Keys To A Successful Delayed Coking Unit Revamp

By

John E. Collins, Technical Services Manager, CB&I
and
Malay Bagchi, Sr. Technical Service Manager, IOCL-Panipat Refinery

Coking.com®
MORE PRODUCTION - LESS RISK!

New Delhi, India
October 2013

IOCL Introduction

- Indian Oil Corporation Limited, or IOCL is an Indian state-owned oil and gas corporation
- World's 88th largest corporation, according to the Fortune Global 500 list
- The Indian Oil Group of Companies owns and operates 10 of India's 22 refineries with a combined refining capacity of 65.7 million metric tonnes per year
- Currently operates eight delayed coker units (DCUs) with combined capacity of 9.3 million metric tonnes per year

CB&I DCUs in India and Abroad

Why Revamp Your DCU?

R Reliability

E Environmental

V Versatility

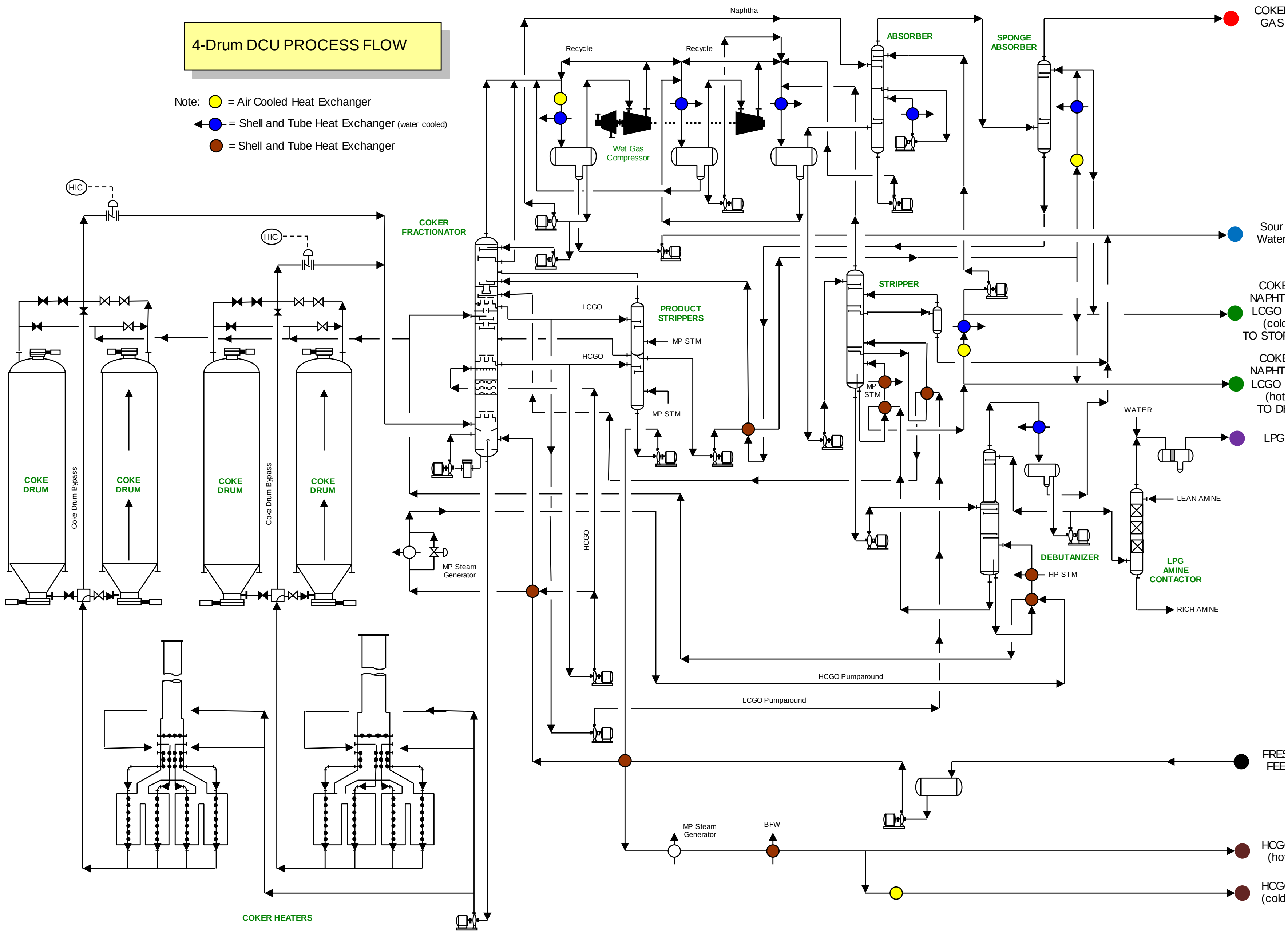
A Advancement

M Metallurgy

P Profitability

S Safety

So What Revisions are Needed?



