BANTREL

Repairs on 40 Year Old Drums at Suncor

Coking.com

Safety Seminar

September 17-20, 2007

Calgary, Alberta

MATERIAL SELECTION ISSUES IN COKER UNITS

Coking.com Safety Seminar,
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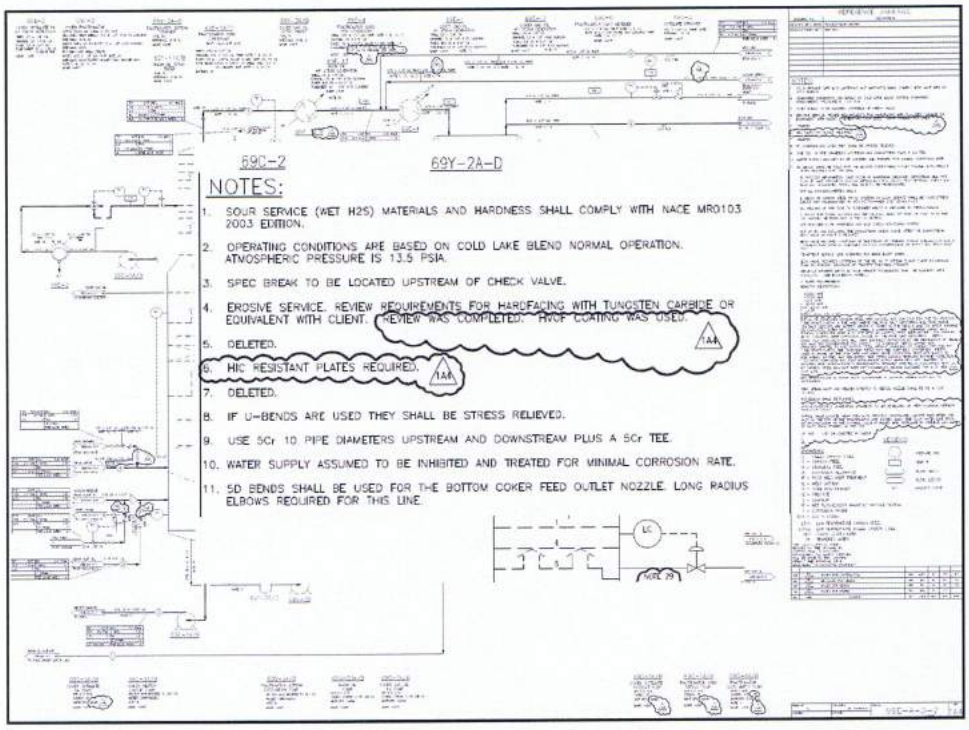
By Lutz Josefiak and Wes Witmer

Agenda

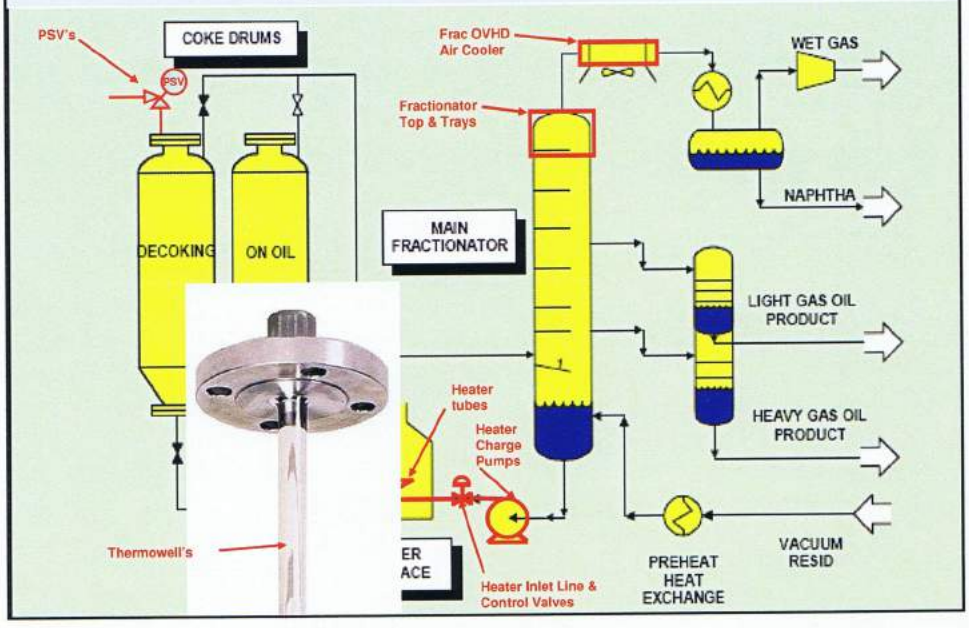
- Format
- Some Issues Found in Coker Units
  - Corrosion
  - Cracking
  - Clad Restoration
  - Welding
  - Erosion
- Application oriented and state-of-the-art hardfacing
- Summary

