NON-TRADITIONAL METHODS OF VOC EXPOSURE ASSESSMENT

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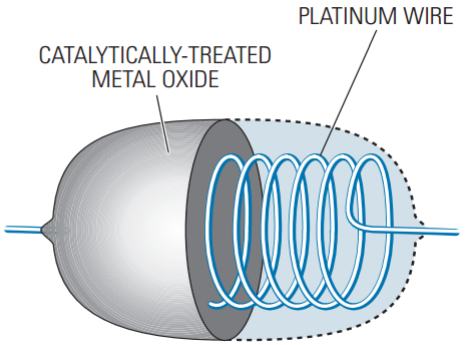
Personal Monitor – Real Time Detection Technologies

- Pellistor
  - The word "pellistor" is a combination of pellet and resistor
  - AKA Catalytic Bead Wheatstone Bridge, LEL

Understanding Pellistors

- Electric current is passed through coils
- Coils reach a temperature at which oxidation of gas readily occurs at the catalyzed bead (500–550 °C)
- The resistance is measured
- Flammable gas oxidizes/burns, changing the coil temperature and resistance
- The change in resistance produces a signal that represents flammability of gas



Making sense of LEL (pellistor) Sensor Response?

- A rule of thumb is to calibrate censor by the same gas it will be exposed to;
- The Sensor that is calibrated by Pentane will read (in ideal conditions) 10% LEL when is exposed to 10% LEL;
- Pentane LEL is 1.4% or 14,000ppm;
- 10% LEL is 0.14 % of Pentane or 1,400ppm;
- So, if we are exposed to pentane and the reading is 10% LEL we are exposed to appx. 1,400ppm of pentane;

Making sense of LEL (pellistor) Sensor Response?

- The sensor is calibrated by Pentane and being exposed to Methane
- Methane LEL is 5% or 50,000ppm
- Correction factor (if calibrated by pentane) is 0.5
- The instrument will show twice the real % LEL
- So, if we are exposed to 1000ppm (2% LEL) of methane, the instrument will read 4% LEL

Making sense of LEL (pellistor) Sensor Response?

- The sensor is calibrated by Pentane
  - 1,000ppm of Methane (2% LEL) will read 4% LEL
  - 1,000ppm of Ethane (3.3% LEL) will read 4.7% LEL
  - 1,000ppm of Propane (4.7%LEL) will read 6% LEL
  - 1,000ppm of Butane (5.5% LEL) will read 6.7 % LEL
  - 1,000ppm of Pentane (7% LEL) will read 7.1% LEL

