Implementation of APC on a Mild HydroCracking Unit at BAYERNOIL’s Neustadt Refinery by Arnold Kleine Büning – BAYERNOIL
Stephen Finlayson – AMT
Zak Friedman – Petrocontrol
1965 ERIAG ERDÖLRAFFINERIE Ingolstadt
1967 BP Raffinerie Bayern Vohburg
1964 ERN ERDOEL-RAFFINERIE Neustadt
1989 RVI Raffineriegesellschaft Vohburg/Ingolstadt
1998 BAYERNOIL

<table>
<thead>
<tr>
<th>Company</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>VARO Energy</td>
<td>45 %</td>
</tr>
<tr>
<td>eni deutschland</td>
<td>20 %</td>
</tr>
<tr>
<td>bp</td>
<td>10 %</td>
</tr>
<tr>
<td>BP</td>
<td>50 %</td>
</tr>
<tr>
<td>Rosneft</td>
<td>50 %</td>
</tr>
</tbody>
</table>

RUHR OEL GMBH
MHC – Process flow diagram

**Diagram Elements:**
- **FEED**
- **Gas/Liquid Separation**
- **Heater**
- **Rx 1 HT/HC**
- **Rx 2 HC**
- **Recycle Gas**
- **Amine Scrubber**
- **Dehexanizer**
- **Fractionator Top 1**
- **Stripper**
- **L-Naphtha**
- **H-Naphtha**
- **Kero**
- **Diesel**
- **LHQ**
- **UCO to FCC**

**Processes:**
- Feeding into the process
- Gas/Liquid Separation
- Heating
- Recycle Gas
- Amine Scrubber
- Dehexanizer
- Fractionation
- Stripper
- Further processing
- Product collection
Overview

• The MHC converts 70% of feed to distillates

• The application covers the reaction and separation sections
  ➢ 6 Subcontroller
  ➢ 50 MV
  ➢ 127 CV

• This presentation is focused on control of the separation section
MHC APC Application Implementation

• The MHC APC Application was developed using the following technologies:
  ➢ AMT/Petrocontrol’s Generalized Cutpoint Calculation (GCC) for the inferential product quality models
  ➢ Aspen’s DMCplus for APC software
  ➢ Aspen’s IQ on-line technology for real time execution of the GCC model

• Design and Implementation of the application was done by AMT supported by Petrocontrol
MHC APC Application Key Objectives

• The combined APC application maximizes product yields
  – The **NAPHTHA** product rate is minimized to:
    ➢ The lower limit for the **KERO FLASH** or the **NAPHTHA 95% point**
  – The **KEROSENE** draw flow is maximized up to:
    ➢ The upper limit for the **KERO 95% point**
    ➢ The upper limit for the KERO stripper level valve
  – The **DIESEL** draw flow is normally maximized up to:
    ➢ The upper limit of the **DIESEL CLOUD**, or **DIESEL 90% point**
    ➢ The upper limit of the DIESEL stripper level valve or
    ➢ The lower limit for the overflash flow or level valve
MHC Fractionator Inferences

• The GCC inferential quality models are used to control product properties
  ➢ Naphtha, kerosene and diesel inferences used for control of those key qualities
  ➢ Analyzers are available for all key properties and are used as a backup to the inferences

• GCC calculates overflash and internal refluxes
  ➢ GCC generated “overflash“ or diesel internal Reflux are used to constrain the Diesel draw and heat balance when necessary
GCC Model and Inferential Concepts
Predict TBP curve from F, T, P measurements

Boiling temperature

Naphtha

Kero

Diesel

Over flash

% off Volume evaporated
GCC Concepts

• Property Predictions
  ➢ A function of cuts, internal reflux, others
  ➢ Example:

  \[ DK \ 90\% = K_1 \times CPK + K_2 \times CPD + K_3 \times \left( \frac{FDK}{FDK + F\text{IntRef}} \right) + \text{Bias} \]

