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Emerging Technologies…

Topics Of Discussion

- Analyzer Technology Review
  - Point and Open Path Detectors
  - Gas Chromatography
  - FTIR
  - Mass Spectrometry

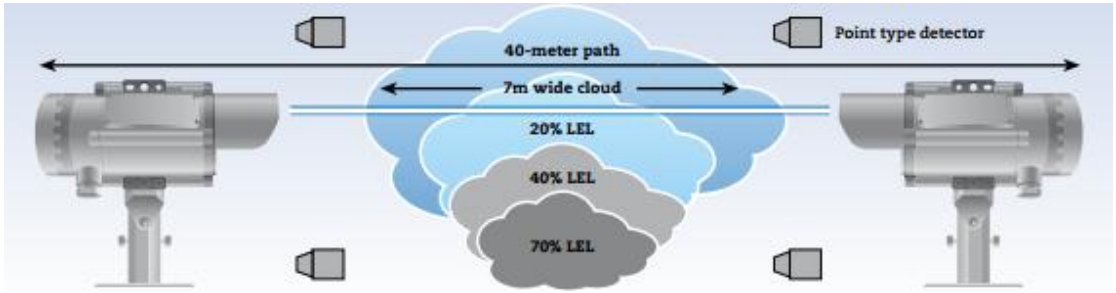
- Engineered Solutions &
  Sampling considerations

Why Continuous Analyzers?

- Once a leak-tight plant has been established routine labour intensive leak detect & repair (LDAR) procedures can be reduced or eliminated in many cases
- Improvements in measurement technology allow for detection capabilities down to parts per trillion concentrations:
  - 1 ppm: 1 minute in 2 years
  - 1 ppb: 3 seconds in 100 years
  - 1 ppt: 3 seconds in 100 000 years

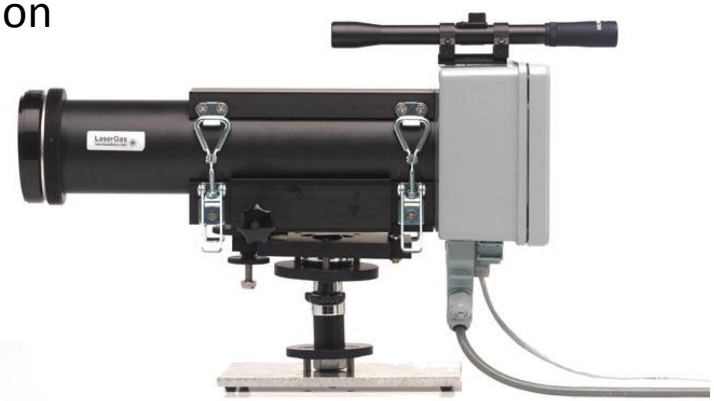
Traditional Point & Open Path Technology

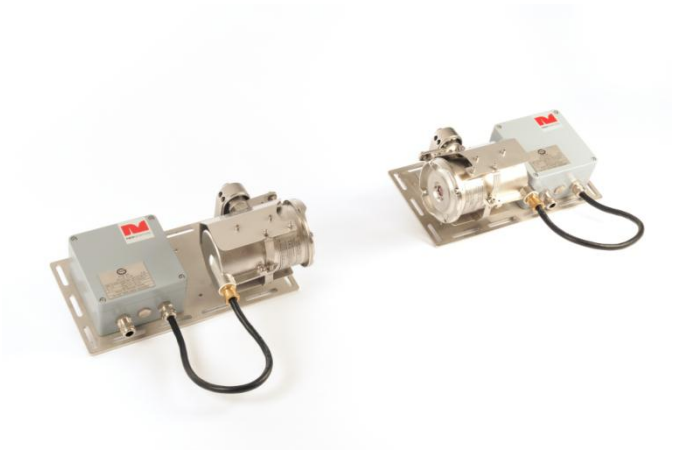
- Low Cost
- % Detection Levels
- Non-specific hydrocarbon response



Open Path TDL

- Long measurement paths up to 1 Km
- Very specific detection to gas of interest
- PPM/PPB levels of detection

