Medidas en fluidos

INEL 5205 Instrumentación

Sensores de Presión

Unidades de Presión

1 psi $\equiv$ 1 lbf/in^2

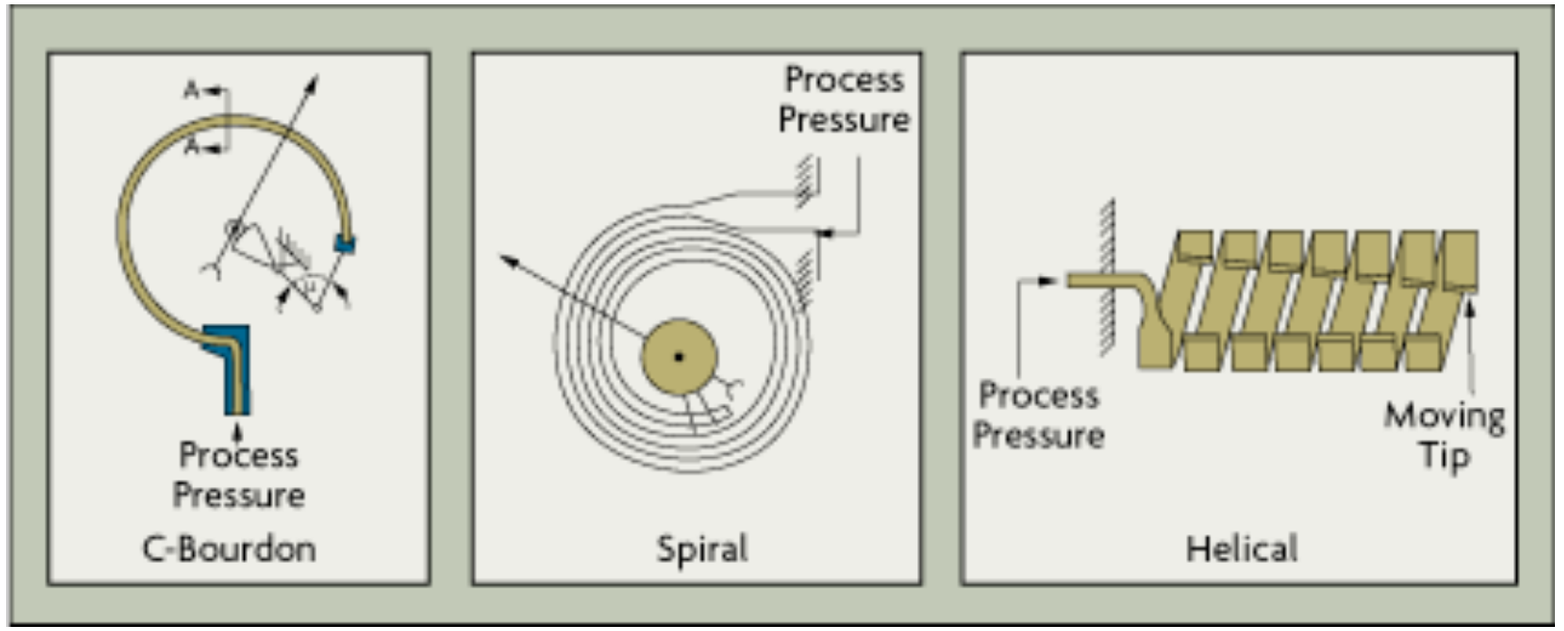
= 6,894.76 Pa = 6,894.76 $newton/m^2$

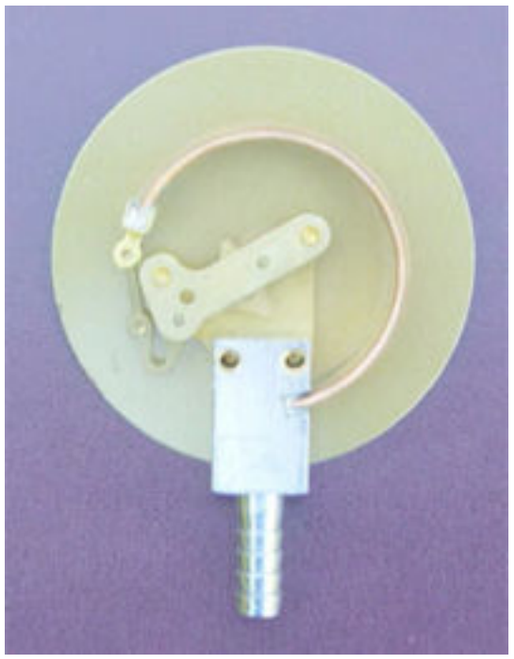
= 68.948×10^{-3} bar (1 bar = 10^5 Pa)