• Overflash Model
  ➢ Predict column temperatures in the wash zone
    ▪ A function of overflash
  ➢ Calculate overflash flow so the predicted temperature equals the measured temperatures
GCC
Inferential results
Overflash & Diesel IR – 7 Months

High Overflash (80 m³/h or 26% of MHC feed), due to location of BPA circuit. Diesel internal reflux minimum is roughly 40 m³/h
The inference is on main fractionator top naphtha whereas the lab sample point is on Dehexanizer bottoms.
Kerosene Flash Point - 7 Months

- Kero flash point inference
- Kero flash point analyzer
- Kero flash point lab result
Kerosene 90% Point – 7 Months

![Graph showing the distillation points over 7 months from April 2014 to November 2014. The graph includes data from Kero 90% point inference, Kero 90% point analyzer, and Kero 90% point lab result.](grafico.png)
Diesel Cloud Point – 7 Months

Cloud point, Deg C

DCLD_A
DSLCL_L
DSLCL_M2

Diesel cloud Pt. inference
Diesel cloud Pt. analyzer
Diesel cloud Pt. lab result
Model seems reliable but it developed a 5 °C bias in June. Probably one of the inputs drifted.
 GCC calculated conversion. Is compensated for changes in the DK cutpoint. Stabilizes feed to separation section.
## APC Application Performance

<table>
<thead>
<tr>
<th>MHC-DMC</th>
<th>Commissioning</th>
<th>AMT Weeks on Site</th>
<th>Project Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part 1: Fractionation</td>
<td>April 2013</td>
<td>&lt; 4</td>
<td>&lt; 6 month</td>
</tr>
<tr>
<td>Part 2: Reactor</td>
<td>December 2014</td>
<td>&lt; 5</td>
<td>&lt; 4 month</td>
</tr>
</tbody>
</table>

- Acceptance from operations is very high
  - For inferentials
  - For control application

=> Service factor > 95%
Diesel 90%-Pt Target – 16 Days
Kero 90%-Pt Target – 26 days

Kero 90%-Pt. Target Set by the Control-Operator

Lab sample Kero 90%-Pt.

Kero 90%-Pt. GCC value
Performance After Start-Up

almost 20 m³/h more Kero

reducing ratio for stripping steam
Performance After Start-Up

- Driving Kero up to the Upper Limit of the 95%-Pt
- Reducing overhead pressure
- Driving overflash to the lower limit
Benefits
APC Benefits Diesel Cloudpoint

The diagram illustrates the distribution of DK Cloud Point, which represents the distance from the upper limit. The chart compares the actual data (2015) with the actual normal distribution (2015), actual mean, actual shift (0.8), specification, original distribution (2009), and original mean. The distribution shows a significant shift from the original mean, indicating a change in the quality or process parameters over the years.
## APC Application Benefits

<table>
<thead>
<tr>
<th>Product</th>
<th>Mass Balance Shifts</th>
<th>Benefits Realized</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m³/h</td>
<td>t/h</td>
</tr>
<tr>
<td>Bottoms UCO</td>
<td>0,4</td>
<td>0,3</td>
</tr>
<tr>
<td>Kerosene</td>
<td>4,8</td>
<td>3,9</td>
</tr>
<tr>
<td>Diesel</td>
<td>-2,2</td>
<td>-1,9</td>
</tr>
<tr>
<td>Overhead Naphtha</td>
<td>-3,1</td>
<td>-2,3</td>
</tr>
</tbody>
</table>

**Hourly Yield Benefit**  
527 €/h

**Annual Yield Benefit**  
> 4.200.000 €/a
Conclusions
Conclusions APC performance

• Sustaining APC performance is the most important factor in realizing the benefits for this application
  – The design and development of the MHC application has delivered on the long term benefits case

• The MHC application has a high service factor because
  – The major and difficult operating constraints are addressed
  – Accurate, high quality property predictions were developed

• The application has less than a 6 month simple pay-back period
Thank you!

Comments/ Questions?