Continuous level measurement on coke drum in DCU

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Delayed Coker Unit @ Danure Refinery, MOL Plc.
<table>
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<tr>
<th><strong>DR Delayed Coker Unit</strong></th>
<th><strong>Unit commissioned in 2001</strong></th>
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<tr>
<td><strong>Technology licensor is Foster Wheeler</strong></td>
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<td><strong>Refinery product portfolio showed a robust change, light product ratio increased with 15%</strong></td>
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<td><strong>Feedstock: 1Mt/year vacuum residual with high sulphur- and heavy metal content</strong></td>
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<td><strong>Relatively lower quality products requiring desulphurisation technologies</strong></td>
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<td><strong>Unit processes FCC C3 compound as well</strong></td>
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<td><strong>Unit is equipped with steam turbine and CH sludge treatment</strong></td>
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Unit areas

- Feedstock system
- Coking including furnace, coke drums, main fractioning, blow-off, slugde treatment, coke cutting
- Gas separation
- C3/C4 sweetener (Merichem)
- Amine regeneration
- Amine cleaning
- Sour water stripper
- Coke storage and logistics
- Flare
- Steam turbine and generator
Technological background 3) - Coking process phases

- **Coking**
  - Pre-heating
  - Drum cover removal
  - Coke cutting
  - Drum cover resettling oxygen elimination, pressure test
  - Drum CH decontamination by steam
  - Cooling with water flush
  - Quech water unload

- Pressure test
Conversation reactions

- No exact reactions can be discussed
- The next three main steps are known
- Feed passing furnace tubing is partially evaporated and mildly cracked (viscosity cut)
- CH vapor passing coke drum is cracked ahead
- Liquid trapped in coke drum is converted to steam and coke after polymerisation and cracking reactions
Process control background 1)

- Semi-consecutive process
- Switched operation of coke drums
- No catalyst, thermal cracking
- Temperature has to be kept within a short range to maintain VCM and HGI
- Process can be controlled by pressure, recirculation ratio and retention time
- Pressure transmitters on feed streams before and following to drum switching valve
- Drum wall temperature transmitters to check drum switching phases
- Material layers in drum
  - Gases
  - Foam – separation of gas outlet and liquids
  - Liquid – coking and cracking reactions
  - Coke – fluid phase at the beginning of coking
Drum level supervisory installed at unit commissioning

- Four nuclear level switches with vertical installation
- Principle based on different absorption of neutron radiation in materials with different hydrogen-content
- Three instrument near to the drum bottom are calibrated to detect coke, water and foam presence
- Fourth level switch is only calibrated for water and foam as coke level can only approach the level of third instrument
- Foam amount is controlled by adding detergent
Process control background 3)

Nuclear level gauging has advantages

- Continuous monitoring of coke and foam amount
- Level increment supervisory, operator intervention, cycle optimization, more adaptive feed quality
- More effective foam detergent amount control
- Cycle time reduction
- Less amount of sour water
- Less cooling and coke cutting needs
- Higher safety
New aim: nuclear level gauging

- Instruments installed one and a half decade became obsolete
- Replacement became necessary
- No manufacturer support and spares are available
- Some sections are not supervised with one-point detection, level gauging advantages shall be achieved
- MOL decided to upgrade to nuclear level gauging
Basics of measurement 1)

- Gamma radiation
- Scintillation counter detector (polymer or crystal)
- Transmitted intensity is measured: \( I = I_0 \cdot \exp(-m \cdot r \cdot D) \)
- Trapping of scintillation light, transport of light along the scintillator
- Conversion in photomultiplier: light to voltage pulse
Measuring solutions

Point source – Rod detector
Most economic
Long measuring ranges
Industry „standard“

Rod source – point detector
More expensive
Higher accuracy & reliability
Berthold only
Installed solution 1)

- Manufacturer: Berthold
- 3 point sources with one ROD type detectors on coke drum D101
- 3 main detectors with 3x2 pieces of additional detector modules and a top level switch
- **Total length of measuring range is 18m of cascade – all time high!**
- LB490-TS „TOWER SENS” level gauging module
- 2000mm scintillation detectors
- LB490-11 detector, NaI 50x50 crystal
Installed solution 2)

- Cs-137 closed radiation source with 7400 MBq of activity
- 5-15 times less radiation needed compared to flexible detectors
- Automatic compensation of activity decrement
- HART compatibility
- ATEX II 2 GD Ex d IIC T6
- ISO/C 66646 conformity
Experiences of installation and operation 1)

Continuous level measurement on coke drum D101
Experiences of installation and operation 2)

- **Challenges of steel support structure arrangement**
  - To ensure support for more rigid and large detector
  - To ensure accessibility of source shields for isolation (maintenance)

- **Positioning of sources and detectors required high attention due to**
  - Banane effect (asymmetric bending)
  - Dilatation
  - Coke drum vibration

- **Calibration difficulties**
  - It has to be performed by filling up drums with water
  - Strict scheduling caused that calibration had to be performed during unit operation, Filling up with water could be realised during turnaround

- **Unit leader and operators are satisfied with solution, installation on D102 drum soon**
Thank you for your kind attention! Do you have questions?