KUWAIT 3RD FLOW MEASUREMENT TECHNOLOGY CONFERENCE

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إحدى شركات مؤسسة البترول الكويتية

A Subsidiary of Kuwait Petroleum Corporation

Importance Of Process Analytics In Custody Transfer & Flare Gas Applications

MANOJ KUMAR

Sr. Analyzer Engineer, EQUATE

About Speaker

- Over 25 years of professional experience in refining and petrochemical industries with roles in engineering design, maintenance, construction and commissioning.
- B.Tech Instrumentation and Control Engg.(India)
- Employed at EQUATE since 1996.
- Certified Six sigma Green Belt Project Leader.

Agenda

- About EQUATE Petrochemical Co.
- Quality Analysis In Custody Metering
- Custody Transfer Analysis - Case Study
- Common Issues – Custody Transfer Analysis
- Flare Analysis - Major Drivers & Challenges
- Flare Analysis – Case Study
- Automatic Validation Systems & Smart Sample Systems.

About **EQUATE Group**

The EQUATE Group* is a global producer of petrochemicals and the world's second largest producer of Ethylene Glycol (EG).

The Group has industrial complexes in Kuwait, North America and Europe that annually produce over 5 million tons of Ethylene, EG, Polyethylene (PE) and Polyethylene Terephthalate (PET). The products are marketed throughout Asia, the Americas, Europe, the Middle East and Africa.

The EQUATE Group's shareholders include Petrochemical Industries Company (PIC), The Dow Chemical Company (Dow), Boubyan Petrochemical Company (BPC) and Qurain Petrochemical Industries Company (QPIC).

The Group is a leading enterprise that pursues sustainability wherever it operates through partnerships in fields that include the environment, economy and society.

* The EQUATE Group includes EQUATE Petrochemical Company (EQUATE), its subsidiaries and The Kuwait Olefins Company (TKOC).

EQUATE Group at a glance

PROFIT

US$ 679 Million (2016)

PRODUCTS

PE / EG / SM
PX / BZ / HA / PP

EMPLOYEES

+1500 Employees

OPERATIONS

Kuwait, North America & Europe

AWARDS

National & International Awards

Providing **valued products** to the world

EQUATE Analytical Asset Base

Descriptions	Total
Analyzer shelters	35
Analyzer cabinets	12
Continuous Gas Analyzers	764
Gas Chromatographs	142
Gas Detectors	1400

Process Analytics

Efficiently monitor and control process parameters to achieve:

- Safety
- Regulatory compliance
- Quality

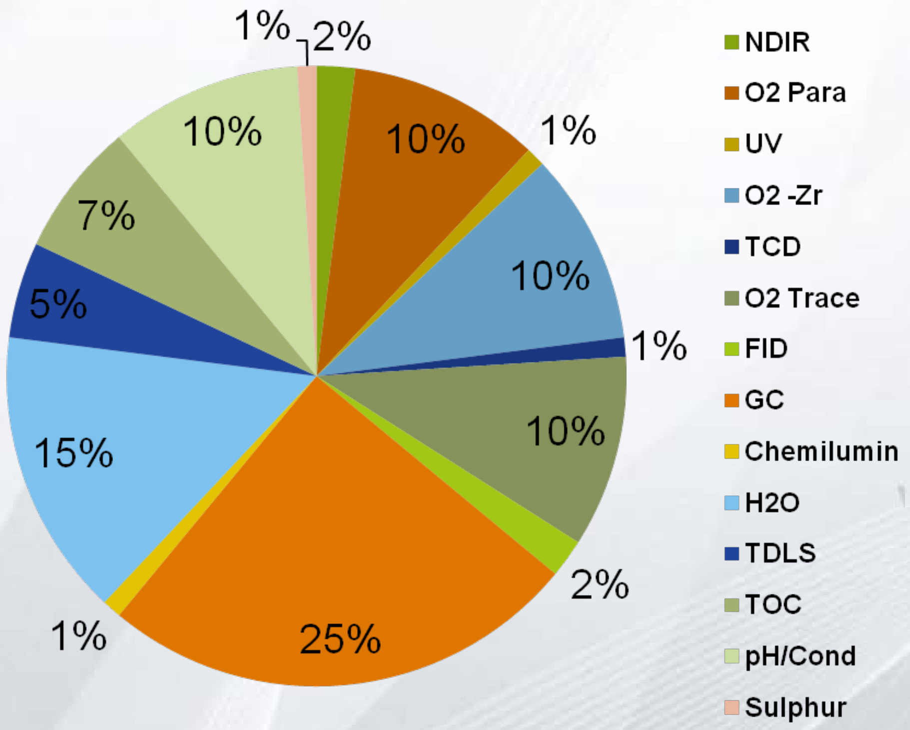
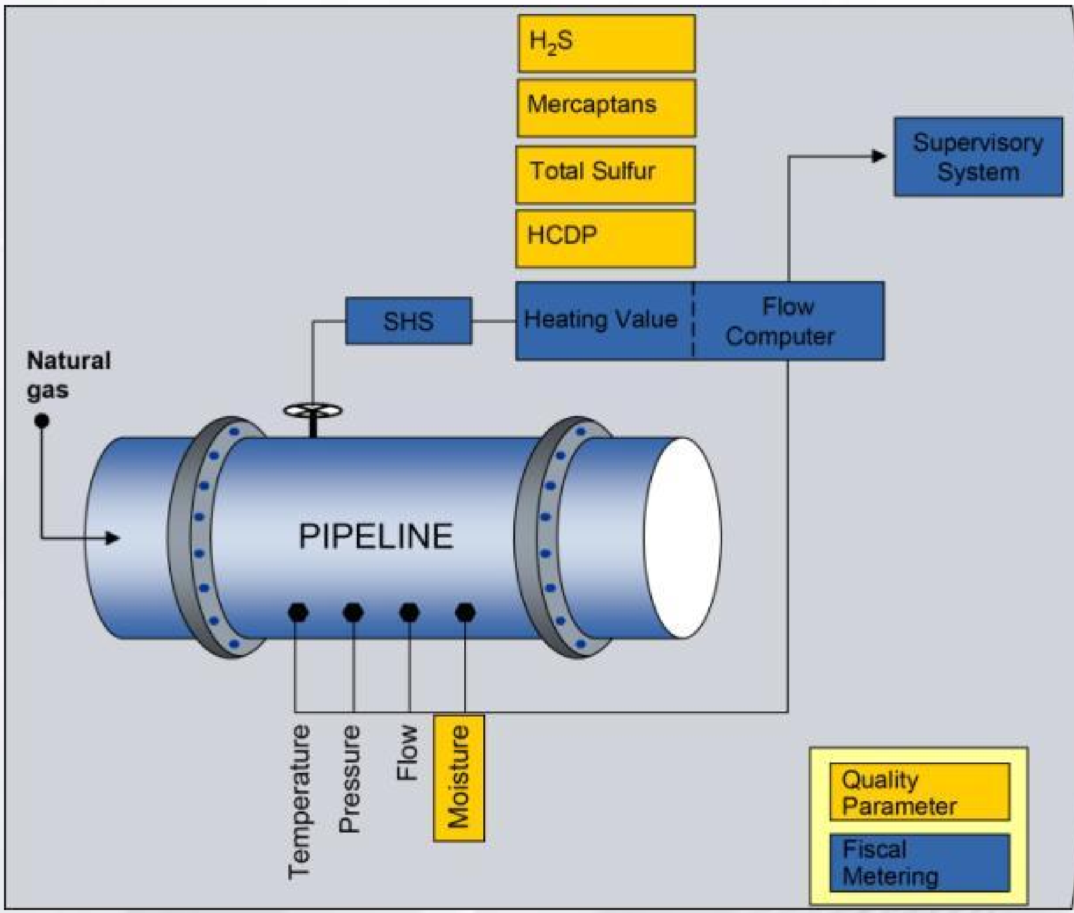


