

Three stream online analyzer installation in HFA Unit

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HF Alkylation Unit @ Danure Refinery, MOL Plc.





Technological background 1)





Technological background 2)

Catalyst regeneration methods

Internal

- in case of acid water content below 1%
- by adding acid to isostripper feed

External

- in case of acid water content exceeding 1%
- by dedicated column and stripping

Neutralisation is a must in case of

Compound of polymers and acid-water aseotrope (CBM)

Acidic blow-off gases

Outlet of acid affected equipment



Hydrofluoric acid and HSE & Assets

Some details of HF safety card

The substance is a strong acid, it reacts violently with bases and is corrosive. Reacts violently with many compounds causing fire and explosion hazard. Attacks metal, glass, some forms of plastic, rubber and coatings.

INHALATION RISK:

A harmful concentration of this gas in the air will be reached very quickly on loss of containment.

EFFECTS OF SHORT-TERM EXPOSURE:

The substance is corrosive to the eyes, the skin and the respiratory tract. Inhalation of this gas or vapour may cause lung oedema. The substance may cause hypocalcemia. Exposure above the OEL may result in death. The effects may be delayed. Medical observation is indicated.





Process control background 1)

Two streams were formerly eqipped with online analyser

- Composition of the feedstock and the recirculated isobutene
- Energy efficient operation and proper product quality can be ensured as without online analysis
 - higher amount of isobutane should be recirculated to avoid sidereactions
 - unreactive n-butane has to be properly separated from isobutane



Process control background 2)

- Further measurement function became necessary
 - One of the most significant parameters is HF acid purity
 - It influences alkylate quality by the acid strength and consumption
 - Water content of acid highly influences corrosion issues of the unit
- Lab measurement of acid properties w/o online analyser
 Sampling realized manually by unit operators
 - Analysis realised traditionally in the laboratory by lab operators
 - It means HSE issues during sampling, transportation and analysis
 - Accuracy of this method is influenced by the sampling and analysis
 - Correct data acquisition requirements can hardly be achieved



Process control background 3)

Two-stream online analysis had been ensured by a gas chromatograph 1997



Instrument type (Hartmann&Braun – Optichrome Advance) reached manufacturer's obsolete status without any support and spare parts



Special sample conditioning system construction and age of instrument caused maintenance costs



MOL decided to upgrade and extend online measurement HF Acid online analysis defined as a must



MOL decided to replace



Basics of (HF) measurement by near-infrared spectroscopy

- The sample is analyzed using a Fourier Transformed Near Infrared (FT-NIR) analyzer
- Sends the modulated source light through fiber optic cables connected to a remote sample cell installed in a sample handling system No indirect physical sensors are applied, result are generated by model based mathematical estimation
- The spectrum covers all possible chemical components in the HF acid including HF, Water, Polymers, Additives, ASO, normal and iso-butanes, olefins and other hydrocarbons
- Each component has a unique signature on the spectrum
- FT-NIR is pre-calibrated with a universally applicable calibration which needs zero modification, as compared with inferential models for physical sensors which require Unit-specific re-training
- Results (phisically unmeasured values) by model based estimation (information received from spectral database)
- The spectrometer and PC can be located in a safe general-purpose environment.



Specification of solution installed @ MOL Danube Refinery

- 3 streams: HF, iC4, LPG/olefin
- Fiber optic based solution with remote sample handling
- Cabinet including spectrometer, PLC to manage SCS and data processing is located in control room
- 3 Sampling Conditioning System cabinets on field
- 🗲 Zone1 IIB T4
- Material of all HF acid wetted parts including SCS enclosures has to be Monel, Hastelloy, Teflon...
- MOL confirmed that NIR based C5+ measurement has reduced accuracy compared to chromatograph
- HF acid/water content and ASO estimation based on PLS (partial least squares) model
- iC4 and LPG streams estimation based on TOPNIR model (chemometric software to determine properties) providing so called aggregate values and uncertainty levels



Installed solution 1)

- Manufacturer and type: ABB
 FTPA2000-HP20
- 3 channels applied, free ones available
- Wash fluid are pentane and toluene
- Toluene has calibration function as well ("toluene shift")
- Vortex coolers for samples
- Flow control
- HF leak detection







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Installed solution 2)

- Software type FTSW100
- InGaAs detector
- SCS#1 HF stream: acid/water/ASO
- SCS#2 iC4 stream: propane, i-butane, nbutane, sum C5
- SCS#3 LPG stream: propane, i-butane, nbutane, sum C4, sum C5+









Installed solution 3)





Experiences of installation and operation 3)

- Fiber optic cabling had to be established with increased supervision and confirmed by vendor expert
- HFA unit experts defined a requirement to comply the 2015 UOP standard about tubing and wetted parts material in spite of projects specifitaiton to comply 2008 standard
- Finally installed material satisfies only 2008 standard as no source seemed to be available on market to comply 2015 standard
- HF acid stream model has been disfunctional for a few months period
- Further model updates in 2017
- Usually online analyser validation is based on lab measurements in MOL practice. LPG and iC4 measurements on NIR can only be validated on available GC data as there is no manual sampling
- Solution is running and ready for future developent and extension



Experiences of installation and operation 1)

NIR vs laboratory – HF water content





Experiences of installation and operation 2)

NIR vs laboratory – HF acid content • DHFAHAIB20_1A.PV | • DHFAHFE4_HELA | 97,08 % | • DHFAHFE4_HELA | 98,1 %(m/m) |





Thank you for your kind attention! Do you have any questions?