= 68.046×10^{-3} atm

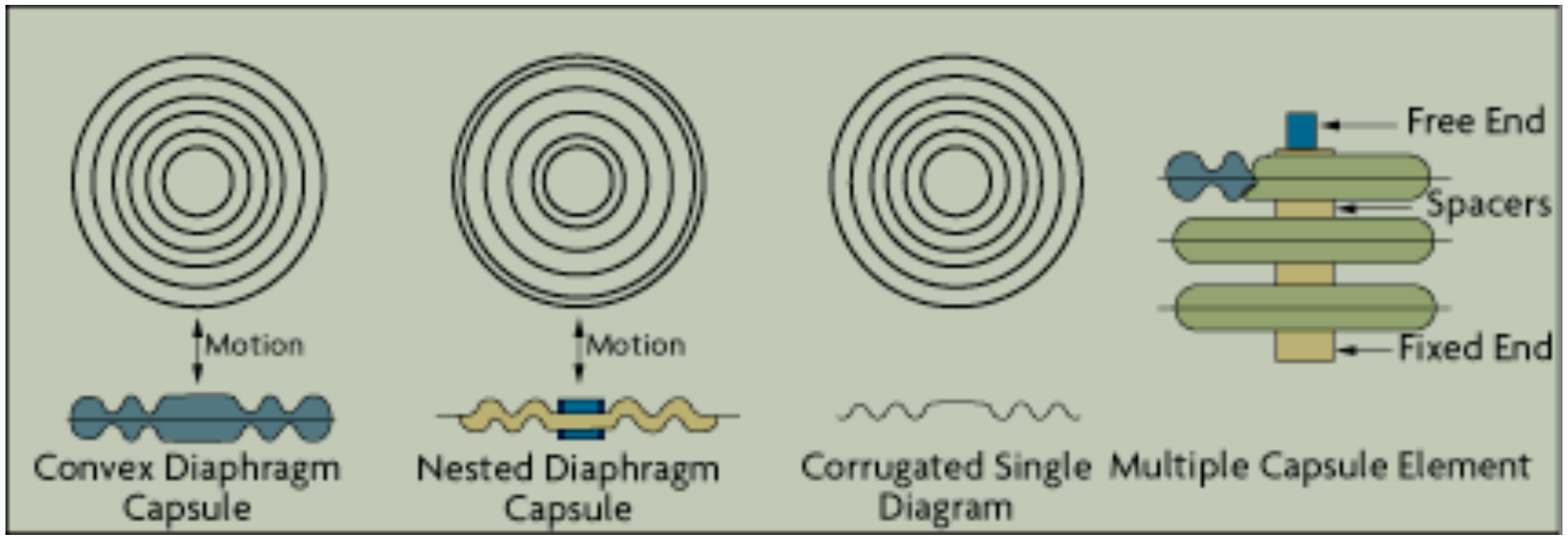
= 51.715 torr = 51.715 mm-Hg

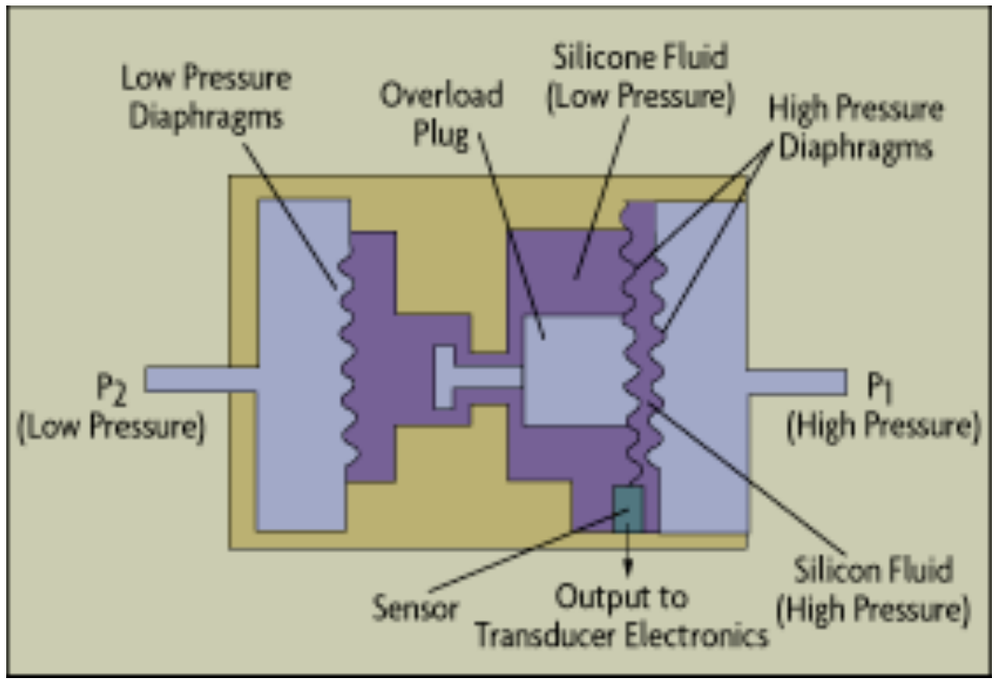
Tubo de Bourdon

