Surviving and Building for the Future - Licensed Technologies in the Downturn

Süleyman M. Özmen
General Manager, Refining and Chemical Licensing
Shell Global Solutions International
The upturn will come

“The upturn in the economy will come, and a long-term demand for energy will continue. $32 billion a year in capital expenditures would drop ‘only a little’ this year. You have to explain long term how compelling energy investments are. This is a better investment than paying out cash in dividends today.”

Jeroen van der Veer, Chief Executive, Royal Dutch Shell plc
Outline

Industry challenges in the downturn
Constrained-capital expenditure (capex) technology solutions
Preparing for the upturn: “Ready-to-launch” tactics
Key takeaways for winning in the downturn
Challenges in refining

Same situation continues
- New refining capacity will be added that is likely to affect margins (Russia, Middle East)
- Stringent regulations will force refiners to produce low-sulphur products
- Assets are ageing

New (compared with two years ago) short-term reality
- Demand for refining products is stagnating (short-term dislocation of demand)
- It has become very hard to get financing for new projects
- Refiners are short of cash (to even implement basic revamps)
- Overcapacity in gasoline, short supply in middle distillates
Constrained-capex technology solutions – Revamp drivers

- **CAPACITY**
- **Product quality (10-ppm diesel)**
- **Margins with new feed and product slates**
Constrained-capex technology solutions – Key options

- Vacuum distillation upgrade
- Revamp HDS hydrotreater into a mild hydrocracker
- Thermal cracker revamp
- Fluidised catalytic cracker revamp
- Reactor internals and catalysts
Vacuum distillation upgrade with Shell deep-flash high-vacuum unit (HVU) technology

Objective
- Produce higher mild hydrocracked (MHC) diesel yield and increase margin

Project scope
- Conversion to deep-flash vacuum operation

Value
- Capital cost: $1.5 million (HVU)
- Timeframe: Six-month project execution; execution within turnaround
- Margin improvement: $2 million/y

Additional yield
- +310 t/d vacuum gas oil (VGO), +158 t/d MHC diesel

Payback time
- Less than one year

Dirty wash oil (DWO) section:
- Spray distributor
- Total draw-off tray
- External DWO vessel
- High-performance packing

Optimised stripping steam

Shell calming section trays
Vacuum distillation upgrade with Shell deep-flash high-vacuum unit (HVU) technology

Deep-flash vacuum distillation recovers around 10% more VGO feed directly to MHC (70% conversion)

MHC heavier feed
- VGO TBP 90% (544C–573C)
- Same VGO quality (Nitrogen=1,650 ppm, CCR=0.85 wt%)

MHC performance
- Cycle length reduced by four months
- Same diesel selectivity
Revamp HDS hydrotreater into a mild hydrocracker

Objective
- Maximise use of existing hardware
- Increase conversion capacity
- Cost-effectively yield higher-quality products

Project scope
- Relocated redundant reactor
- Added new stabiliser
- Shell internals in all three reactors
- Criterion pretreatment and cracking catalyst

Value
- Capital cost: $12 million
- Project time frame: 18 months
- Margin improvement: $10 million per year

Additional yield
- Design target: 40 wt% conversion of VGO over a 12-month cycle
- Achieved: 70 wt% at a 24-month cycle length
- Diesel rerouted to new ultra-low-sulphur diesel hydrodesulphurisation (HDS) unit

Payback time
- Less than two years
Revamp HDS hydrotreater into a mild hydrocracker

Revamp scope
- Relocated redundant reactor
- Added new stabiliser
- Shell internals in all three reactors
- Criterion pretreatment and cracking catalysts

Diagram showing flow of VGO and MHC, with diesel production.
Leverage state-of-the-art reactor internals and catalysts

Objective

• To produce ultra-low-sulphur diesel (ULSD), <10-ppm sulphur with existing hardware at a higher diesel yield

Project scope

• Adding new reactor internals and higher activity catalyst can help to
  – Reduce debottlenecking costs
  – Optimise catalyst consumption
  – Increase product quality and yield
  – Reduce maintenance costs and enhance reliability
  – Reduce process safety incidents

Value

• $200,000–$1 million
• Time frame: 6–12 months (from design to start-up)

Payback time

• 3–24 months

Shell Global Solutions’ HD trays are designed to maximise catalyst utilisation and thermal uniformity
Hydrocracking unit revamp – Proof point

Problem
- Flow maldistribution, high radial temperature differentials
- Difficult feedstocks and stringent distillate product specifications
- Suboptimal product slate and cycle life limitation

Project scope
- Constrained capex revamp with Shell reactor internals
  - Shell HD tray, ultra-flat quench interbed internals, filter tray
  - Tailored Criterion catalyst system

Value
- Margin improvement: +$3.5 million/y
- 2.5% higher cracking conversion, 10% higher distillate yields
- Increased cycle life
  - Around 20°C lower weighted average bed temperature
- Met ULSD requirements: less than 10ppm

Payback time
- <18 months
Fluidised catalytic cracking (FCC) revamps

Objective
• Low-cost revamps with fast return on investment (combination of capacity, conversion and reliability improvement)

Project scope
• Replaced with Shell feed nozzles, riser, internals, cyclones or/and stripper

Value
• $2–10 million per item, depending on scope and capacity
• Can be implemented in a normal turnaround with a typical 12–18 month lead time (for design and ordering equipment)
• Additional yield: 1–5%