Key Input to Revamp Study

- Complete feed characterization
- Maximum demonstrated capacity
- Existing facilities limitations
- Equipment reliability history
- Plant testing with *close coordination between owner/operator and process licensor*

Leverage Existing DCU Information

- Current knowledge of the unit is essential
  - to define the revamp scope,
  - to project schedule and planning, and
  - to budget, by minimizing scope
- Communications with licensor
  - to insure consistent expectations
  - to insure successful deliverables

Impact of DCU Revamp

- Operational Differences
  - Higher coke drum pressure
  - Lower unit recycle
  - Higher preheat temperature
  - Reduced cycle times

- Performance Differences
  - Product yield shift from liquid distillates to coke
  - Heavier HCGO end point
  - Shorter heater run lengths

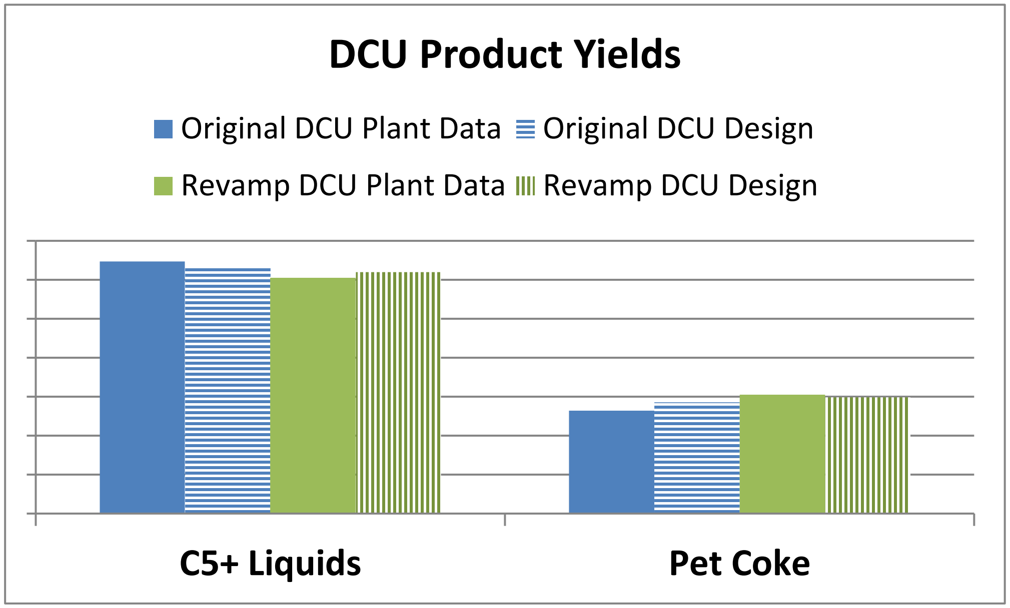
Pre/Post Revamp Operations

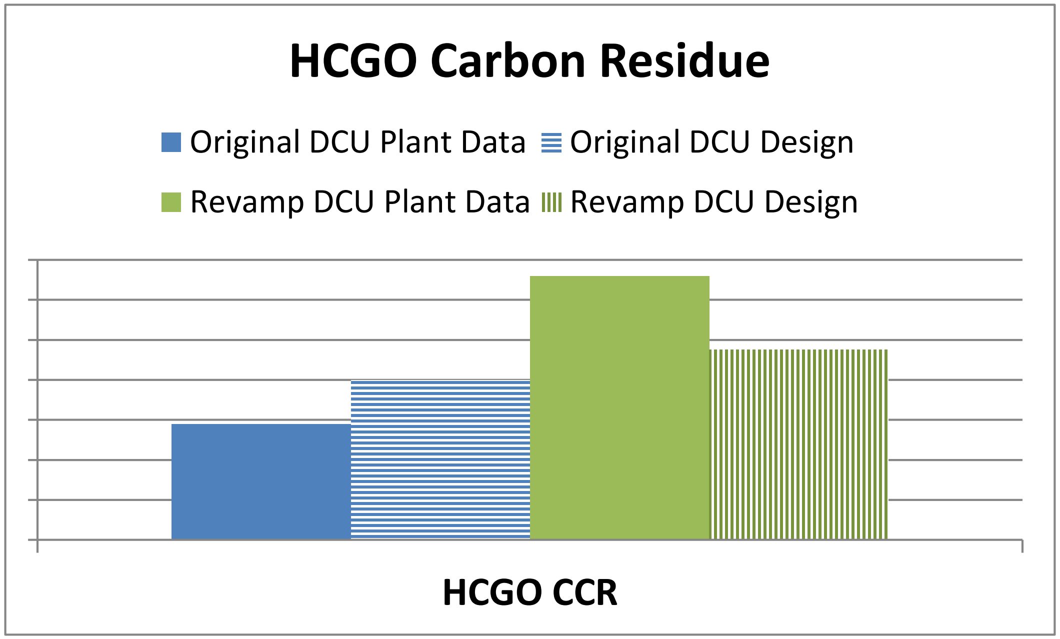
Operating Basis	Capacity		Unit Recycle	CD Press, kg/cm2g	CD Cycle Time, hrs	Temperatures, °C		
	TPH	% Orig Cap				To Fract	To Htrs	Fr Htrs
Original DCU Data	298	99	11%	1.23	23-24	258	279	495
Original Design	300	100	10%	1.05	24	300	311	507
Revamp DCU Data	378	126	10%	1.31	18-19	283	302	500
Revamp Design	375	125	4%	1.05-1.47	18	300	311	507

