CatCracking Safety and Reliability Seminar
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Improving Light FCC Product Recovery

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MORE PRODUCTION - LESS RISK!

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Presentation Overview

- Basic principles
- Potential problems areas
- Design considerations
- Provide insights based on global Process Consulting Services experience – Articles
- Facilitate interactive discussion
- Broad audience speaker dilemma

- Don't start with solution – understand problem

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Presentation Take-Aways

- Get out of your office and measure what is actually happening in the field
  - Everywhere we go we see more and more people trying to troubleshoot their units from the comfort of their air-conditioned offices (Example – DHDS)
- P3>P2>P1
- The newest high-tech widget is not always the best solution

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Basic Principles
Product Fractionation

- Product fractionation is controlled by liquid/vapor ratio (L/V) in each fractionation section
- The number of fractionating trays or amount of packing is important
- But without adequate reflux (L) fractionation will be poor
- Location and amount of heat removal set L/V
- Heat balance determines fractionation assuming column internals operating correctly

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Column Internals
General

- Valve and sieve tray are used in most new FCC designs by all licensors
- Structured packing and grid is primarily used for revamps, although a few new units have been designed with packing
- Structured packing has been used for more than 30 years in the Main Column and Gas Plants
- Poor liquid distribution single biggest cause of poor packing performance

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Packing Benefits/Debits

- Reduced pressure drop
- Higher capacity than trays
- More expensive
- As a revamp tool it is unmatched; replacing a column is very expensive

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Fractionation Efficiency

- Well designed trays that are not flooding have an efficiency of ~ 65-70%
- Structured packing (0.5” crimp) has approximately a 24” HETP assuming good liquid and vapor distribution
- Packing efficiency is primarily a function of liquid distribution
- Poor liquid distribution can increase 0.5” crimp HETP from 24” to 10 feet! Yes, 10 feet!!

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Wet Gas Compressor System

- Compresses main column overhead gas to gas plant operating pressure
- Maintains reactor pressure and raises outlet pressure so C_5's and lighter can be recovered using cooling water
- Higher gas plant operating pressure improves C_3 recovery but increases compressor discharge pressure and power consumption

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Gas Plant Operation

- Primary absorbers recover the C_3's and heavier
- Strippers reject C_2's and H_2S to fuel gas
- Debutanizer, C_3/C_4 splitter and gasoline splitter separate the stripper bottoms for downstream processing and/or blending

- SIMPLIFY
- GET OUTSIDE - SURVEY
- DEFINE - WHAT ARE YOU TRYING TO ACCOMPLISH?

