Conversion of Sulfinol-D to MDEA at the Shell Canada Burnt Timber Facility

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April 27, 2007
GPAC O&M Conference

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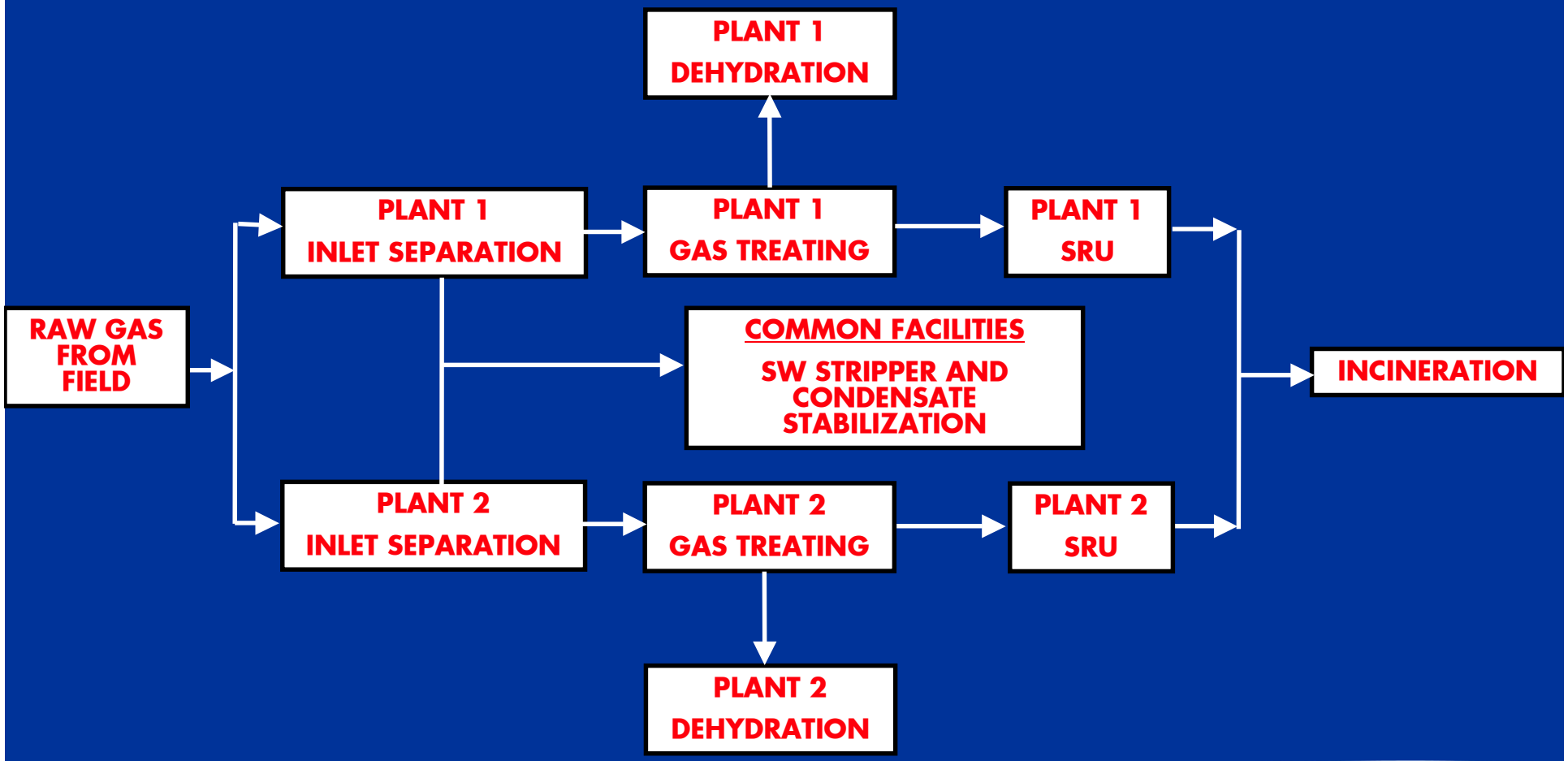
Introduction

- Shell Canada's Burnt Timber Facility is located 120 km northwest of Calgary, Alberta
- Plant 1 – constructed in 1970
  - Capacity of 1830 e3m3/d (65 MMSCFD)
- Plant 2 – constructed in 1976
  - Capacity of 2000 e3m3/d (71 MMSCFD)