- Operating basis for both the original DCU and revamp DCU were essentially satisfied
- The VR feed temperature was the most significant discrepancy
- The coke drum pressure ran high in the original DCU, but only rose slightly in the revamp design

Pre/Post Revamp Performance

- The DCU liquid product yields exceeded the original design basis.
- In the revamp DCU, coke yields have increased and C_5^+ liquid yields have fallen slightly.



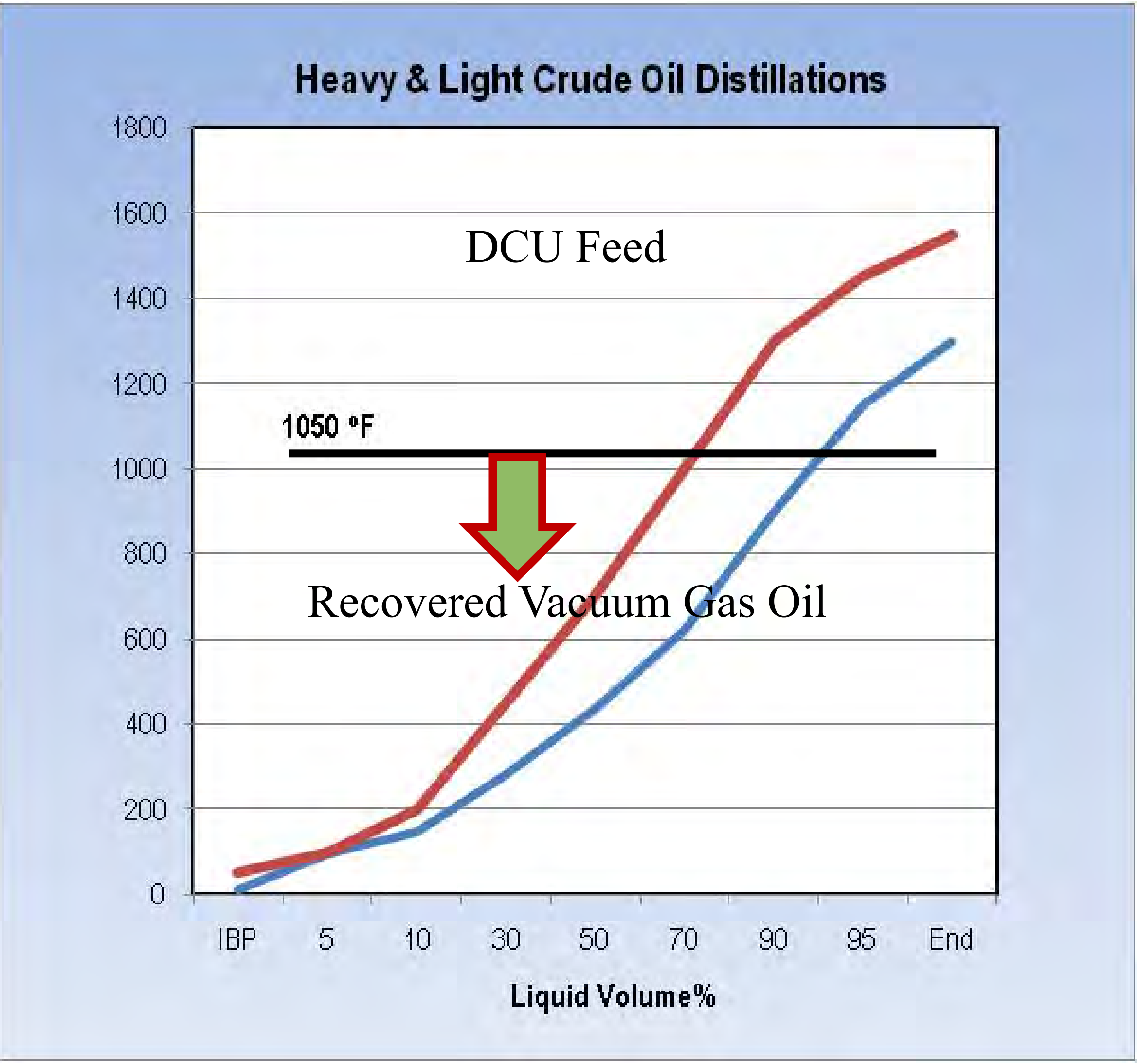