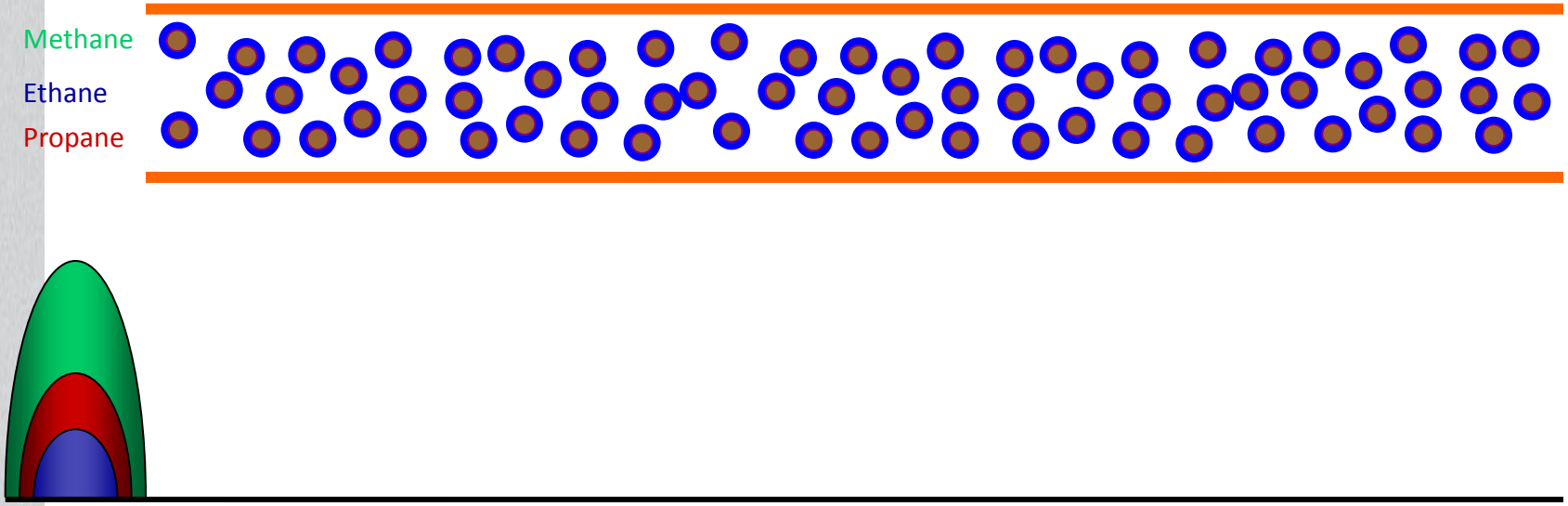




Gas	Range	LDL/resolution
NH3	0-50 ppm	0.01 ppm
HF	0-1 ppm / 0-10 ppm	0.001 ppm
CO	0-50 ppm / 0-2%	0.015ppm / 0.005%
CH4	0-50 ppm / 0-5%	0.01 ppm / 0.01%
CO2	0-2%	0.005%
H2S	0-2000 ppm	0.5 ppm

