Sulfur Recovery & Tail Gas Treating Analyzers
The Normal, the Abnormal & the Paranormal

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13 October 2016
Analyzer Tags in the SRU/TGTU Process

13 October 2016
Part 1 / BTEX Analysis for Control of Co-firing

- BTEX (benzene, toluene, ethylbenzene, xylene)
  - >700 ppm in the amine acid gas (AAG)
  - >50 ppm leaving the reaction furnace
  - Results “carsul” formation and severe deactivation of catalyst

- Co-firing of natural gas to maintain reaction furnace temperatures > 1,050-1,080 C destructs the BTEX
  - Practical but has a considerable operating cost if continual

- BTEX values in the AAG >700 ppm are mostly short lived
  - Background values vary according to process conditions

- Xylene is the worst contributor to catalyst deactivation
IPS-4 Full Spectrum analyzer
- Developed for Superclaus “ABC+ feed forward control
- Combination of UV & IR
  • IR for total hydrocarbon for feed forward control
  • UV to speciate the BTEX

Heated Acid Gas (HAG) Probe
- Provide for it at FEED phase
- Install at EPC phase, savings is huge
- Future analyzer is the simple part
Design Case Gasco Habshan 5 Plant

- FEED had nominal 0.1% (1,000 ppm) BTEX in base case
  - On-line analysis was not provided for
  - Soot and carsul deposits on the catalyst were evident
  - Minimum reaction furnace temp of 1,050 was established utilizing co-firing of natural gas

- After initial quantification of the cost of co-firing an on-line BTEX / total HC analyzer was considered important enough to implement immediately

- Gasco, AIMS & Ametek worked closely and quickly to install the analyzer
Fourteen Day Trend of BTEX
Transient BTEX Spike to 929 ppm on Aug 11

Graph showing BTEX concentration levels:
- 800 ppm
- 600 ppm
- 400 ppm

The graph depicts a spike in BTEX concentration to 929 ppm on Aug 11.
## ACID GAS REPORT

**Report Date:** 16/01/2016

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Trends for BTEX, Toluene, Xylene (H₂S, CO₂, THC)

A  Green: BTEX
B  Blue: Toluene
C  Yellow: Xylene
D  Purple: H₂S
E  Red: CO₂
F  White: HC

800 ppm
600 ppm
400 ppm
Summary & Conclusions On-Line BTEX Analyzer

- On-line analysis of BTEX for control of co-firing is practical
  - Close relationship & onsite support from vendor is essential

- Quantifiable Benefits
  - $1.75 million/yr fuel savings, 12 wk payback based on this alone
  - Increased catalyst life
  - Consequential $CO_2$ reduction of 120,000 tons/yr

- Front End Engineering Design must provide for the sample connection in a proper location fitted with the HAG probe

- If co-firing is standard operating practice, install an analyzer
Part 2 / The Normal, Abnormal & Paranormal

- On-line process analyzers are “trusted” when providing predictable results and called into question when not.

- Tail gas analyzers exhibit a characteristic $\text{H}_2\text{S}/\text{SO}_2$ signature; any deviation is suspect and called into question.

- Other on-line analytical data runs very static and near zero; any deviation from zero is suspect and called into question.

- SO$_2$ breakthrough to the TGTU can be prevented, mitigated with a feed forward (total HC, H$_2$S) analyzer.

- Five case studies illustrating this……
SRU at Turndown (slow response vs plugging)

5:1 turndown
N-Gas Assist

10:1 turndown
N-Gas Assist

Plugging
SRU TAIL GAS ANALYSIS (Model 900 Air Demand Analyzer)
COS & CS₂ in SRU Tail Gas (Refinery)
Field Data / HC Process Upset

- H₂S swings from 83 to 87%
- THC = 0.02%
- THC = 0.25%
- 12 fold increase in THC from 0.02 to 0.25%
- lasting ~3 minutes
Effect of SO₂ Excursions on TGTU H₂

![Image of a metal component with various data points and labels]
TGTU (COS & H₂S) Steady State & Upset
Summary & Conclusions – Abnormal Results

- It is very rare for an analyzer to give a “false positive” result
  - *In particular* $H_2S/SO_2$ *in tail gas, when it is moving its working*

- Train operators on the chemistry & physics of SRU-TGTU
  - *There is generally a sound explanation, resolve it, build confidence*

- Instrument data sheets analyzer at the FEED stage
  - *Do not specify a range 2 orders of magnitude between the primary and secondary functions of a multicomponent analyzer*
  - *Consider the upset condition. Do not just set the full scale range at some random multiple of the normal value*
  - *Consult with the vendor, have a staff process analyzer specialist*

- Consider the utility of a feed gas analyzer to prevent $SO_2$ breakthrough to the TGTU