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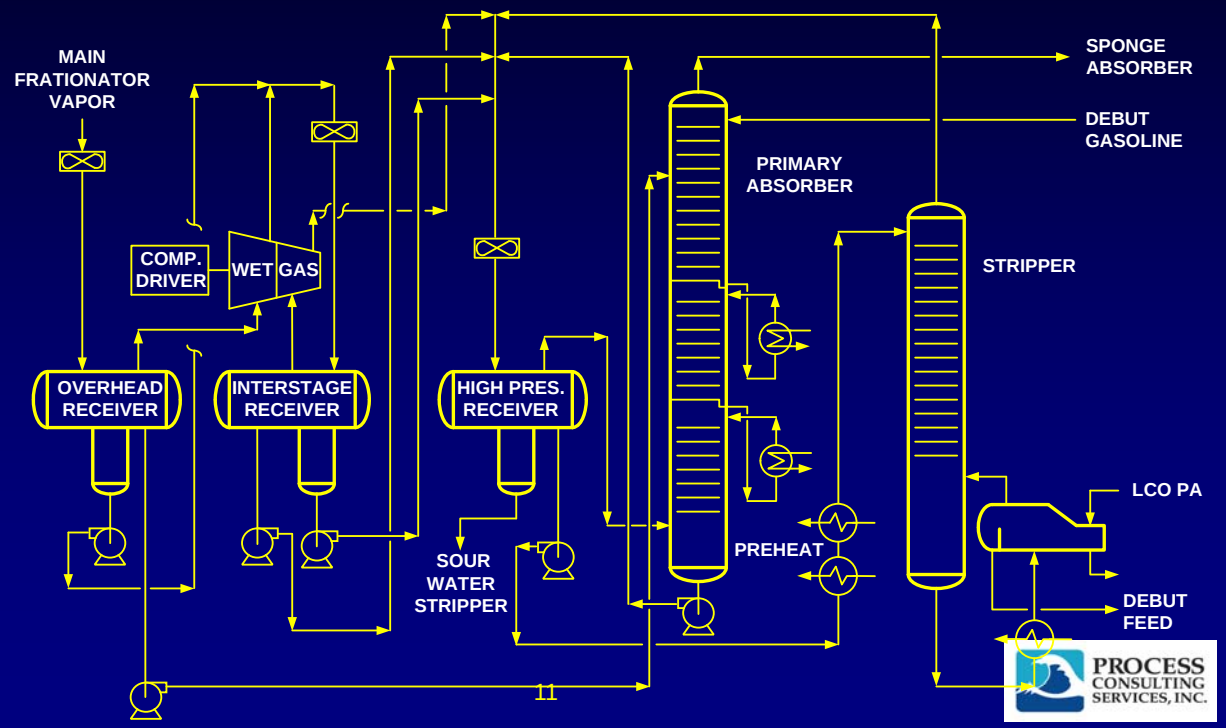
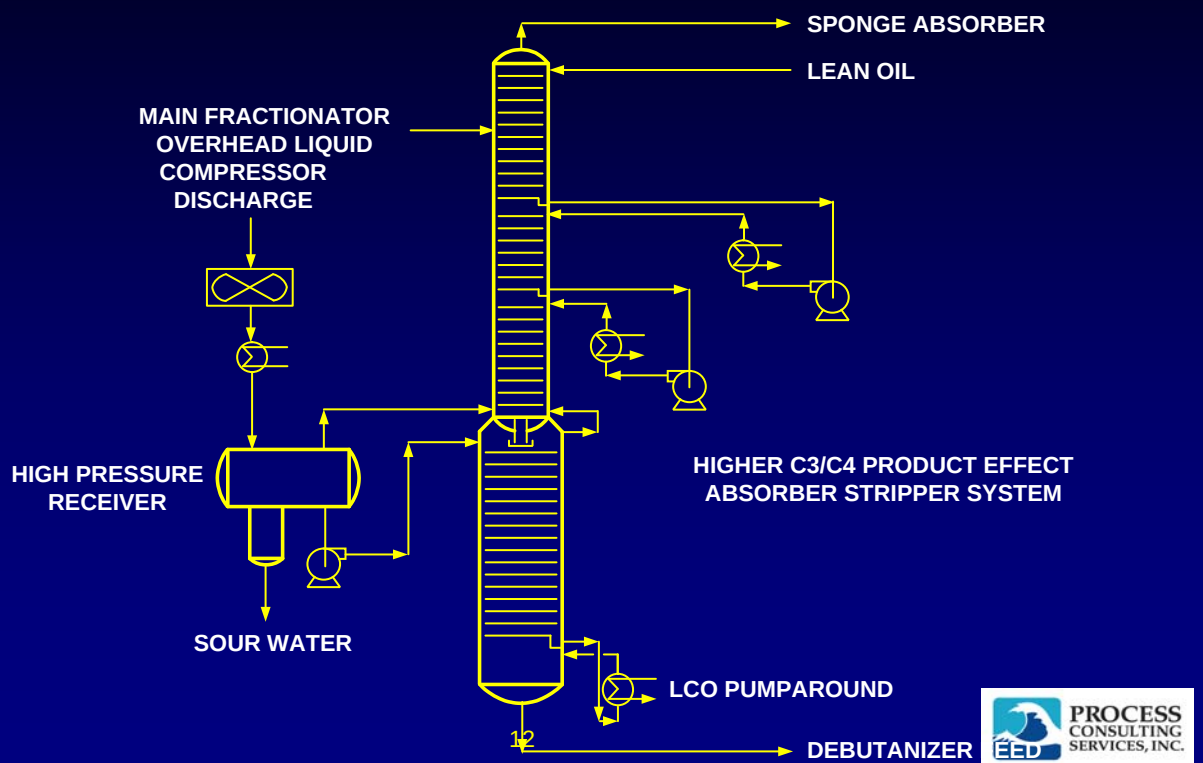
Gas Plant Design & Operation