Fig: Typical Process Analyzer Distribution

Types Of Quality Measurement

- Gas chromatographic-CO_2 /H_2S/HC
- Tuned diode laser –TDL- O2/H20/H2S
- BTU analysis/Wobbe Index-CARI
- Sulfur-TRS
- Density
- Viscosity
- Moisture
- B S &W analyzer /water cut and more

Quality & Fiscal Measurements



- **Heating Value**
  - GC preferred for high volume flow
  - Gas quality analyzer optional for medium volume flow
- **H2S**
  - UV, TDLS, **GC**, Lead Acetate
- **Mercaptans / Total Sulfur**
  - UV, **GC**, Lead Acetate
- **Hydrocarbon Dewpoint**
  - Chilled Mirror, Quartz,**GC**
- **Moisture**
  - Chilled Mirror, Quartz, TDLS

Benefits Of Reliable Analysis

- Cost/Profitability
- Reliability of Up/Down stream equipment's
- Safety & Environment Regulatory compliance
- Quality

Value addition of Extended Analysis

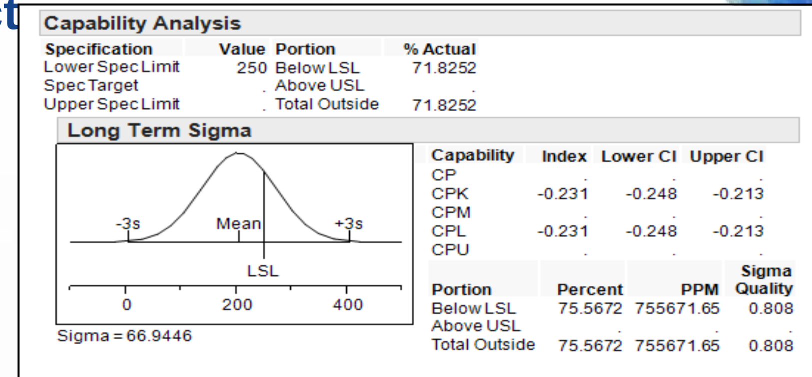
C_6+ Measurement	C_9+ Measurement
Heating value: 9,6919 kWh	Heating value: 9,6952 kWh
Price: 12 cent per kWh	Price: 12 cent per kWh
Volume: 10 million Nm³ per day*1	Volume: 10 million Nm³ per day*1
$\sum$ = 11630000 €	$\sum$ = 11634000 €

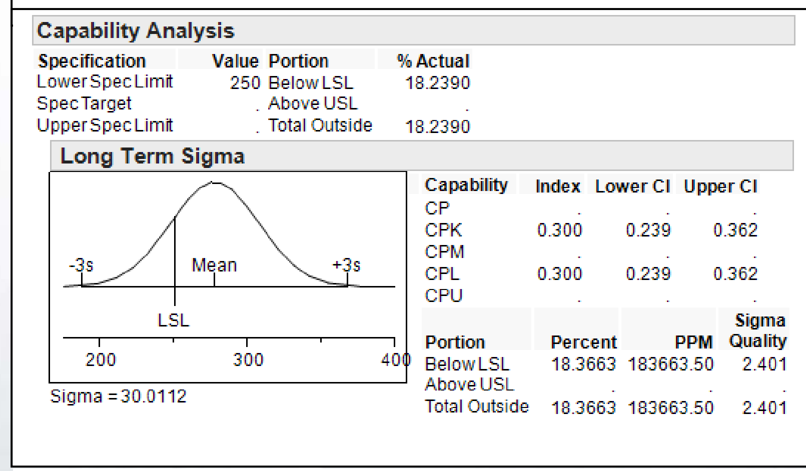
Extended measurement saves 4000 € per day !!!!