- Similarly, the HCGO product quality was well within the original design basis during stable operations
- However, this critical product quality has increased considerably in the revamp operations

Revamp Process Considerations

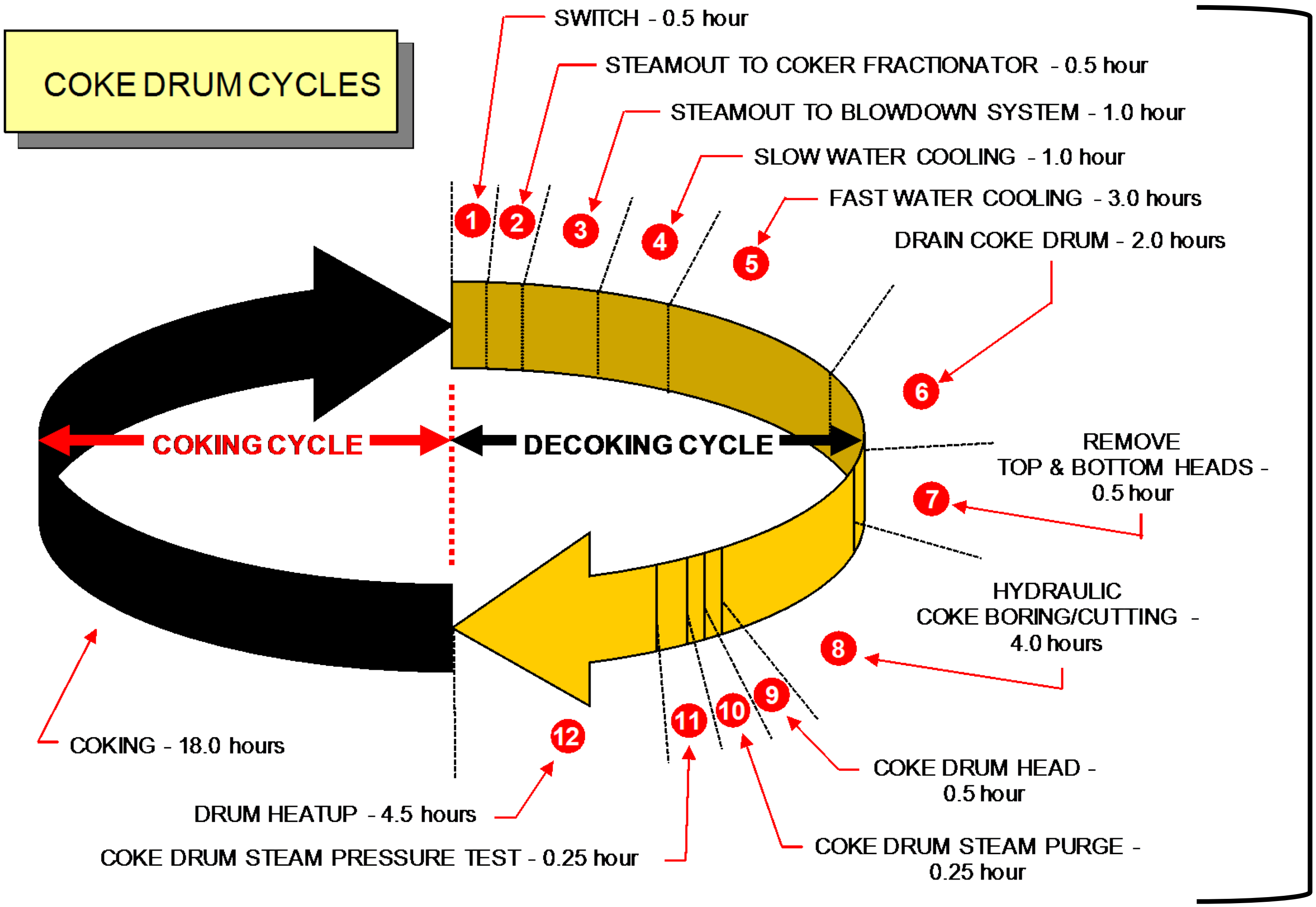
- VDU cut point
- Coke drum cycle time reduction
- Coking heater capacity
- Blowdown/CCD loading/reliability
- Coke handling and dewatering
- Gas processing and cooling
- Product recovery and hydraulics
- Product treating
- Safety and PSV/flaring facilities
- OSBL considerations

