Safety Considerations on FCC Valves Design

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Icebreaker: Fill the knowledge gap!

Friedrich Engelhorn (1821-1902)
Founder of Badische Anilin und Soda Fabrik

Marcel Bich (1914-1994)
Founder of Société Bic

If you can correlate those two objects, then you are older than you think.

IMI Critical Engineering

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Are you getting the most out of your FCC? Let’s REdefine the possibilities.
FCC Plants Safety Issues
Concerns and Countermeasures
Two of the major FCC incidents happened in the USA in recent years gained a lot of attention in the worldwide community: End Users, Process Licensors, EPC, OEM.

The two events happened in Torrance (California) on February 2015, and Husky Superior (Wisconsin) on April 2018.

Just like any similar issue, in both cases a single cause cannot be identified, but rather a complex chain of events that finally lead in both cases to a major explosion of the FCC plant.

However, a common root cause in Torrance and Husky events consisted in a flow bypass across a fully closed Slide Valve (not from IMI).
Is the FCC Slide Valve a Tight Shutoff Device?

NO.
- All Process Licensors do not specify any leakage class for FCC Slide Valves.
- The extreme temperatures, the thermal gradients across the internals, the harsh environment require some mechanical clearances between sliding components.
- A typical gap is around 1.5mm value for an average size Slide Valve, actual value depending on disc width.
- It’s very difficult to estimate the actual catalyst flow rate across a closed Slide Valve, as this value is strongly dependent on the catalyst self-flow/build up capabilities, which in turn may change with temperature, steam contents, etc.
Is there is a gap in the FCC Community?

Licensors & OEM

- The Valve is not TSO.
- Catalyst barrier is not guaranteed for long times.
- Erosion plays a major role and may greatly degrade the valve “sealing” performances.
- It’s very difficult to diagnose valve conditions during service, only catastrophic erosions may be detected by correlating Stroke vs Pressure Drop.

(some) Operators

- The Valve is TSO.
- Catalyst barrier can be indefinitely guaranteed.
- Plant Safety Operational Procedures assume that Air Side and HC sided can be kept separated by a Catalyst Barrier for an unspecified amount of time.

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How can we fill the gap?

- We can fill this gap using:
  - “Catalyst Tight” Slide Valves
  - Flue Gas Isolation Valves
  - Erosion Monitoring Technologies
  - Revised safety SOPs
Catalyst Tight Shutoff Slide Valves

- Dual Disc Slide Valve:
  - Two overlapping disc in series, one for control and the other for shutoff only. It would require two actuators, and a bulkier and more expensive valve. Hard to be retrofitted in existing FCC units.

- Wedge Design Slide Valve
  - One disc only, with a wedge system that engages only in overlap range (valve closed). Can be potentially retrofitted in existing units.
Wedge Design Slide Valve Internals

Seal between Stellite surfaces

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Video of Wedge Seating Stroke

Are you getting the most out of your FCC? Let's REdeFINE the possibilities.
IMI (Remosa and Z&J) has in its portfolio Special Valves specifically designed to:

- Isolate Fractionator from Reactor
- Isolate Turbo Expander Upstream & Downstream lines
- Isolate ESP, Scrubbers, CO Boilers
• Designed to prevent coking of the internal working components.
• Protecting seats from Erosion & Coking while the valve is in the open position.
• Double Block & Purge Isolation to allow for the quick / safe installation of a blind.
• Typical mounting orientation – Valve: Vertical Stem, Line: Horizontal.
• Valves can range in size from 6” to 100”.
• Materials of construction are based on customer specifications and design conditions.
• Cast refractory and/or erosion resistant lining can be used to further protect the valve body and throughway.

Are you getting the most out of your FCC? Let’s REdeFINE the possibilities.
Double Clapet Expander Isolation

- Class V Leakage.
- Double Block and Purge N2 positive Barrier.
- Patented Design.
- Slow operating time, not used for ESD.
- Large footprint, difficult to retrofit on existing plants.
- Low Pressure Drop.
Triple Offset Butterfly Valve

- Class V Leakage.
- Single Barrier
- Can be used in ESD
- Same footprint of a regular Class II Butterfly, no field modifications required.
- Low Pressure Drop, but in general is higher than a Double Clapet.
Whatever type of valve is used, no material is able to withstand Catalyst erosion for indefinite amount of time.

Eroded and worn out components shall be inspected and if needed replaced during every TA.

Except some cases (e.g. cold wall refractory on pressure boundaries), it’s **impossible** to monitor erosion inside the FCC units: Valves, Cyclones, Riser.

Well, actually now it’s possible!
The new IMI Remosa technology permits to monitor, in real time and non invasively, the erosion in refractory walls and abrasion resistant lining in the internals of FCC plants.

Are you getting the most out of your FCC? Let’s REdeFINE the possibilities.
System Architecture

1X16 Ch Optical Analyzer (ATEX certified)

- 16 1X128 Optical switches
- 16X2X60 interconnecting FO cables
- 32X60=1920 sensing probes

FO Patch Panel (60 channels.)
- 60 hermetically sealed FO
- 60 LC/APC FO connectors
- 60 Erosion Sensing FO
- 60 1/32 compression fittings
- 60 SS Probes OD 0.8mm
- 60 1/32 compression fittings
- 60 SS Capillary Tubes OD 1.2mm

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Conclusions

- Improved designs are available to decrease leakage on FCC Slide Valves, and to monitor erosion in real time.
- On the other hand, in the HAZOP of the FCC, the assumption that the Slide Valve is leak tight poses a safety issue.
- Improved safety SOP can be derived, taking into account the availability of isolation valves for Fractionator and Expander.
Thank you!