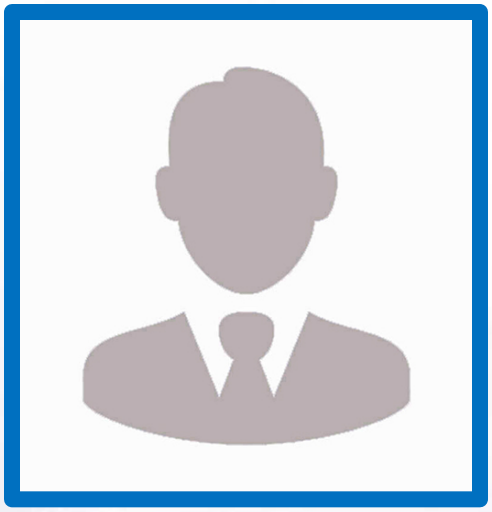
GAS CHROMATOGRAPH DESIGN AND OPERATION AT CUSTODY TRANSFER



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WHY GC REQUIRED FOR CUSTODY TRANSFER .

- Some Liquid Products are sold/purchased in volume and Some products are sold/purchased on Weight basis.
- Most of the gas products are sold and purchased on Btu basis.
- Gas is not stored and difficult to store and get the average sample . Historically sample is done once per shift or once per day .
- This often leads error in energy measurement and correction of the meter for correction .
- 1% ERROR can potentially cost

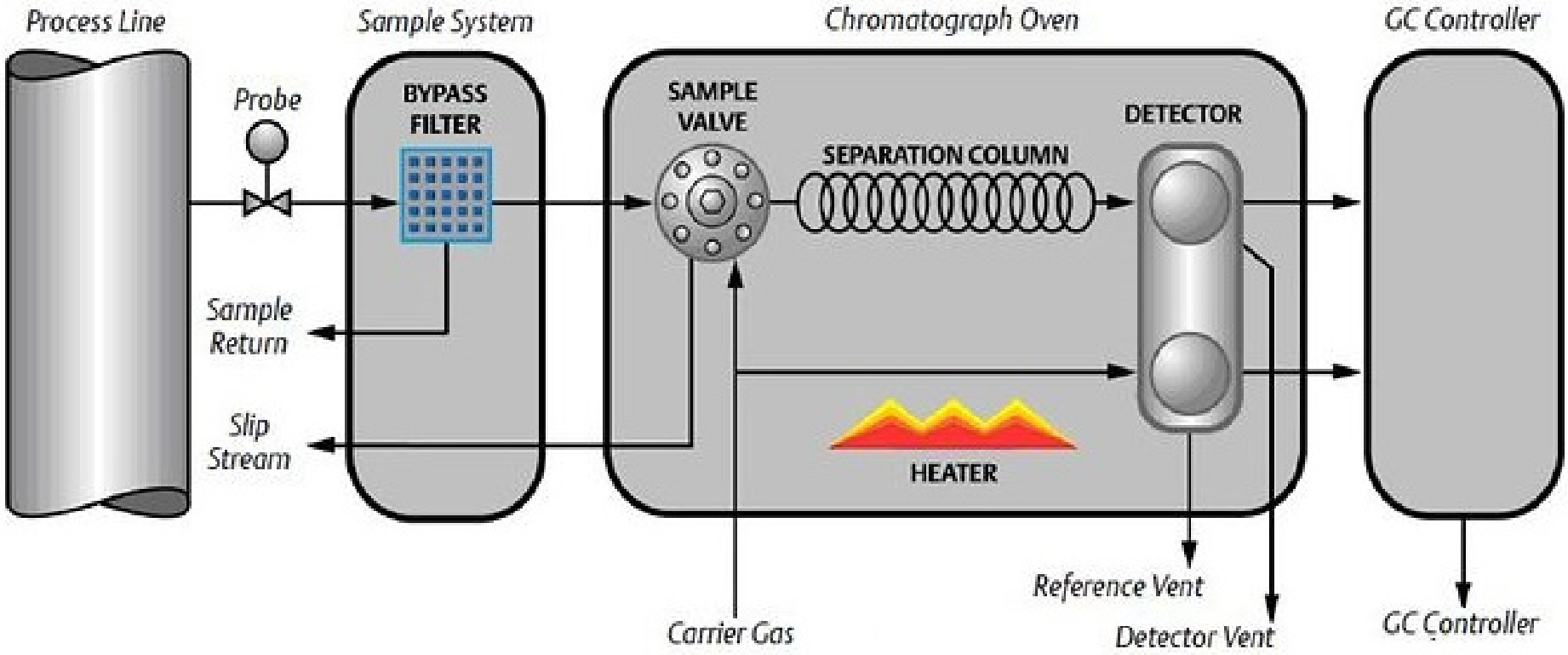
  =1600 MMSCFD*1200 BTU/SCF*8 $/MMBTUX365

  = 5.4 BILLION $/ANNUM*.01=54 MILLION $/ANNUM

USE OF GC IN CUSTODY METER APPLICATION

- On-line chromatographs are used to determine the individual components of a natural gas stream continuously .
- The individual components are then used to calculate BTU and Specific Gravity using GPA component data.
- The chromatograph Data is multiplied with flow rate data to calculate total energy value.

