



Journey towards Hydrocracker Operational Excellence through Strategic Collaboration

Shell Global Solutions

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A low-angle, upward-looking photograph of several firefighters in red protective suits and helmets. They are gathered around a yellow tablet held by one of them, looking at the screen with interest. The scene is brightly lit, suggesting an outdoor setting.

Outline

- Importance of identifying opportunities
- Opportunities identified at SASREF
- Actions taken to realise benefits from the opportunities identified
- Key learnings
- SASREF's view



Importance of opportunities...

“Too often, we miss out on opportunities in life because we were too busy waiting for them to fall into our lap...”

Daniel Willey

Identify opportunities to achieve **operational excellence**

Most refiners have a list of things to **fix** in the next turnaround. The most competitive refiners have a list of things to **improve** in next turnaround.

“In the midst of difficulty lies opportunity”

Albert Einstein

Proactively identify opportunities such as:

- Increasing feed rates – to improve margins
- Increasing product yields – to improve margins
- Improving cycle length – to improve margins
- Improving safety and reliability – to reduce losses
- Improving product properties – to improve marketability

SASREF hydrocracker: Main objectives studied in 2015

■ Increase unit capacity

■ Increase middle distillate yields

■ Increase cycle length



Opportunities identified through studies at SASREF hydrocracker in last 4 years



Challenges for turnarounds

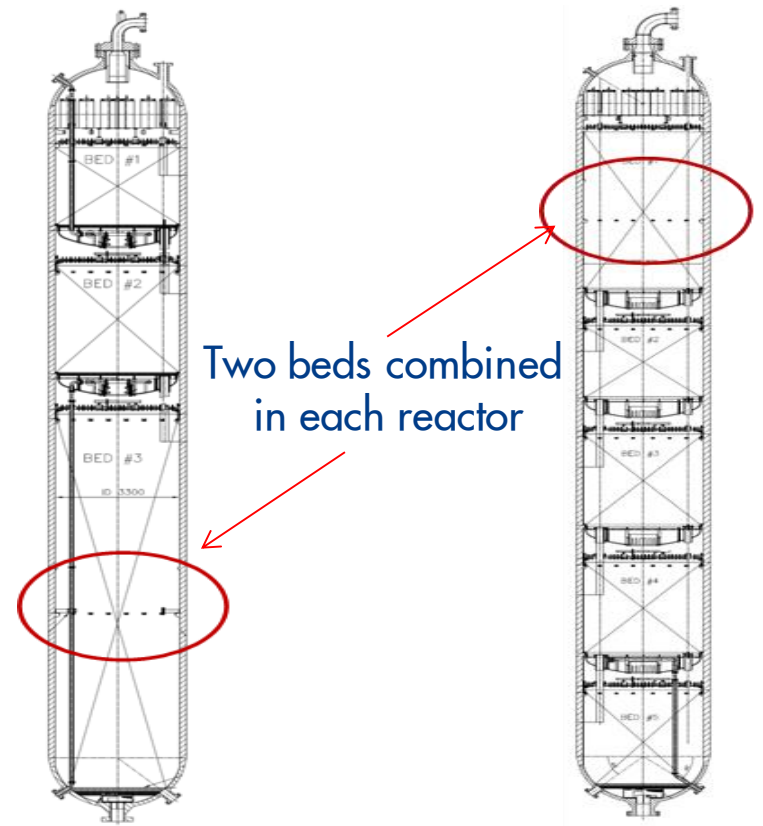
- Convert the hydrocracker from maximising full range naphtha to maximising middle distillate yields – with minimum changes/revamp (within constraints)
- Guard against fouling and catalyst migration
- Maximise utilisation of catalyst inventory at site
- Debottleneck downstream constraints



Providing solutions through **strategic collaboration**

Increased catalyst volume and utilisation via:

- Bed combinations (thermal stability study performed)
- New Shell reactor internals increasing catalyst utilisation
- Optimised bed temperature monitoring system (flex thermocouples)
- New catalyst system more selective toward middle distillates.



Results of **strategic collaboration** at SASREF hydrocracker 2015

6% increase in middle distillates – worth > \$10 million a year



Installed during a single turnaround window and **eight days early hand over for start-up**

More flexible hydrocracker's mode of operation – SASREF can **swing from naphtha to middle distillates** without investment

Catalyst utilisation improvement:
21% (pretreatment reactors); 52% (cracking reactors)