Single Column Absorber/Stripper



Primary Absorber

- Temperature, pressure and L/V affect C_3's and heavier recovery
- Minimizing temperature important: inter-coolers and refrigeration are sometime used
- Pressure depends on equipment design
- L/V depends on dry gas rate, gasoline yield and debutanizer recycle

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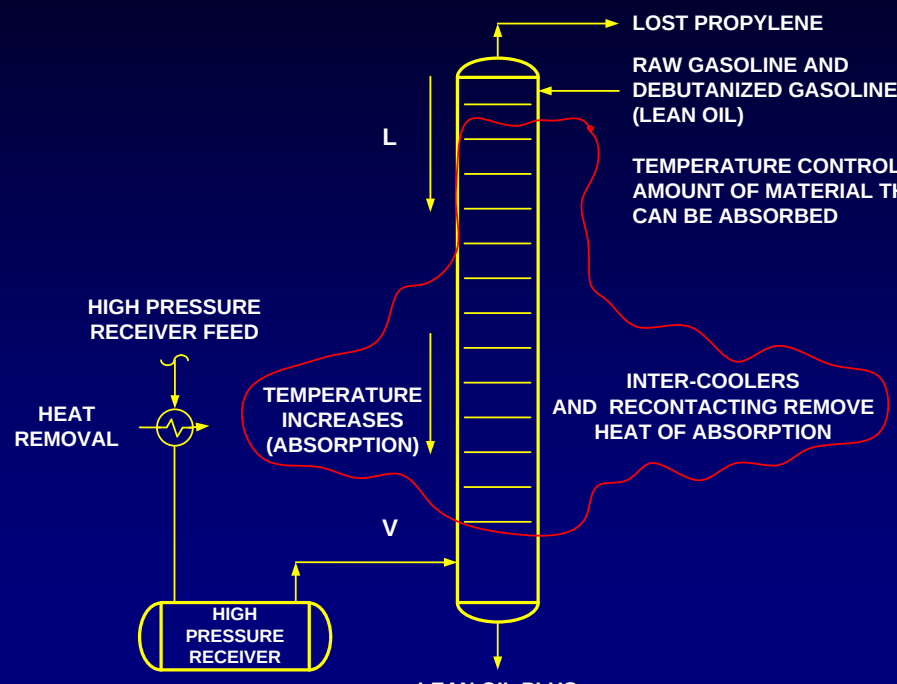
Primary Absorber



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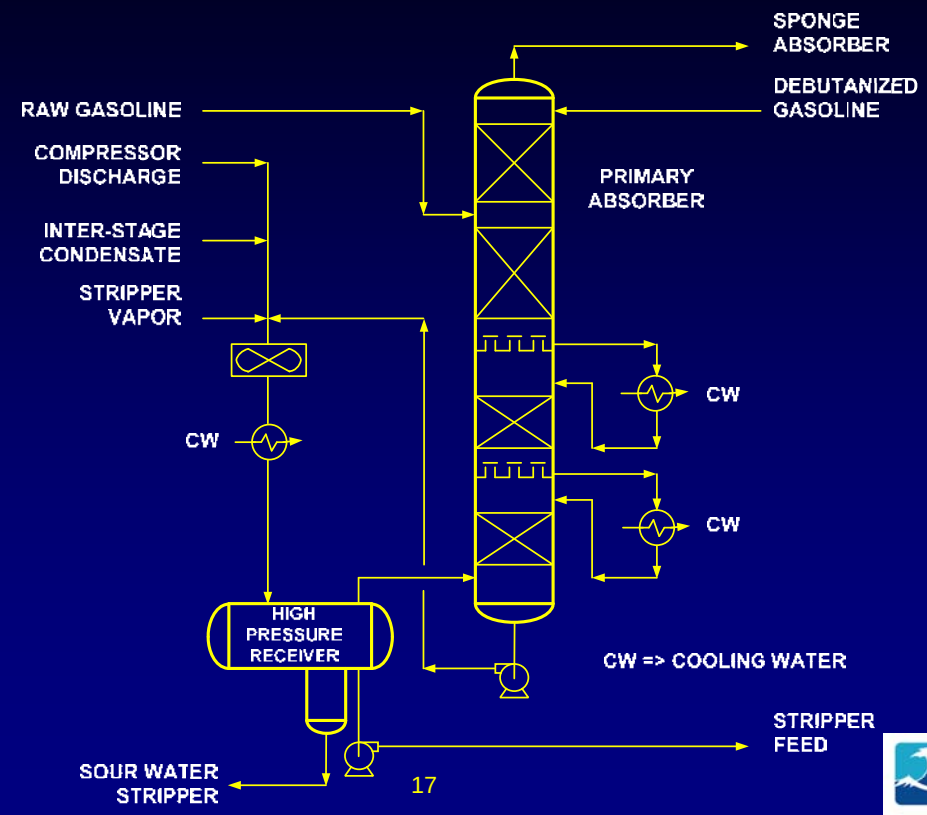
Primary Absorber Liquid

