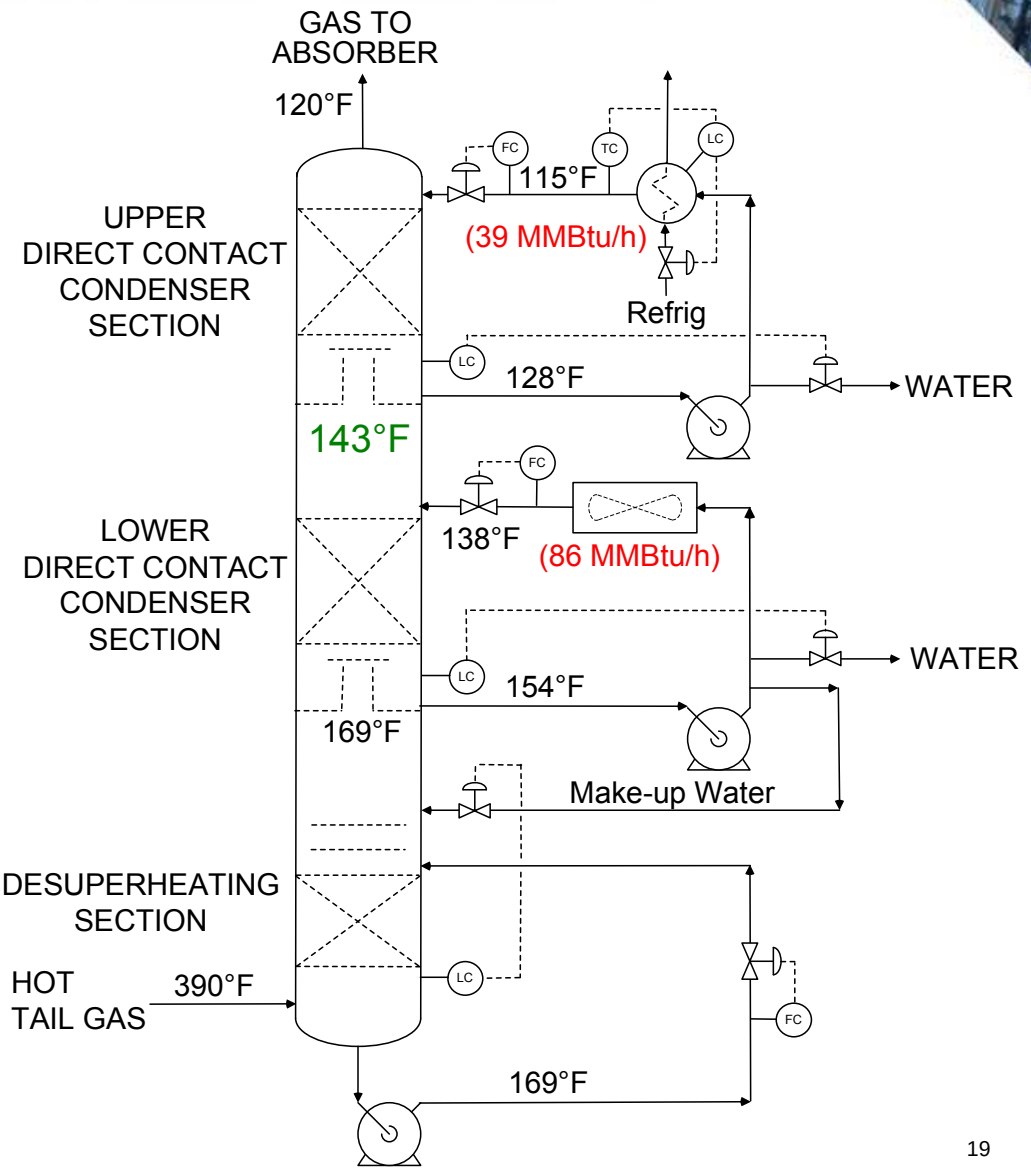

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