VDU Cut Point



- Increasing the VDU cut point reduces the net DCU feed
- Higher cut point typically achieved by modifications to the flash zone (i.e. higher efficiency packing, revised feed/vapor horn) and/or vacuum system upgrades.

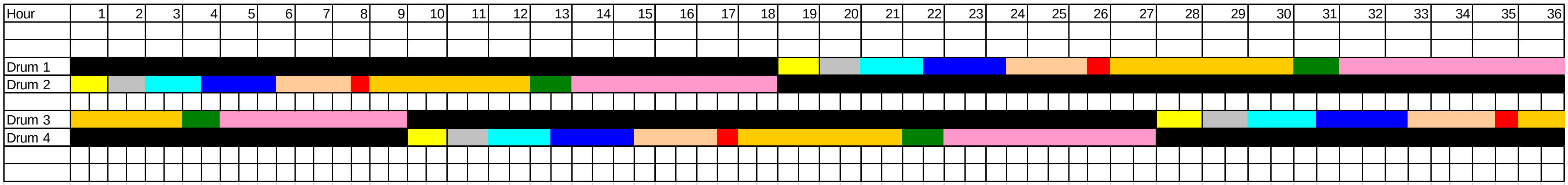
Cycle Time Reduction



Which step times can be safely trimmed?

Cycle Time Reduction

Must address – if not avoid – overlapping activities.



	Color Code
Coking	18
Switch Drums	0.5
Steamout to Fractionator	0.5
Steamout to Blowdown	1
Slow water cooling	1.5
Fast water cooling	2
Drain coke drum	2
Remove top and bottom heads	0.5
Hydraulic boring/cutting	4
Reheading/Pressure Testing	1
Drum Heat-up	5