What can Owner / Operators expect?

- Bring in cutting edge technology
  - Apply Client specific lessons learned & material performance data
  - Update projects with revisions of industry standards
  - Participate in committee work
  - Attend conferences and seminars
- Material Selection Diagrams (MSD's)
  - Incorporate lessons learned, Client experience & latest industry standards
  - Include special fabrication, heat treating, cladding and hardness control notes



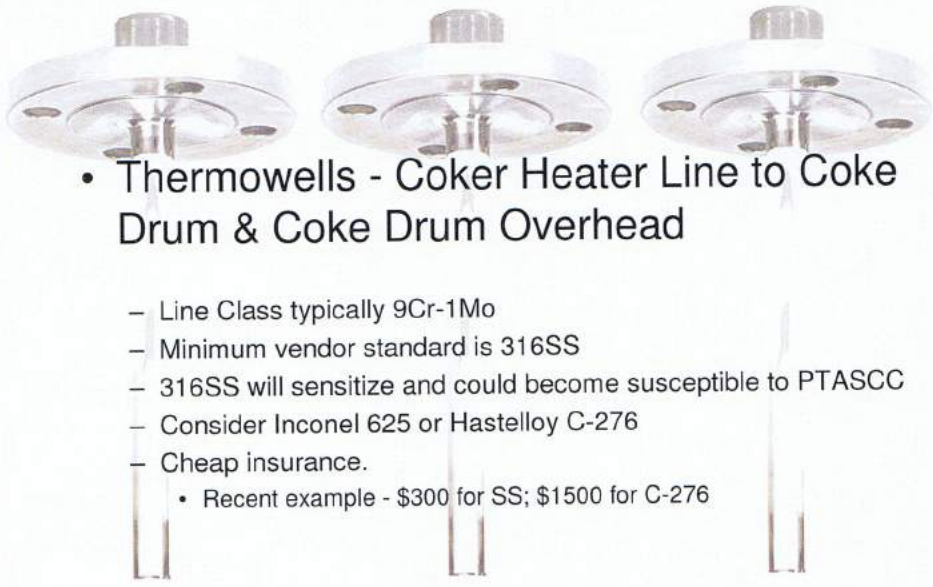
Typical Coker Unit



Corrosion Issues in Coker Units

- Furnace Tubes
  - Typically 9Cr-1Mo
  - Some tubes have only 5 to 6 years life. Why?
  - Consider Alloy 800HT and Alloy 825

Corrosion Issues in Coker Units



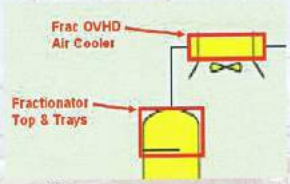
- Thermowells - Coker Heater Line to Coke Drum & Coke Drum Overhead
  - Line Class typically 9Cr-1Mo
  - Minimum vendor standard is 316SS
  - 316SS will sensitize and could become susceptible to PTASCC
  - Consider Inconel 625 or Hastelloy C-276
  - Cheap insurance.
    - Recent example - $300 for SS; $1500 for C-276

Corrosion Issues in Coker Units

- PSV's - Coke Drum Overhead
  - Line Class typically 9Cr-1Mo
  - Minimum vendor standard is 316SS nozzle and disc
  - 316SS will sensitize and could become susceptible to PTASCC
  - Consider Inconel 625 or Hastelloy C-276 for all components (body/bonnet/nozzle/disc)
  - Some Clients have experienced PTASCC on PSV's

