Training Coarse ECOPROBE 5

CHEMISTRY

RS DYNAMICS

Contents

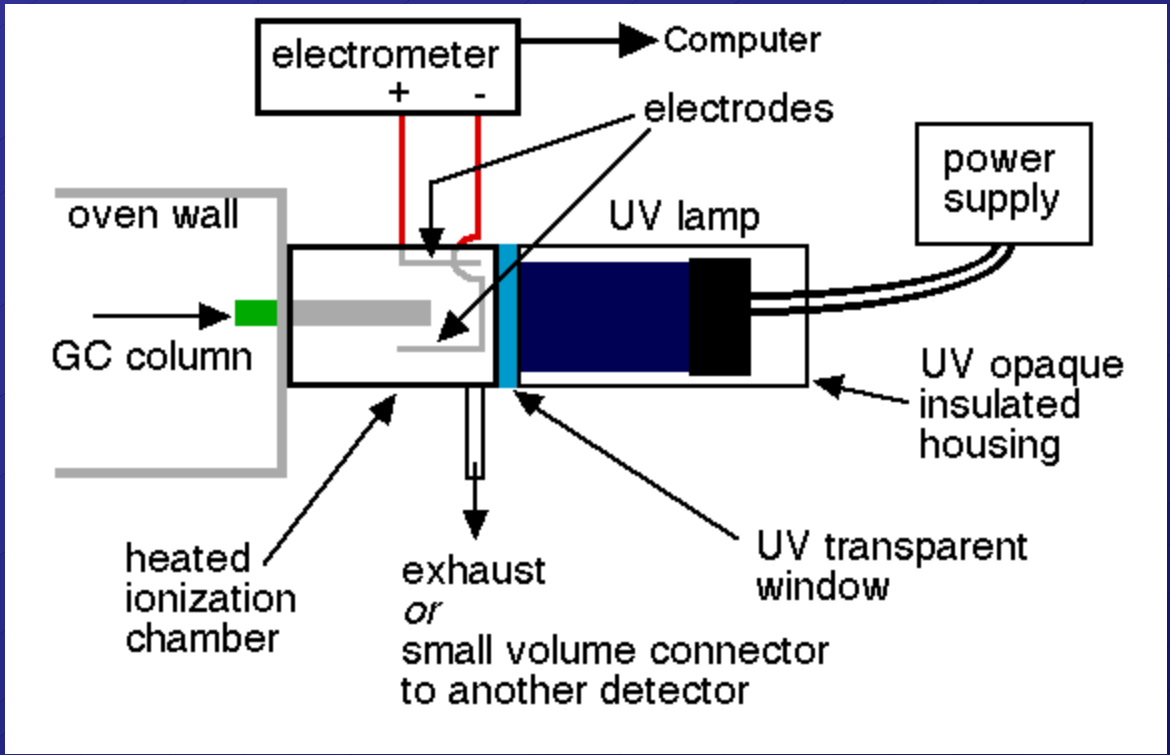
PID: first detection principle

PID

measures total level of organic compound including chlorinated HC's.

- Detection limit: 2 ranges – 0.1 ppm / 0.1 ppb
- ppb resolution, 0.1 ppb zero stability.
- Calibration for over 200 compounds included!
- Zero response for methane
- Large dynamic range (0.1 ppb to 4000 ppm), fast response
- ppm or mg/m3 output
- Ion lamp 10.2 eV (other energy levels are optional)

Photoionization: Schematics



Photoionization

Ionization which occurs as a result of the absorption of photone by a molecule:

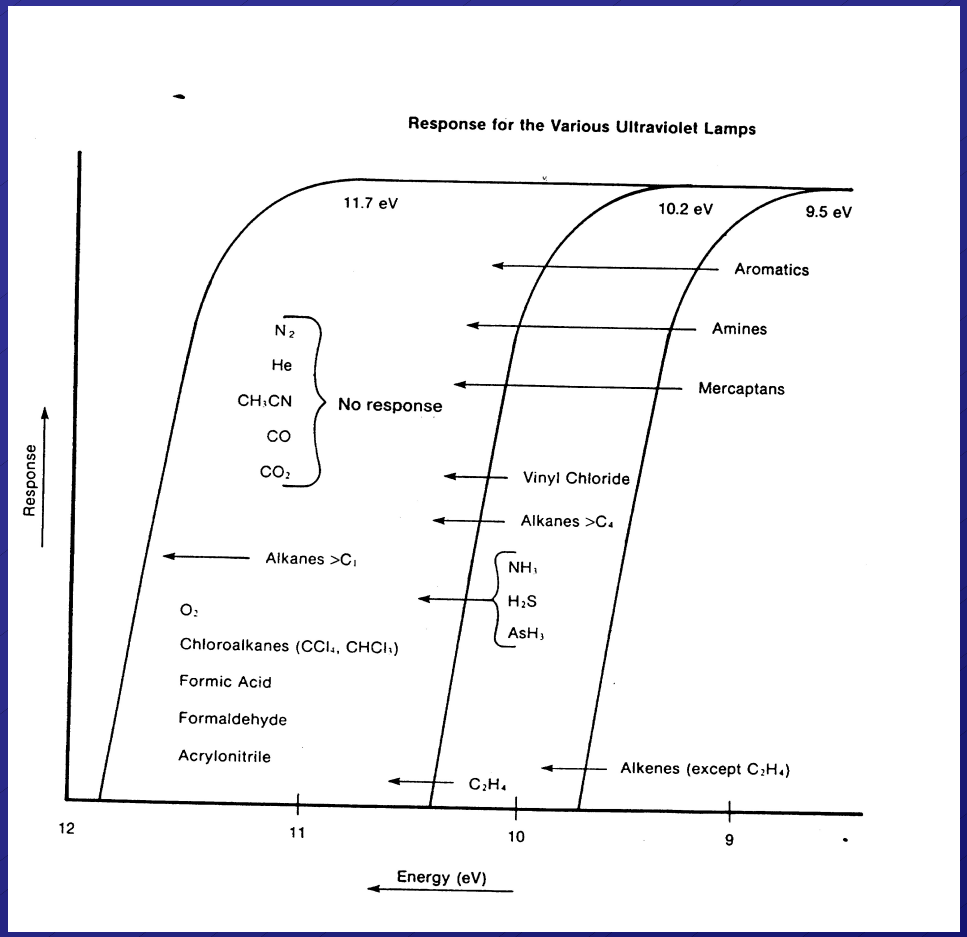
$$R + h? \text{ ® } R^{+} + e^{-}$$

R - ionizable molecule
h? – photon with energy = ionization potential of R

A positively charged HV electrode accelerates the resulting ions to a collection electrode. The current produced by the ion is measured by the electronics and “proportional” to concentration.

Photoionization: PID lamp

Ionization source available at different energy levels:
8.4eV, 9.6eV, 10.2eV, 11.7eV



Photoionization: Quenching and signal decreasing

Neutralization of ionized molecules that results in a decrease of measured signal:

$$R + h? \rightarrow R^+ + e^-$$

$$R^+ + e^- \rightarrow R$$

$$x + e^- \rightarrow x^-$$

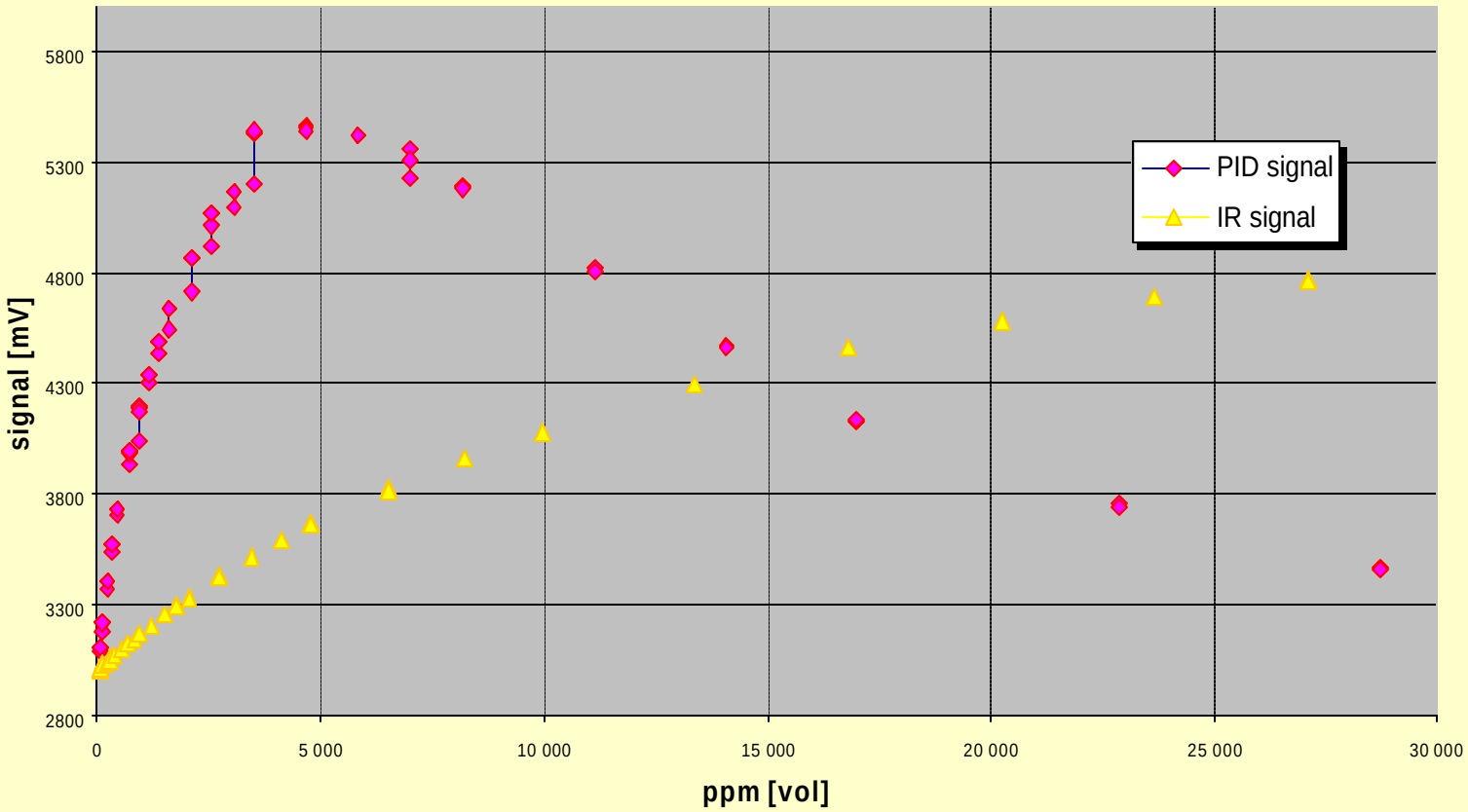
$$x^- + R^+ \rightarrow x + R$$

R - ionizable molecule

h? – photon with energy = ionization potential of R

X - electron capturing species [O_2, CCL_4, CH_3CN etc..]

PID and IR response : GASOLINE



PID: Not detected ?

IP of your compound?

Should be lower or at least equal to energy of your lamp. See the table...

Breakdown

Too big concentration of gas. See the log of signal instead of maximum peak

Too low concentration

Smell “good” but zero reading.

Conditions

Condensation, sorption, vapor pressure of compound.

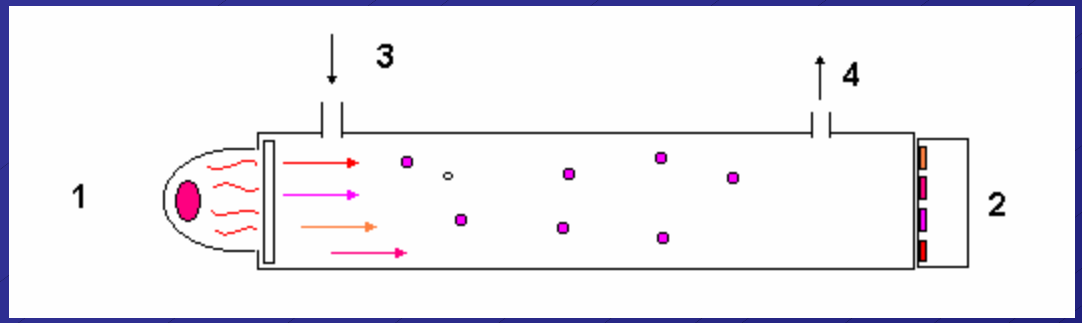
IR: second detection principle

IR

provides selective measurement of Methane, Petroleum Hydrocarbons and Carbon Dioxide