Shorter turnarounds – worth \$2.5 million per turnaround

Enhanced safety: 75% less time required for confined space entry

Catalyst fill cost saving of 30% for the cycle

Increased bed temperature readings

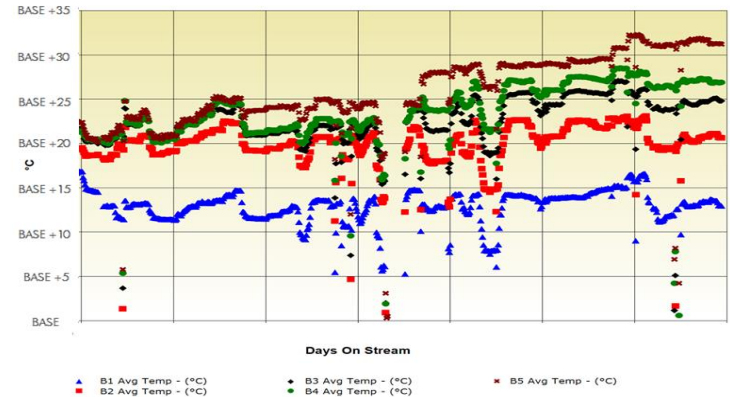
Better catalyst loading

Achieving **operational excellence** during the cycle

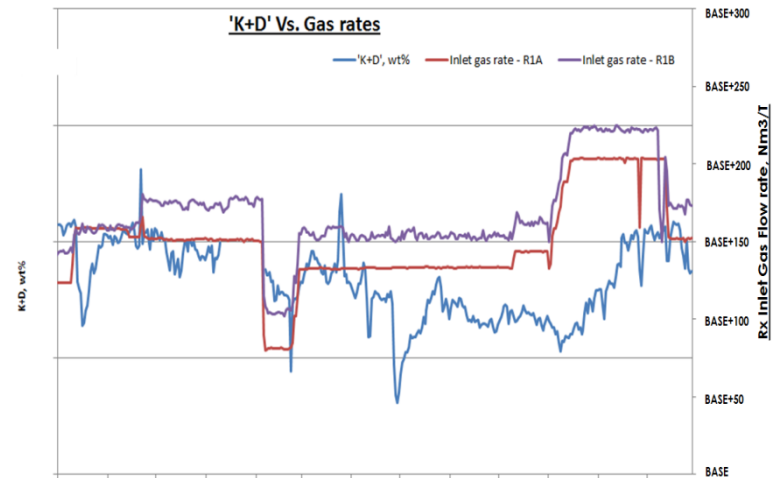
Maximise middle distillates during the run:

- Temperature profile optimisation
- Optimise hydrogen consumption
- Utilisation of ASA at the bottom of pretreat catalyst
- Maximise utilisation of catalyst stack
- Feed and product properties analysis at vendor's facilities
- Utilise residual catalyst activity.

