Concentration Sensors

- Concentration sensors react to the concentration of a specific chemical.
- The concentration modulates some physical property (eg resistance or capacitance).
- Generally speaking, no chemical reaction takes place in the sensor.
- Often called *physical sensors*.

Resistive Sensors

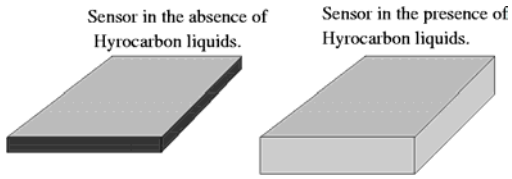
To detect the presence of a liquid phase chemical, a sensor must be specific to that particular agent a certain concentration.

Eg. Resistive detector of hydrocarbon fuel leaks. (Bell Corporation).

Made of silicone and carbon black composite

Polymer matrix is the sensing element.

Constructed as a very thin layer with large surface area.



Sensor is not susceptible to polar solvents like water.

However hydrocarbons are absorbed by the polymer matrix

The matrix swells and the resistivityy increases from 10 Ω/cm to 10^9 Ω/cm

Response time is less than a second.

Sensor returns to normal conductive state when hydrocarbon is removed.

The device is reusable and can be placed underground.

Ideal for oil exploration.

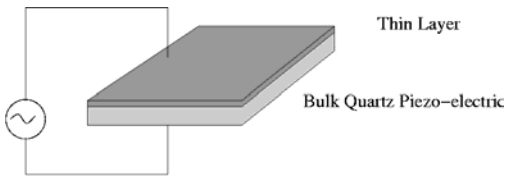
Gravimetric Sensors

Measurement of microscopic amount of mass cannot be accomplished using conventional balances.

Use oscillating sensor (sometimes called acoustic gravimetric sensor) which measures thin layers.

The oscillating sensor measures the shift in the resonant frequency of a piezoelectric quartz oscillator.

The resonant frequency is a function of the crystal mass and shape.



The device can be described as an oscillating plate whose natural frequency depends on its mass.

Adding material to that mass would shift the frequency which can be accurately measured electronically.

$$\frac{\Delta f}{f_o} = S_m \Delta f$$

F_0 = the unloaded natural frequency, Δf is the frequency shift, Δm is the added mass per unit area and S_m is the sensitivity factor.

The numerical value of S_m depends upon the design, material and operating frequency of the sensor.

The oscillating detector converts mass value to a frequency shift.

It is extremely easy to dtermine frequency, so the sensor's accuracy is determined by how well S_m is known.

Fluid density sensors.

Several basic methods are used for determination of fluid density

Measurement of inertial mass.

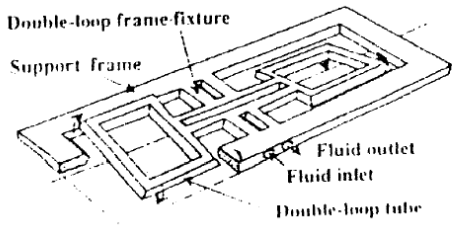
Measurement of Gravitational Mass.

Buoyant force.

Hydrostatic pressure.

Attenuation of γ-rays

Density measurement



The fluid is forced to flow through the sensor which has a hollow tube.

The sensor is made of silicon and the tube forms a double-loop within the device.

The tube inlet and outlet are at the side and the entire loop is designed for torsional vibration.

The mass of the actual tube is kept small so the total mass of the vibrating object is mostly that of the fluid.

The resonant frequency of the vibration is proportional to the total mass of the tube and fluid.

Since the volume in the tube is constant, the frequency is proportional to the density of the fluid.

Once again we exploit the physical properties of the material to directly measure characteristics of the material (the fluid).