Coke Cutting of large Drums

Coking.com Safety Seminar

Rio de Janeiro 3rd – 5th August 2009

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Agenda

- Process and Drum data
  - 1980 to 2012
- Data of Coke Cutting Pump
  - 1980 to 2012
- Coke Cutting Equipment and Pull Force
  - Weight of Coke Cutting Equipment
  - Pull Force, required for large drums
  - Specific Pull Force
- Coke Cutting Analysis and Verification
  - Jet Pump
  - Cutting Equipment
- Conclusion
## Ruhrpumpen – References, systems

<table>
<thead>
<tr>
<th>Year</th>
<th>Company</th>
<th>Drums</th>
<th>Scope</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Petrolera Ameriven, Venezuela</td>
<td>4 x 29’</td>
<td>Complete HDS, hydraulic</td>
<td>new</td>
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<tr>
<td>2002</td>
<td>BP-Gelsenkirchen, Germany</td>
<td>4 x 26’</td>
<td>Cutting system, electric +</td>
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<td></td>
<td></td>
<td></td>
<td>semi automated top deheading</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>semi automated bottom deheading</td>
<td></td>
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<tr>
<td>2003</td>
<td>BP – Lingen, Germany</td>
<td>2 x 17’</td>
<td>Cutting system, hydraulic</td>
<td>new</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>36” top deheading valves</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>semi-automated bottom dh</td>
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<tr>
<td>2004</td>
<td>Jinling, China</td>
<td>2 x 31’</td>
<td>Jet Pump and decoking Valve</td>
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<td>2005</td>
<td>CNRL, Canada</td>
<td>4 x 30’</td>
<td>Complete HDS, elec/hyd</td>
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<td>2005</td>
<td>ENERCON, Chile</td>
<td>2 x 29’</td>
<td>Complete HDS, hyd</td>
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<td>2005</td>
<td>BP-Lingen, Germany</td>
<td>2 x 17’</td>
<td>Cutting system, hyd</td>
<td>revamp</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>30” top deheading valves</td>
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<td></td>
<td>semi-automated bottom dh</td>
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<td>2006</td>
<td>BP Castellon, Spain</td>
<td>2 x 25’</td>
<td>Complete HDS, hyd +</td>
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<td></td>
<td></td>
<td></td>
<td>30’ top deheading valves</td>
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<td>Sinclair Oil, USA</td>
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<td>revamp</td>
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<td>2006</td>
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<td>4 x 32’</td>
<td>Jet Pump and DC-valve</td>
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<td>2007</td>
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<td>6 x 32’</td>
<td>Complete HDS, elec</td>
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<td>2007</td>
<td>Frontier, CB&amp;I, USA</td>
<td>2 x 26’</td>
<td>Complete HDS, elec</td>
<td>revamp/new</td>
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<td>2007</td>
<td>OMV, Germany</td>
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<td>revamp</td>
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<td>2007</td>
<td>Rosneft, Komsomolsk, Russia</td>
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<td>Complete HDS, elec</td>
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<td>2007</td>
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<td>revamp</td>
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<td>2007</td>
<td>Petro Canada, Montreal, Canada</td>
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<td>Complete HDS, elec</td>
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<td>2007</td>
<td><em>Petro Canada, Fort Hills</em></td>
<td>4+2x32’</td>
<td>Complete HDS, elec</td>
<td>new, canceled</td>
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<td>2007</td>
<td>Hunt Ref., USA</td>
<td>2 x 28’</td>
<td>Cutting system, elec</td>
<td>extension</td>
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<td>2008</td>
<td>HMEL, India</td>
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<td>Complete HDS, elec</td>
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<td>2009</td>
<td>StaoilHydro, MWKellog</td>
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<td>Cutting system, elec</td>
<td>revamp</td>
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</tbody>
</table>