- Main column overhead liquid is the main source of liquid (L) in the primary absorber
- Recycling debutanized gasoline increases liquid rate, improving LPG recovery by raising L/V
- The recycle must flow through the stripper and debutanizer, increasing column loadings and reboiler duty
- When gasoline production is high and dry gas low, C_3 recovery is high because L/V is high -- even with no recycle!

Primary Absorber Inter-coolers

- Primary absorber lean oil absorbs gases
- Latent heat of absorbed gases increases the liquid temperature
- As temperature rises the liquid absorbs less gases
- Inter-coolers reduce temperature increase allowing more gas to be absorbed
- Adding an inter-cooler increases C_3 recovery by ~ 3%

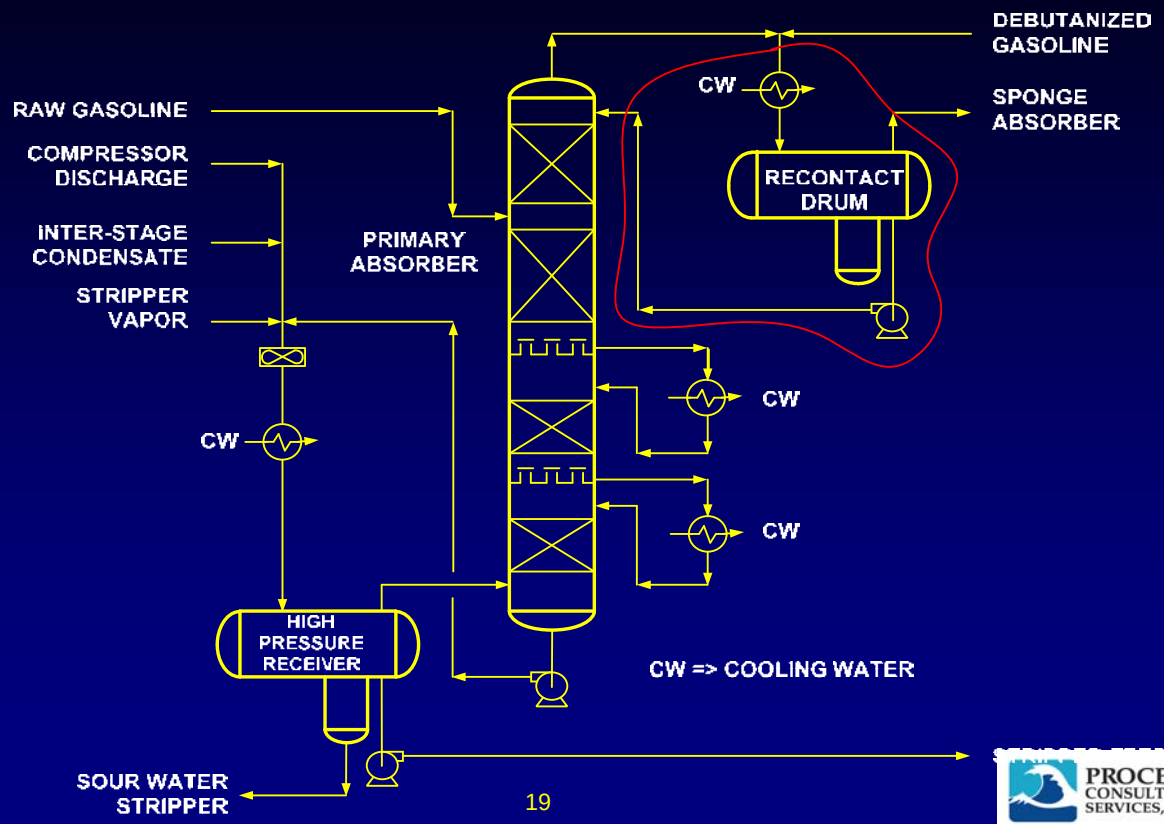
Absorber Inter-coolers



Primary Absorber Pre-saturator

- Used to increase C_3 recovery
- Contact the leanest gas with the leanest liquid
- Temperature rise from gas absorption is eliminated in exchanger reducing absorber lean oil temperature