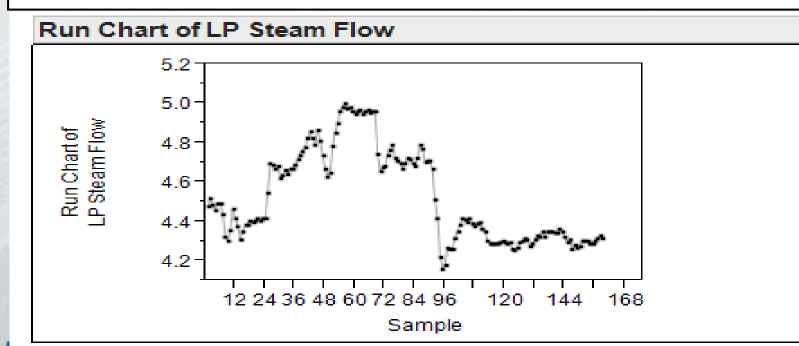
Case Study – Liquid Phase Custody Transfer

Reduction in over processing of final product

- ➢ **Project focused to optimize Product Specification Targets:**
  - Product water content spec is 400 ppm max.
  - Control limits Optimization 250 – 360ppm.
- ➢ **Profitability:**
  - Reduction of steam used to evaporate water to optimize product purity.
- ➢ **Improvements done for better analyzer reliability** :
  - Improved response time
  - Sample system improvement to avoid two phase sample
  - Calibration and validation methods.







Case Study – Gas Phase Custody Transfer

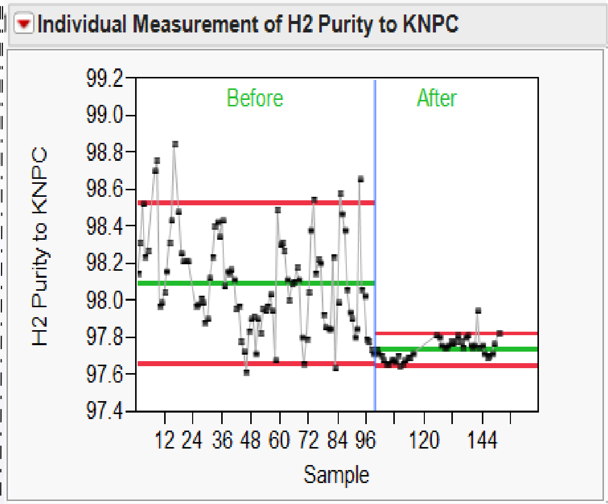
- **Project Opportunity**: Increase H_2 production by optimizing H_2 purity
- **Defect**: 97.5%<= H_2 Purity =< 97.9%
- **Process**: Ratio of bypass flow to total flow is calculated and controlled by ratio controller. Total flow is the sum of bypass flow and PSA feed flow. Product purity measured by GC.