Ugh…

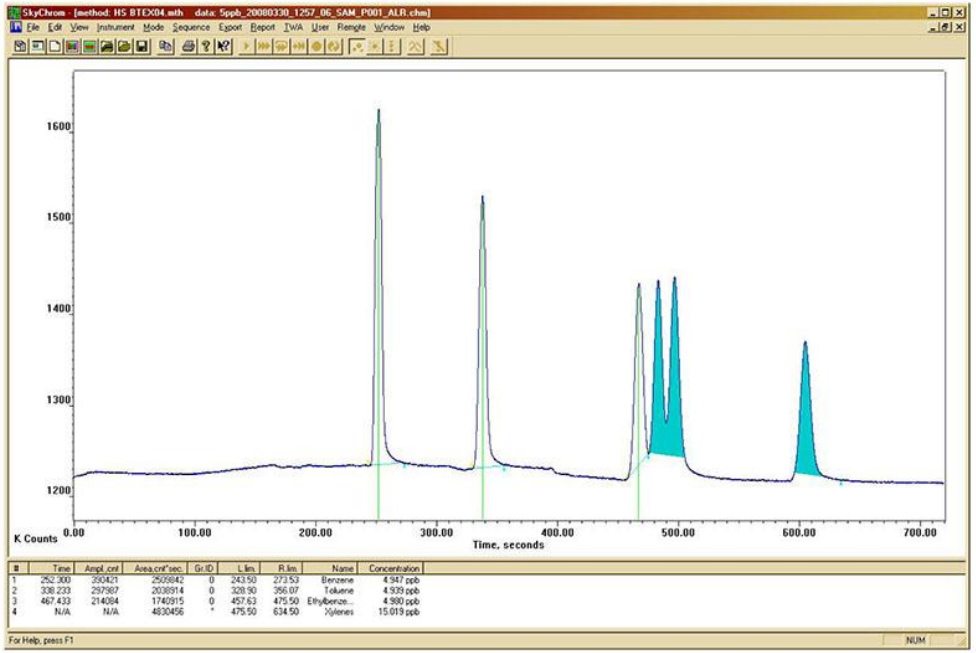
Gas Chromatography



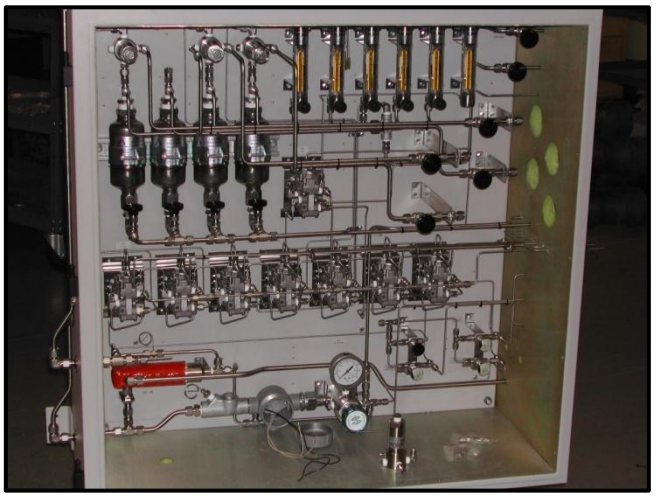
One at a time, each component leaves the Column and heads to the Detector for measurement

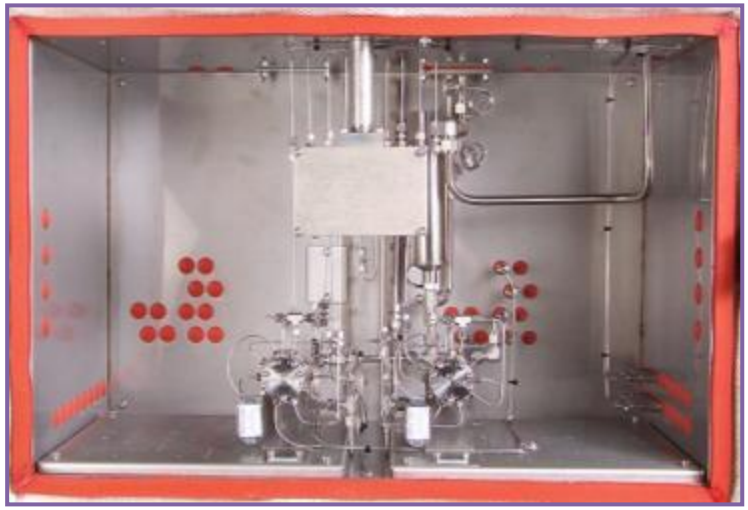
Rack-Mount Gas Chromatograph - FID/PID Detectors

- PPB/PPT detection levels
- General purpose, ambient air stations
- Longer analysis cycle times



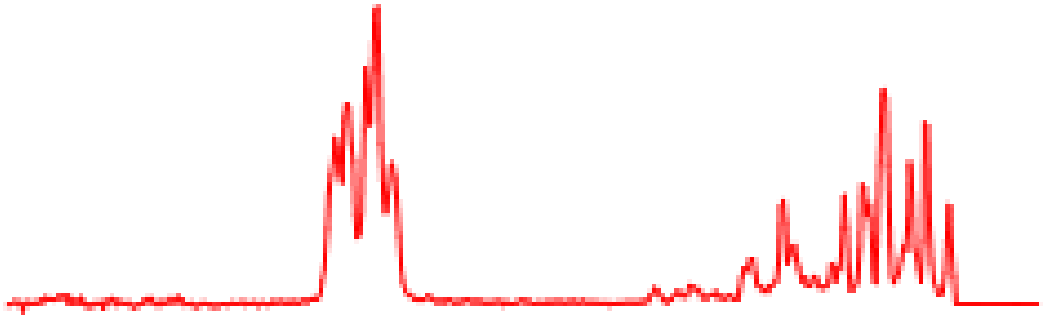
Process Gas Chromatograph – FID Detectors





- PPM Detection levels
- Parallel stream capability
- Longer analysis cycle times