Characterization of VOCs Exposure

	Stressor Concentrations MOLE% (VOLUME%)														
	Methane	Ethane	Propane	iso-Butane	Butane	iso-Pentane	Pentane	n-Hexane	other Hexanes	Benzene	Ethylbenzene	Toluene	m, p, o-Xylene	Other VOC	H2S; N2; H2S
	11.22	22.40	25.88	4.75	13.70	3.07	4.69	1.75	3.20	0.58	0.11	0.56	0.19	5.22	2.68
	12.66	27.20	29.28	3.94	12.15	2.82	4.24	1.26	2.27	0.32	0.01	0.13	0.03	1.49	2.193
	19.89	23.50	20.36	2.53	7.37	2.98	5.34	4.09	7.24	0.57	0.00	0.04	0.00	5.16	0.925
	18.34	22.64	29.26	4.08	12.02	2.08	2.59	0.50	0.81	0.06	0.01	0.14	0.03	1.63	5.812
	12.37	29.81	34.34	4.28	11.22	2.22	2.95	0.07	0.99	0.09	0.01	0.03	0.03	0.89	0.716
	27.34	23.62	23.10	3.22	11.86	1.96	3.32	0.55	0.36	0.04	0.38	0.04	0.02	0.89	3.294
	17.16	26.34	28.74	4.36	12.77	2.09	2.84	0.40	0.30	0.03	0.00	0.05	0.02	0.74	4.136
	28.35	23.47	20.85	2.71	8.99	2.12	3.59	1.67	2.36	0.49	0.07	0.54	0.08	3.51	1.227
	17.42	25.38	29.08	3.77	10.98	2.32	3.17	0.84	1.72	0.25	0.06	0.19	0.17	2.16	2.486
	26.46	23.78	22.13	3.00	9.21	2.45	3.67	1.31	2.42	0.35	0.02	0.20	0.04	1.76	3.2
	23.72	26.65	24.74	2.97	9.30	2.02	3.05	1.05	1.80	0.38	0.05	0.41	0.08	2.91	0.858
	16.66	24.22	28.72	4.25	14.89	2.34	3.11	0.55	0.38	0.04	0.00	0.04	0.01	1.53	3.251
	11.22	24.40	25.88	4.75	13.07	3.07	4.69	1.75	3.20	0.58	0.11	0.56	0.19	3.86	2.68
	17.31	26.44	26.05	4.12	13.76	2.98	4.05	0.81	1.37	0.17	0.02	0.17	0.02	1.21	1.537
	9.37	20.67	23.30	4.65	18.37	4.10	8.35	2.13	1.32	0.14	0.02	0.27	0.08	4.08	3.144
	16.81	28.56	25.36	3.86	11.71	2.54	3.90	1.15	1.80	0.33	0.06	0.25	0.10	2.27	1.318
	13.41	28.98	27.57	4.18	12.13	2.27	2.94	0.61	0.96	0.25	0.11	0.28	0.21	2.65	3.454
	25.33	24.21	23.01	2.84	9.91	2.45	3.61	0.98	1.93	0.30	0.05	0.16	0.12	2.01	3.094
	17.76	30.46	24.00	3.54	11.04	2.52	3.63	1.17	1.53	0.36	0.02	0.17	0.04	2.61	1.16
	16.82	32.40	25.83	3.61	10.09	1.89	2.49	0.46	0.72	0.13	0.06	0.12	0.07	1.03	4.291
# of Samples	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Mean	17.98	25.76	25.87	3.77	11.73	2.51	3.81	1.15	1.83	0.27	0.06	0.22	0.08	2.38	2.57

Making Sense of LEL Reading

LEL Reading is a function of:

- Concentration of the VOC mixture in the air
- VOC mixture composition
- Correction factor for each mixture constituents
- LEL of each constituency ppm

0.719	1.227	1.540	1.037	0.394	0.175	0.021	0.005	0.015	0.006	0.110
Total: 5.247 % LEL										

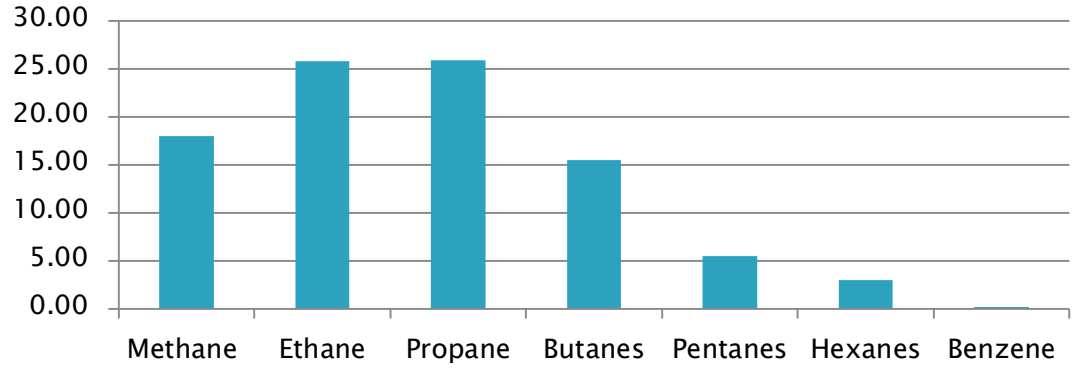
1000 ppm of VOC

Methane (%)	Ethane (%)	Propane (%)	Butanes (%)	Pentanes (%)	Hexanes (%)	Benzene (%)	Ethylbenzene (%)	Toluene (%)	m,p,o-Xylene (%)	Other VOC (%)
17.98	25.76	25.87	15.50	5.51	2.980	0.27	0.06	0.22	0.08	2.38