Corrosion Issues in Coker Units

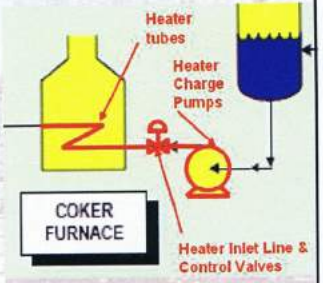
- Fractionator Trays, Top Head and line to OVHD Coolers
  - Ammonium Chlorides
    - Water soluble
    - High risk of deposition
    - Severe loss of tray capacity and efficiency
    - Highly corrosive
  - Consider Inconel 625
  - Some Clients opt for carbon steel with increased inspection



- Fractionator Overhead Coolers
  - Ammonium Chlorides
  - Ammonium Bisulfides
  - Consider Inconel 625
  - Some Clients opt for carbon steel with increased inspection

Corrosion Issues in Coker Units

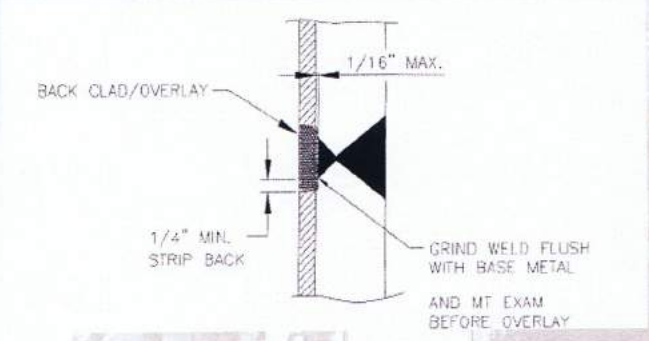
- Heater inlet lines
  - Typically 317SS
  - Some Clients have had good experience with 316SS even where high levels of naphthenic acids are present.
- Heater Charge Pumps
  - Typically 317SS
  - Can experience high erosion due to coke fines
  - Consider hardfacing of all wetted surfaces
- Heater inlet valves
  - Typically 317SS
  - Can experience high erosion due to coke fines
  - Consider hardfacing of all wetted surfaces



Clad Restoration Problems in Coker Units

- Preferential corrosion at weld joints between cladded sections
  - Dilution from base metal can result in lower than acceptable chemistries.
  - Grind caps of base metal welds for best chemistries

Cross-Section of Clad Restoration



Welding Problems in Coker Units

- Cracking of 309 stainless steel weld metal due to differential coefficients of thermal expansion
  - Use nickel alloy filler metals
- Weld repairs of coke drums

Erosion Problems in Coker Units

- Valves Downstream of Charge Pumps

Erosion Problems in Coker Units

- Valves Downstream of Charge Pumps

Erosion Problems in Coker Units

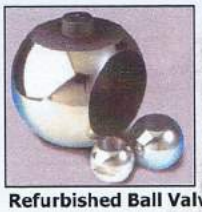
- Furnace Tubes, Outlet Piping and Fractionator Bottoms Piping
  - Sand and coke particles
  - Long radius elbows
  - Restricted velocities
  - Locate thermowells on the downstream side of returns?
- Charge Pumps
  - 18Cr-8Ni SS versus 13Cr-4Ni SS
  - HVOF spray coatings

Summary

- Highlighted what Owners / Operators can expect from Engineering Companies
- Corrosion, cracking and welding issues within coker units were discussed
- Alternate materials of construction were presented