Payback time
• Typically 6–24 months
FCC revamps – The technology

FCC technology – value creation through Shell design features
FCC revamp – Proof point

Objective

• 5% (vol.) conversion increase at increased capacity

Previous conditions

• Unit A: 6,400 t/d feed, licensor L

Solution

• New feed nozzles, riser with internals and reactor cyclones Penta-Flow stripper packing

Value

• 24-month payback

<table>
<thead>
<tr>
<th>BEFORE</th>
<th>AFTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONVERSION</td>
<td>BASE</td>
</tr>
<tr>
<td>FEED</td>
<td>BASE</td>
</tr>
</tbody>
</table>
Thermal cracker revamps

Objective

• Catch up with growth in demand for diesel, reduce fuel oil production and generate power, improving margins

Project scope

• A value-for-money phased investment project using a range of thermal cracker technologies:
  – Phase 1: Revamp coil cracker into a Shell soaker visbreaker
  – Phase 2: VGO thermal cracking unit
  – Phase 3: VGO thermal cracking unit capacity increase
  – Phase 4: High pressure VGO thermal cracking unit + IGCC

Timeframe

• Debottlenecking can be implemented in a normal turnaround
  – 12–18 month lead time for design and ordering equipment

Payback time

• Typically 3–36 months
• Capital investment: $3–60 million (excluding IGCC)
Thermal cracker revamps

Refinery yield – increase diesel production while minimising fuel oil production

Product yields and intake

Yields, %moc

IGCC feed
Fuel oil
Bitumen
Diesel
Mogas
Gas and LPG
Intake

Intake, Mt/annum

Year
Thermal cracker revamps

Basic scheme Shell soaker visbreaker unit with Shell visbreaker vacuum flasher

VBU: combined kerosene and gasoil yield: 13.6% weight on feed
TBP cut: 165–350ºC
Density=0.861, S=2.1 wt%, CN = 44.6

- Gas: 2.2wt%
- Naphtha: 4.8wt%
- Kerosene/diesel: 13.6wt%
- LVVGO: 23.4wt%
- HVVGO: combined
- VFCR: 56.0wt%
Thermal cracker revamps

TGU: combined kerosene and gas oil yield: 39.9% weight on feed

TBP cut: 165–350°C

Density=0.858, S=2 wt%, CN = 45.3

Flow scheme of modern Shell thermal gasoil unit

- Vacuum residue/atmospheric residue
- Residue furnace
- Soaker
- Cyclone
- Combi tower
- Distillate furnace
- Vacuum flasher
- Stripper
- L/HVGO
- LVVVOG/HVVGVO
- VFCR

Gas 6.2wt% vs 2.2wt%
Naphtha 12.0wt% vs 4.8wt%
Kerosene/diesel 39.9wt% vs 13.6wt%

Vacuum residue/atmospheric residue 0wt% vs 23.4wt%
VFCR 41.9wt% vs 56.0wt%
Investing in constrained-capex projects

Many constrained-capex projects are available with payback times of less than two years.

Well-designed projects can improve average energy consumption and reduce CO₂ emissions.

Flawless start-up processes can enhance the success of the project.

A well-designed project will help its financial viability.
Preparing for the upturn: “Ready-to-launch” tactics

Invest to prepare for an inevitable demand surge

Avoid the “stop-and-go” behaviour of past crises

Fundamentals of the long term are unchanged

Demand for clean diesel fuels is expected to grow faster than gasoline demand

Regulations for cleaner fuels in all applications will continue
High-capex technology solutions – Revamp drivers

- Minimum gasoline and maximum diesel
- Clean fuels
- Margins while processing difficult crudes
High-capex projects to optimise diesel production, minimise fuel oil production

1. Deep flash HVU in combination with thermal cracking to dramatically reduce fuel oil production

2. Conversion of residue gas oils to diesel
   - Heavier SR VGO deep flash
   - Thermal cracking
   - Delayed coker

3. Deep-flash HVU in combination with hydrocracker/SDU or coker unit to maximise diesel production

4. Upgrading of FCC LCO
   - Solution for diesel market
   - Solution for gasoline/BTX market

5. Production of winter diesel
   - Optimised cold flow properties
   - Integrated ULSD/dewaxing HDS
Doing the project right – Be ready to launch

- Take advantage of engineering services availability
- Take advantage of beneficial prices that may prevail
- Requires minimum initial investment but gives a head start for when funding will be available

Doing the RIGHT project

Doing the project RIGHT

FRONT-END DEVELOPMENT

Value

CONSTRUCTION

REALISATION

95% costs

5% costs

Good definition

Poor definition

Good execution

Poor execution

A

B

C

D

A

B

C

D

Good project definition and execution

Good project definition and poor project execution

Poor project definition and good project execution

Poor project definition and poor project execution
Key takeaways for winning in the downturn

The long-term pressure on demand remains

- But the current economic climate makes investment more challenging

There are several options for refiners to make smaller, incremental investments in their existing facilities

- This can help you meet demand challenges, for clean middle distillates in particular

Act now

- Prepare projects carefully for enhanced performance and financing

Invest during the downturn to avoid regrets
Thank you

Shell Global Solutions is a network of independent technology companies in the Shell Group. In this presentation, the expression ‘Shell Global Solutions’ is sometimes used for convenience where reference is made to these companies in general, or where no useful purpose is served by identifying a particular company.