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Delayed Coker Unit
Operating Experiences and Revamp Approach

March 2016

Presentation Sequence

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1. Operating Experience Sharing
    - Unit Introduction
    - Distillate yield and process improvements
    - Experience sharing for
        - Coke drum system vibration mitigation
        - Repair of crane track cracks
        - Hot spots during coke cutting
        - Maintenance practices
2. DCU revamp approach

Unit Introduction

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Capacity : 1.36 MMTPA

Commissioned on: 26 Jan 2011

Licensor : Lummus

Detailed Engineering : EIL

CDSP : LSTK by Naftogaz

Heaters: LSTK by Thermax

Unit Introduction

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Flexibility in feed

Property / VR Feed	Kuwait	65:35 AM	45:55 AM	Oman
API - Gravity	4.5	4.2	3.8	12.0
Sulfur wt%	5.5	5.2	5.5	2.5
CCR wt%	22.3	24.0	25.0	15.6
Asphaltenes wt%	21.0	--	--	1.8

Extraneous feeds can be processed in the unit

- Refinery sludge from ETP
- Black slop from Refinery
- Filter backwash stream from the Hydrocracker

Unit design Features

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Two Heaters for one pair of Coke Drums

- Provision of On-line pigging
- Isolations at inlet & outlet
- On line spalling

Saves Downtime

Technology Advancements

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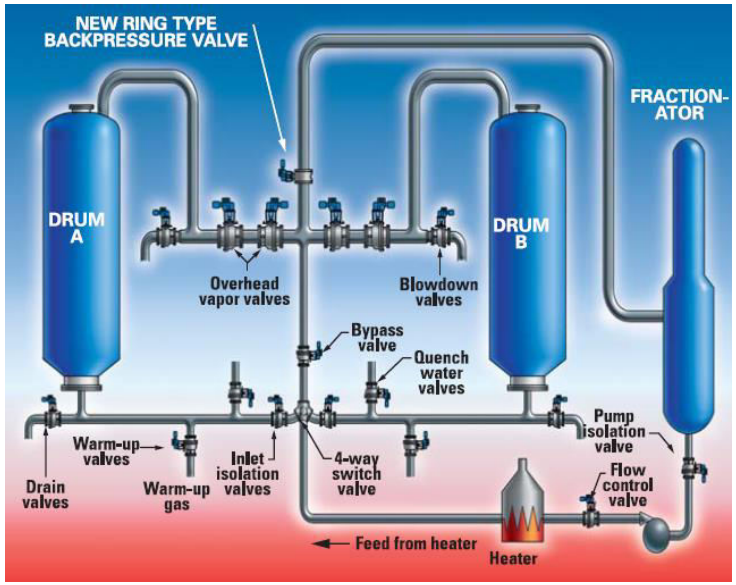
Motor operated valves in coke drum area



Automated Coke drum heading / un-heading valves from Z & J

Process & Fire Hazard Eliminated

Unit performance parameters

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Products	Unit	Design	Actual
Gas yield	Wt%	8.0	10.6
Distillate Yield	Wt%	62.8	56.6
Coke Yield	Wt%	29.2	32.8
Feed CCR	Wt%	24	24.8
COT	Deg C	507	502
Drum Pr	Kg/cm2g	1.05	1.1
Recycle Ratio	Wt%	5	8

Operational Availability (excluding turnarounds) = 98.4%

Unit Utilization = 92%

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Distillate Yield Improvement

Actions taken for Increasing Heater COT

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Action Taken

Heater feed pass flow meters replaced from orifice type to Ultrasonic type

Result

Heater duty reduced by 3%

Actions taken for Increasing Heater COT

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Action Taken

Fractionator bottom coke catcher design modified

Result

Reduces fines carry over to heater tubes

Actions taken for Increasing Heater COT

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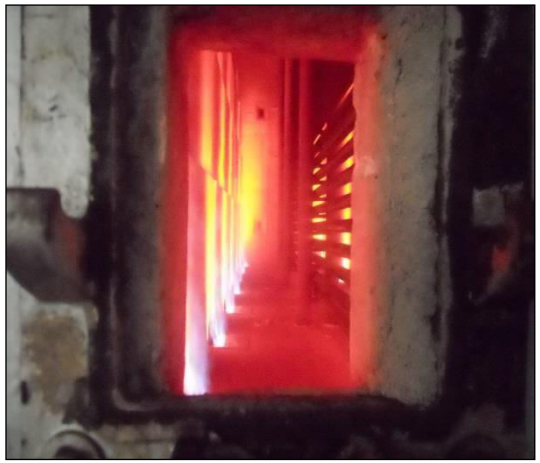
Heater fuel gas burner orientation modified – Flat Flame profile away from heater tubes