Hydrocracking Average Bed Temperature



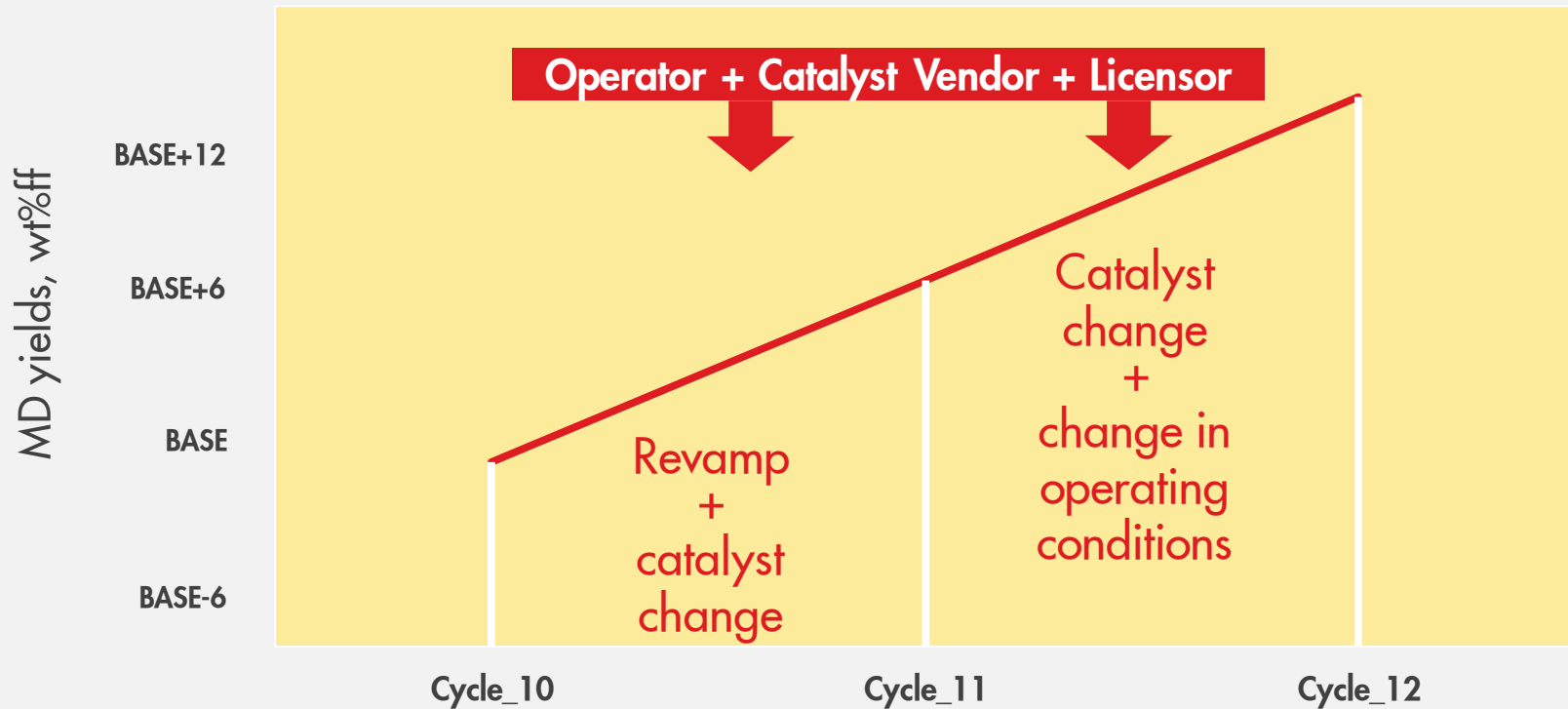
'K+D' Vs. Gas rates



- Improve colour scheme for visibility, e.g. replace white lines

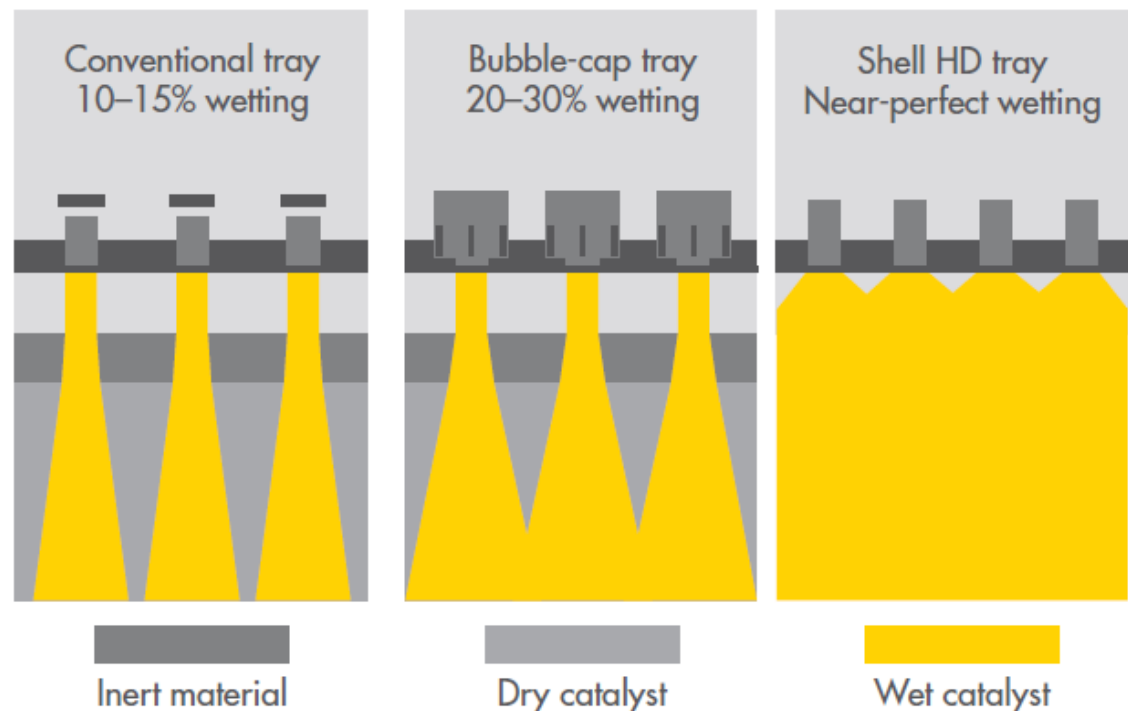
The journey to improve middle distillate yields

Middle distillate yields chart



The journey to **improve catalyst cycle length**

Enabling more catalyst to be loaded into the hydrocracker's reactors and using almost 100% of the catalyst load gives SASREF the opportunity to **increase yield and extend the catalyst cycle life**



The journey to **improve safety and reliability**

SASREF and Shell conducted a temperature stability analysis, identified and implemented a major upgrade:

- Replaced vertical thermobars with carefully selected reliable thermocouples and appropriate voting systems
- Upgraded distributed control system and safety-instrumented system
- Revised quench system to increase safety and enhance value-add
- Performed risk assessments for every critical activity
- Largest possible manways
- Eliminated any need for hot work.



The journey continues...to **improve product properties**

- Sulphur in products
- Euro V diesel specs
- Diesel cloud point for better marketability

✓ **Quality assurance**



Key learnings

- Identify opportunities to realise desired targets practically and safely.
- A new base is drawn with each improvement (continuous improvement/evolution process).

Therefore, in order to be the most competitive refiner in the world:

One must explore new **opportunities** from cycle to cycle, every cycle, and lead the **journey** towards hydrocracker **operational excellence** through **strategic collaboration**.

Questions and answers

Q&A