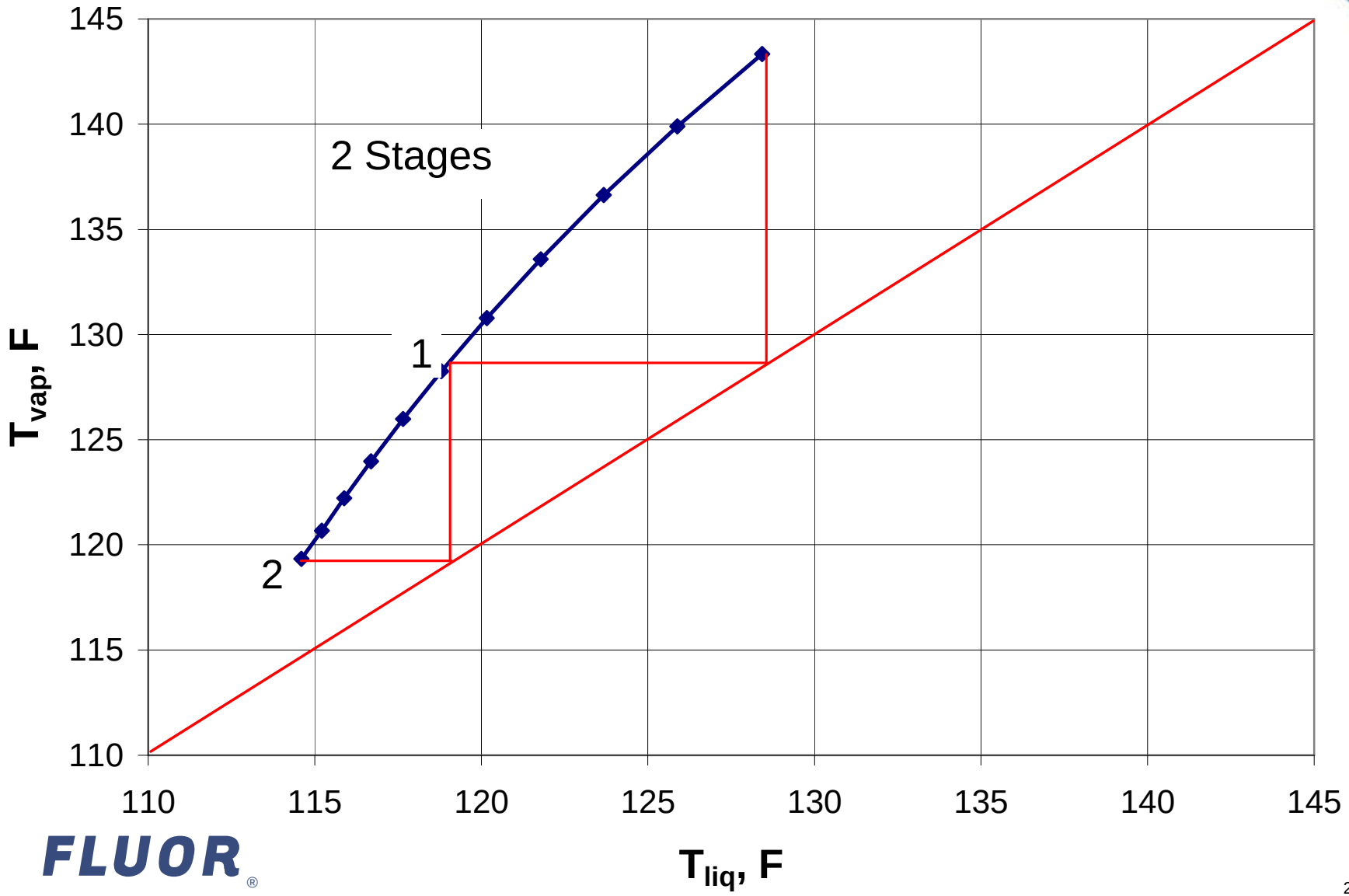
Upper Bed Operation



