Maximising throughput and minimizing costs in a delayed coker unit

Using radiometric measurement for continuous level measurement

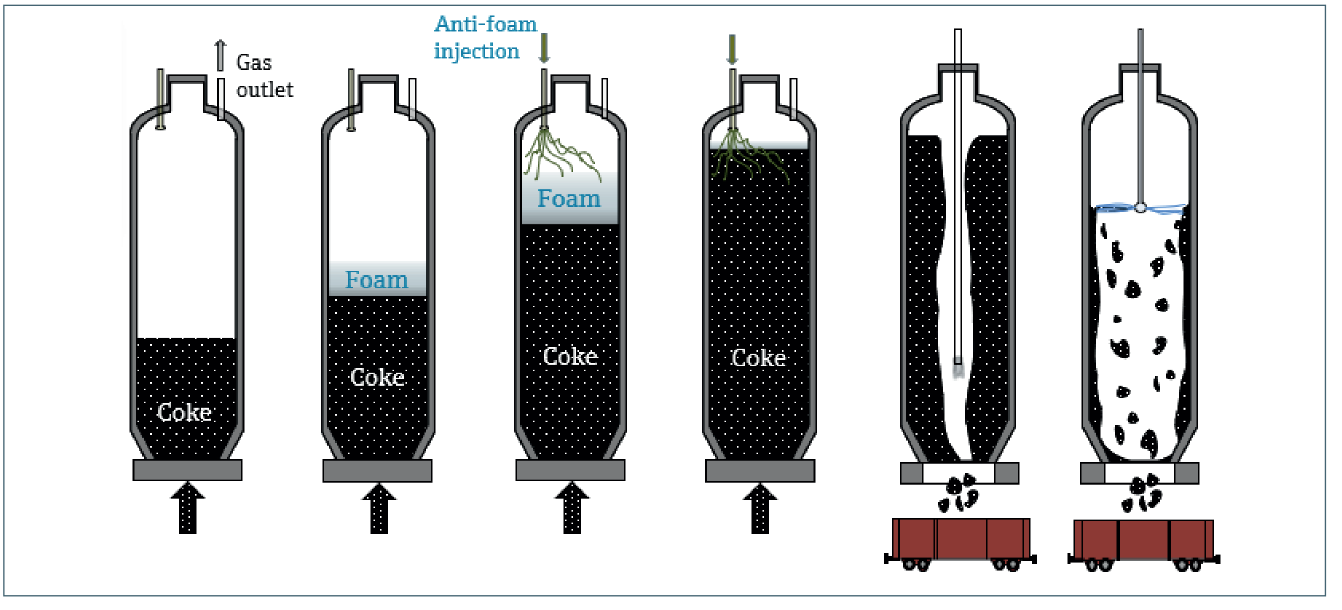

Figure 1: From left to right:
A) Filling of crude B) Formation of foam C) Anti-foam injection D) Coke filled up to setpoint E) Fracturing of solid coke.
F) Hydraulic cleaning of solid coke

What are delayed coker units (DCUs)?

A coker unit converts the residual oil in a refinery into low molecular weight hydrocarbon by a thermal cracking process. One of the most prevalent methods of coking is the delayed coking where large drums (with diameters ranging from 6 metres (20ft) to 9 metres (30ft)) are filled with residual oil and heated to a thermal cracking temperature of about 500°C (932°F). The storage in large drums provides the long residence time which is needed to allow the cracking reactions to proceed to completion.

When cracking takes place, the lighter hydrocarbon gets converted into vapour and separates from the liquid and solid. The solid remains, known as coke, is left behind in the drum. The emergence of vapours from the crude, leads to formation of foam on the top of the medium. Several other factors like temperature, pressure, filling rate and composition of crude also affect the formation of foam.