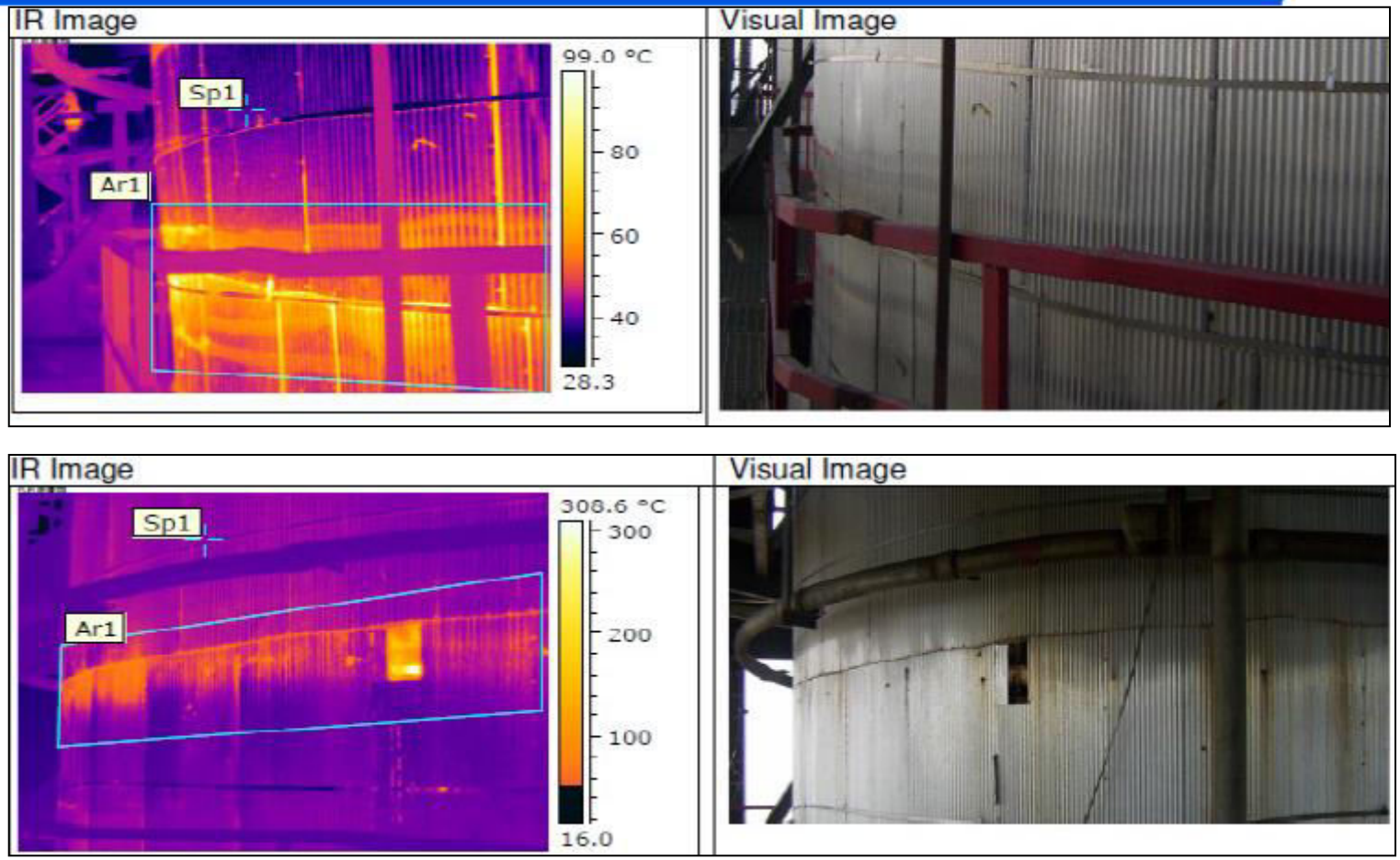
On line monitoring of caustic dosing in desalter downstream - Control over VR Sodium content, target is 15 ppm max

Before



After

Coke Drum Insulation Repairs



Drum outlet operating temperature is 440 deg C

"every 5.5 deg C increase in coke drum vapor line temperature reduces coke yield by 0.8 wt%"

