Lessons learned in Delayed Coking units by the use of nuclear level technology.

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Coke Drum Level Measurement
Differences

- Considerable difference between Neutron Back Scatter (NBS) and continuous

NBS is point level
- Measures difference in densities of hydrogen content
- High foam height and low hydrogen density will give the same output as a low foam height and high hydrogen density.

Continuous measures anything that get between the source and detector
Differences

NBS tracks the increase of the density of hydrogen present. Could be a significant difference in readings between the NBS' continuous level reading.

- Due to the thickness of the foam layer which could be many feet thick at times and thin at other times.
- Foam layers vary with many factors, such as:
  - Type of crude
  - Fill rate (Charge rate, cycle time)
  - Operational procedures
    - Operating Temperature and Pressure
    - Recirculation Ratio
    - How anti-foam is injected and how long
Continuous Level vs. NBS

Continuous level tracks top of foam layer

NBS tracks level at some point where foam density increases
Continuous Level vs. NBS
Levels showing “Foam Dome”

Fill with foam (dome surface)  Fill with water (flat surface)
Typical Coke Drum Cycle

This graph shows a foam up after the switch and how the NBS responds vs how the continuous level responds. Switching of the drum occurs at Point 1. The NBSs (Purple, Red and Brown) starts a downward trend since the foam is increasing in height and not in hydrogen density. The same amount of hydrogen being spread over a larger area will decrease the overall hydrogen density in front of the NBSs.
Catching a Foamover
NBS output compared to Gamma Density
Vapor Density during the coking stays relatively constant except towards the end of the cycle when the level is at its highest. This is where it starts to measure how much particulate matter is being carried over. Gases velocities are high enough to entrain matter with them and overcome gravity. Switch out of the drum happens at Point 1.
Repeatability from Cycle to Cycle

DRUM 2
Repeatability from Cycle to Cycle
Buildup in vapor space
Buildup in vapor space
Level increase from Tangent to Tangent (not linear)

All level gauges are 22’ long (all equal lengths)
Level increase from Tangent to Tangent (not linear)

3 hrs

4 hrs

All level gauges are 22’ long (all equal lengths)
Level increase from Tangent to Tangent (not linear)

3 hrs  4 hrs  12 hrs

All level gauges are 22’ long (all equal lengths)
Caustic Overtreatment - Before
Caustic Overtreatment - During
Caustic Overtreatment - After
Gauge Arrangement

Drum 1  Drum 2  Drum 3  Drum 4
Drum 2
Drum 3
Drum 4
Vapor Flow
Conclusion

We have learned many things about the internal dynamics of fluid levels inside coke drums by the use of nuclear level and density technology.

Some things appear to be a “gauge issue” when in fact it is the process itself.