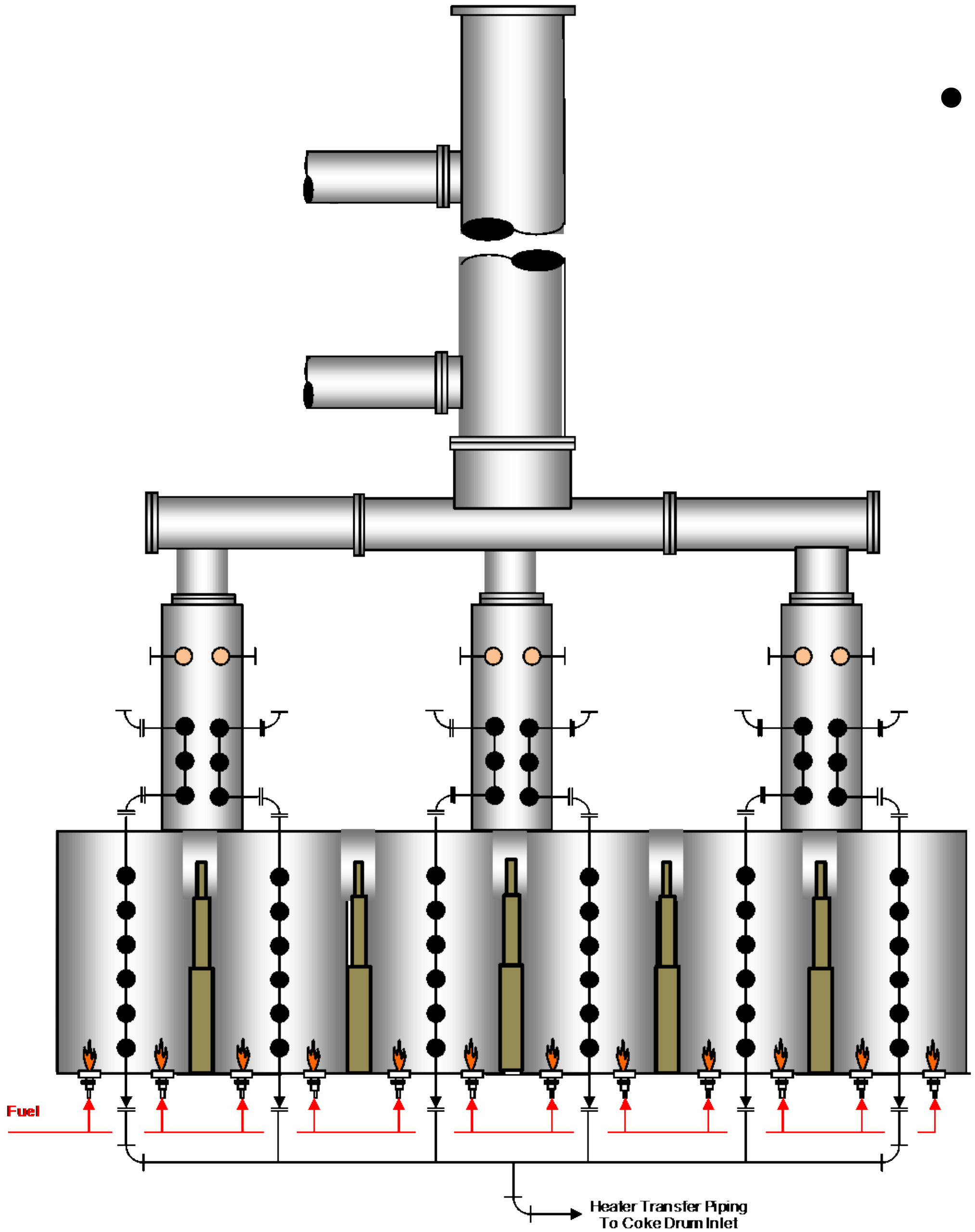
Cycle Time Reduction

- Some Common Cycle Time Reductions
  - Coke cutting (up to 2 hrs+)
  - Drum draining (~1 hr)
  - Unheading/reheading (1.5 hrs+ with replacement of semi-enclosed heads)
  - Step sequential efficiency (0.5 hrs+ in steam-out transitions, heating transitions)

Cycle Time Reduction

- Decoking Activities to Preserve