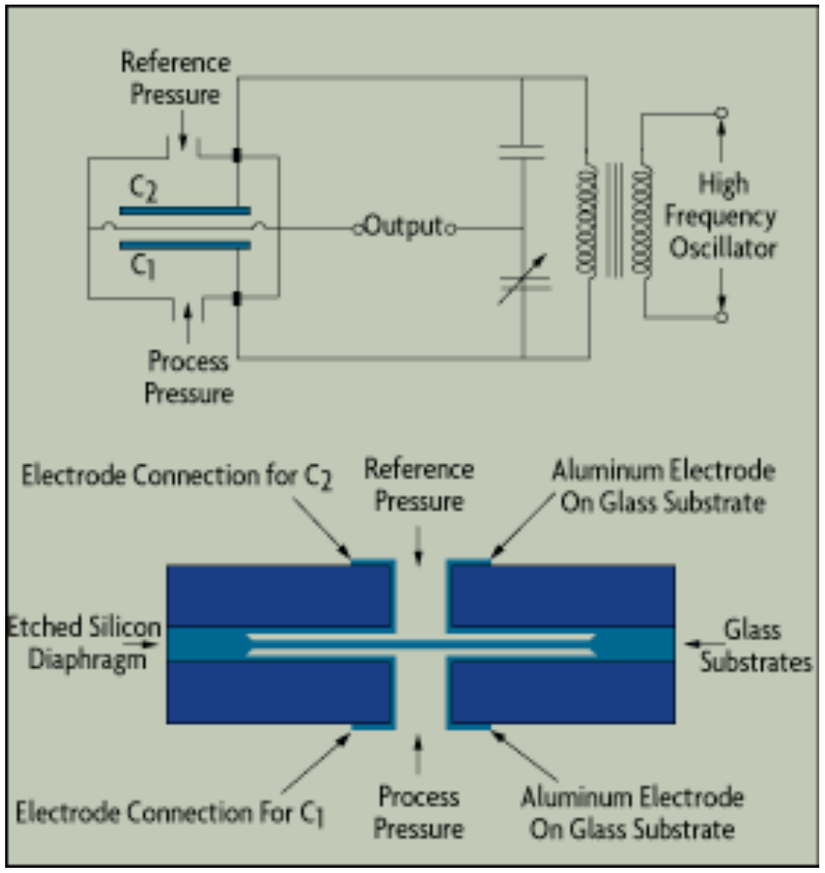


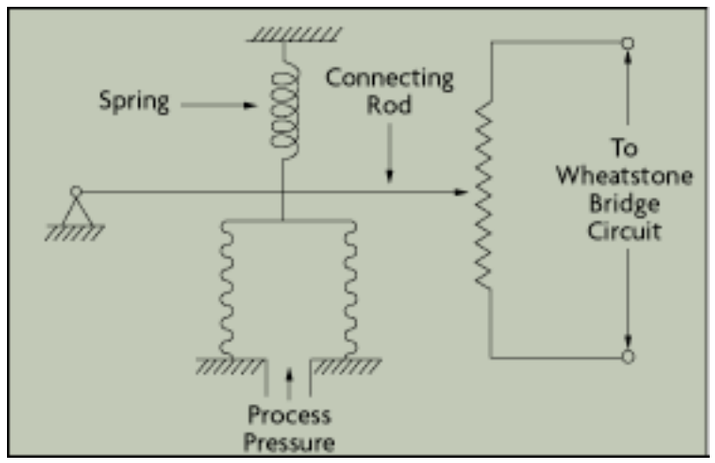


Desplazamiento

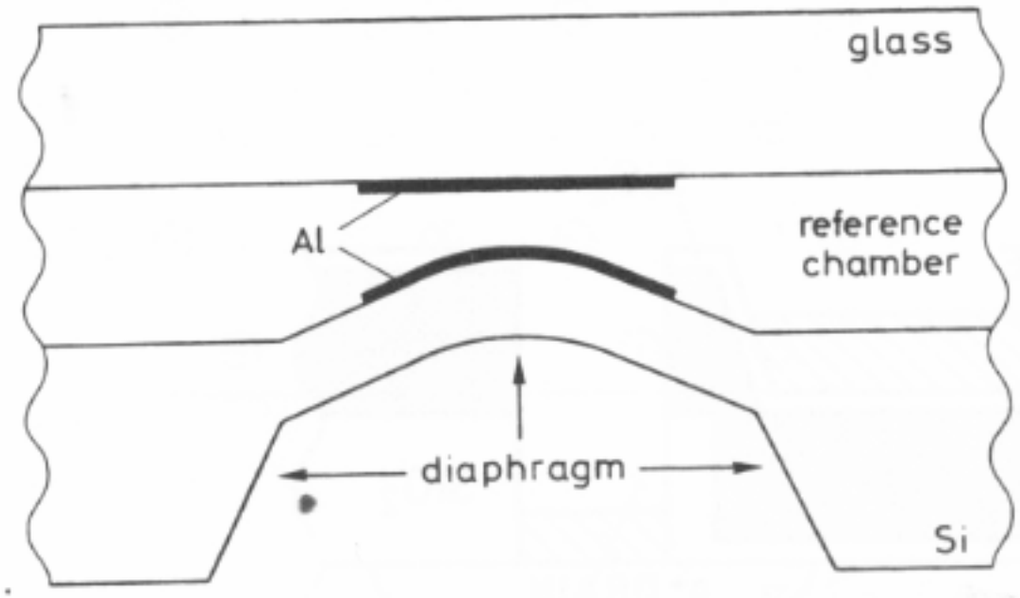



Low Pressure Diaphragms
Overload Plug
Silicone Fluid (Low Pressure)
High Pressure Diaphragms
P2 (Low Pressure)
P1 (High Pressure)
Sensor
Output to Transducer Electronics
Silicon Fluid (High Pressure)