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Process

COKER-DECOKER-ARRANGEMENT

Pump requirement

Coke Cutting Pump
Medium: Water
Q = 300 m³/h
H = 3.500 m
T = 75 °C

Heater Charge Pump
Medium: Hot oil
Q = 400 m³/h
H = 400 m
T = 250 °C

Pit Pump
Medium: Water with coke fines
Q = 600 m³/h
H = 40 m
T = 20 °C

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Coker unit

Refinery
with
Delayed Coker

Coke Drums
Dia = 29‘; 8,90 m
FF = 121‘; 36,88 m

Coke Cutting Pump
Medium: Water
Q = 300 m³/h
1200 gpm
H = 3,200 m
4,425 psi
T = 75 °C
140 °F

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Definitions

Parameterization

- $C_{Vol\, drum} = \frac{Vol_{drum}}{Vol_{Cylinder}} = 0.74 \ldots 0.82$

- $C_{coke} = \frac{m_{coke\, design\, filling}}{m_{coke\, full}} = 0.70 \ldots 0.83$

- $C_{coke\, type\, cutting\, factor} = \text{needle / anode\, grade / fuel\, grade / shot} = 1.3 / 1.1$

- $C_{coke\, cut\, time} = \frac{T_{cut\, time}}{T_{Standard\, (4\, hrs)}}$

- $C_{daily\, prod\, pair} = \frac{1}{T_{cycle\, /\, 24\, hrs}}$

- $m_{cutted\, coke\, hrs\, [t/hrs]} = \frac{m_{coke\, per\, cycle}}{T_{cut}} = \frac{m_{coke\, per\, day \times T_{cycle}}}{T_{cut} \times 24}$

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Diameter and Height FF of large Drums

![Graph showing the diameter and height of large drums over time.]
Volume of Drums and Weight of Coke

- V drum, [m³]
- m coke filling, [t]
- V drum, XXL, [m³]
- m coke filling, XXL, [t]
- Polynomisch (m coke filling, [t])
- Polynomisch (V drum, [m³])

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Decoking Jet Pump

ADC 6x12
Jet Pump: installations

Example

ADC 6x12
Jose, Venezuela

ADC 6x10
CNOOC, China

ADC 6x10
Castellon, Spanien
Jet Pump: flow and pressure

Parameterization

- Time frame 1980 – now

- Large drums
  - without small drums,
  - without revamps
Jet Pump: flow, large drums

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Jet Pump: pressure, large drums

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Cutting Equipment: installations

Examples

- DSD, elec
- CH + FFA, CNRL, Canada
- CH + FFA, DSD hyd
- BP-Li, Germany
- Tool, auto switch
  - Worldwide, more than 50 installations

- DSD, elec
- BP-Ge, Germany
- Hoist, elec.
- Frontier, USA

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Cutting equipment

Weights

- **Version A**
  - Rotary Joint, (Pac, Wor)
  - Crosshead, shoe type
  - Crosshead, rail type
  - Drill Stem 6” OD, till approx. 1995
  - Drill Stem 7” OD, since 1995
  - 7” OD
  - Water in Drill Stem
  - Flanges
  - HP water hose
  - 3,5” ID water hose
  - 4” ID water hose
  - Water in hose
  - Tool auto shift FS/Del
  - A cross sectional 0,246 m²

- **Version Ruhrpumpen**
  - Drill Stem Drive DSD, (Ruhrpumpen)
  - Crosshead, rail type with FFA
  - Drill Stem
    - 7” OD
    - Water in Drill Stem
    - Flanges
  - HP water hose
    - 3,5” ID water hose
    - 4” ID water hose
    - Water in hose
  - Tool auto switch
  - A cross sectional 0,080 m²

Weights are approximate weights as known

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Cutting Equipment: Pull Force

- Cut Equ Weight [kg]
- Hoist RP hyd, 1st Layer [kgf]
- Hoist RP hyd, 4th Layer [kgf]
- Hoist RP elec, 1st Layer [kgf]
- Hoist RP elec, 4th Layer [kgf]
- Hoist FA5i pneu/hyd, 1st Layer, rated, [kgf]
- Hoist FA5i pneu/hyd, 8th Layer, stall [kgf]
- Cut Equ, XXL, Weight [kg]
- Polynomisch (Cut Equ Weight [kg])

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Analysis

Drum size
- Increase in Diameter
  - Largest influence for increasing coke production
  - Investigation to drum size D (XXL) = 10.36 m (34 ft)
- Increase in height FF
  - Often limitation of the structure itself
  - Investigation of FF (XXL) = 45.5 m (150 ft)