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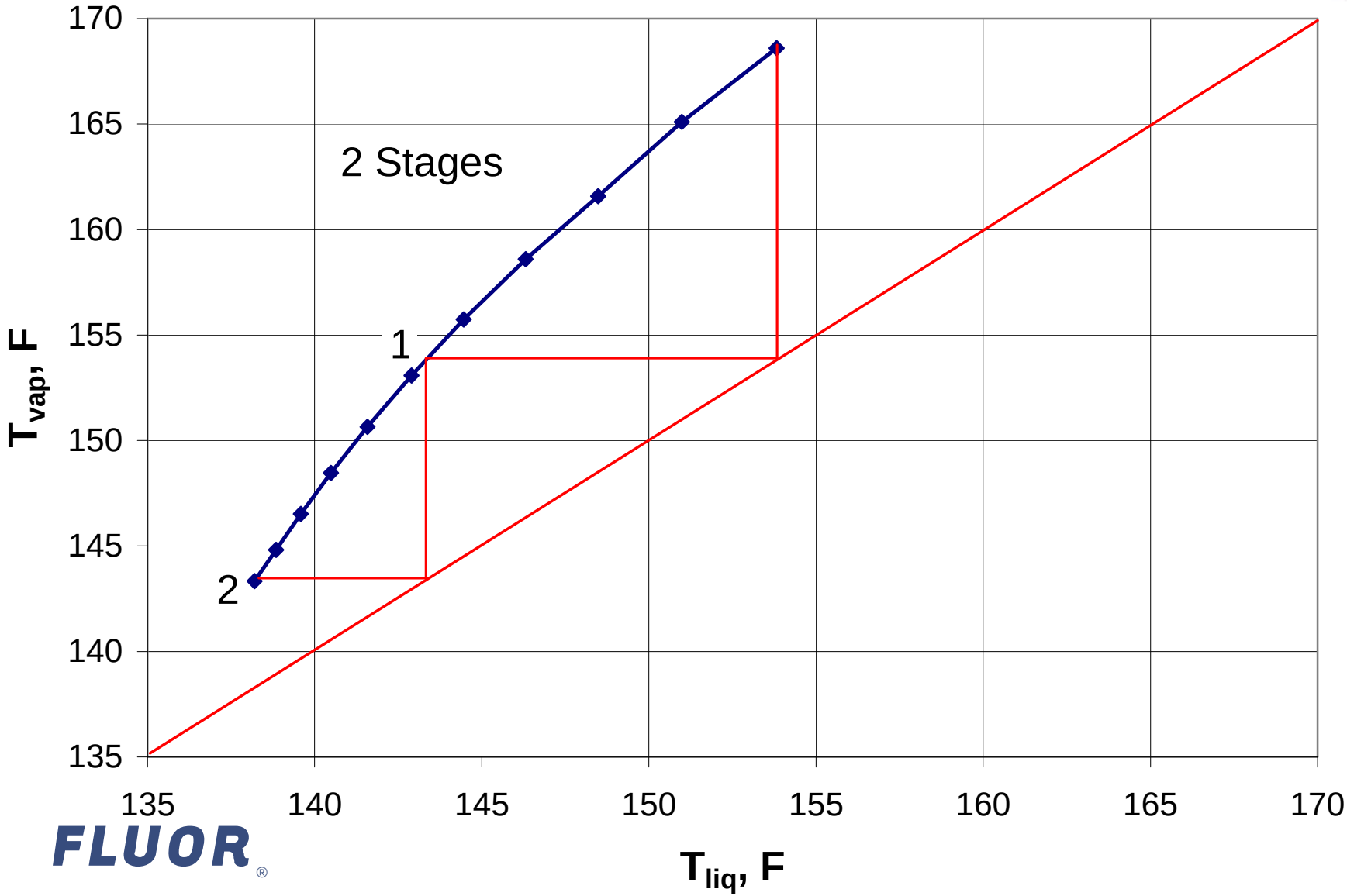
Lower Bed Operation