Current Plant Configuration



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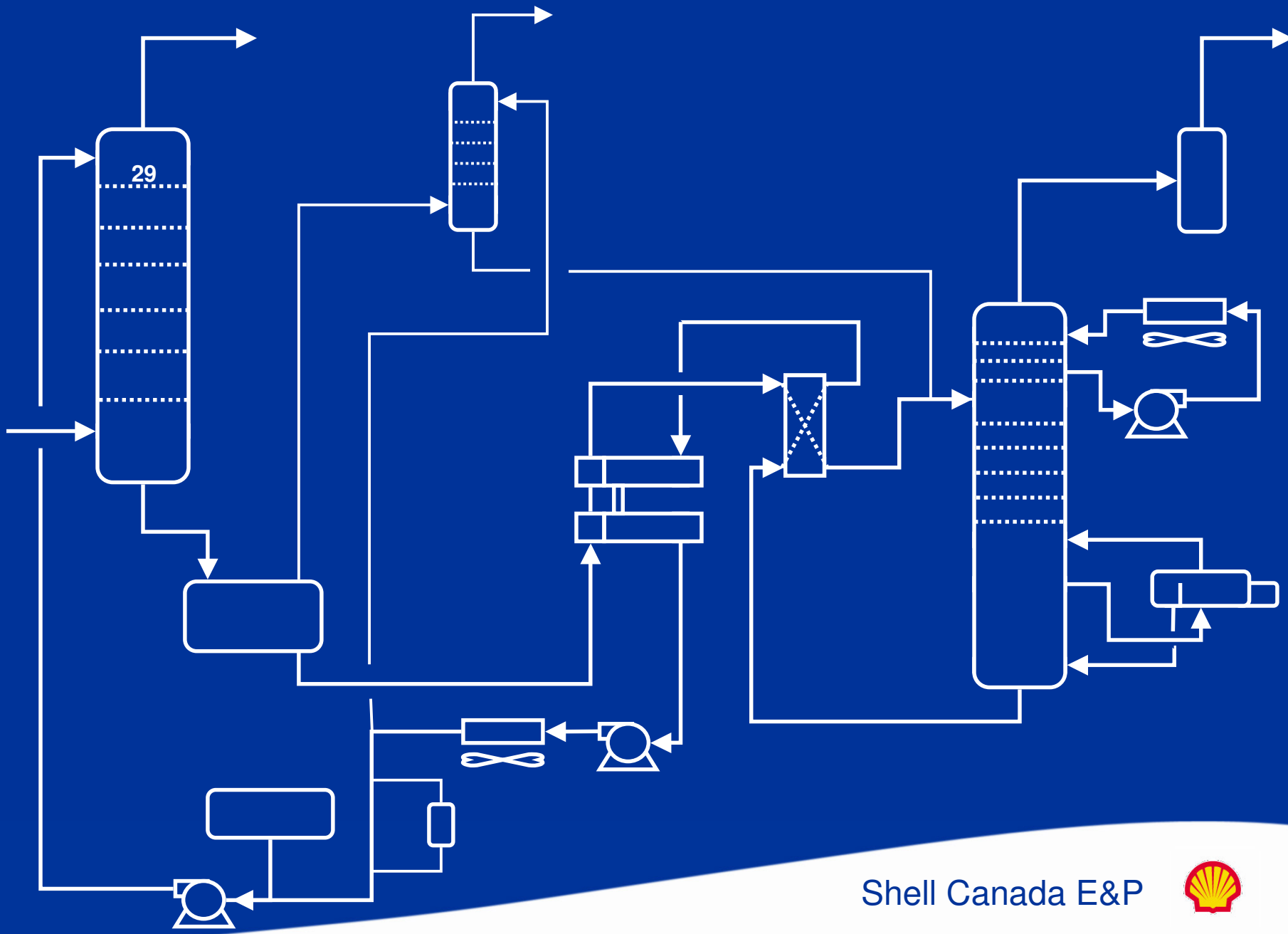
Original Gas Treating Configuration



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Reasons for Change

- Hydrocarbon Content in Acid Gas
  - Consumption of air
  - Produced large amounts of CS_2
  - Un-combusted BTX caused deactivation of 1st converter bed
- This resulted in 1st bed catalyst being changed every 6 to 9 months.
  - Excessive operating costs
  - Lost Production

Reasons for Change

- High CO_2 Content in Acid Gas
  - Increases pressure drop therefore reducing blower capacity and plant capacity
  - Production of COS reducing sulphur recovery
  - Reduces reaction furnace flame temperature

Reasons for Change

- Change in feed gas composition
  - Burnt Timber Field: $H_2S = 10.2\%$ $CO_2 = 6.4\%$
  - Panther Field: $H_2S = 7\%$ $CO_2 = 11.5\%$

Component (mole %)	Year	
	2005	2020
H_2S	10.1	8.1
CO_2	8.0	10.2
N_2	0.6	0.5
C1	75.8	80.4
C2	2.1	0.8
C3	0.4	0.2
i-C4	0.1	0.0
n-C4	0.1	0.0
i-C5	0.1	0.0
n-C5	0.1	0.0
C6	0.3	0.1
C7+	3.3	1.2

Reasons for Change

- **Changing Feed Composition would result in:**
  - **Poor Acid Gas H_2S:CO_2 ratio**
  - **Higher acid gas HC content due to higher amine circulation ratios**
- **End Result = Lower Plant capacity and lower sulphur recovery**