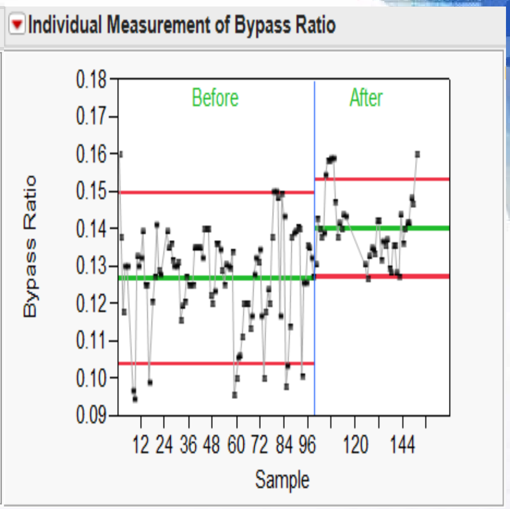
Risks Assessment

- Low H2 purity to customer< 97.0%
- Low FG production impacting FG Allocation

Benefits Assessment

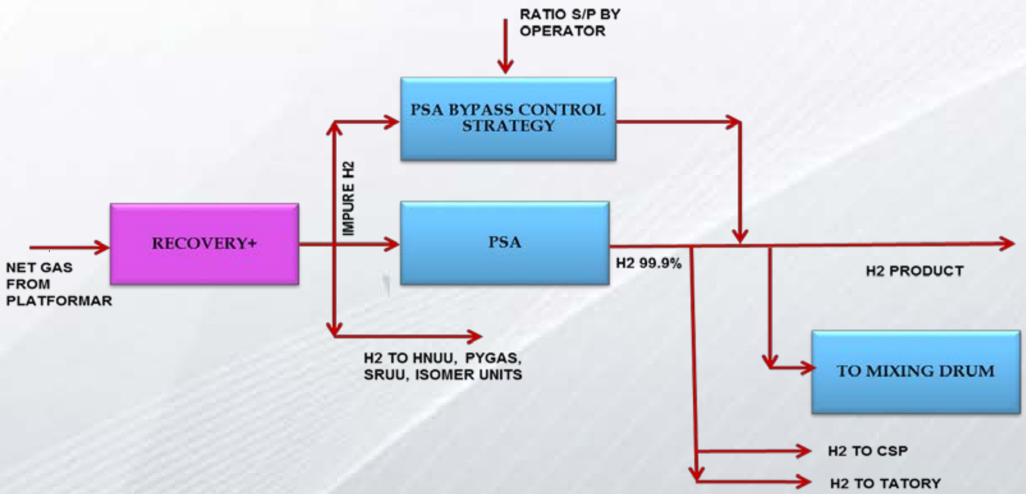
- More H2 production.
- Longer life of PSA adsorbent





Root Cause :

- Ratio SP not updated based on demand
- Unreliable analyzer performance
- Too much operator intervention to avoid flaring
- Variation in H2 purity from PSA
- Variation in customer header pressure
- Ratio/Flow cascade sluggish performance
- Plant load variation



Improvements done for better analyzer reliability :

- Sample system improvements to reduce uncertainty
- Robust analysis with Application change
- Additional analysis for early indicator of off spec product

Project Savings:

Hard Dollar : ~ xx MM$

Concerns In Custody Transfer/Metering Analyzers

- Installation Issues
- Improper Sample system design
- Calibration standard Inconsistency
- Operating Discipline

Flare Analysis

- **Major Drivers:**
  - EPA regulatory compliance requirement-40 CFR Part 60 subpart Ja- Emission reduction
  - Safety –Detonation
  - Cost –Quantification & combustion efficiency.
- **Parameters to be measured**
  - HC-H_2 content /O_2 content/ BTU content/H_2S-TRS/CO_2
- **Technologies for measurement**
  - GC/ TDLS/ Calorie meter /Sulfur analyzer- UV/Furnace

EPA Monitoring Guidelines

Gaseous Fuels and Natural Gas

Gaseous Fuel	Data Source	Analytical Method	
		Methode	Regulations
net calorific value	Own calculation on basis of the gas composition (typically by lab on online system)	Determination of individual components by gas chromatography and calculation from calorific values of gas composition.	Gaschromatography: EN 15984-2011 ISO6974 DIN 51872 Calorific Value EN15984 ISO 6974 DIN 51857 Performance Evaluation: ISO10723
Carbon Content	see calorific value	Determination of individual components by gas chromatography and calculation from carbon content of gas composition.	see calorific value EN15984
Biomass Content (biogene carbon content)	see calorific value	C14-Methode	see DIN CEN/TS 15474 (draft)
Emission Factor	Own calculation on basis of the analysis of calorific value and carbon content (ev. including biomass content)	Calculation of weighted annual mean value for specific load (charge)	$EF = \frac{C_{present} * 3{,}664}{Hu}$

- ISO 6974, DIN 51872 = Description of the measuring method gas chromatography (GC)
- ISO 6976, DIN 51857 = Calculation of calorific value and other physical properties
- DIN ISO10723 = Performance evaluation of gas chromatographs
- EN15984 = Measuring method GC and calculation parameters including carbon content for refinery heating gas