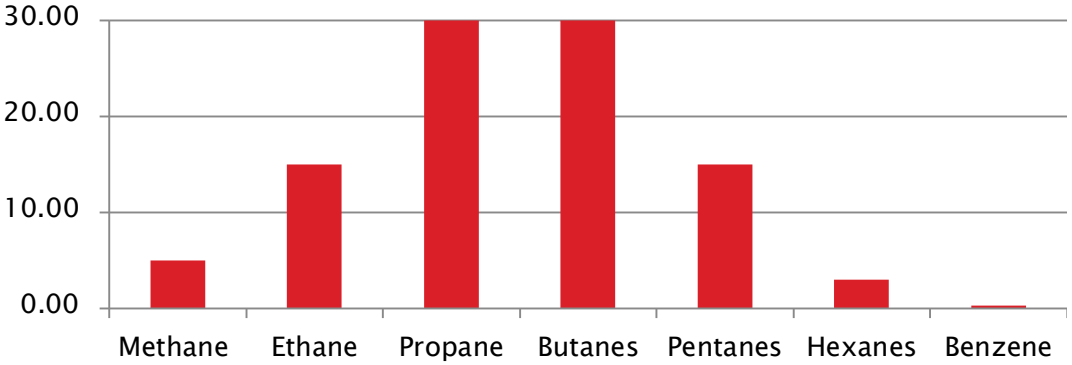
0.5	0.7	0.8	0.8	1.0	1.4	1.0	1.3	1.3	1.3	1.2