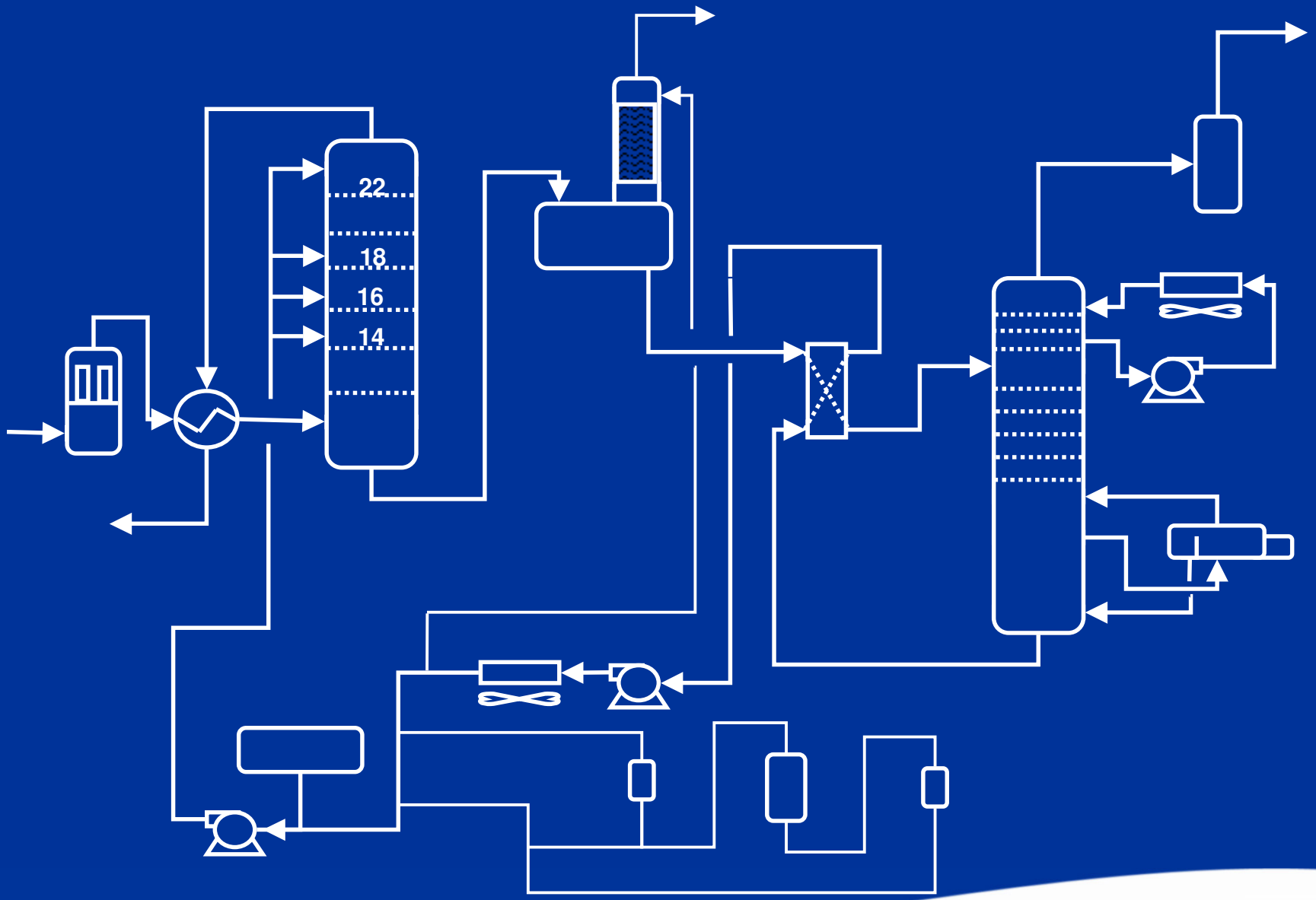
Benefits of Conversion to MDEA

- Slip CO_2 to sales improving acid gas H_2S:CO_2 ratio.
- Decrease HC co-absorption in the amine.
  - Decrease air requirements in SRU and increase capacity.
  - Increase heating value to sales gas.
  - Reduce flash gas volume.
- Circulation rate not impacted by H_2S:CO_2 ratio.
- Lower reboiler duty

Risks of Conversion to MDEA

- Reduced removal of trace sulphurs
  - Depending on raw gas trace sulphur content, may not be able to meet specification.
- Aqueous MDEA has a higher foaming tendency than Sulfinol which may lead to capacity constraints
- Decision was made to change amine to MDEA.
- Millenia Resource Consulting of Calgary was contracted to do the detailed Engineering design.

MDEA Conversion Modifications



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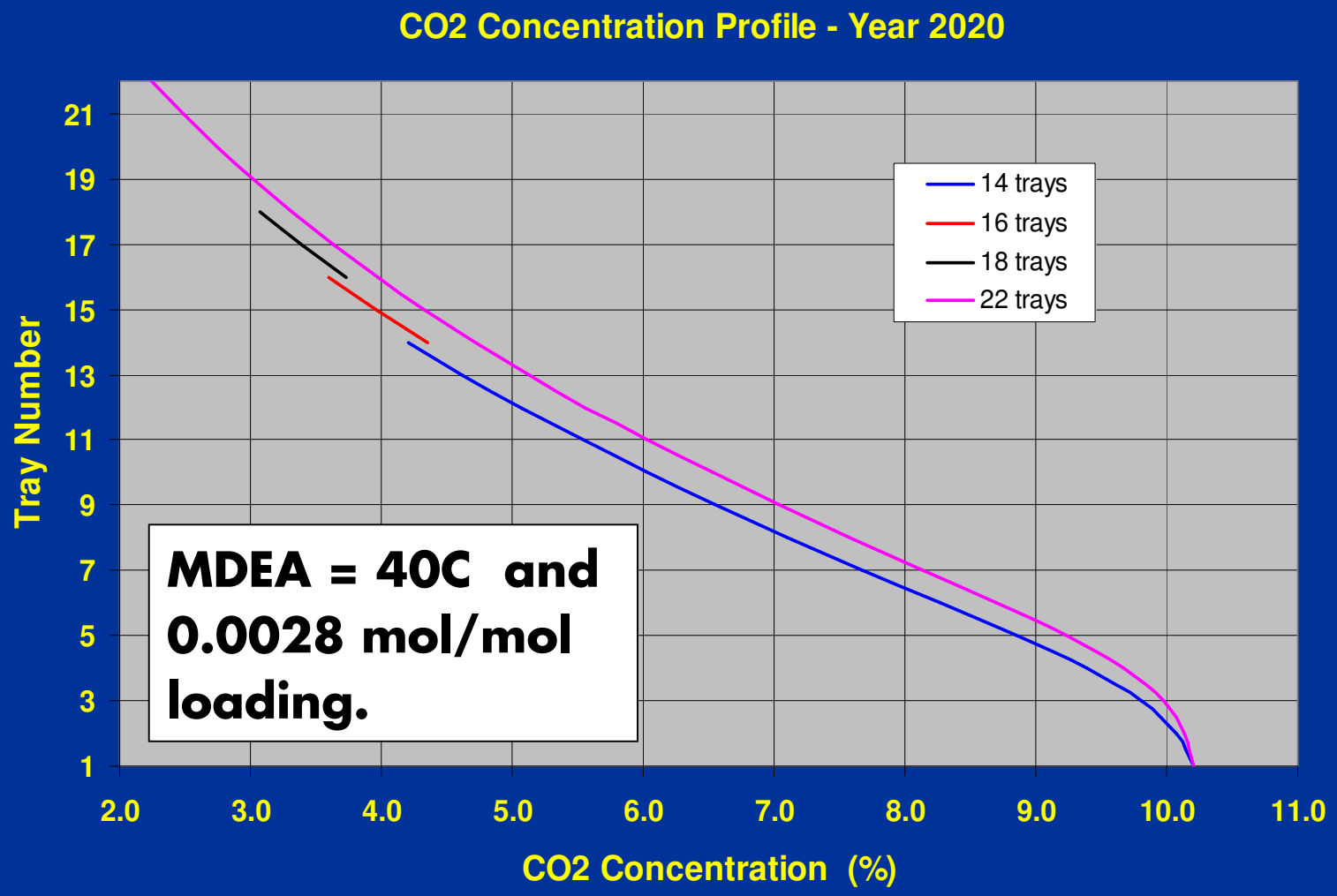
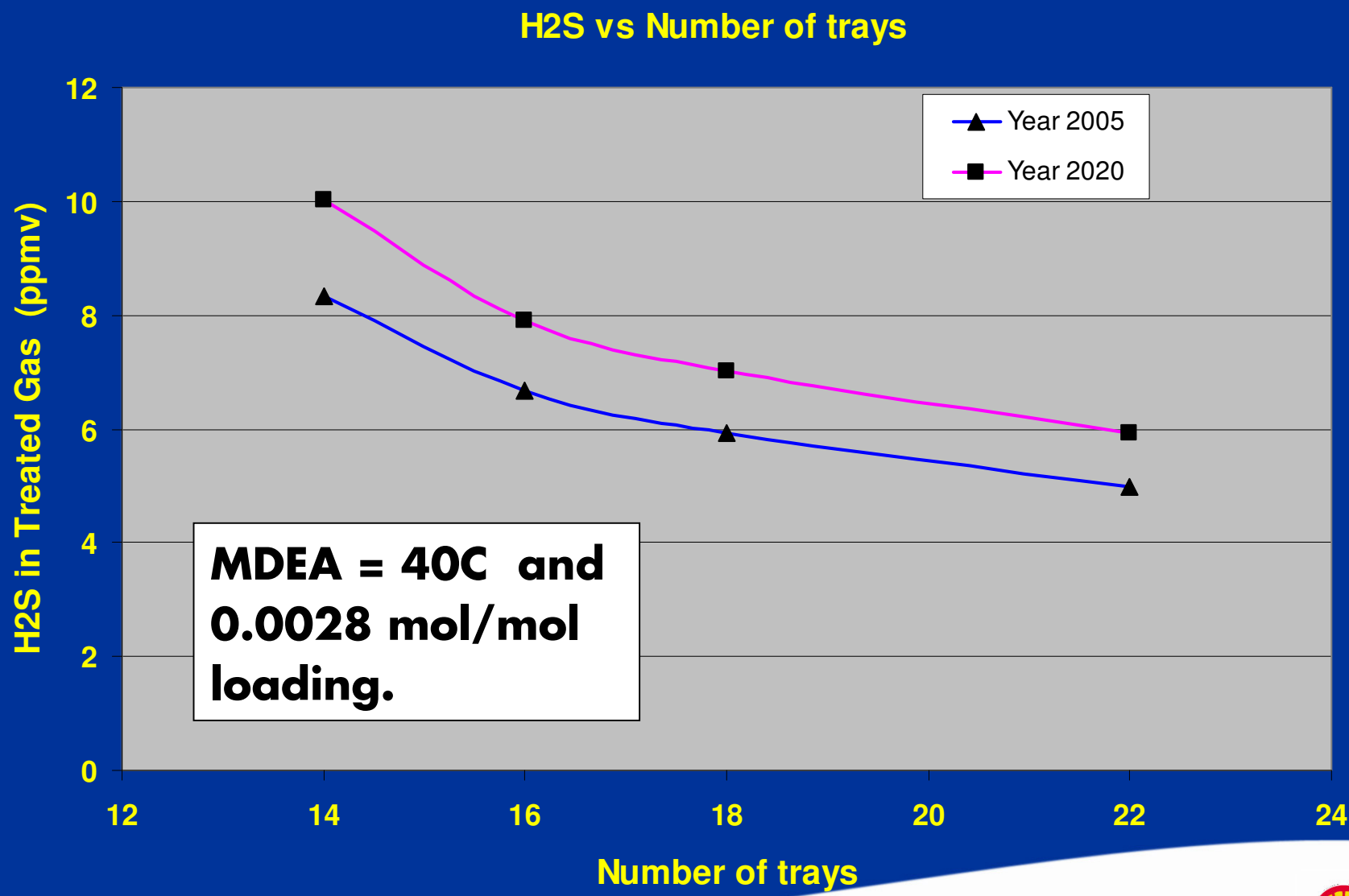
Absorber Design