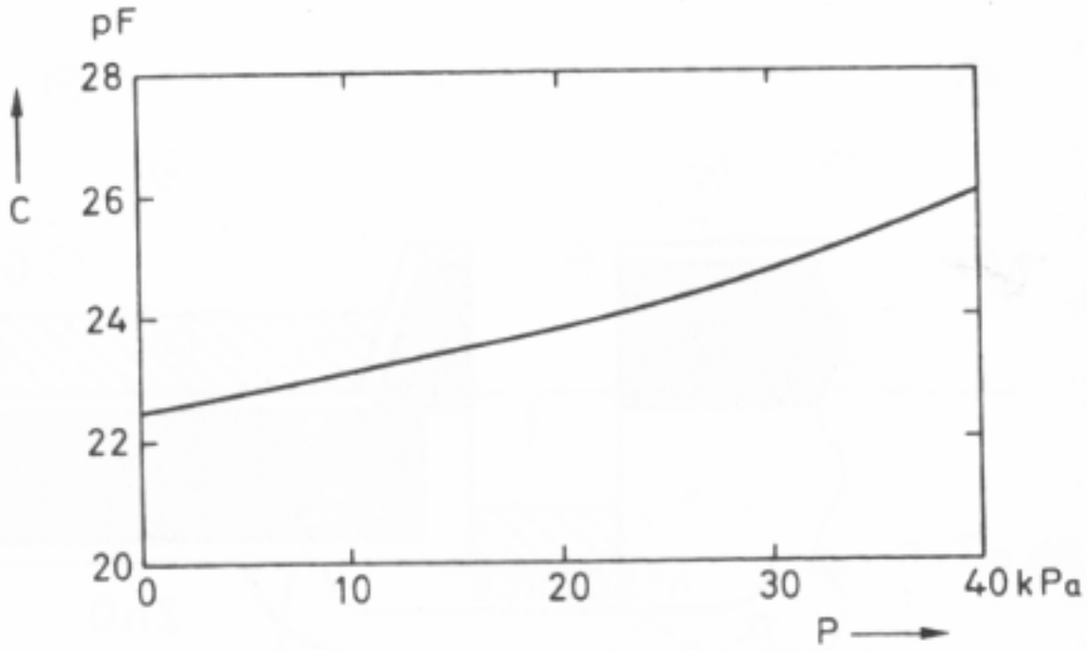

Reference Pressure
C2
C1
Output
High Frequency Oscillator
Process Pressure
Electrode Connection for C2
Reference Pressure
Aluminum Electrode On Glass Substrate
Etched Silicon Diaphragm
Glass Substrates
Electrode Connection For C1
Process Pressure
Aluminum Electrode On Glass Substrate


Spring
Connecting Rod
To Wheatstone Bridge Circuit
Process Pressure

Capacitivo - basado en membrana de Si



(a)



(b)

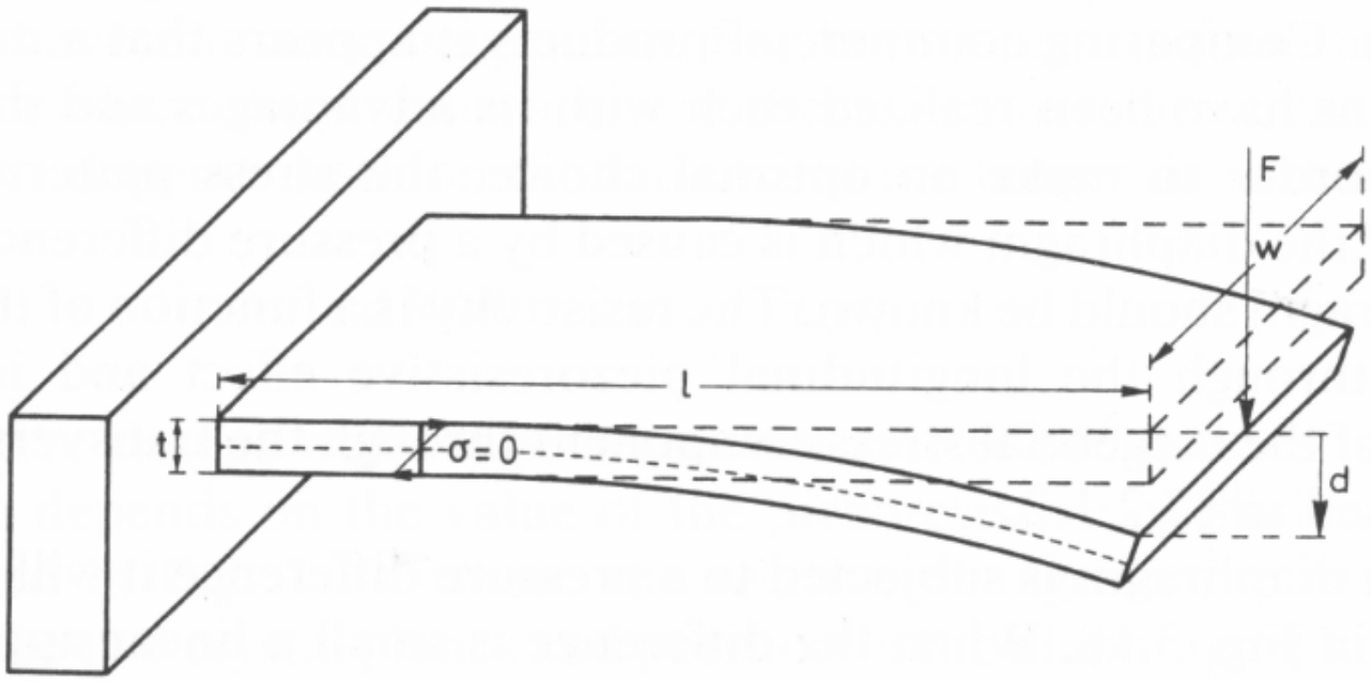


Fig. 3.17 Bending of a cantilever.