Actions taken for Increasing Heater COT

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Modified Operating Procedures

1. Variable fractionator level control to limit peak skins to 7 deg C from earlier value of 18 deg C during switch over vapor

2. Feed Preheat temp improved by ~ 8 deg C by reducing steam generation

3. Maximizing hot feed upto 85% and temperature from CDU/VDU

Current COT increased to 503 Deg C

Pet Coke Yield Vs Heater COT

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High COT Test Run

Parameter	COT 500 Deg C	COT 506 Deg C	Remarks
Unit Load (%)	113.2	109.7	-3.5
Gas + LPG wt%	10.7	11.3	0.6
Distillates wt%	55.8	56.1	0.3
Pet coke wt%	33.5	32.6	-0.9
Pet Coke VCM wt%	8.0	7.5	-0.5
HCGO CCR wt%	0.8	1.0	0.2
TST DegC/day	0.5	1.9	1.4

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Coke Yield is at break point of Q1-Q2 performers

Innovative Operating Approaches

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- 30% Turn down
- Hot start-up of the unit
- Minimum slopping & zero flaring during start-up / shut down
- Sludge processing

Coke Drum System Vibrations

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Vibrations in piping, structures, stairs, elevator since unit commissioning

Vibrations do not respond to

- Unit load, feed conditions or operating parameters
- Coke cutting activities

Operator safety and unit integrity was a concern

Licensor and PMC were involved for vibration study

Coke Drum System Vibrations - Actions

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- Drum foundation bolts refractory removed
- Existing foundation bolts were replaced as nuts were loose
- Structural members modified – clear drum gap/growth
- Piping supports were rectified
- Vibrations continued

Coke Drum System Vibrations – Expert Study

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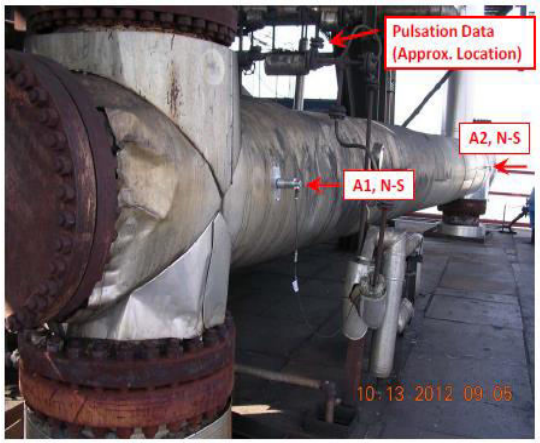
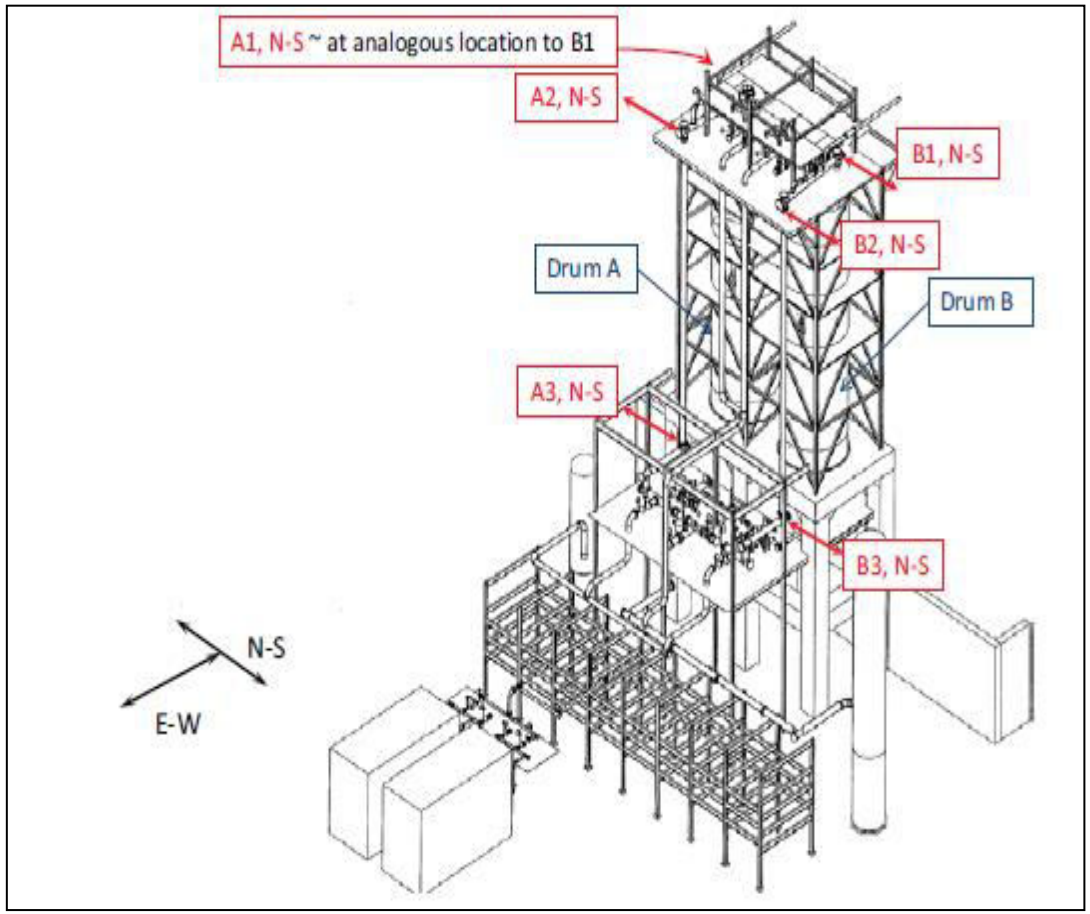
Experts were involved to analyze vibration and operating data