- Methane range: 0-500 000 ppm, detection limit < 100 ppm
- Petroleum Hydrocarbons range: 0-500 000 ppm, detection limit -- 30 ppm
- Carbon Dioxide range: 0-500 000 ppm, detection limit -- 20 ppm
- Reference channel
- ppm or mg/m3 output

IR: Schematics



1 - IR lamp

Produce whole IR range

2 – Detector

Measure loose of energy on four different channels (wavelengths): Methane, Carbon dioxide, Total petroleum, reference channel

3 – Inlet of gas

4 – Outlet of gas

IR: range

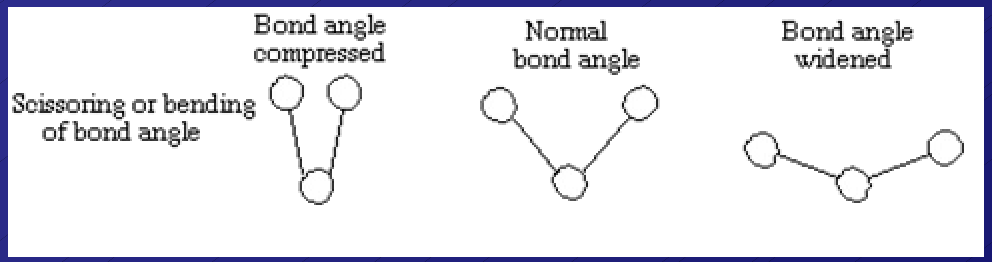
Region	Wavelength range (mm)	Wavenumber range (cm-1)
Near	0.78 - 2.5	12800 - 4000
Middle	2.5 - 50	4000 - 200
Far	50 -1000	200 - 10

The most useful I.R. region lies between 4000 - 670cm-1.
wavenumber = 1 / wavelength in centimeters