Pre-saturator



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Maximizing C_3 Recovery

- Maximum C_3 recovery is ~ 99%
- This requires chilled water or refrigeration
- Next slide shows all the bells and whistles used to increase C_3 recovery

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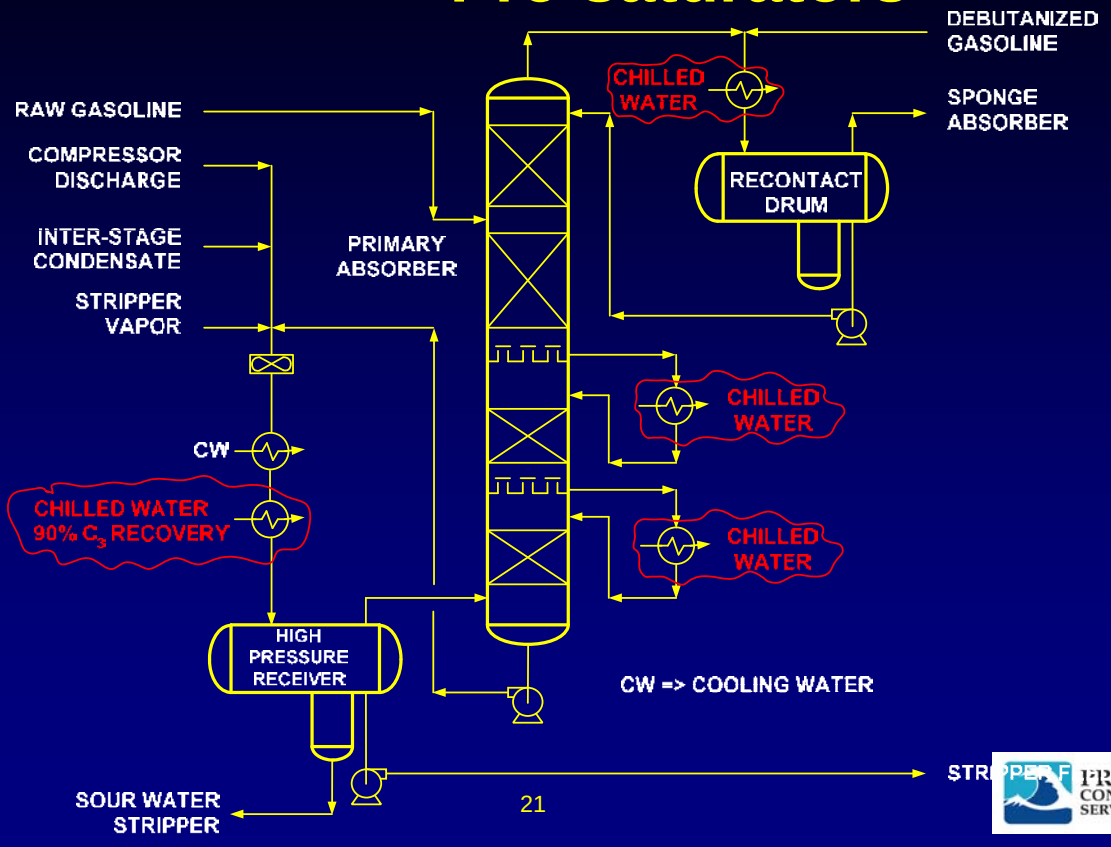
Chillers and Pre-saturators



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Stripper Column

- Strippers reject C_2's and H_2S to fuel gas
- Water can form inside the column due to low feed temperature OR
- Free-water can be present in the feed
- If free-water forms or is in the feed then column capacity suffers
- At low column loading, water can be tolerated, and at high loadings it cannot