- Slip up to 4% CO_2 and less than 8 ppmv H_2S
- 2% CO_2 required when Plant 1 is shutdown



Absorber Design



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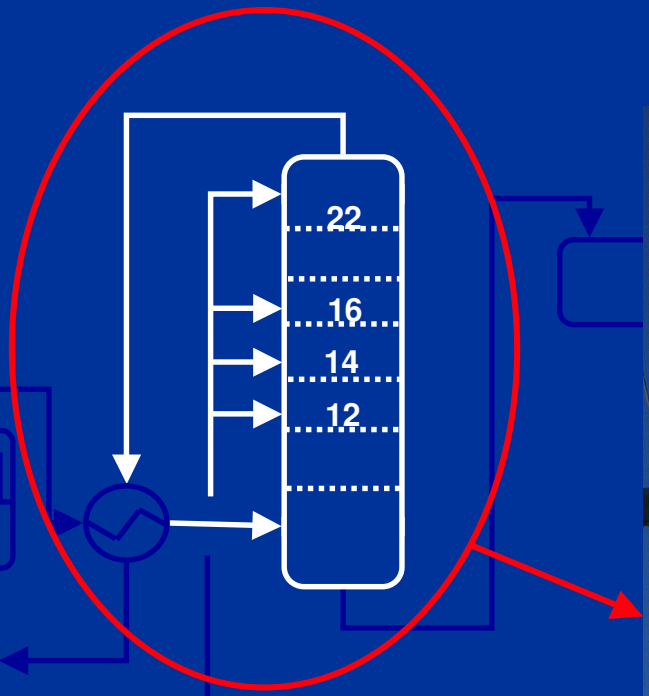
Absorber Design