FTIR



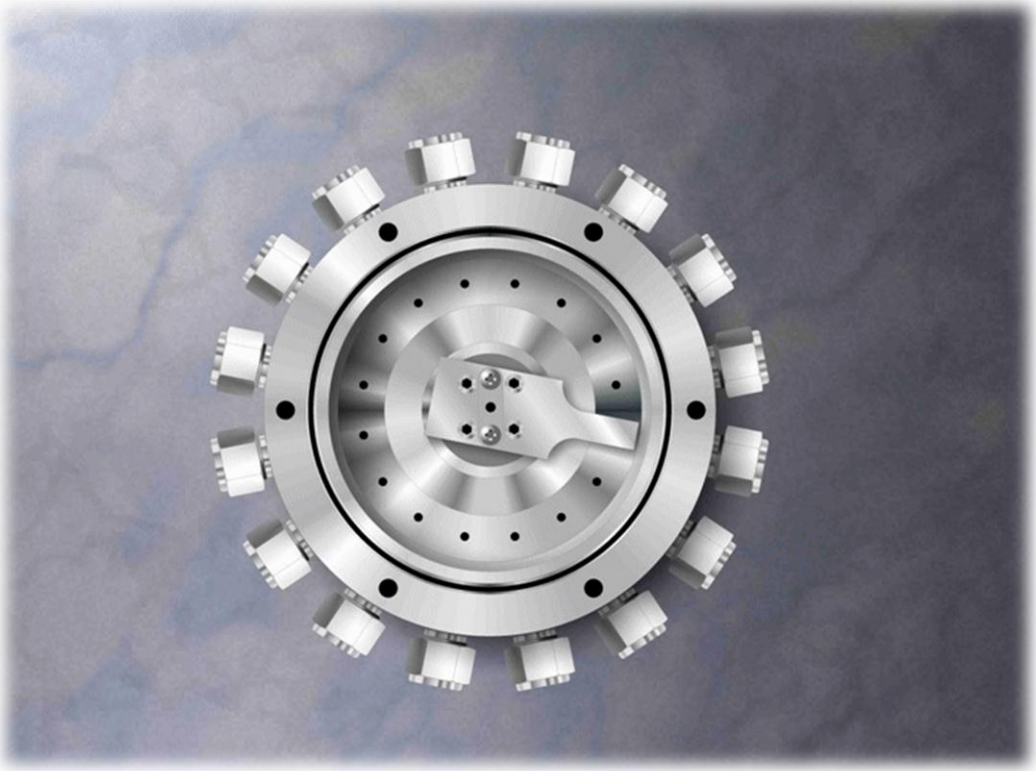
- Measures up to 50 compounds
- Can identify unknowns
- PPM Detection limits

For Example…

GASMET CALIBRATION COMPONENTS				GASMET CALIBRATION COMPONENTS			
Compound name	*CAS number*	*Maximum range*	*Unit*	*Compound name*	*CAS number*	*Maximum range*	*Unit*
Carbon dioxide	124-38-9	30	vol-%	Styrene	100-42-5	500	ppm
Carbon monoxide	630-08-0	1	vol-%	Ethyl benzene	100-41-4	500	ppm
Sulfur dioxide	7446-09-5	2000	ppm	*m*-Xylene	108-38-3	500	ppm
Ammonia	7664-41-7	500	ppm	*o*-Xylene	95-47-6	500	ppm
Hydrogen chloride	7647-01-0	500	ppm	*p*-Xylene	106-42-3	500	ppm
Hydrogen fluoride	7664-39-3	100	ppm	1,2,3-Trimethylbenzene	526-73-8	500	ppm
n-Propene	115-07-1	200	ppm	1,2,4-Trimethylbenzene	95-63-6	500	ppm
1-Butene	106-98-9	200	ppm	1,3,5-Trimethylbenzene	108-67-8	500	ppm
Isobutene (2-Methyl-1-propene)	115-11-7	200	ppm	Propylbenzene	103-65-1	200	ppm
cis-2-Butene	590-18-1	200	ppm	Naphthalene	91-20-3	200	ppm
trans-2-Butene	624-64-6	200	ppm	Methyl ethyl ketone (MEK)	78-93-3	200	ppm
1,3-Butadiene	106-99-0	200	ppm	Methyl isobutyl ketone (MIBK; 4-Methyl-2-pentanone)	108-10-1	200	ppm
1-Pentene	109-67-1	200	ppm	Carbon disulfide	75-15-0	200	ppm
Isopentene (2-Methyl-2-butene)	513-35-9	200	ppm	Methylmercaptan (Methanethiol)	74-93-1	200	ppm
1-Hexene	592-41-6	200	ppm	Ethylmercaptan (Ethanethiol)	75-08-1	200	ppm
1-Heptene	25339-56-4	200	ppm	Dimethyl sulfide (DMS)	75-18-3	200	ppm
1-Octene	111-16-0	200	ppm	Dimethyl disulfide (DMDS)	624-92-0	200	ppm
1-Nonene	27215-95-8	200	ppm	Carbonyl sulfide	463-58-1	200	ppm
Benzene	71-43-2	200	ppm	Methylamine	74-89-5	200	ppm
Toluene	108-88-3	500	ppm	Ozone	10028-15-6	200	ppm