HVOF / Hard Metal Coatings

HVOF / Applications



Refurbished Ball Valve

Conveying Screw

Carbidic Coatings

WC/10Co4Cr

Hardness: $HV_{0.3}$ **1000**
Service Temp.: **up to 930 °F**

Impeller

Gate Valve

Cr_3C_2/25NiCr

Hardness: $HV_{0.3}$ **1000**
Service Temp.: **up to 1800 °F**

Source: Brodeur Machine Company

Influence of Chamber Pressure/ Particle Velocity on Impact

WC/Co 83/17

Jet Kote

- Carbon Loss: 60 %
- Hardness: 950 $HV_{0.3}$

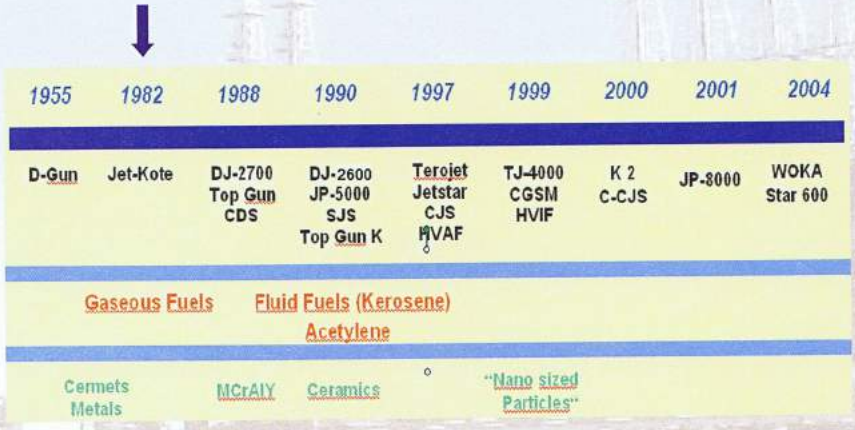
K2

- Carbon Loss: 37 %
- Hardness: 1490 $HV_{0.3}$

Sintered Hardmetal

- Hardness: 1630 $HV_{0.3}$

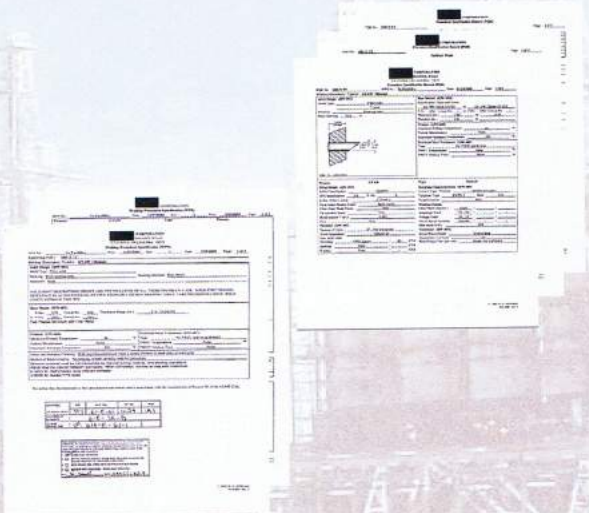
History of HVOF-Processes



Coating Quality assurance by plant operating and designing company

Decisive Spray Parameters:

1. Chamber pressure
2. Kind of Fuel
3. Method of Media Control
4. Fuel/Oxygen Ratio
5. Gun Nozzle Length
6. Powder Size
7. Powder Composition
8. Powder Morphology
9. Feed Rate
10. Spray Distance
11. Spray Angle
12. Surface Speed
13. Substrate Preparation
14. Substrate Cooling
15. Coating Thickness
16. .....



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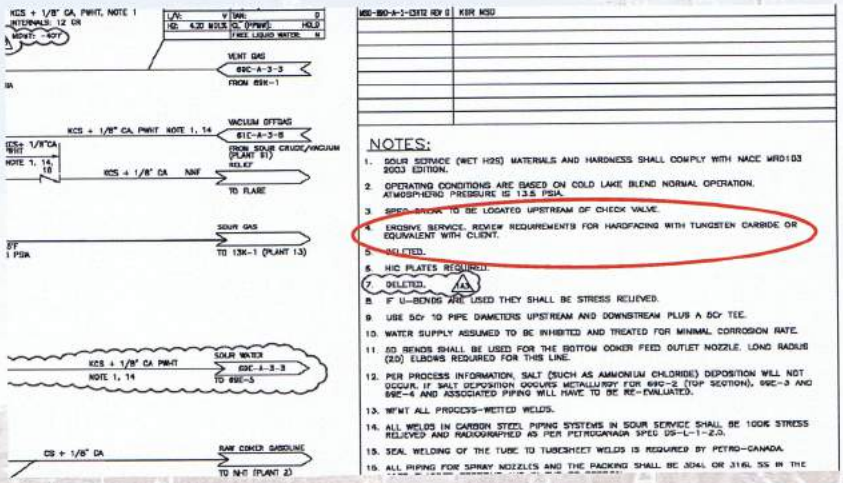
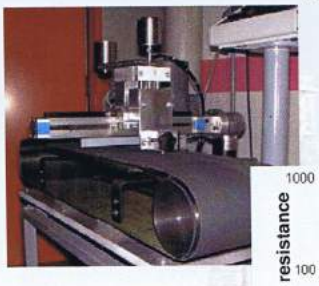
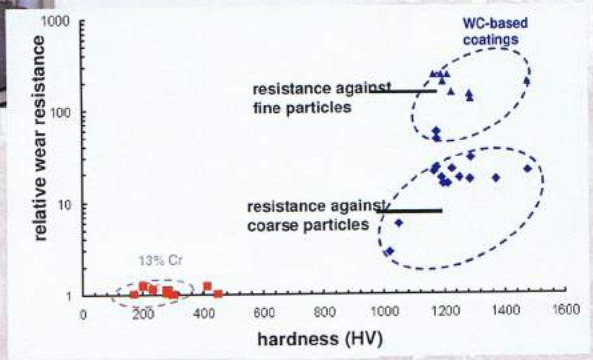