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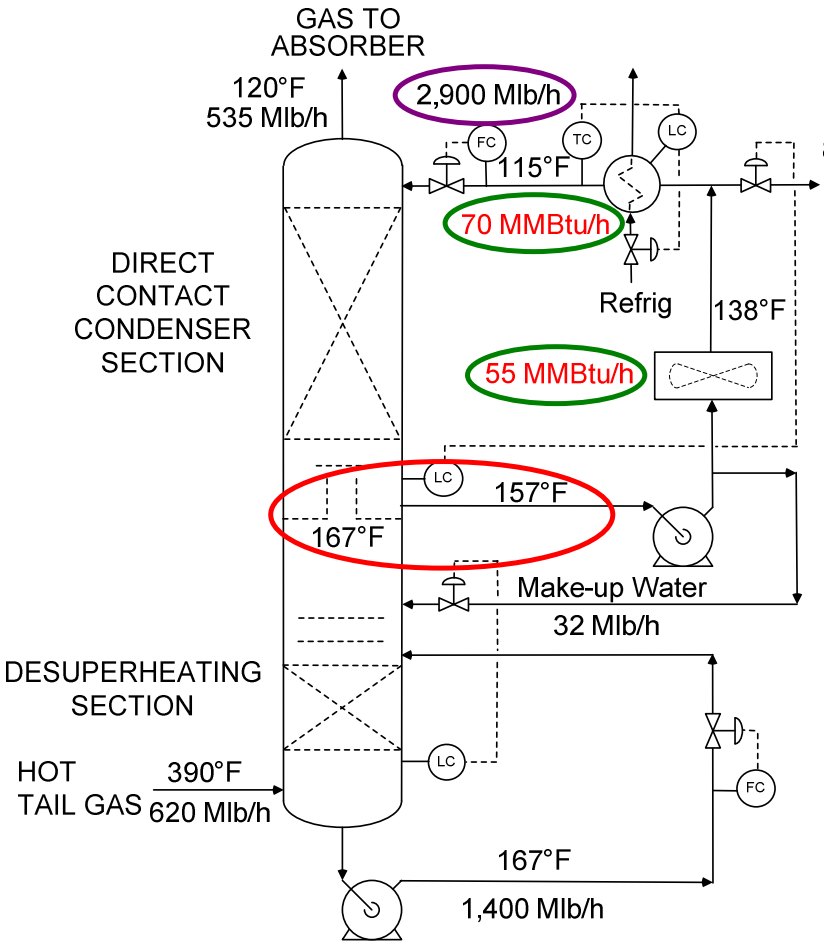
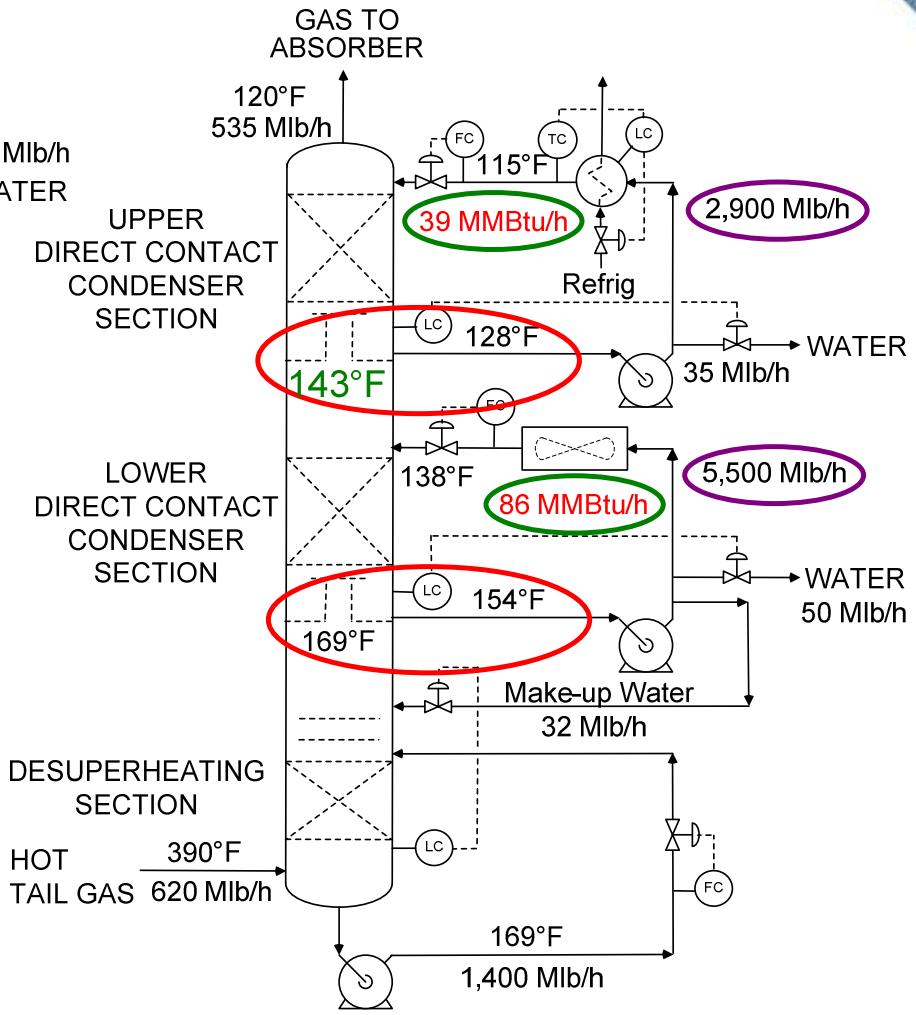
Economic Benefits of New DCC Process Scheme