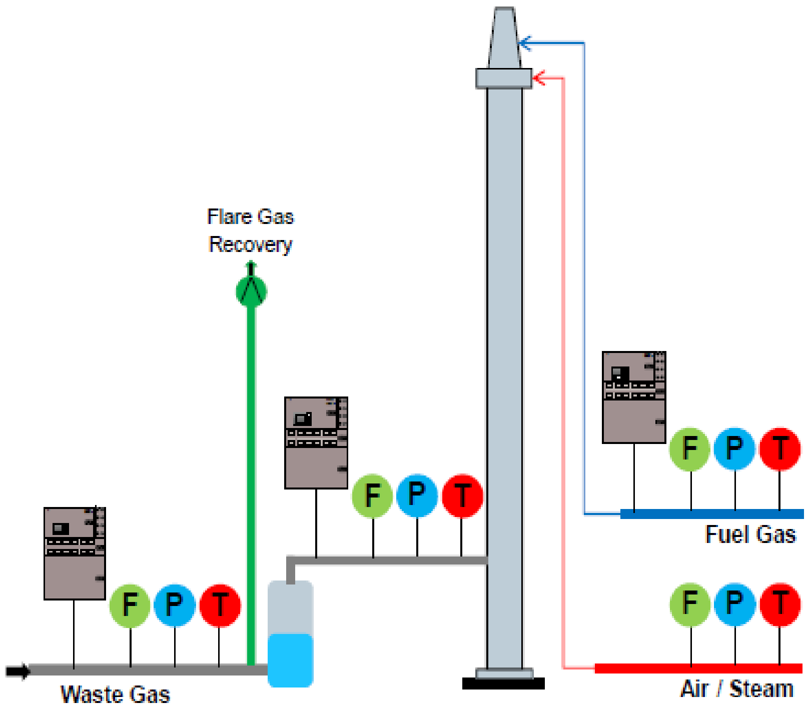
Gaschromatography is the recommended technology described in specific standards and norms

Environmental Protection Agency's (EPA) Clean Air Act

- Effective January 30th 2019, 40 CFR part 63.670 and 63.671 mandates to reduce toxic air emissions
- Install Control devices to ensure a minimum BTU value of 270 BTU/Scf.
- Prevent high penalties/NOV and Company image towards CSR
- 40CFR60 subpart Ja – Hydrogen Sulfide- Limit the short-term concentration of H2S to 162ppmv in the fuel gas sent to flares during normal operating conditions.

Combustion Efficiency & Emission

Air/Steam	Combustion Efficiency Flare gas velocity	T, P, F
Fuel Gas	Pilot Light ensure minimum BTU Heat Value, Emission	T, P, F Analytics
Waste Gas	Waste Gas emission Heat Value, Emission	T, P, F Analytics
Recovery	Return to process Heat Value, Emission	T, P, F Analytics



Safety

Infiltration of air into flare stack may lead to a flame flash back resulting in detonation.