  - Steam-outs to fractionator and blowdown
  - Slow and fast water quenching
  - Steam purge/pressure test
  - Hydrocarbon preheating

Coking Heater Capacity



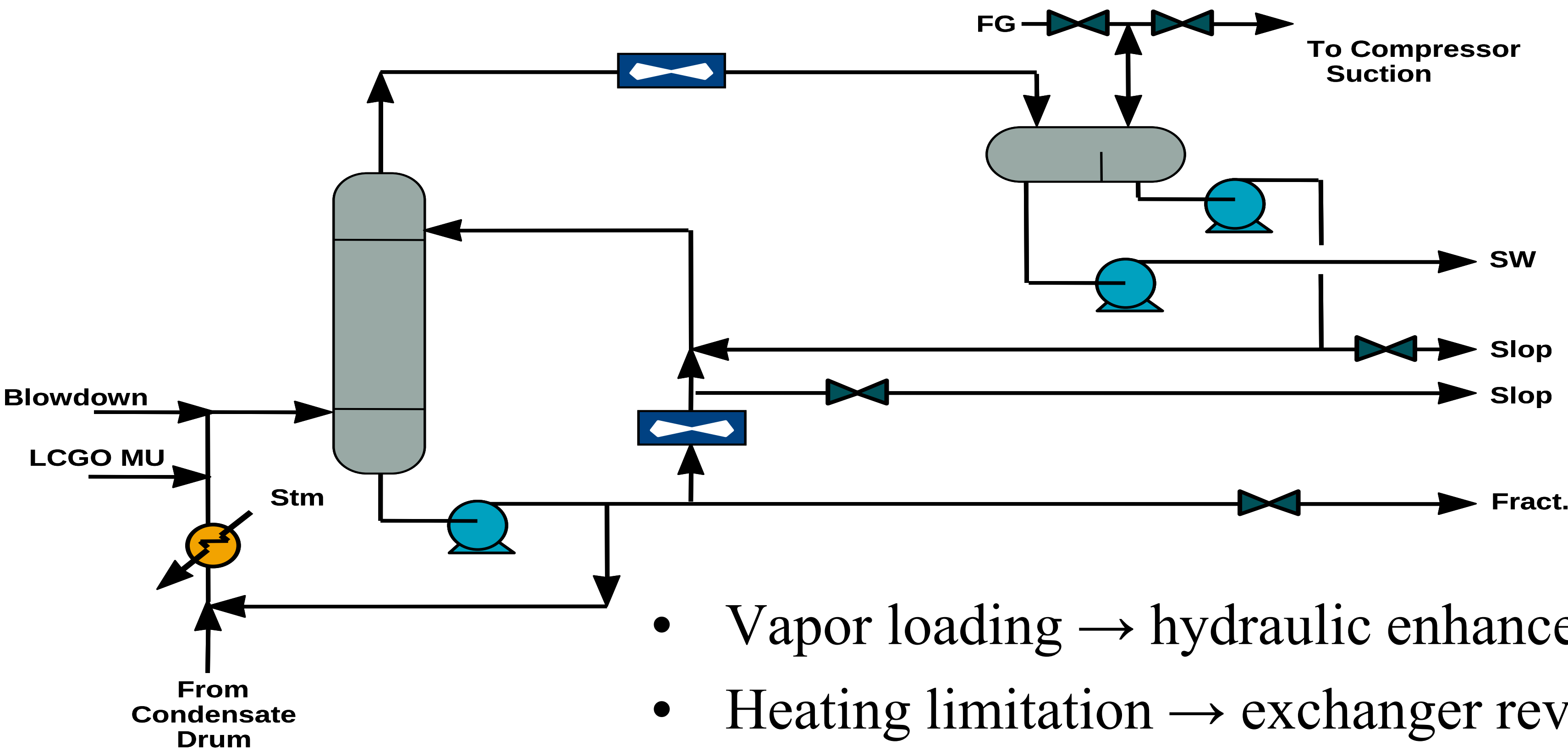
- Key Challenges
  - Sensitivity to coking rate and heater run lengths
  - Limited practical revisions to firebox dimensions
  - Panipat coker heater run length (typical):