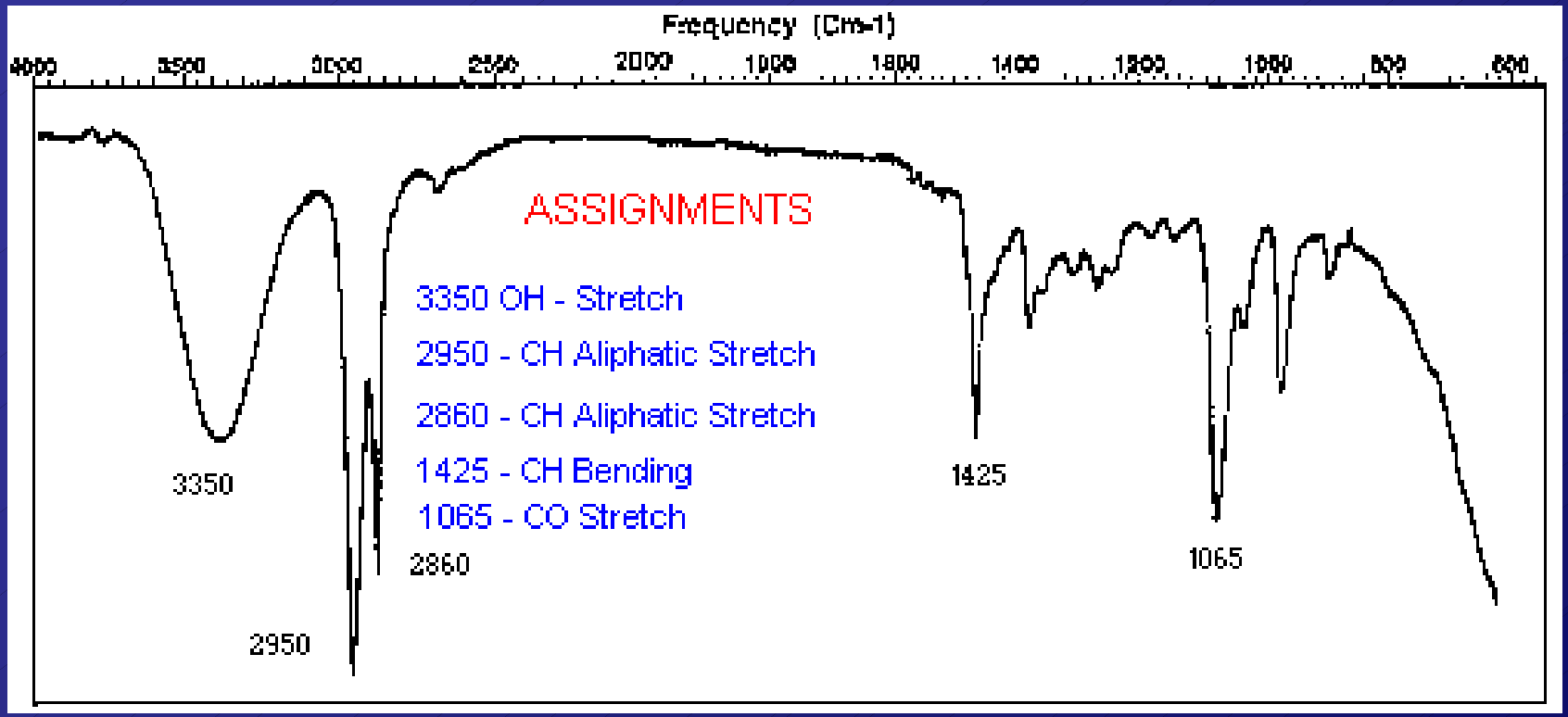
IR: description

IR radiation does not have enough energy to induce electronic transitions as seen with UV. Absorption of IR is restricted to compounds with small energy differences in the possible vibrational and rotational states.

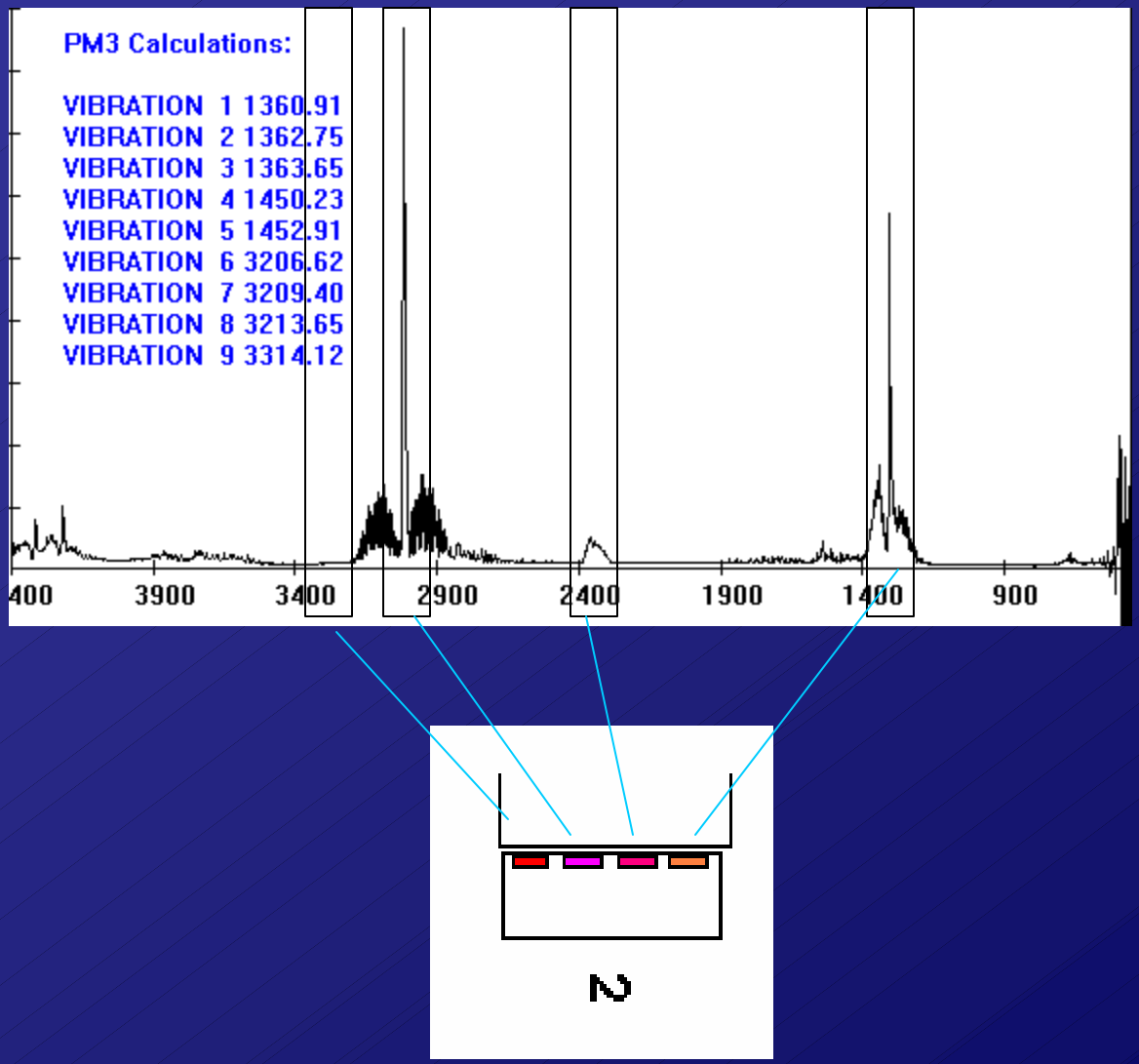
„Molecules are flexible, moving collections of atoms. The atoms in a molecule are constantly oscillating around average positions. Bond lengths and bond angles are continuously changing due to this vibration. A molecule absorbs infrared radiation when the vibration of the atoms in the molecule produces an oscillating electric field with the same frequency as the frequency of incident IR "light".