$$
\begin{aligned}
\sigma(x) &= \frac{6F\,(l-x)}{t^2 w} \\
d &= \frac{4Fl^3}{Ewt^3} \\
\sigma &= E\epsilon \quad \rightarrow \quad E_{Si} = 16 \times 10^6 psi \\
\frac{\Delta R}{R} &= \frac{\Delta\rho}{\rho} = GF \times \epsilon = \pi_{\parallel}\sigma_{\parallel} + \pi_{\perp}\sigma_{\perp} \\
\rho_n &= 11.7\Omega - cm \\
\rho_p &= 7.8\Omega - cm \\
R &= \frac{\rho L}{A}
\end{aligned}
$$

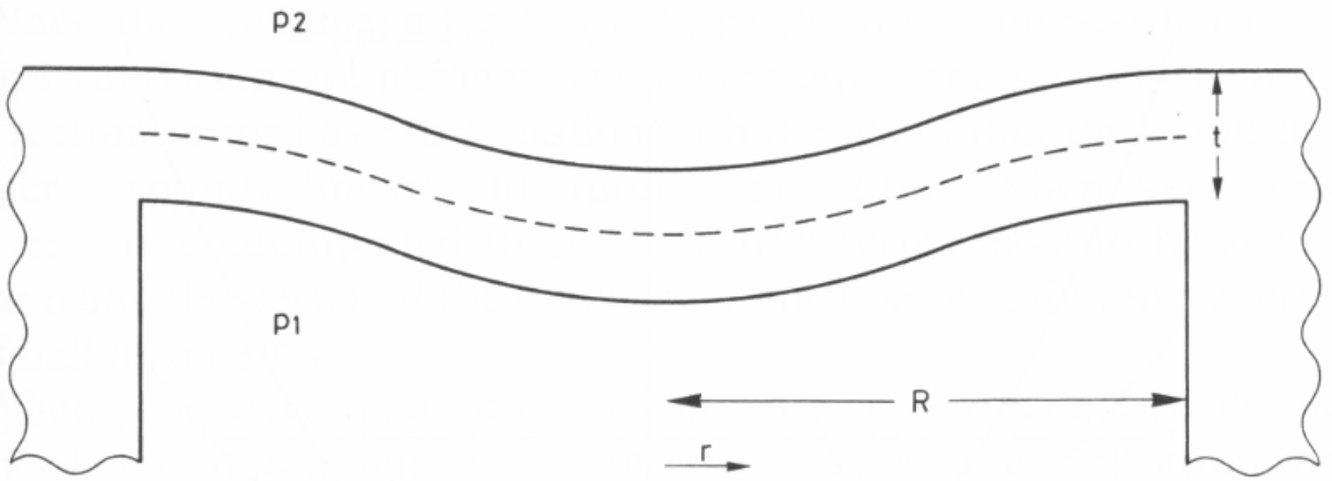


Fig. 3.18 Bending of a diaphragm due to a pressure difference.

$$\sigma_r = \frac{3\Delta p z R^2}{4t^3}\left(1+\upsilon-(3+\upsilon)\frac{r^2}{R^2}\right)$$