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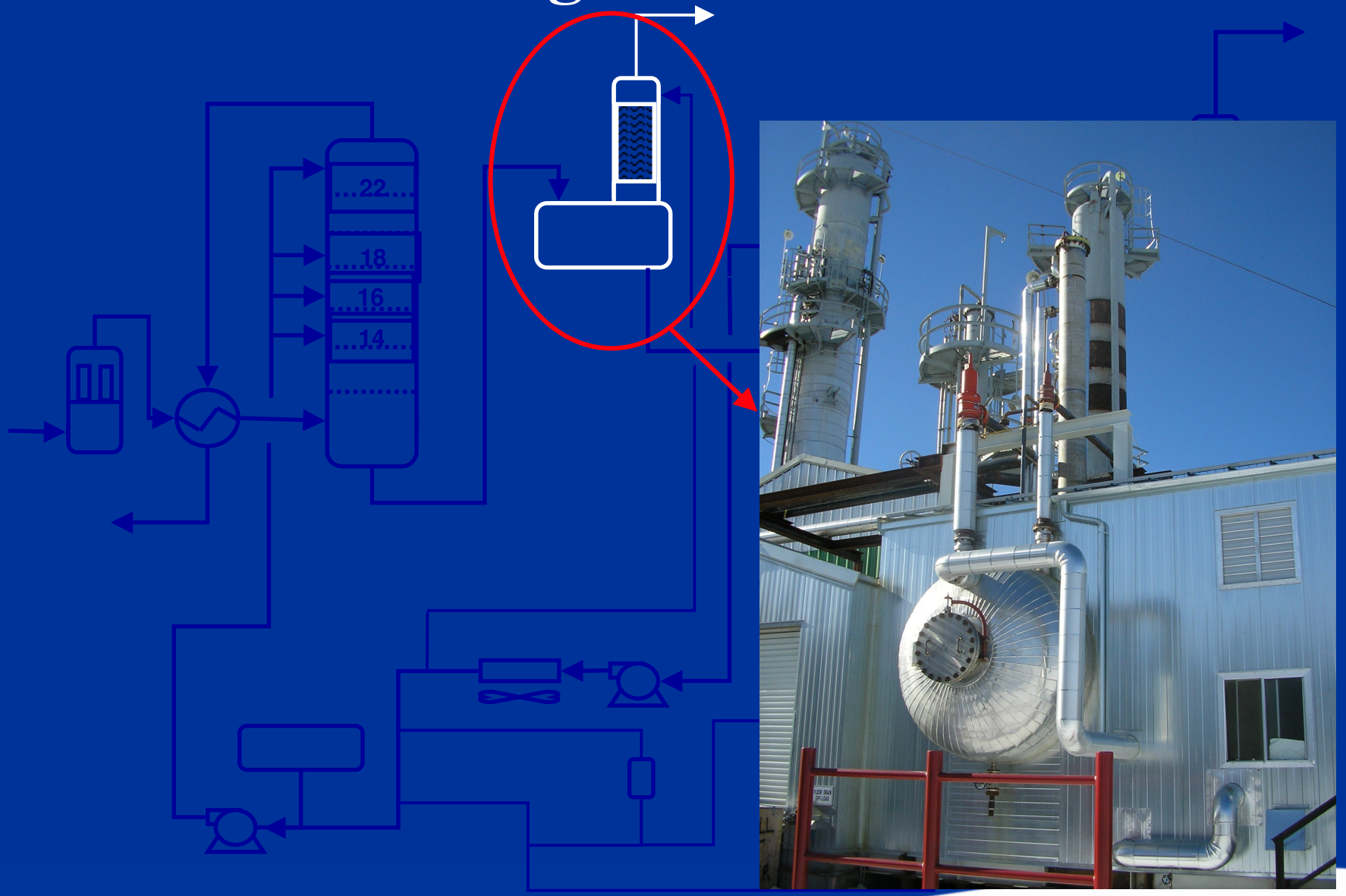
Flash Drum Design



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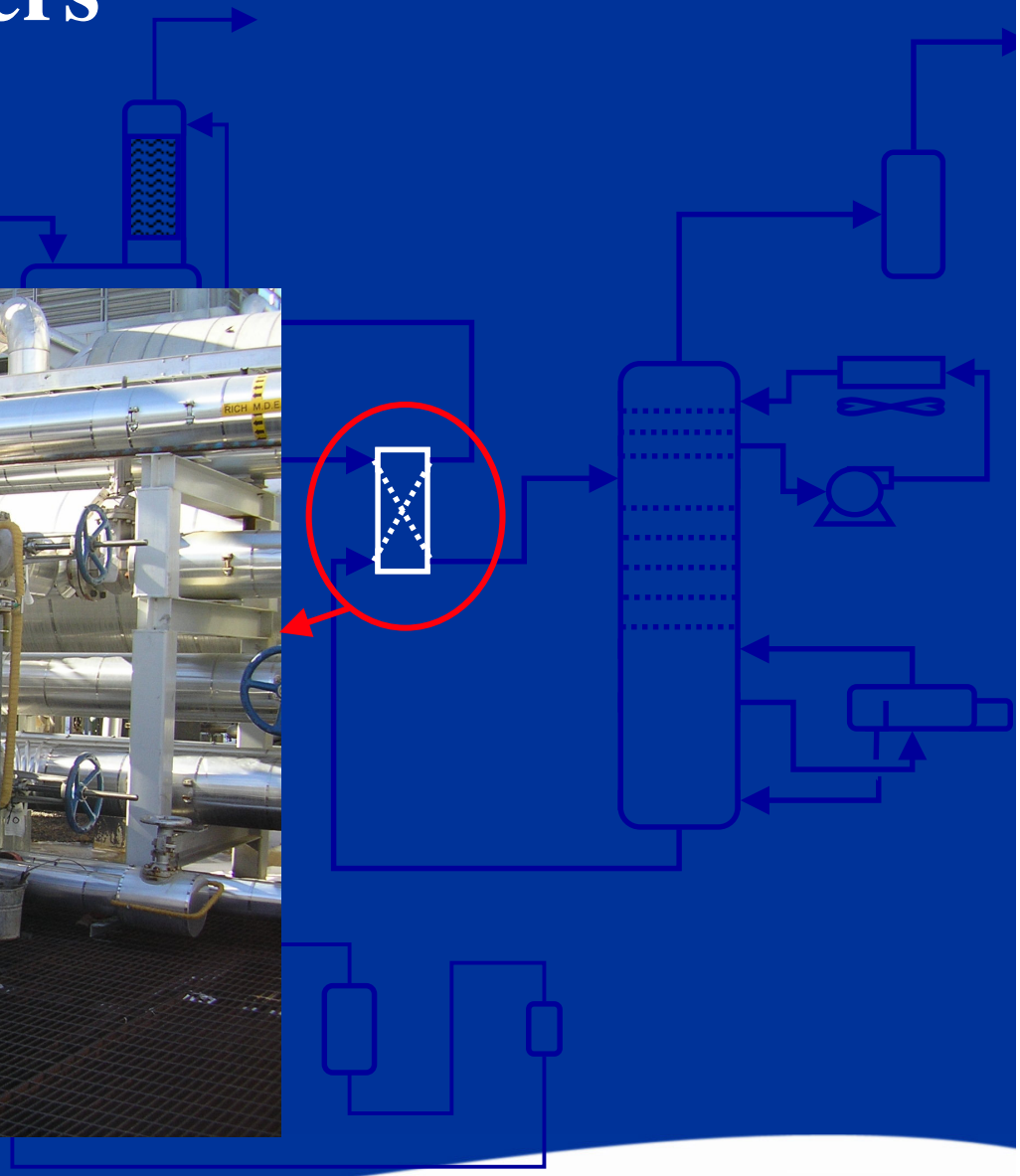
Lean Rich Exchangers