It is very important that the foam does not reach the gas outlet or 'foam over' does not occur. To counter this, anti-foam agents, typically compounds of silica, are injected from the top so that only coke is left behind in the drum. Once the coke reaches a predetermined level, the process is stopped, and flow is diverted to another drum to maintain a continuous operation. The full drum is then steamed to strip out uncracked hydrocarbons, cooled by water injection, decoked by mechanical or hydraulic methods and the solid coke is collected from below.

Measurement challenge in a DCU

- Process temperatures up to 500°C (932°F)
- Foam and build-up formation
- Ambient temperatures higher than 60°C (140°F)
- Long measuring range

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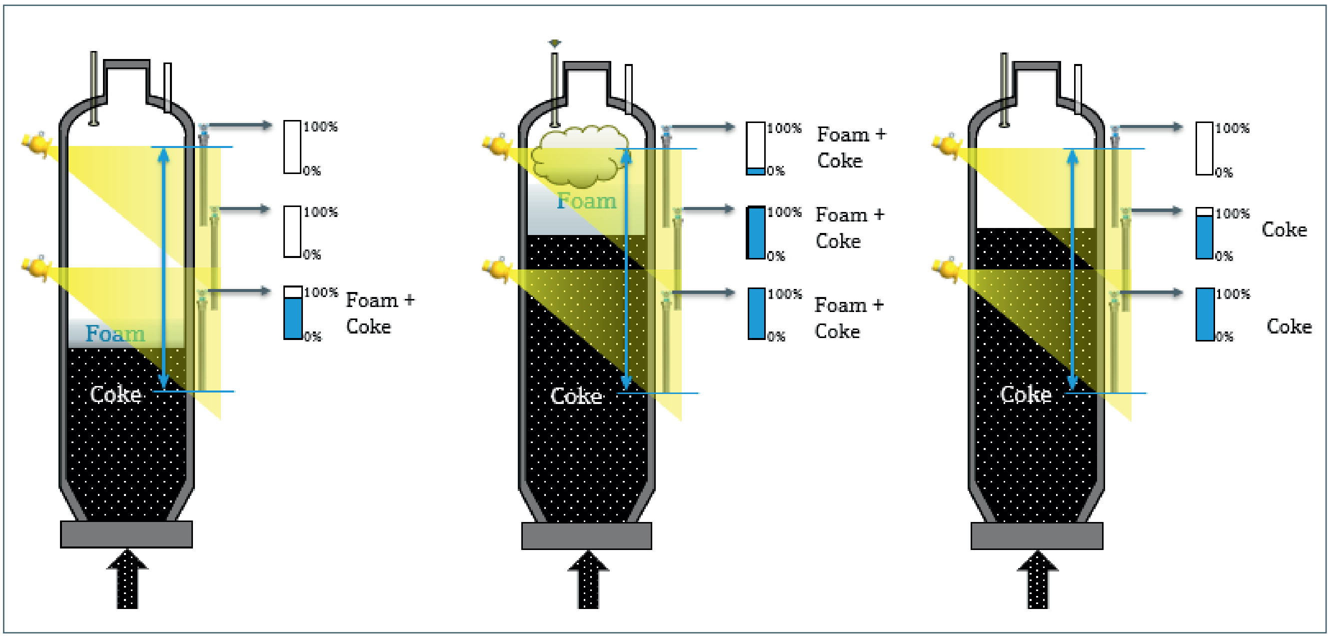

Figure 2: From left to right:
A) Filling of residual crude B) Injection of anti-foam C) Actual coke level

Optimizing anti-foam injection while monitoring level

Radiometric level measurement from Endress+Hauser offers the perfect solution to monitor the level of the residual crude while monitoring the impact of anti-foam injection. A typical solution consists of two/three radioactive sources contained in a source container mounted on one side of the drum while up to several detectors are mounted on the other side of the drum to monitor the level. When the detectors are connected individually to the DCS, the impact of anti-foam injection can easily be visualised. Figure 2 illustrates the effect.