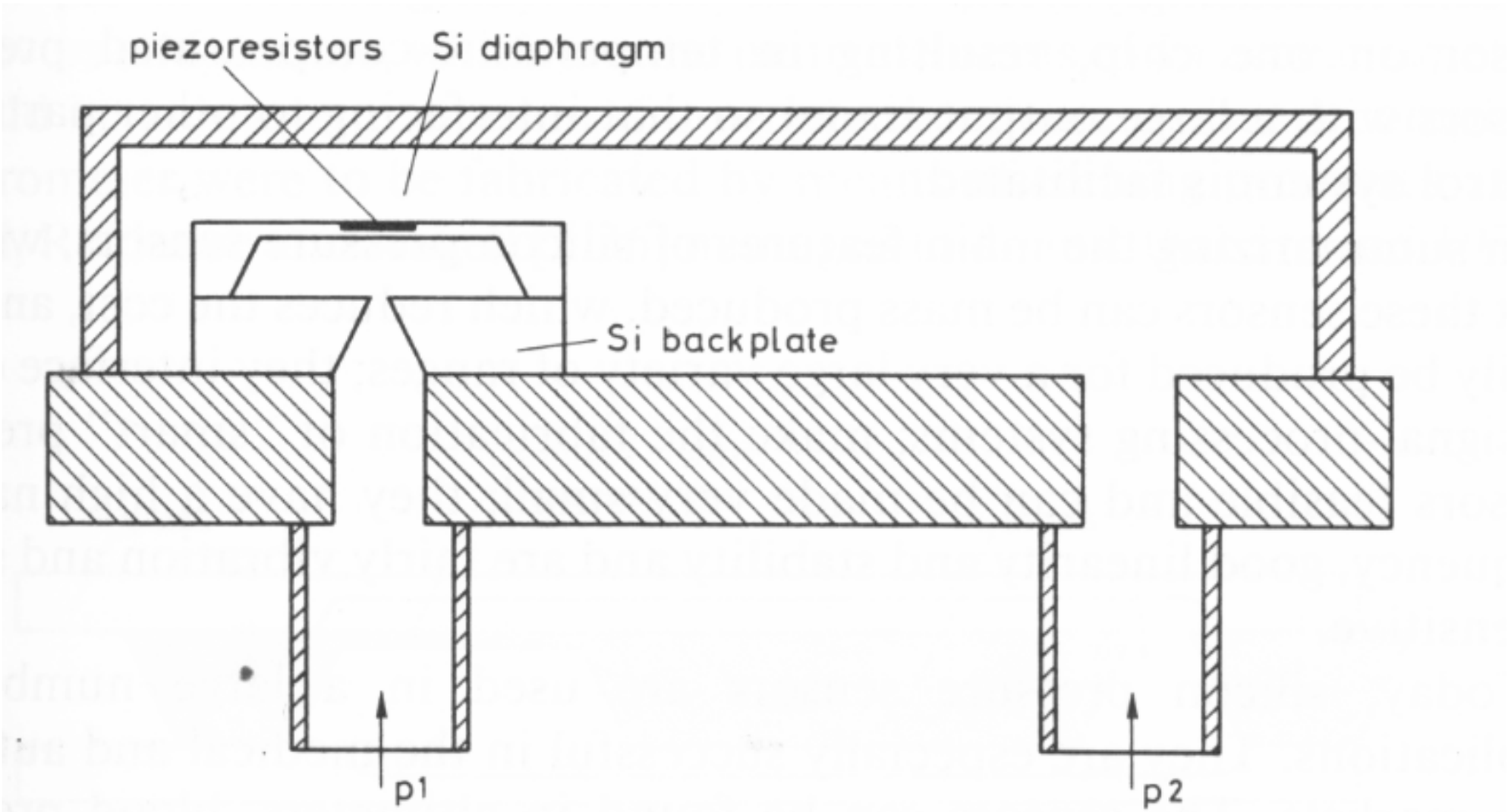
$$\sigma_t = \frac{3\Delta p z R^2}{4t^3}\left(1+\upsilon-(1+3\upsilon)\frac{r^2}{R^2}\right)$$

$$d(r) = \frac{3\Delta p(1-\upsilon^2)(R^2-r^2)^2}{16Et^3}$$

z is vertical coordinate (zero for central plane)