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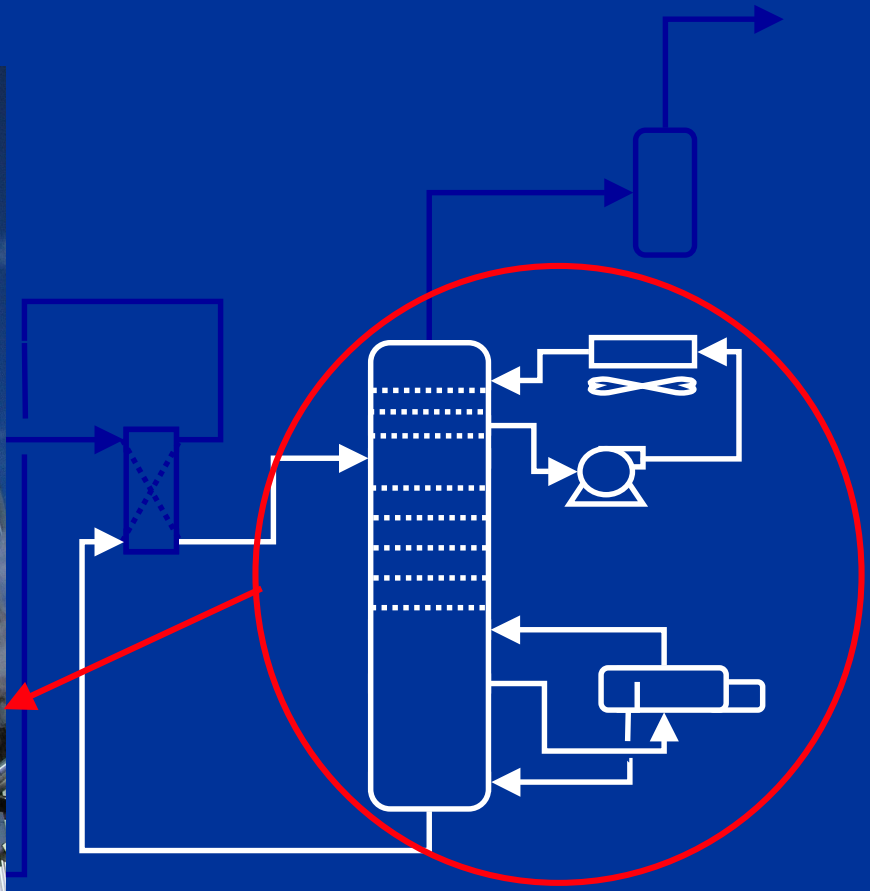
Regenerator



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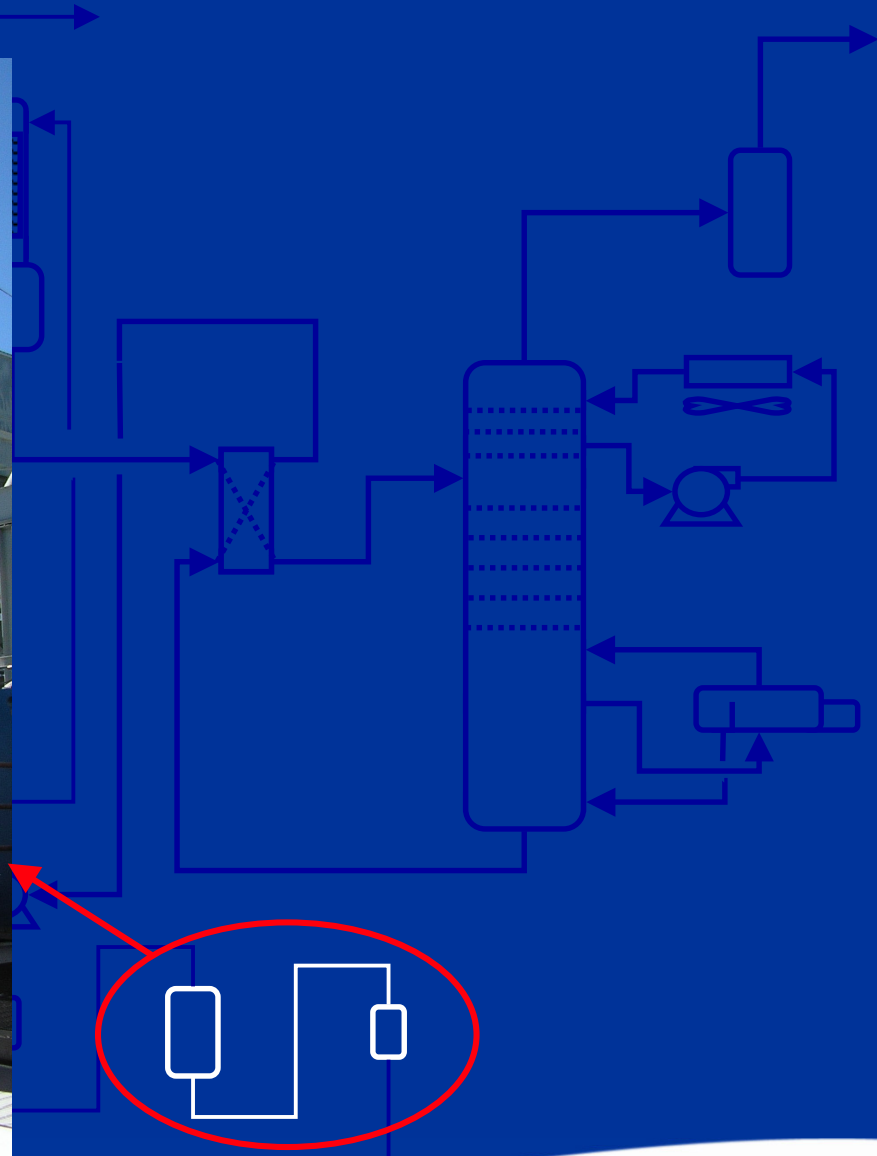
Carbon Filter