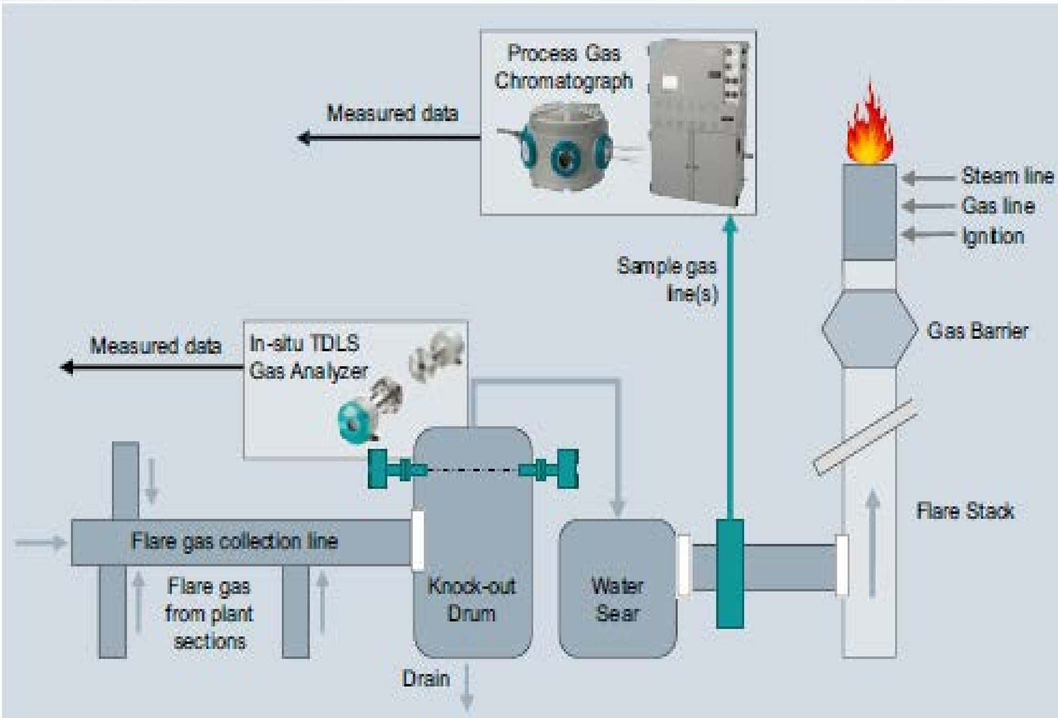


Fig. 3: Flare gas monitoring (Siemens concept)

Cross interference Effect conventional O2 Analysis

Residual gas (concentration 100 % v/v)		Zero deviation in % v/v O_2 absolute
Organic gases		
Acetic acid	CH_3COOH	-0.64
Acetylene	C_2H_2	-0.29
1,2 Butadiene	C_4H_6	-0.65
1,3 Butadiene	C_4H_6	-0.49
iso-Butane	C_4H_{10}	-1.30
n-Butane	C_4H_{10}	-1.26
1-Butene	C_4H_8	-0.96
iso-Butene	C_4H_8	-1.06
cyclo-Hexane	C_6H_{12}	-1.84
Ethene	C_2H_6	-0.49
Ethylene	C_2H_4	-0.22
Dichlorodifluoromethane (R12)	CCl_2F_2	-1.32
n-Heptane	C_7H_{16}	-2.4
n-Hexane	C_6H_{14}	-2.02
Methane	CH_4	-0.18
Methanol	CH_3OH	-0.31
n-Octane	C_8H_{18}	-2.78
n-Pentane	C_5H_{12}	-1.68
iso-Pentane	C_5H_{12}	-1.49
Propane	C_3H_8	-0.87
Propylene	C_3H_6	-0.64
Trichlorofluoromethane (R11)	CCl_3F	-1.63
Vinyl chloride	C_2H_3Cl	-0.77
Vinyl fluoride	C_2H_3F	-0.55
1,1 Vinylidene chloride	$C_2H_2Cl_2$	-1.22

Residual gas (concentration 100 % v/v)		Zero deviation in % v/v O_2 absolute
Noble gases		
Argon	Ar	-0.25
Helium	He	+0.33
Krypton	Kr	-0.55
Neon	Ne	+0.17
Xenon	Xe	-1.05
Inorganic gases		
Ammonia	NH_3	-0.20
Carbon dioxide	CO_2	-0.30
Carbon monoxide	CO	+0.07
Chlorine	Cl_2	-0.94
Dinitrogen monoxide	N_2O	-0.23
Hydrogen	H_2	+0.26
Hydrogen bromide	HBr	-0.76
Hydrogen chloride	HCl	-0.35
Hydrogen fluoride	HF	+0.10
Hydrogen iodide	HI	-1.19
Hydrogen sulphide	H_2S	-0.44
Oxygen	O_2	+100
Nitrogen	N_2	0.00
Nitrogen dioxide	NO_2	+20.00
Nitrogen oxide	NO	+42.94
Sulphur dioxide	SO_2	-0.20
Sulphur hexafluoride	SF_6	-1.05
Water	H_2O	-0.03

Challenges

- Selection of technology
- Sample system design issues
- Automatic Validation
- Wide variability of concentrations quick variations

Case Study

Suspected O2 infiltration into Flare header

- There is no oxygen leak in the flare header, the problem is the type of oxygen analyzer that is installed in the flare header, it is effected by the presents of hydrogen.