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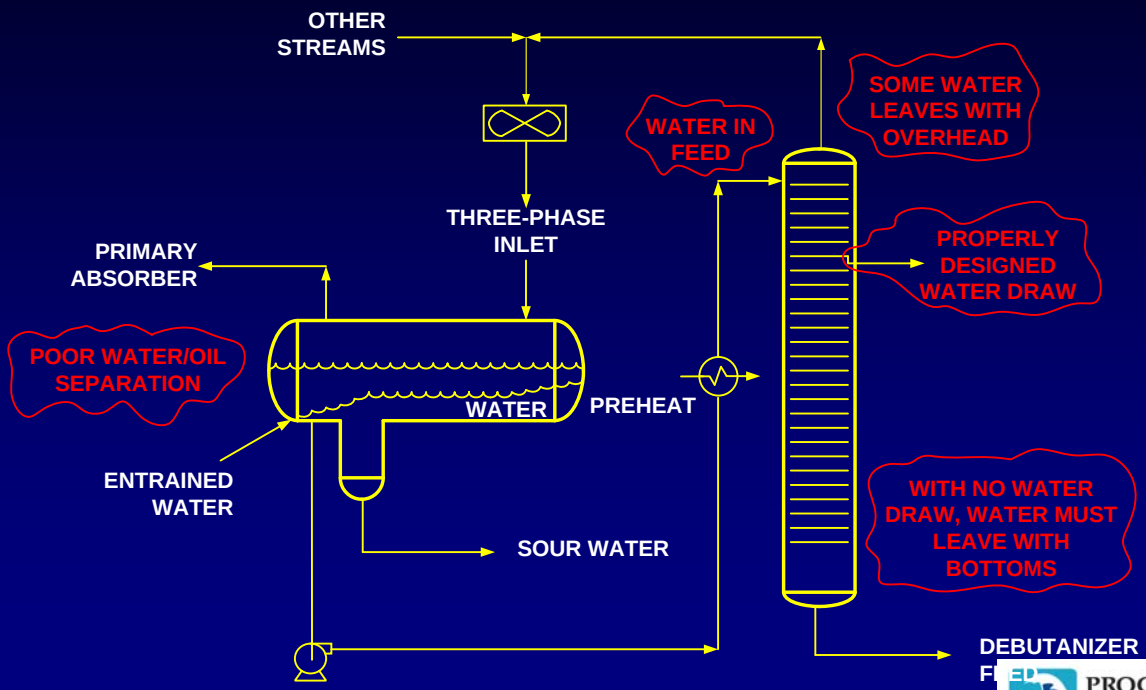
Stripper -- Sources of Water



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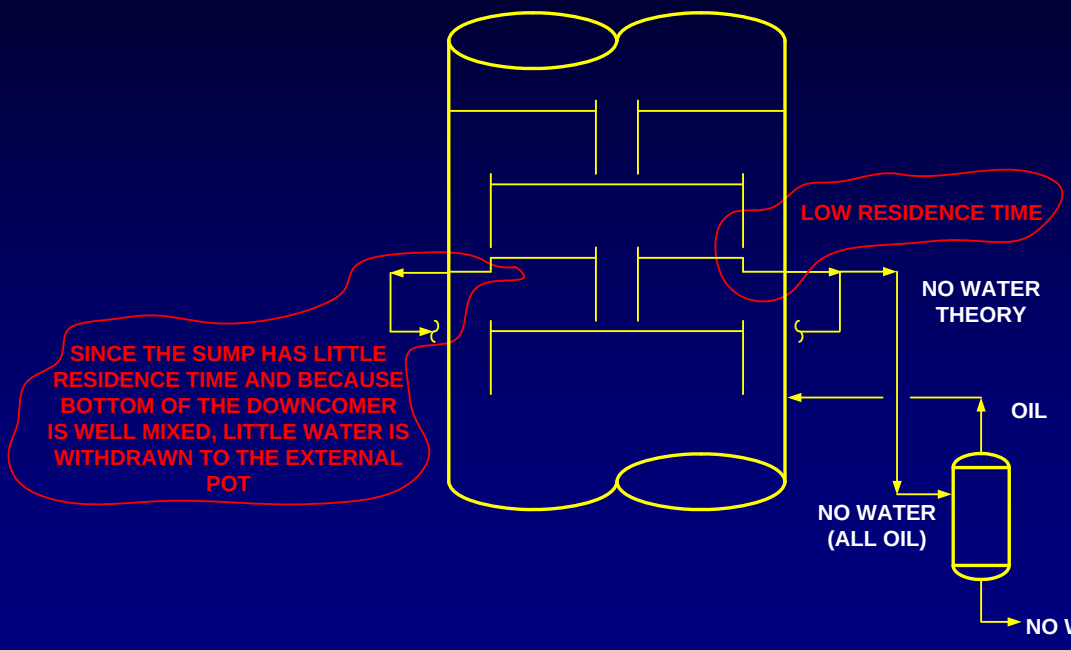
Poorly Designed Water Draw