Jet Pump selection
- Flow and Pressure
  - Flow. Increase is possible and required for a stable jet
    - Investigation for Q max = 340 m³/h, (1500 gpm)
- Pressure
  - Max pressure has been set for flange rating ANSI B16.5, 2500 lbs
  - Max. cutting pressure P max = 350 bar (5.075 psi)

Cutting Equipment
- Crosshead, rail type
  - Rail type CH with FFA has been considered for further calculation
  - FFA system must be capable for equipment weight as calculated
Analysis

**Past**
- Selection of Jet Pump Pressure and Flow by Drum Diameter
- Selection of Cutting equipment
  Pull Force and pull speed was constant over years constant

**Actual and future**
- Selection of Jet Pump Pressure and Flow by coke production per drum full scale Tool / nozzle tests
- Selection of Cutting equipment (Hoist, Drill Stem, CH + FFA) by drum height FF, secondary by D drum
Jet Pump: Flow vs Diameter of drum

Drum dia (m)

J Pump Q m³/h
Projects Q m³/h
RP Q m³/h
XXL Q m³/h
Polynomial (J Pump Q m³/h)

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Jet Pump: Flow vs Coke weight / drum

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Jet Pump: Pressure vs Diameter of drum

Drum dia (m)

J Pump P bar
Projects P bar
RP RP - P bar
XXL P bar
Polynomisch (J Pump P bar)

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Jet Pump: Pressure vs Coke weight / drum

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Cutting procedure 32 x 130

Drum, 9,75 x 40,0 (32 ft x 130 ft)

Coke cutting with acousto-vibro system
- Pilot hole
- Cone
- Drum

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Cutting procedure 34 x 150

Drum D = 10,36 m x 45,7 m FF, (D = 34 ft x 150 ft FF)

Coke cutting with acousto-vibro system
- Pilot hole
- Cone
- Drum
Verification

Cutting System

- High Performance Jet Pump
  - Flow 340 m3/h
  - Pressure 350 bar

- High Performance Cutting Equipment
  - Hoist Pull Force \( F > 40 \text{ kN} \) (8 800 lbsf) at all layers
  - Hoist Pull Speed \( v = 40 \text{ m/min} \) (130 ft/min)

- High Performance Cutting Tool
  - Hydrodynamic Tool and Nozzle optimization
  - CFD calculation and full scale testing

- High Performance Control System
  - Measurement and Control of all parameters
  - Visualization, data logging and analysis
Verification by calculation

Calculation

- pressure drop
Verification by calculation

Calculation

- Coke condition
Verification at test bed conditions

Hydraulic Decoking System

◆ Performance test of Jet Pump
  ◆ Full speed performance test, (full flow and pressure)
    + Lube oil system
    + Decoking valve
    + Auto switch Tool

◆ Performance test of hoist
  ◆ Hoist max Pull Force
  ◆ Hoist reduced Pull Speed

◆ Performance test of Crosshead with Free Fall Arrestor
  ◆ Functional test at RP test bed
  ◆ Full load test at site
Verification at test bed conditions

Auto switch Drilling and Cutting Tool

- Switch tests
  - > 200 cycle for every tool at test bed I
    - Reduced flow and pressure
  - > 10 cycle for Tool with Jet Pump at test bed II
    - Test of switch device full flow and pressure
    - Test of nozzles full flow and pressure
    - Test of nozzles full distance R up to 6,0 m

- Nozzle optimization
  - Nozzle test reduced flow and pressure
  - Nozzle test full flow and pressure
Tool: full performance test bed

Test distance
R = 6,00 m (20ft)
Flow up to 400 m³/h
1760 gpm
Pres up to 350 bar
5075 psi
Conclusion

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- Is able to provide high performance

Hydraulic Decoking System

for

Drum size up

Diameter $D = 10.36 \text{ m}, \ (34 \text{ ft})$
Height $\text{FF} = 45.70 \text{ m}, \ (150 \text{ ft})$

System can be fully performance tested
with testing of each individual functional group
at full working condition
End

THANKS FOR YOUR ATTENTION