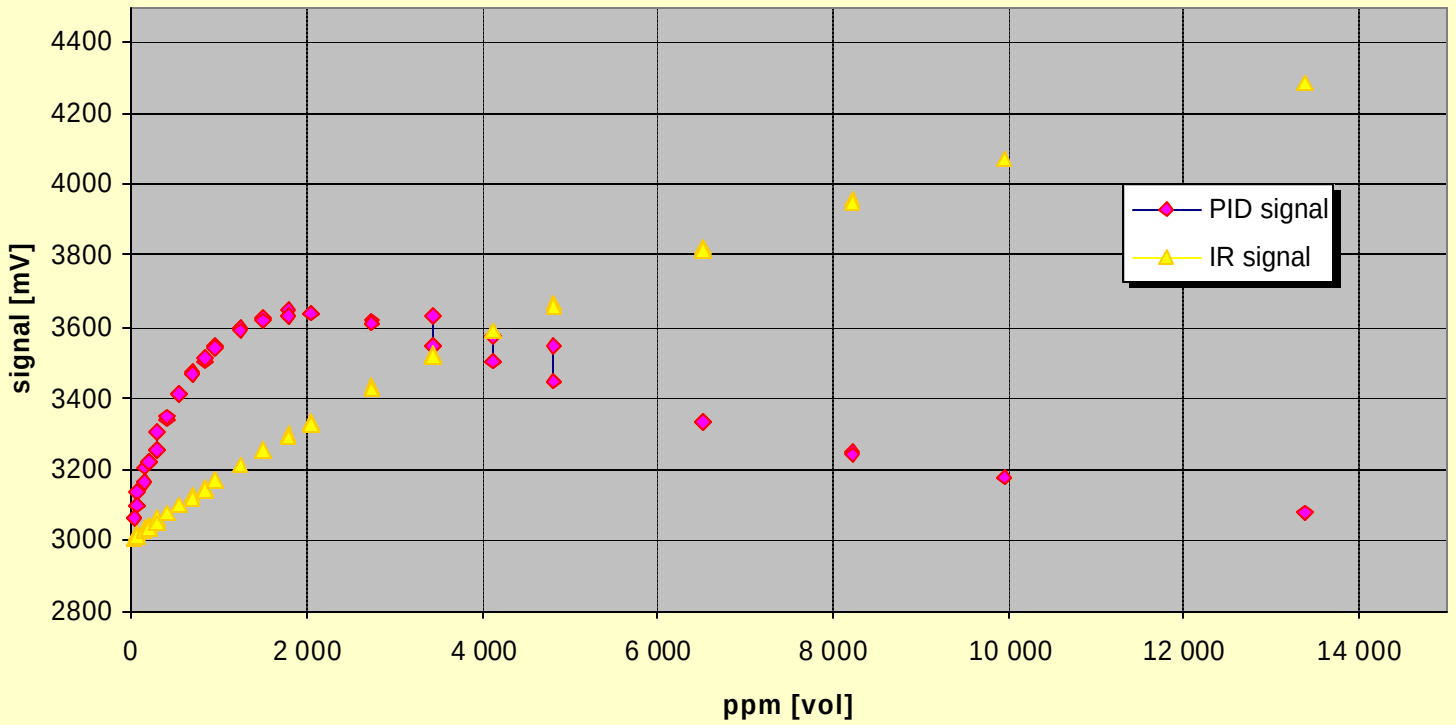
IR: example of spectrum



IR: four channel detector



IR and PID response : HEXANE



IR : Not detected ?

Methane channel cosstalks ?

At very high concentration oh hydrocarbons (more than 10.000ppm) the methane signal could be mask up to few hundreds ppm

Too low concentration

See detection limits

Conditions

Condensation, sorption, vapor pressure of compound.

Pollutants: responses

1 – SOIL :Petrochemical products

Mostly engine fuels. These are MIXTURES of many compounds, different type of hydrocarbons.

PID response well to most of hydrocarbons

Exception: volatile chlorinated solvents (need 11.7eV lamp)

IR (TP) response to all hydrocarbons

2 – AIR: different gases (industrial hygiene)

PID response to most of organics and also some inorganic gases

IR usually not used due to low measured concentration

Pollutants: aging

- Keep on mind that pollutants moving and changing with time.
- You will not measure the same values on place after some time.
- Theoretically after sufficient time the bacteria remove (eat) all hydrocarbons and change it to CO2, H2O, and CH4. This process is called bioremediation. Schematic of this reactions:

$$R + \text{bacteria} \rightarrow CO_2 + H_2O$$

Aerobic conditions O2, $\rightarrow NO^-, NO^- \rightarrow SO4^-$

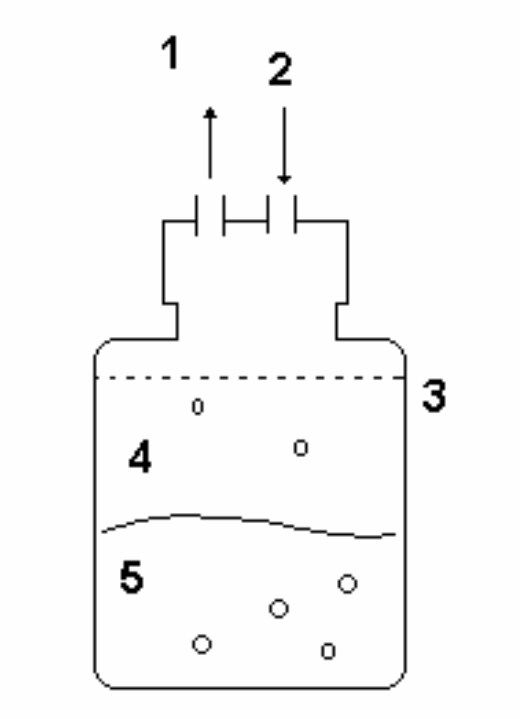
$$R + \text{bacteria} \rightarrow CH_4$$

Anaerobic conditions

Tips on demos

- Check the instrument before demo
- Check the GPS operation
- Run 2 or 3 measuring cycles before demo to stabilize the instrument
- Vapor test:
  - make a hole into the ground and measure it with Ecoprobe 5.
  - Put a blade of grass into a bottle with a hydrocarbon (gas fuel etc.) and throw it into the hole.
  - Run the measurement again. Relatively high values can be seen on the instrument screen in seconds.

Head space: water analysis



- Circulate the equilibrium vapor fhase throw Ecoprobe
-External calibration
- Will be delivered as „Ready to use solution“

1 - To Ecoprobe inlet
2 - From Ecoprobe outlet
3 - Permeable membrane
4 - Vapor phase
5 - Water