50000	30000	21000	18000	14000	12000	13000	10000	12000	11000	18000

% LEL Response to various gas composition

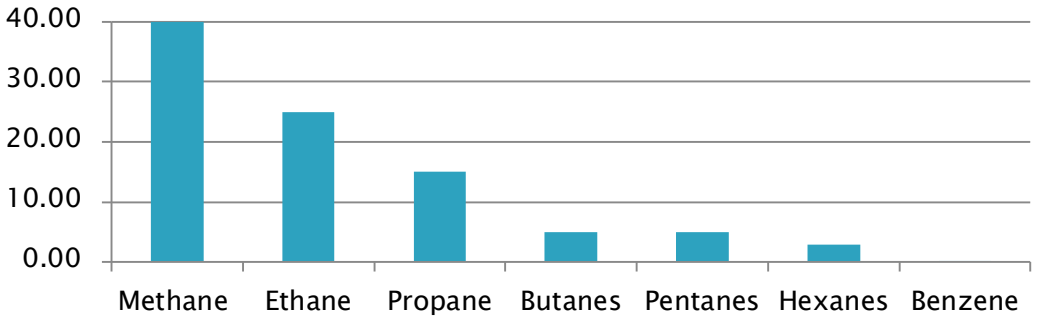


1000ppm- 5.25 % LEL



1000ppm- 6.11 % LEL

1000ppm- 4.71 % LEL

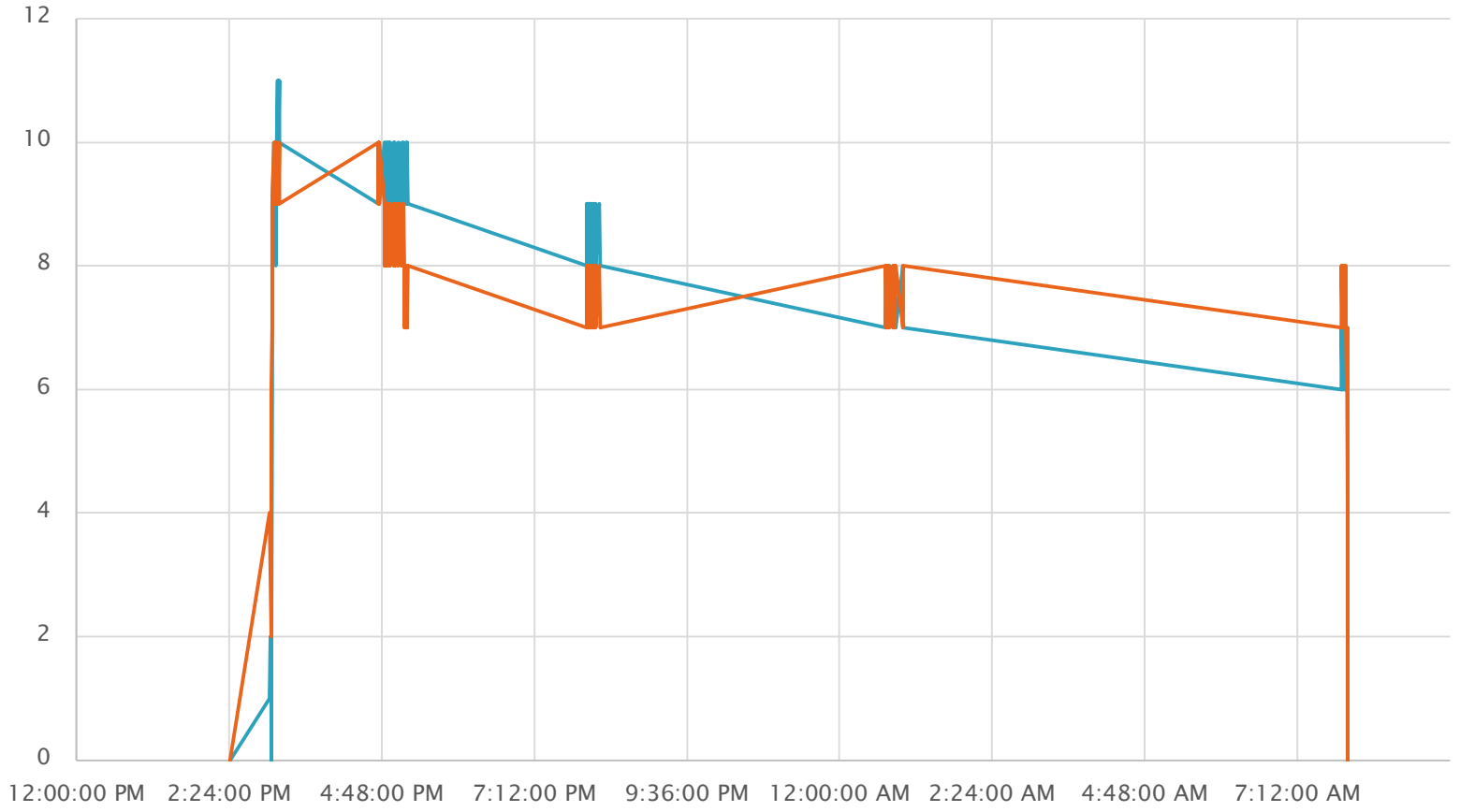


Experiment

Calculated LEL Sensor Response

VOC	Concentration (PPM)	LEL (%)	CF (by pentane)	LEL% (in the air)	LEL% (reading)
Methane	300	50,000	0.50	0.60	1.20
Ethane	555	30,000	0.70	1.85	2.64
Propane	545	21,000	0.80	2.60	3.24
Butane	360	18,000	0.83	2.00	2.41
Pentane	145	14,000	1.00	1.04	1.04
n-Hexane	70	12,000	1.40	0.58	0.42
Benzene	10	13,000	1.00	0.08	0.08
Toluene	9	12,000	1.26	0.08	0.06
p-Xylene	6	11,000	1.30	0.05	0.04
Total	2000			8.9	11.1

MX-4 LEL Sensor Response to the Gas Blend (Experiment)



Pellistor Concerns

- ✓ Problems with interpretation of data
  - Highly reliant on gas composition
  - Depends on the level of:
    - Oxygen
    - Temperature
    - Humidity and life of sensor
  - Sensor response time;
  - Combustible sensor poisons: silicone, hydrogen sulfide, high concentrations of flammable gas;
  - Sensor drift;
  - Environmental factors (temperature, humidity, etc.) effect the sensitivity;
  - Low resolution;

Pellistor Advantages

- ✓Large fleets of 4-gas monitors being currently used by upstream oil and gas companies;
- ✓Large amount of exposure data is generated daily;
- ✓Linear response to a wide range of flammable gas concentration;

Conclusion

- In addition to atmosphere flammability assessment Personal 4-Gas Monitors could be used in minimizing exposure to light end VOC
  - Need to know the gas composition

Questions
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