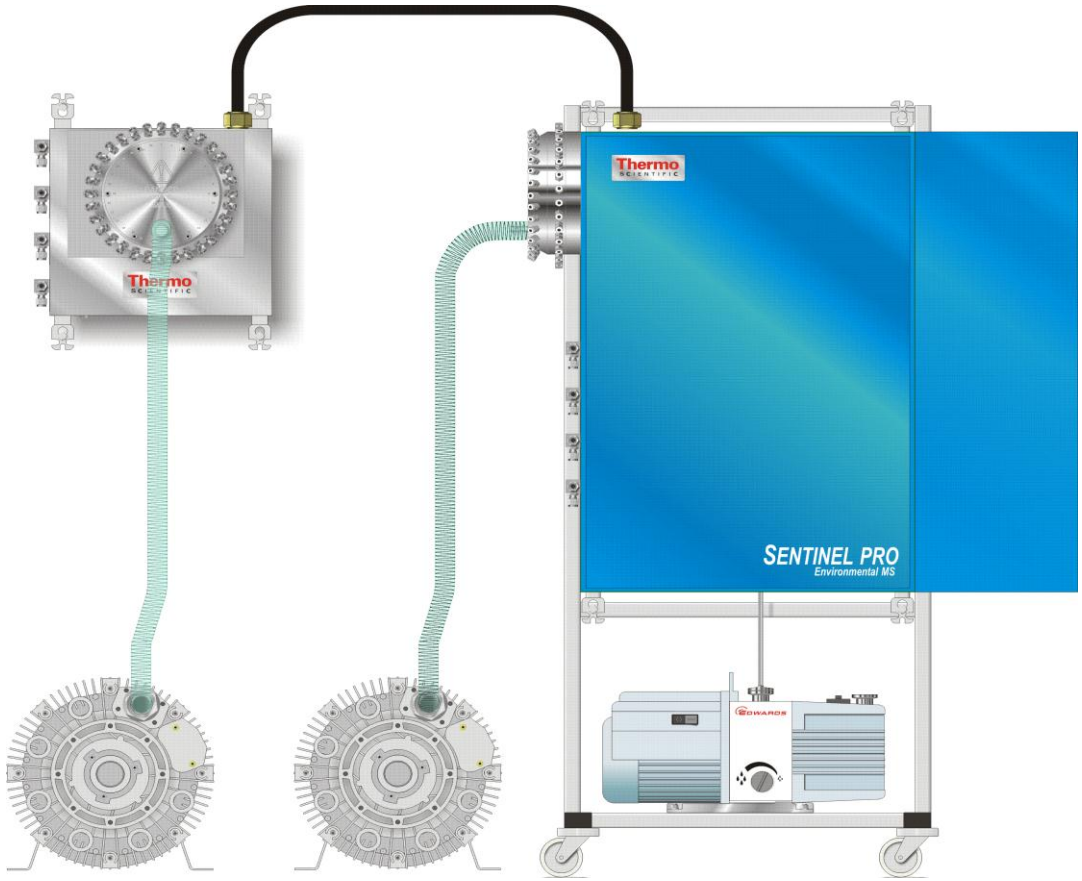
Mass Spectrometer – 64 Sample Points

- PPB detection levels
- High stability
- Fast Cycle time



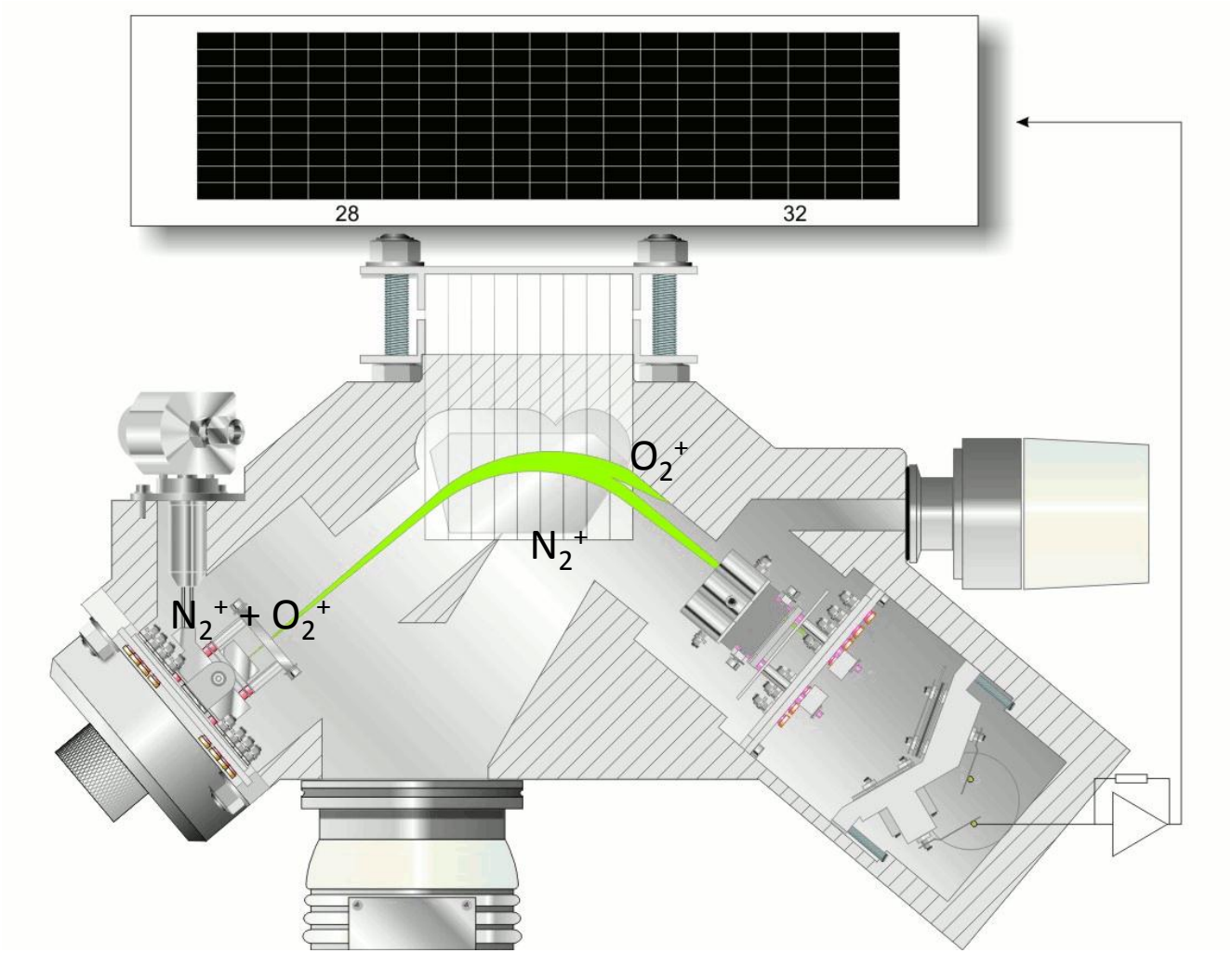
Mass Spectrometer -128 Sample points

Remember:
A Sentinel PRO can monitor about 100 streams within 15 minutes (which defines short-term exposure limit)