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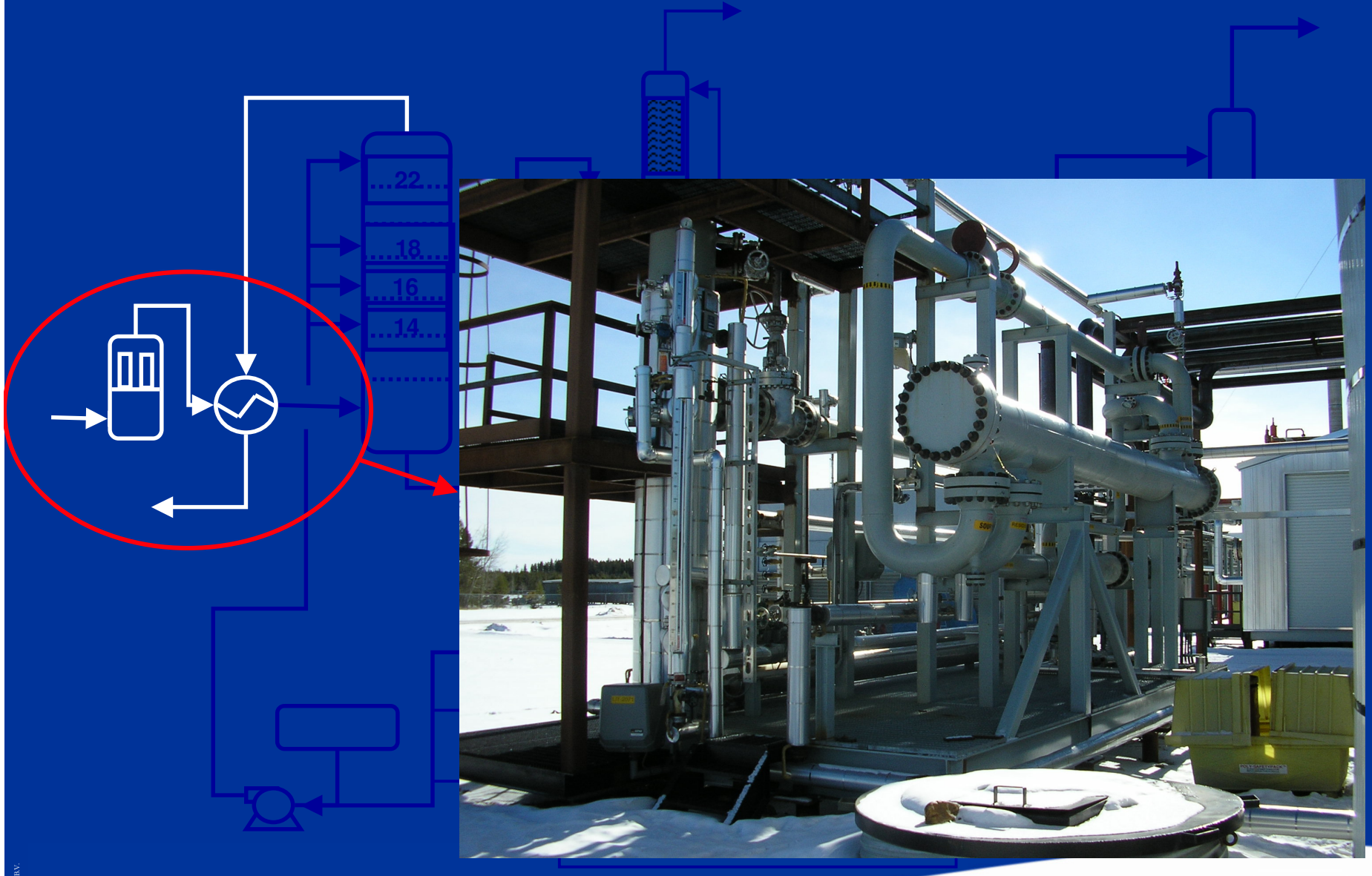
Inlet Filter Coalescer & Preheater



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Construction

- Construction was one of the most challenging aspects of the project
- Equipment located on three skids
  - Gas/Gas Exchanger and Coalescer Skid
  - L/R Exchanger Skid
  - Flash Tank Skid
- Issues with the skids – late and unfinished.

Construction

- Major work during shutdown was in the Absorber
  - Installation of three feed nozzles
  - Installation/modification of tray rings
  - Strip lining the bottom 10 m
  - Lining the nozzles with stainless steel
- Absorber had to have a hydrogen bake out, continuous weld preheat, and stress relieving.

Commissioning, Start-up and Operation

- First task was to clean the system
  - Absorber and regenerator were vacuumed.
  - Start-up suction strainers installed.
  - Vessels and piping were air freed and gross leak tested using N_2.
  - Final leak check at operating pressure with fuel gas.

Commissioning, Start-up and Operation

- Cleaning the system cont'd
  - System was charged with steam condensate.
  - Circulation was established with L/R exchangers by-passed.
  - Steam condensate temperature was raised to 60 deg C.
  - A degreasing solution was added (1% soda ash, 1% tri-sodium phosphate and 0.2% surfactant).

Commissioning, Start-up and Operation

- Cleaning the system cont'd
  - The system was completely drained and then refilled with fresh steam condensate.
  - Circulation was then established for 3 hours or 3 full circulations.
  - The system was drained then charged with 50:50 MDEA/Water mixture.