Capacity MMTPA	**Online Spalling Frequency**	**Steam Air Decoking Frequency**
2.4	every 6 months	After 2-3 online spalling
3.0	every 3 months	After 2-3 online spalling

Coking Heater Capacity

Heater Revision	+Cap @ Same TST	Coil Pressure Drop	Comments
Operational – Increase Excess Air	Up to 10%	10-15% higher due to increased flow	Heater efficiency will decrease up to 4%
Preheat – Higher Feed Temperature	Up to 15%	Up to 20% higher due to increased flow	Crossover temperature increases due to reduced LMTD
Addition -- Roof Tubes	Up to 20%	Up to 40% due to increased coil length and flow	
Retrofit -- Replace Coil with Larger Tubes, Same Spacing and Wall Thickness	Up to 5%	50% reduction	Added surface reduces heat flux but larger diameter increased film temperature.
Retrofit -- Replace Coil with Larger Tubes, Increased Wall Thickness	Up to 20%	25% reduction	Tube wall temperature will be higher, but thicker schedule allows for much higher temperature rating

Blowdown System Loading

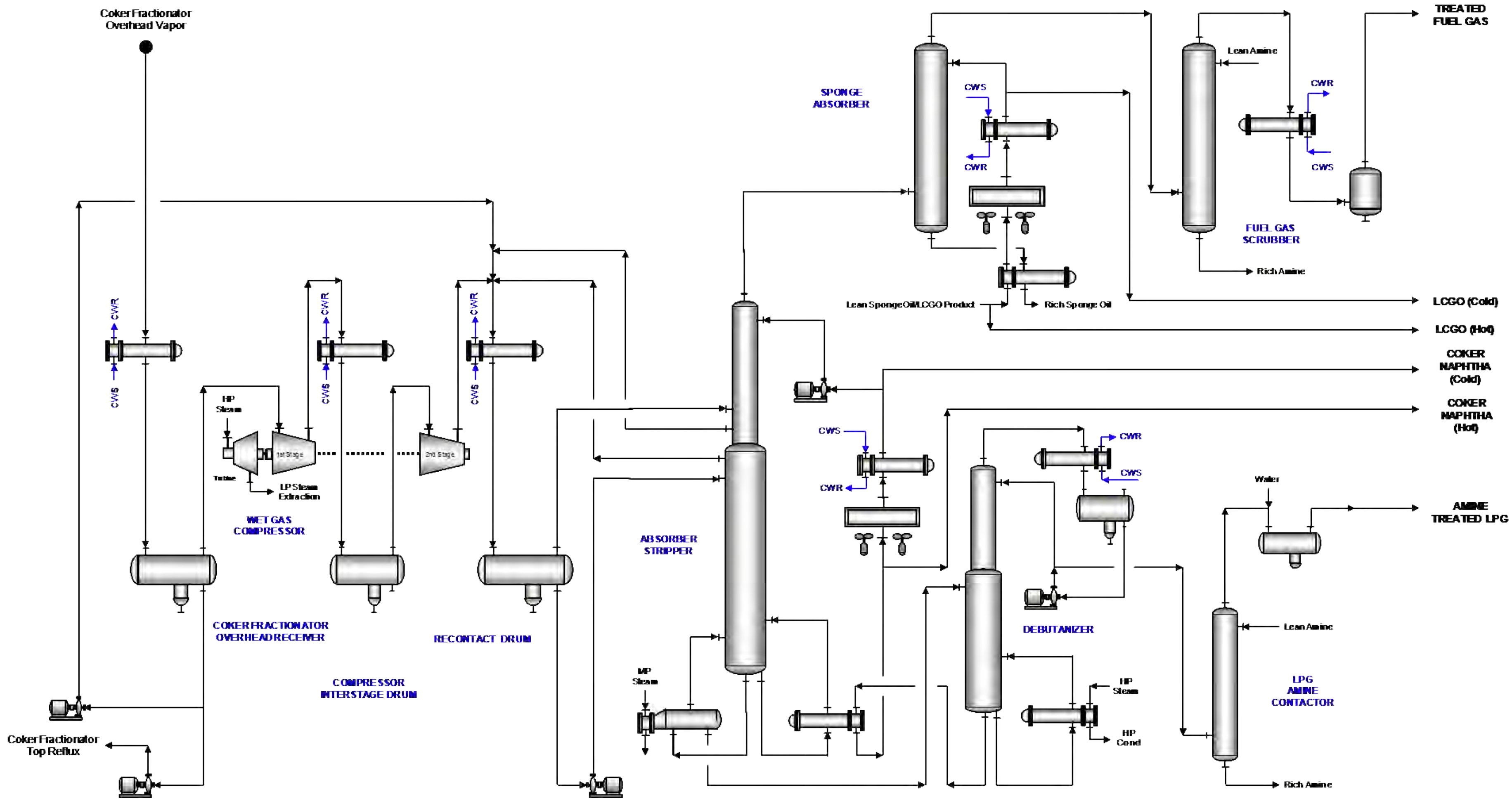


- Vapor loading → hydraulic enhancements
- Heating limitation → exchanger revision
- Pump reliability → filter/piping revisions
- Pump capacity → add/revise pumps
- Cooling limitation → revise fin fan coolers

Coke Handling and Dewatering

- Review crane duty cycles
- Check crusher load rating
- Confirm OSBL facilities are sufficient
- Check pad drainage and fines settling
- Potential revisions to hydrocyclones and/or maze

Gas Processing and Cooling



- Rerating the wet gas compressor facilities
  - Possible rotor replacement
  - Possible driver revisions
  - Potential increase in driver rpm
- Ensure sufficient cooling in gas circuit
  - Possible addition of shells
  - Possible air cooler revisions

Product Recovery and Hydraulics

- Highest capacity test run to find the bottlenecks
- Debottleneck existing limitations
- Choose most practical options to alleviate limit (larger pump impellers, new pump, piping modifications)
- Expect minimal revisions up to 125% of capacity

Product Treating

- Often overlooked, but can undermine revamp success
- Accurate feed characterization is crucial
- Current treating performance and utilities limitations also crucial

Safety and PSV/Flaring Facilities

- Coke drum interlocks
- Coke cutting system safeguards
- Fired heater ESD upgrades
- Expanded PSV/flaring loads review and potential modifications (i.e. SISs e.g. HIPPS)

OSBL Considerations

- Is steam supply sufficient?
- Can sour water strippers handle increased production?
- Are higher B/L pressures needed to reach tankage/downstream dispositions?
- Power distribution?

Project Planning Considerations

- ***Safety must be foremost consideration***
- Determine environmental/permitting requirements well in advance of procurement/construction phase
- Long lead items coordination with shutdown schedule
- Constructability review for major equipment revisions
- Possibility of taking necessary hook-ups/pipe laying while unit onstream
- Pre and post shutdown work well defined

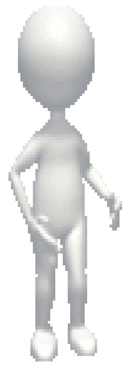
Benchmarking Metrics

- Vacuum residue feed: 566 ^{o}C+ (1050^{o}F) cut point
- 3-4 months+ heater run-lengths depending on feed quality/throughputs
- Low recycle: < 1.05 TPR
- Lower cycle time: < 16 hours
- Drum pressure: < 1.3 kg/cm2 for low pressure operations

Key Issues in Next Revamp

- Product quality issues w.r.t HCGO
- Drum vapor velocity
- Fractionator Flashzone C-factor
- More Capacity

Who Else Needs A Revamp?



Thank You for Listening

Malay Bagchi
bagchim@indianoil.in

John Collins
jcollins@cbi.com