FUNCTION COMPONENTS OF GAS CHROMATOGRAPHY



FUNCTION COMPONENTS OF GAS CHROMATOGRAPHY

- Sample Handling Systems
- Chromatograph Oven
- Controller Electronics

	Lab 1	lab 2	Analyser
H2	0.0	0.0	0.000
H2O	0.0	0.0	0.000
N2	0.3	0.2	0.280
O2	0.0	0.0	0.000
H2S	0.2	0.2	0.200
CO2	1.0	1.0	1.000
CO	0.0	0.0	0.000
C1	73.3	73.2	73.290
C2	14.0	14.0	13.950
C3	7.9	7.9	7.850
i-C4	0.9	0.9	0.900
n-C4	1.9	1.9	1.900
i-C5	0.3	0.3	0.340
n-C5	0.2	0.2	0.240
C6	0.0	0.1	0.050
C7+	0.0	0.1	0.000
TOTAL	100.0	100.0	100.000
AVG MW	22.0	22.2	22.1
	1178.8	1187.4	1181.9
		0.729%	0.263%

- Joule Thompson effect (Condensation)
- Reference gas
- Base temp
- Dry basis
- H2S
- Neo pentane .
- Heavy component

Joules – Thompson Effect on Sample handling system

- Sample to be controlled typically between 15 to 30 PSIG
- Majority of application the sample will be at considerably higher pressures
- Joules – Thompson Effect : Temperature of the gas will decrease as the pressure is reduced.
- Cooling of natural gas is 7 DegF per 100PSI
- Some of the larger hydrocarbon components will begin to drop out of the gas phase into the liquid phase. The temperature at which this begin to occur is hydrocarbon dew point
- Temperature of the sample to be maintained at least 30 DegF above hydrocarbon dew point. Use of heated regulators , insertion regulating probes, heat traced tubing is used to overcome JT effect. Located inside the analyser house

Condensation of Reference gas

- What is TEMP in Kuwait
- 55°C to -3 °C ?

- What happens C5/C6 in these temp , Gas or Liquid?

- Reference gas contains larger hydrocarbon components will begin to drop out of the gas during winter.
- Leading to wrong calibration of analyser . Reference gas cylinder has to be heated . Or kept in controlled environment .

Base Temperature

- 60 ° F = 15 °C ?

- Adopting standards for calculation of volume and energy is very significant. One common mistake happened , suppose the contract agreement between the consumer and the supplier is 15degC as base temperature 14.696 Psia as base pressure, but for energy measurement it adopts GPA2172. GPA2172 table takes temperature of 60degF (15.56degC) and pressure 14.696 Psia. This different base temperature can result in energy measurement error upto 0.19%

Measurement Errors Due to Moisture

- The measurement of moisture content in natural gas is extremely important, from a technical perspective and in order to ensure conformance to contractual specifications.

- Typically, this measurement is one of the most difficult to perform successfully. Natural gas sources are generally dirty, corrosive, heavily moisture laden and at high pressure

- Prior to transportation, water is separated from raw natural gas. However some water still remains present in the gaseous state as water vapour

H2S

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- GPA standard also consider 0 Calorific value for H2S in the calorific value calculation. But many GC calculation are using calorific value of H2S .

Measurement Errors Due Analog to Digital .

- Many time signals travels in analog then converted to digital .
- These convertors have potential error due the following :
  - Analog is 4 to 20 mA
  - The analog signal have to be converted to digital by ADC. ADC will have several errors. The significant one is quantization error.
  - The errors are measured in Least Significant Bit (LSB).
  - For an 8 bit ADC , an error of one LSB is 1/256 of the full range , equivalent to 0.4%.
  - 12bit ADC will have an error of 0.024%
  - https://www.maximintegrated.com/en/app-notes/index.mvp/id/748
  - Hardware to be purchased with higher bit ADC ie. 12 bit , 16bit etc.

Measurement Errors Due to C6+ Measurement

- Most GC can analyse gas composition upto C6.
  But very little higher hydrocarbons C7, C8, C9 etc. can be find in natural gas.

- An availability of C7, C8 of 0.1mole% each and C9, C10 of 0.05mole% can cause a change in compressibility factor resulting in 0.056% reduction in natural gas volume.
  can cause a higher calorific value resulting in 0.466% increase in energy

- Normally C6+ is measured by GC. A fixed split ratio (based on gas analysis done in lab) can be introduced to reduce these errors.

CONCLUSION

	Issue	Solution
1	Condensation	To be avoided in the sample line and heater should be inside Analyzer house
2	Reference gas	It should be stored so that no condensation happens and quality is maintained . (Expected Error More than 1%)
3	Base temp	60°F is not 15 °C (Error .19%)
4	Dry basis	All custody transfer should have water measurement and composition to be adjusted.
5	H2S	H2S calorific valve should not be considered. (0.2% to 2.0%)
6		Analog and Digital conversion to be avoided. (0.4%)
7	Neo pentane .	Should be analyzed and used for calculation
8	Heavy component	C6/C7 in Stream can create huge Error. (Expected Error More than 1%)

Thanks for Attention