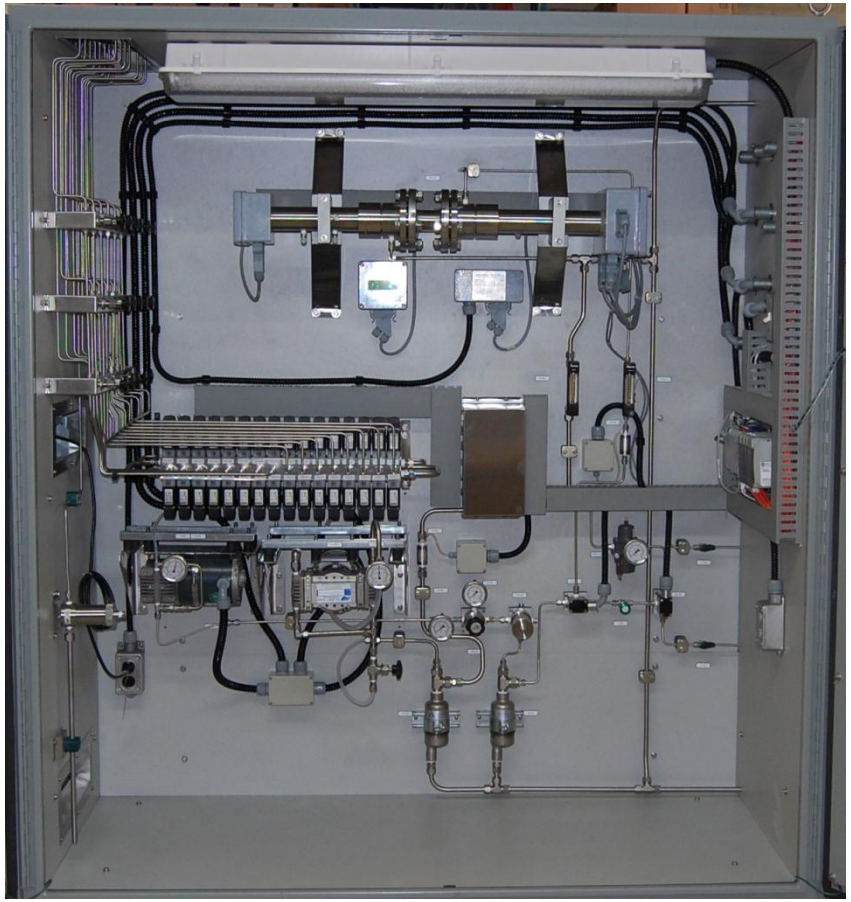


Mass Spectrometer

Magnetic sector principles of operation



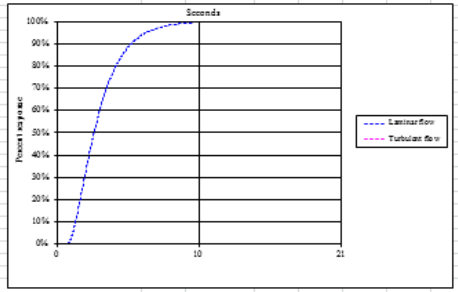
Engineered Solutions and Sampling considerations: TDL System



Reference:

LINES	Probe	Line	Bypass	Sample	
Relative roughness factor		1.5			x10-6
Length	0	0.1	3.0	2.0	M
Diameter (id)	7.6	4.6	4.6	4.6	mm
Pressure	1.00	1	1.00	1.0	BarrA
Flow	8	8	8	8	SLPM
Velocity	0.80	8.02	8.02	8.02	Mtrs-cond

SYSTEM COMPONENTS		Line	Bypass	Sample	
Filter		0	150	0	cm3
Analyzer				0	cm3
Other		0	0	0	cm3
Circuit volume	0.0	1.7	199.9	0.1	cm3
Specific volume	0.00	0.00	0.20	0.00	Litres
Circuit residence time	0.00	0.01	1.50	0.00	seconds
Dead time			0.75	0.00	
Analyzer	Response time T90			3	seconds
	Fundamental time constant			0.87	seconds
Pure dead time				0.75	seconds
Transitional		Max	Min		
System T90		#N/A		#N/A	seconds
System T99		#N/A	#N/A	#N/A	seconds
Display range	#N/A			10	seconds