Coke Drum System Vibrations – Expert Study

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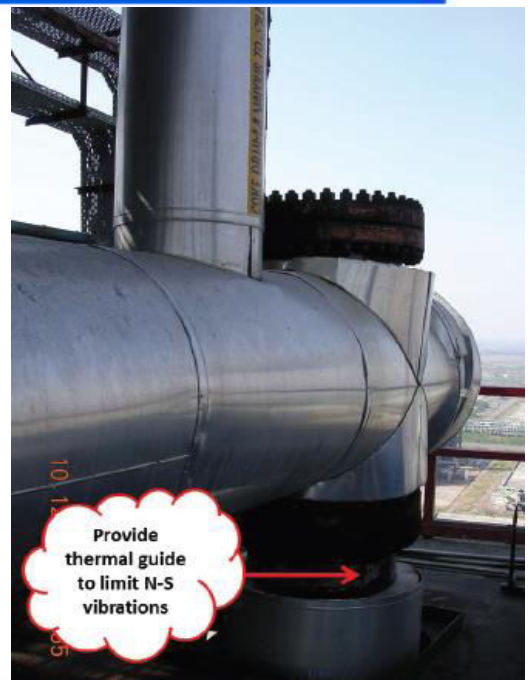
Conclusions and recommendations

- Excessive flexibility in the coke drum overhead piping
- Securing drums to the foundation with predetermined load by bolt stretch rather than torque
- Structural audit of CDSP by DEC
- Gaps between as built and AFC were identified and rectified



Crane for Coke Handling

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Started facing the problem of ‘Cracked rail joints’ early in to the Operation

Reasons attributed to :

- Improper ‘Thermite’ welding
- ‘Less than Perfect’ alignment

Computer Alignment and Thermite Welding Repairs

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Reliability Improvement Measures

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Frequent winch rope replacement

- Winch continues to operate even after ‘slag rope’ resulting in unwinding of rope
- Tension meter replaced

Cross head rotating joint frequent leakage – Scheduled torque tightening of the gasket is practiced

Cutting tool mode does not change – Scheduled oil replacement of cartiridge is practiced

Safety during coke cutting

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Introduce 2 MT/hr steam before feed cut to the drum

This retains coke bed porosity for effective coke bed cooling

Enclosure for diverting blow outs during coke cutting

Improved operator safety

DCU

REVAMP PROJECT

REFINERY REVAMP OBJECTIVE

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Increase in processing capacity from 6.0 to 7.8 MMTPA

Compliance of Auto Fuel policy & Vision 2025

REVAMP METHODOLOGY

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- Utilizing inbuilt design margins
- Benchmarking current operation through test run
- Attention to unit operating constraints
- Short shutdown period
- Retain major equipment
- Low revamp cost