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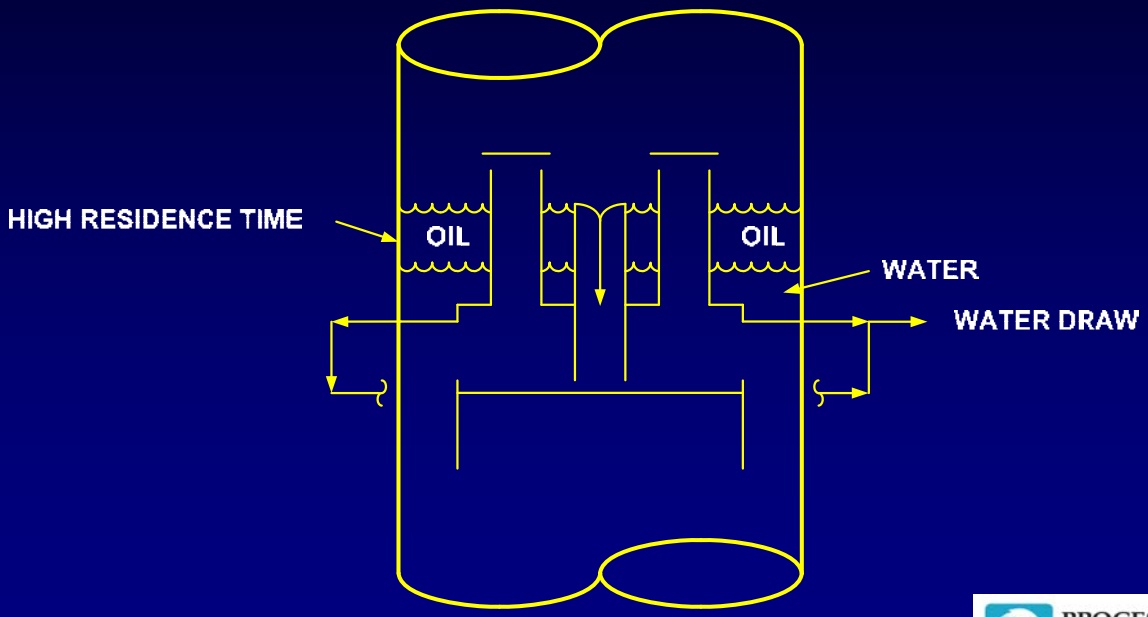
Well Designed Water Draw



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Stripper Column

- Minimizing feed temperature and optimizing reboiler duty improves C_2's rejection
- Low feed temperature can lead to water entrapment
- Stripper columns with low feed temperature need a water draw or heat feed
- Trade off reboiler duty and tower loading vs recovery and water problems

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General Comments

- Sponge Absorber
  - LCO foams more than heavy naphtha in the sponge absorber
  - Tray spacing is critical
  - "Credibility Precipice"
- Debutanizer
  - Never pack the debutanizer -- all attempts have failed (avoid being next!)
  - WHY?
  - Debutanizer Reboiler Fouling

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Debut Shell-side Fouling

Debutanizer Reboiler Shell-side Fouling

- Debutanizer reboiler shell-side fouling is caused by heat source temperature, reboiler design and di-olefins content
- Keeping heat source temperature below 600°F is essential
- Reboiler needs to be designed to minimize phase separation in baffle window

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REMEMBER
UNDERSTAND THE FUNDAMENTALS
PRINCIPLES>PROCESS>PROBLEM
GET OUTSIDE AND TEST IT!

THANK YOU

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