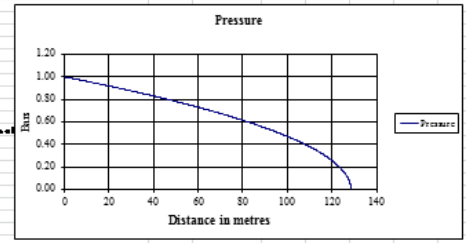


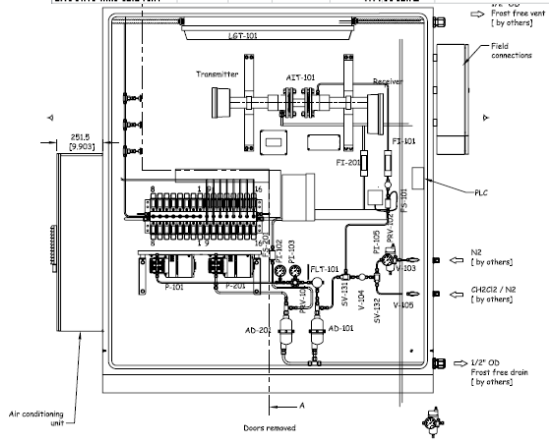
Analysis for: Apatox analyzer

Reference: 0

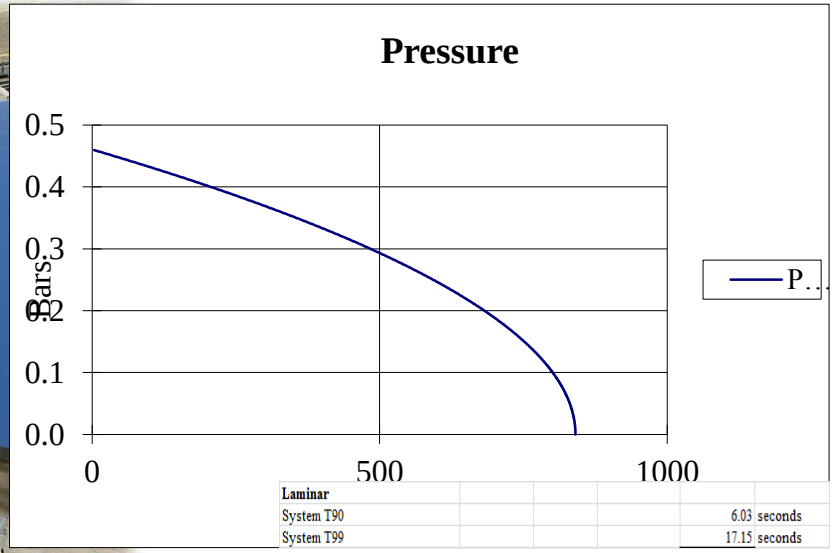
Temperature		25	°C
Viscosity	Mu	1.840E-05	kg/ms
Density at STP	Rho	1.1859	kg/m^3
Flow rate in normal L/min	qi	8.00	L/min
Inlet flow rate	Qi	1.33E-04	Nm^3/sec
Mass flow rate	M	1.58E-04	Kg/sec
Line diameter	Dia	4.60	mm
Cross-sectional area	A	1.66E-05	M^2
Relative roughness factor	e	1.5E-06	
Inlet velocity	Vi	8.0	m/sec
Reynold's number	Re	2378	**Transitional**
Friction factor	4f	0.0471	
Effective length		0.1	m
Design length		0.1	m
Final pressure		1.0000	Bars
Transit time		0.05	Seconds
Final velocity		8.02	m/sec
Dead time		0.05	seconds
Specific line volume		0.00	Litres
Effective time constant		0.01	seconds

Pressure drop analys Date 21-Oct-14

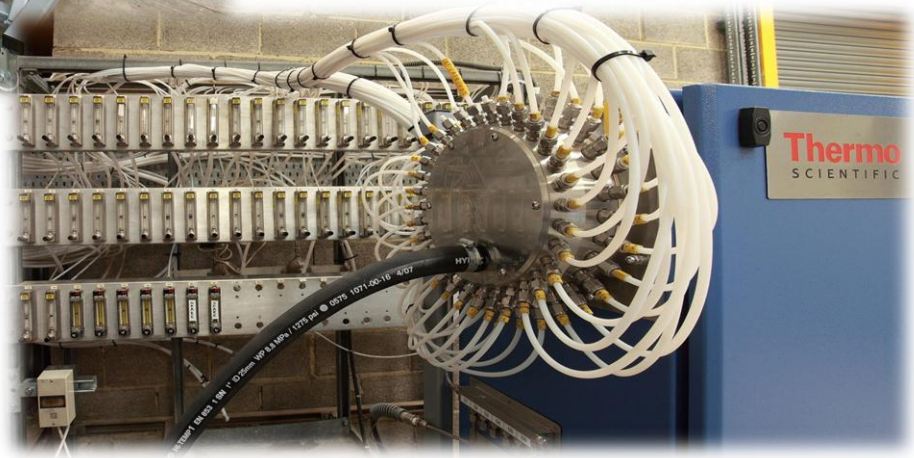




Engineered Solutions and Sampling considerations: Mass Spectrometer System



length	# points	accummulated run length	line ID in mm	Subtotals	design flow for 100 mBar drop	flows	T90 response time in seconds	T90 response time in minutes
100	47	4700	4.4	4700	3.3	155.1	37.5	0.63
150	43	6450	6		7.6	326.8	57	0.95
200	8	1600	6		5.7	45.6	79	1.32
250	10	2500	6	10550	4.6	46	123	2.05
300	1	300	10		12	12	165	2.75
350	2	700	10		12	24	193	3.22
400	4	1600	10		12	48	219	3.65
450	1	450	10		12	12	246	4.10
550	1	550	10		12	12	296	4.93
600	1	600	10		12	12	319	5.32
650	1	650	10		12	12	343	5.72
750	1	750	10	5600	11.8	11.8	398	6.63
						717.3		



Q & A