DCU Design basis

Capacity

- 1.822 MMTPA from 1.36 MMTPA
- 220 MT/hr from 170 MT/hr

Operating days 345 from 333 days

TD as 50%

Feed cases

- 45:55 AL: AH; CCR 27 wt%, Sul 6 wt%
- 50 : 50 AM: Oman; CCR 22 wt%, Sul 4 wt%

Three Drum Coker Operation

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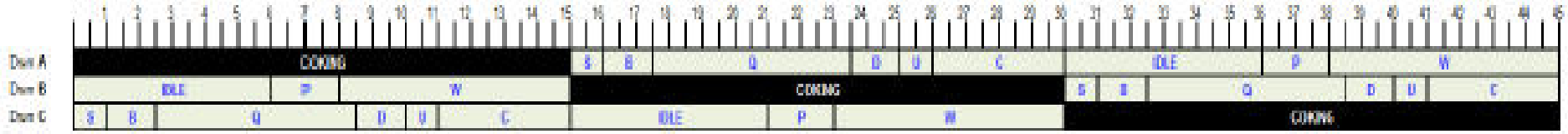
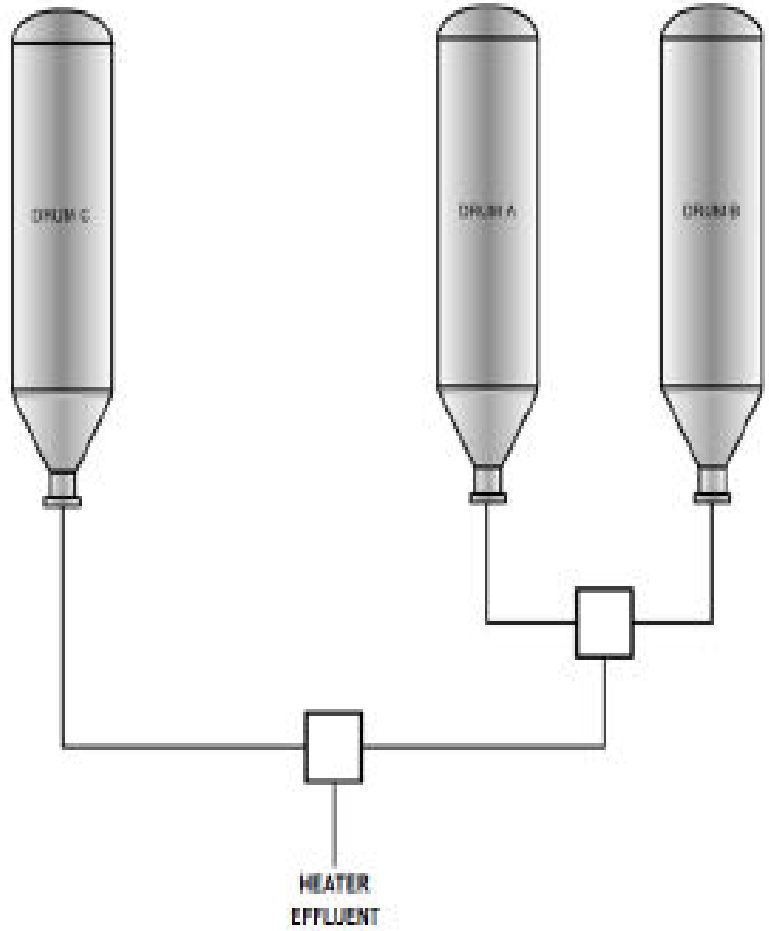


	Hours	
	15	Filling/Coking
S	1	Steamout to Fractionator
B	1.5	Steamout to Blowdown
Q	6	Quench and Fill
D	1.5	Drain
U	1	Open Top & Bottom Heads
C	4	Hydraulic Coke Boring/Cutting
P	2	Re-head & Pressure Testing
W	7	Drum Warm-up
I	6	Idle Time
Total Cycle	45	



Three drum operation

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Advantages

- Enables operation at higher throughput
- Crude processing at higher than 7.8 MMTPA
- Throughput loss from spalling, maint is made up
- Lower coking cycle results in higher disengaging height in drum
- Drum operation at higher velocities & lower pressure is possible – higher distillate yield