CONVENTIONAL DESIGN



IMPROVED DESIGN

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Economic Benefits of New DCC Process Scheme

	Conventional Design	Improved Design
Capacity	Large Scale Middle East plant	Large Scale Middle East plant
Cooling Duty/Gas Rate/Gas Inlet and Outlet Temperature	Base	Base
Cooling Medium	Air + Propane Refrig	Air + Propane Refrig
Temperature Approach on Top of Bed	5℉	5℉
Temperature Approach on Bottom of Bed	10℉	15℉
Total Packing Height	Base	Slightly < Base

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Economic Benefits of New DCC Process Scheme

	Conventional Design	Improved Design
Column Internals Costs	Base	Slightly < Base
Tower Height & Diameter	Base	Same as Base
Air Cooler Duty	55 MMBtu/h	86 MMBtu/h
Trim Cooler Duty	**70 MMBtu/h**	**39 MMBtu/h**
Power Savings NPV[1]	Base	$13 MM
Capital Cost Savings	Base	$40 MM
Total Savings	Base	$53 MM
Notes:		
1. NPV (net present value) based on 8% discount rate, $24.5/MWh and 20 year plant life		

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Summary

- Single PA DCCs in hot and arid regions lead to excessive capital and energy costs in trim cooling
- Fluor's patent pending DCC technology transfers as much as 50% of trim cooling duty to air coolers by utilizing two PA loops instead of one
- Resulting power and capital cost savings can be large
- As added benefit, two small packed beds instead of one large packed bed results in reliable, robust design
- Good process optimization can save energy and capital

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Questions

Sulfur Recovery Solutions

by FLUOR®

Unique experience and knowledge in the design of sulfur recovery plants and tail gas treating units. A full range of services from feasibility studies to final start-up

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