During the filling process, the detector initially shows the coke and foam level. In the above scenario, in case A, the lowest detector shows a 90% level to indicate the coke and foam level. As the filling continues, the height of the medium increases and reaches the defined setpoint. At this moment, the anti-foam agent is injected. For example, in case B, when both the lower and middle detector indicate 100%, the setpoint is reached and the injection starts. Now the effect of anti-foam can be easily seen on the DCS screen in case C as the level shown by the middle detector starts decreasing as the foam, which was absorbing all the radiation is now reduced.

This process can be repeated and when there is no further decrease and the total level reaches 100%, the filling is stopped and switched to the second drum. The same behaviour can be seen in figure 3. When detector 5 reaches the setpoint, anti-foam injection starts. This leads to a drop in level and the process is iterated again in some time. Once Detector 6 reaches the setpoint, 100% level is reached, and filling is stopped. It is important to note that such a system can only be achieved when the detectors are connected individually to the DCS and **not summed or cascaded together**.

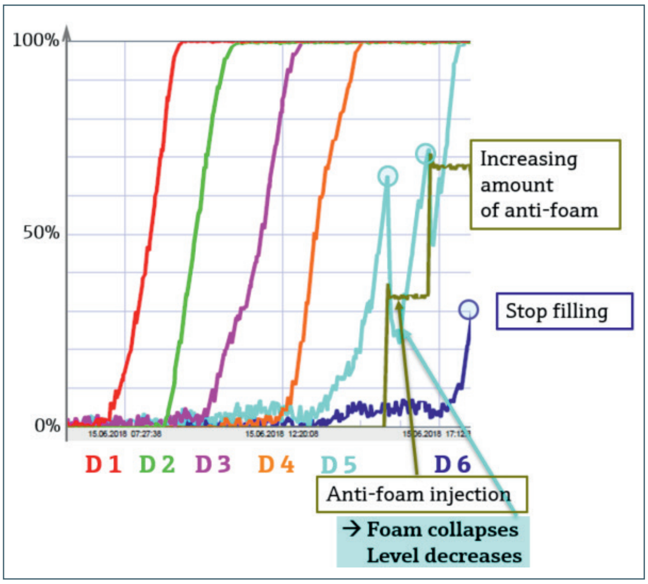

Figure 3: Snapshot from DCS at a refinery in Germany: Output of the 6 detectors (D1-D6) starting with the lowest detector D1.

Running out of parts for your Neutron Back Scattering System (NBS)?

- With the continuous radiometric level measurement, a plant operator can visualize the efficiency of the anti-foam dosage. Unlike the NBS, which provides level at some pre-defined points with high foam density (and with high hydrogen content), the radiometric measurement gives a continuous information of the top of the foam layer across the height of the drum.
- Contrary to the radiometric technology which measures across the diameter of the vessel, the NBS system only measures on one side of the wall. Non-uniform level profiles across such large drums cannot be detected by an NBS.
- Also, the NBS system employs GM tube sensors which are 10 times less sensitive than the current scintillator technology. That means the source activity can be reduced to less than half of the current activities employed in NBS systems.
- Having replaced numerous NBS system in delayed coker units around the world, Endress+Hauser can help you to modernize your coke drum. Feel free to contact your local Endress+Hauser office.

With Endress+Hauser's latest radiometric detector, Gammapilot FMG50, the measurement in a coke drum gets easier and even more intuitive. A quick overview of the advantages of the Gammapilot FMG50 are listed here:

Gammapilot FMG50 – Savings for you

- First 2-wire loop-powered compact transmitter - CAPEX savings up to 800 EUR (900 USD) on cabling and power consumption compared to a 4-wire device.
- Heartbeat Technology Monitoring allows better downtime planning thanks to predictive data like expected source operating time and sensor lifetime which are easily readable from the device
- ***Bluetooth***® Technology for easy access to the device, out of the radiation beam.
- Increased Proof test coverage thanks to the extremely low failure rate of 23 FITs.
- Innovative sensor technology for the use without additional water cooling for ambient temperatures up to 80°C (176°F) ensures reduced installation and operating costs of up to 3,000 EUR (3,400 USD).

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