Three drum operation

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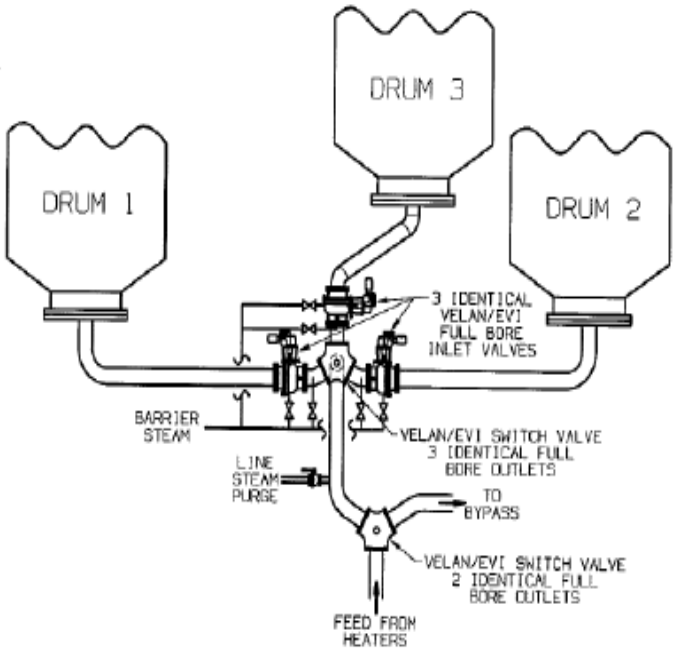
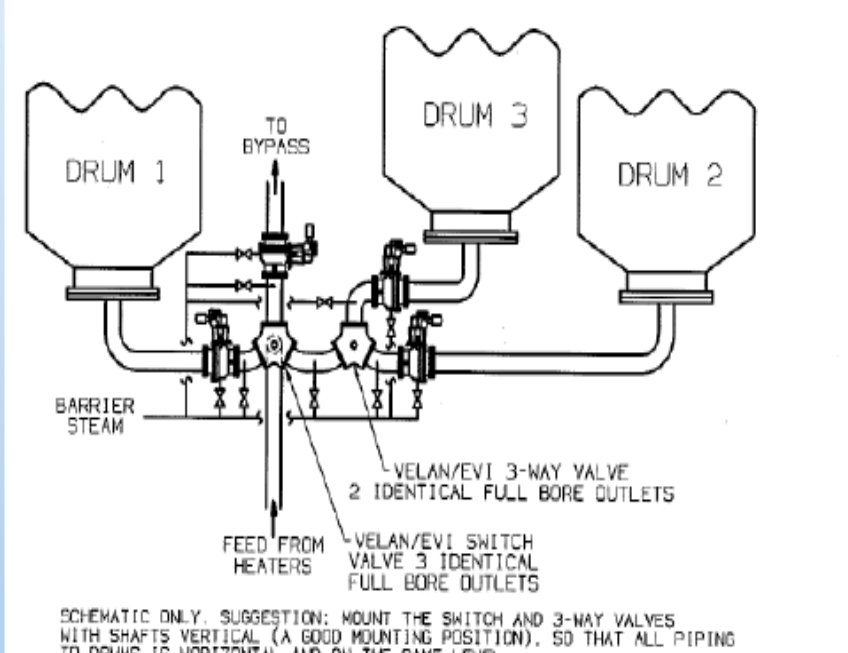
Disadvantage

- A few references available for odd number drums
- Constructability issues drum location/transfer line
- Surprises

Typical layout of switch valves





Additional features CDSP

- New coke drum features
  - Provision for adding center feed device in future
  - Floating insulation
  - Vibration sensors
  - Vertical plate construction
  - Uniform shell thickness
- Blow down tower ring comp for improved safety

Additional Features - Heaters

- Heater coil metallurgy up-gradtion to stainless steel (SS347), suitable upto 30 ppm Cl.

  Lower Pr drop because of higher area

  Higher flux

  Design skin temp will be 750 deg C
- Design margin of 10%
- Additional skin temperature measurement for heater coils
- HP steam Swing exchanger for switch over and vap heating cycles

Major Challenges

- Pre shut down civil and erection works for coke drum and structures during plant operation
- Relocating of equipment on blowdown section
- Coke pit extension
- Fabrication of coke drum in yard and shifting, hard stand
- Relocation of ring valve
- Erection of feed line, vapor overhead lines for the new drum

Suggestions for New Projects

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- Build unit capacity margin spalling & pigging
- Build up margin in heaters for
  - Flushing/purging oil
  - Cold feed
  - Swings in preheat
- Review of heater heat flux
- Variable duty HP Steam exchanger in preheat train

Suggestions for New Projects

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- Provide realistic VR feed properties
- Mass flow & Ultrasonic Flow meters in Product streams
- Coke drum area structural Inspection by licensor during erection stage
- Ear mark area for expansion especially for coke drum
- Fire water availability at cutting deck

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Thank You