Today we started removing the vent gas from the flare header and started to burn it in the styrene furnaces. The flare oxygen content went from .16% to 0.0% with in minutes of removing 90 % on the vent stream. We also know the vent stream has no oxygen in it, as there are 3 oxygen analyzers on this stream.

- Path forward is to replace this oxygen analyzer with one that is not effected by the presence of hydrogen.

- We are now in the process of reducing the huge amount of nitrogen we have had flowing into the flare header and we will reduce this down to the amount required by zeeco for the seal

- This is an excellent achievement in solving the problem. We all know how many man-hours have been spent on identifying and taking corrective actions to avoid process hazards.
- This brings to the another point that who looks into the analyzer specifications before selection and installation

Technology Expert

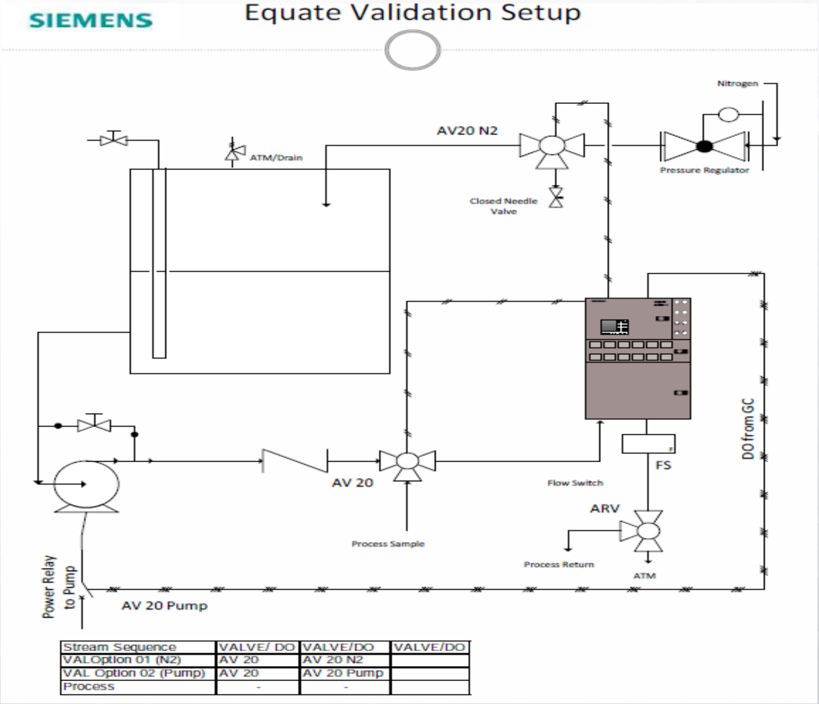
Process Safety Expert

Automatic Validation Systems

- ➢ Monitor , control and report analyzer performance
- ➢ Over calibration contribute to unstable process equilibrium
- ➢ Performance audit Increase confidence level for operations
- ➢ Indicates SQC , Availability , Maintainability

❑ <u>Case study for Glycol analyzers</u>

- Improve the MTBF of SIV seals
- Improved MOC of seal
- Introduce remote start/stop
- Introduce auto validation Scheme
- SMART sample system concept



Stream Sequence	VALVE/ DO	VALVE/DO	VALVE/DO
VALOption 01 (N2)	AV 20	AV 20 N2	
VAL Option 02 (Pump)	AV 20	AV 20 Pump	
Process	-	-	

Thanks for Attention