ProtAgon 4G: Novel FCC Catalyst Technology for Light Olefins Maximization

A Case Study from OMV Schwechat

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Outline

- OMV – An Integrated, International Oil and Gas Company
- FCC Schwechat Refinery and the way to max Propylene
- 2011 Revamp Project ‘FCC Propylene Maximization’
- Catalyst Testing at Vienna University of Technology
- Unit Plant Data After The Revamp
- Grace supplying high Propylene FCCUs in EMEA
- Grace Catalyst Technologies
- Conclusions
OMV – an integrated, international oil and gas company

One of Austria’s largest listed industrial companies

**Exploration & Production**
- Worldwide activities, Mature core countries Austria, Romania
- Production of 288 kboe/d
- Proved reserves 1,131 mnboe

**Refining & Marketing**
- 3 refineries with a total capacity of 17.4 mn t/yr
- Fuels storage capacity 4.5 mn m³
- ~4.200 filling stations in 11 countries

**Gas & Power**
- Gas sales business in CEE, SEE and Turkey
- Gas-fired power plants in Romania and Turkey
FCC Schwechat – The situation before the 2011 revamp project

UOP Stacked Design
- Started up 1963
- 25,500 BPD / 3840 to/day
- Hydrotreated VGO, full combustion
- Reactor temperature 550°C
- 6 year run length

Limitations
- Low Regenerator temperature
- CO-Afterburning
- Air Blower
- Slide valves
- High Reactor cyclone velocities
FCC Schwechat – The way to maximum Propylene production

Major revamp 2000
- Double C3= yield to 8 wt% ex RX
- Change to hydrotreated feed
- Short term riser termination device (UOP VSS)
- New gas concentration unit

Start up 1963
- 1.470 to/day 10,259 BPD

Several capacity and technology revamps
- 3.840 to/day 26,815 BPD

The ‘FCC Propylene Maximization‘ project 2011
- 3.650 to/day 25,500 BPD
2011 Revamp project
‘FCC Propylene Maximization’

Objectives
- Maximize Propylene production
- No modifications at catalytic part
- Revamp of the Gas Concentration unit

Requirements
- No increase of RX-cyclone velocities
- No increase of Dry Gas yield
- Raise Regen-Temps to minimize after burn
- Minimize Slurry Recycle

Approach
- Implement newest catalyst technology to raise Propylene production
- Increase delta coke for higher Regen-Temps
- Lower unit throughput by ~5% to keep cyclone velocities const

Change to Grace’s new catalyst system ProtAgon™

* Based on 98% purity
Extensive catalyst testing at Vienna University of Technology

Full continuous operated FCC Pilot Plant

- Riser length: 2 m
- Riser diameter: 0.025 m
- Regenerator diameter: 0.180 m
- Feed rate: 3.5 kg/h
- Catalyst: 9.5 kg

Long term partnership with OMV

- Feed variations
- Lift gas studies
- Temp variations
- Catalyst tests
- Bio-components
- $O_2$-enrichment
Pilot Test Results – Vienna University of Technology

Propylene

Pilot tests confirmed a significant higher propylene production
→ Decision for an intermediate catalyst exchange

Riser outlet temperature [°C]

wt% related to feed

Propylene

Composition C1-C4s

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<tr>
<th></th>
<th>Base</th>
<th>Protagon</th>
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<tbody>
<tr>
<td>12.7</td>
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<td>3</td>
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<tr>
<td>2</td>
<td>4.7</td>
<td>5.4</td>
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<td>13.0</td>
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OMV Refining & Marketing, Alexander Mittelmayr, November 2014
Revamp project ‘FCC Propylene Maximization’ – Plant data after revamp

Grace’s light olefin selective catalyst helped meet refinery’s design objectives

Pilot plant test data closely matched plant data

Profitability increase of ca $3/MT FF from catalyst (based on propylene increase only)

### FCCU Yields

<table>
<thead>
<tr>
<th>(wt.% FF)</th>
<th>Before</th>
<th>After</th>
<th>Delta</th>
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<tbody>
<tr>
<td>Avg Propylene Yield</td>
<td>10.0</td>
<td>11.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Avg C4 Olefin Yield</td>
<td>10.0</td>
<td>11.5</td>
<td>1.5</td>
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Revamp project ‘FCC Propylene Maximization’ – Plant data of ProtAgon 4G trial since June 2014

- Grace’s light olefin selective catalyst helped meet FCCU design limits
- Profitability increase of ca $3/MT FF from catalyst (based on propylene increase only)

<table>
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<th>FCCU Yields</th>
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<td>(wt.% FF)</td>
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Simulations under same operating conditions and feed quality confirm +0.7wt% propylene and -1wt% slurry with ProtAgon 4G.
Revamp project 'FCC Propylene Maximization' – Ecat data of ProtAgon 4G trial

Analysis of Ecat samples with ACE™ are in line with the observed Unit data for both propylene increase and bottoms reduction.
Conclusions

With the project 'FCC Propylene Maximization' OMV converted its unit to one of Europe's leading Propylene producing FCCUs

Key success factors of the Project
- Early catalyst evaluations with the Vienna University of Technology to define:
  - Clear business case
  - Exact scope for revamp of the Gas Concentration unit and off site adaptions
- Grace’s light olefins-selective ProtAgon™ FCC catalyst technology

Further Major improvements with ProtAgon 4G
- Maximum light Olefins production
- Slurry recycle and producton reduced to minimum
- Further reduced CO-afterburn at no NOx penalty
Mehr bewegen. Mehr Zukunft.