NOTES:

1. SOUR SERVICE (WET H2S) MATERIALS AND HARDNESS SHALL COMPLY WITH NACE MR0103 2003 EDITION.
2. OPERATING CONDITIONS ARE BASED ON COLD LAKE BLEND NORMAL OPERATION. ATMOSPHERIC PRESSURE IS 13.5 PSIA.
3. SPEC BREAK TO BE LOCATED UPSTREAM OF CHECK VALVE.
4. EROSIVE SERVICE. REVIEW REQUIREMENTS FOR HARDFACING WITH TUNGSTEN CARBIDE OR EQUIVALENT WITH CLIENT.
5. DELETED.
6. HIC PLATES REQUIRED.
7. DELETED.
8. IF U-BENDS ARE USED THEY SHALL BE STRESS RELIEVED.
9. USE 5Dr TO PIPE DIAMETERS UPSTREAM AND DOWNSTREAM PLUS A 5Dr TEE.
10. WATER SUPPLY ASSUMED TO BE INHIBITED AND TREATED FOR MINIMAL CORROSION RATE.
11. ΔD BENDS SHALL BE USED FOR THE BOTTOM COKER FEED OUTLET NOZZLE. LONG RADIUS (2.0) ELBOWS REQUIRED FOR THIS LINE.
12. PER PROCESS INFORMATION, SALT (SUCH AS AMMONIUM CHLORIDE) DEPOSITION WILL NOT OCCUR. IF SALT DEPOSITION OCCURS METALLURGY FOR 69C-2 (TOP SECTION), 69E-3 AND 69E-4 AND ASSOCIATED PIPING WILL HAVE TO BE RE-EVALUATED.
13. NPWT ALL PROCESS-WETTED WELDS.
14. ALL WELDS IN CARBON STEEL PIPING SYSTEMS IN SOUR SERVICE SHALL BE 100% STRESS RELIEVED AND RADIOGRAPHED AS PER PETROCANADA SPEC DS-L-1-2.0.
15. SEAL WELDING OF THE TUBE TO TUBESHEET WELDS IS REQUIRED BY PETRO-CANADA.
16. ALL PIPING FOR SPRAY NOZZLES AND THE PACKING SHALL BE 304L OR 316L SS IN THE

HVOF / Coating tests





source: www.sulzerinnotec.com

Application-specific materials testing

High pressure water jet pump for coke cutting

- DLC versus HVOF WC/CoCr and WC/267
- slurry jet erosion test with neutral pH slurries, metallurgical

Ball valve in "severe" service (Coker Furnace Charge Line)

- hot bitumen and bitumen hydrogen mixes
  T: 300 - 450 °C, P: up to 15 MPa
  ppH_2: up to - 12MPa, ppH_2S up to – 1.1Mpa
  S: 2-5%, Solids: ≈ 2000ppmw, Coke deposits
- DLC, HVOF WC/CoCr and WC/267, Laser clad stellites, spray and fuse Co based SFA
- high temp. and pressure sulphidation test in autoclave
- pin-on-disc, thermal shock, 3-point-beam, metallurgical