Commissioning, Start-up and Operation

- **Start-up**
  - **Gas was introduced with no unexpected issues.**
  - **When L/R exchangers were placed in series, the Booster Pumps experienced cavitation.**
  - **The pumps were damaged and 3 day outage was necessary due to delivery of replacement parts.**

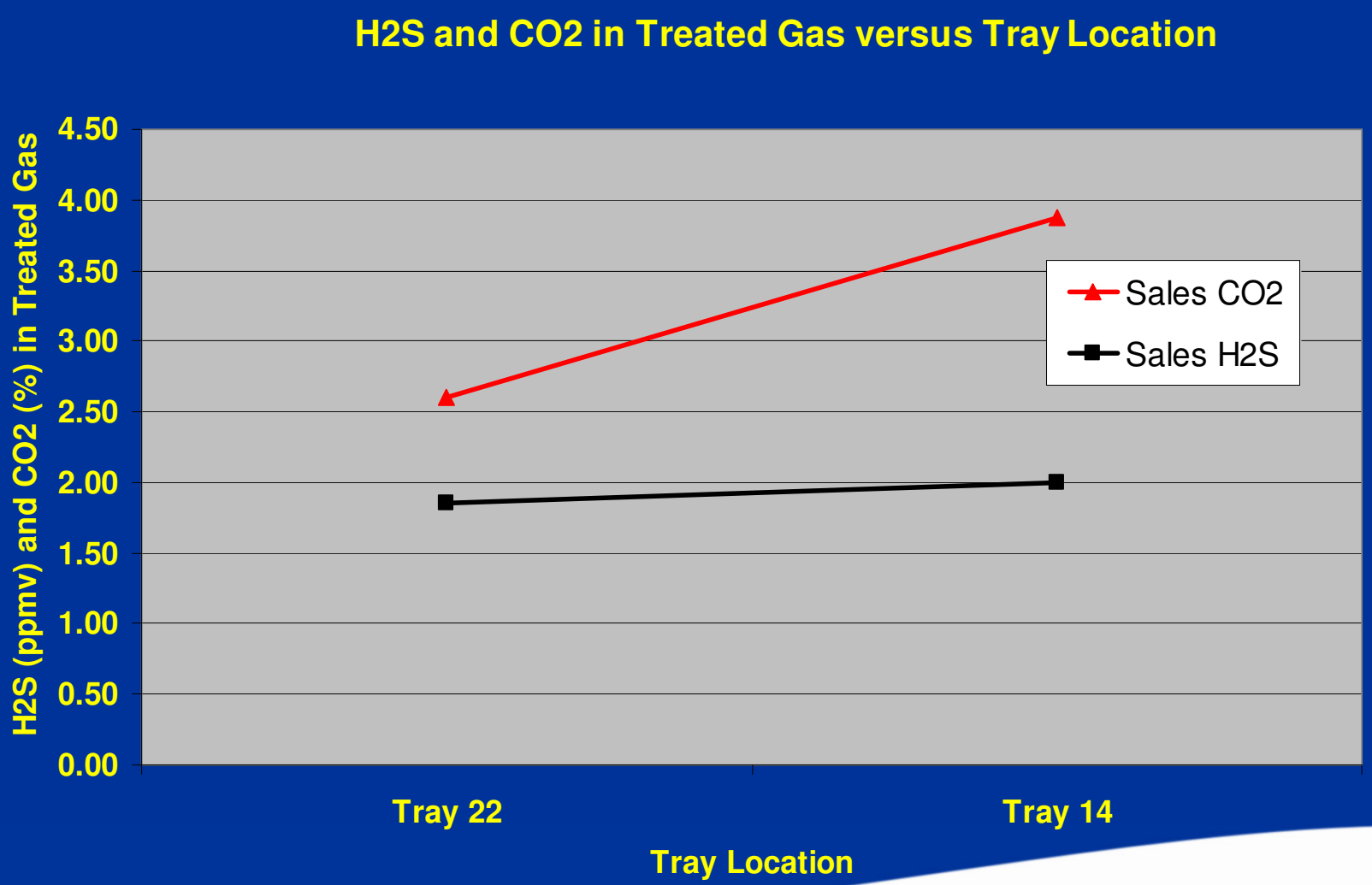
Commissioning, Start-up and Operation

- **Start-up….Next Problem**
  - **Plugged Absorber Level Control Valve.**
  - **Valve was plugged with welding slag, bolts, and other debris.**
  - **This occurred three more times with the same result.**
  - **Installed a bypass LCV with different style trim.**

Commissioning, Start-up and Operation

- Start-up
  - Hang-ups were experienced in the regenerator due to excessive steaming
  - Placing L/R exchangers in series on the rich side solved this issue.
  - The L/R exchangers did experience some plugging.
  - They were cleaned several times online.

Optimization and Current Operation



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Key Process Performance Results

- Inlet Raw Gas
  - Design = 1850 e3m3/d
  - Performance Test = max. 2050 e3m3/d
- Reboiler Steam demand
  - 25% less steam per volume of raw gas
- Flash Gases
  - Reduced from 30 to 2-4 e3m3/d

Key Process Performance Results

- **Sulphur Plant Operation**

Parameter	Sulfinol	MDEA
Acid Gas H_2S	58%	Up to 70% H_2S
Acid Gas HC Content	2.5% (CH_4 eq.)	<1% (CH_4 eq.)
BTX in Acid Gas	> 2300 ppmv	400 – 500 ppmv
CS_2 to 1st Converter	1.25%	0.23%
COS & CS_2 from Stack	130 & 200 ppmv	50 & 16 ppmv
TRS (Total Reduced S)	600 ppmv	100 ppmv
Sulphur Recovery	95%	96.9%

Key Process Performance Results

- **Trace Sulphur Removal**

	Inlet Gas	% Removal	
		COS	RSH
Design (MDEA)	117 mg S/m^3	28%	37%
MDEA	112 mg S/m^3	26%	47%
Sulfinol	112 mg S/m^3	85%	80%
Total Sulphur in Sales = 59 mg S/m^3 (spec = 115)			

Key Process Performance Results

- **Trace Sulphur Removal**
  - **Subsequent tests showed only 8% and 15% removal of COS and RSH with the inlet containing 199 mg S/m^3.**
  - **Combined Sales contained = 141 mg S/m^3**
  - **Inlet Trace Sulphur was high due to sulphur washes on a sulphur producing well.**

Summary

- Conversion to MDEA was a success at Burnt Timber.
- System operates well with little foaming.
  - Inlet coalescer and carbon bed.
- MDEA was the correct solution to the problem at Brunt Timber.