υ = Poisson's ratio = 0.3 for (111) plane

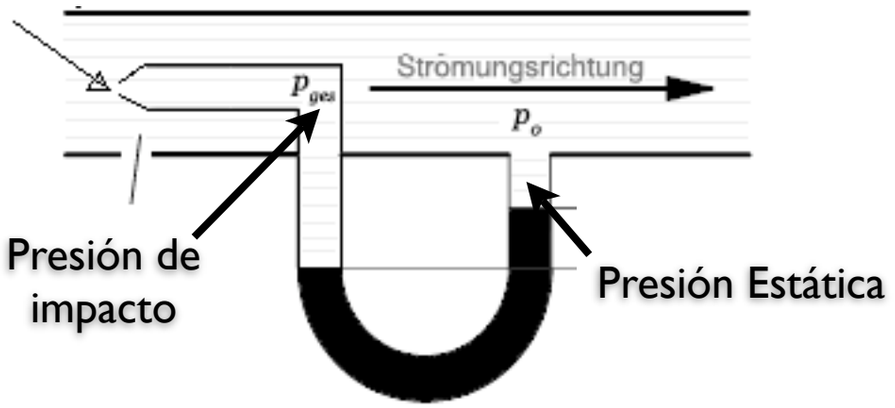
Medición de flujo



Q = flujo volumetrico

Q_m = flujo de masa = ρQ = dm/dt

Q_v = velocidad del flujo = Q/A



tubo de Pitot

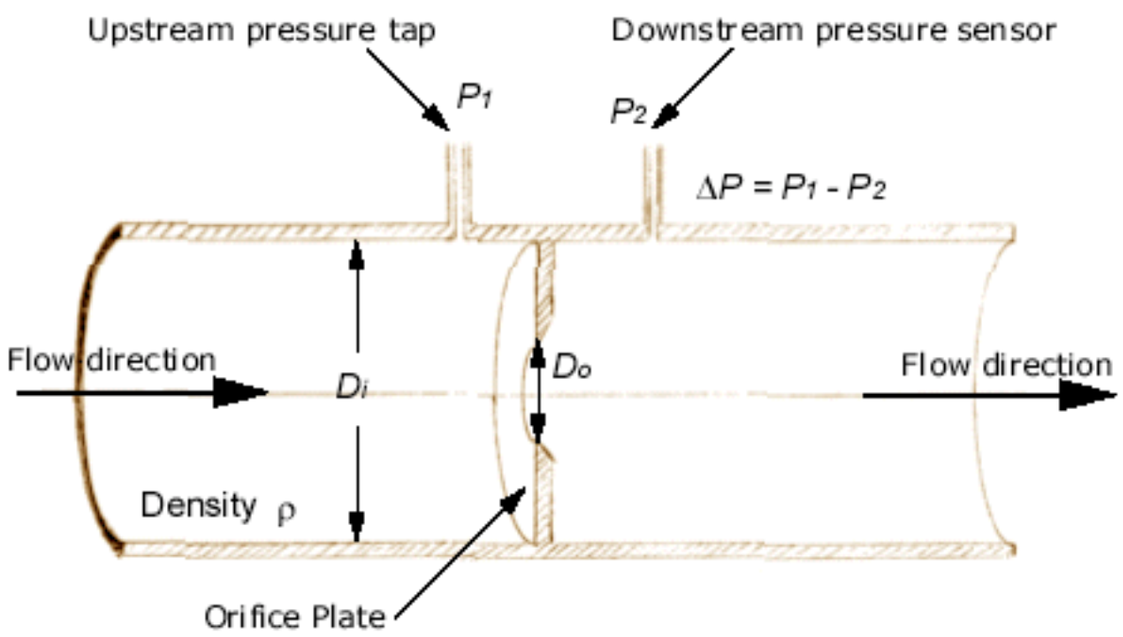
Flujo turbulento: N > 4000

Flujo laminar: N < 2000

N = numero de Reynolds

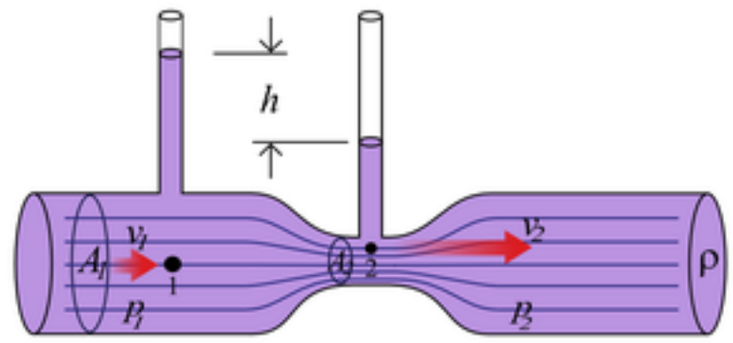
$$N = \frac{Q_v d \rho}{\mu}$$

μ = viscosidad del fluido

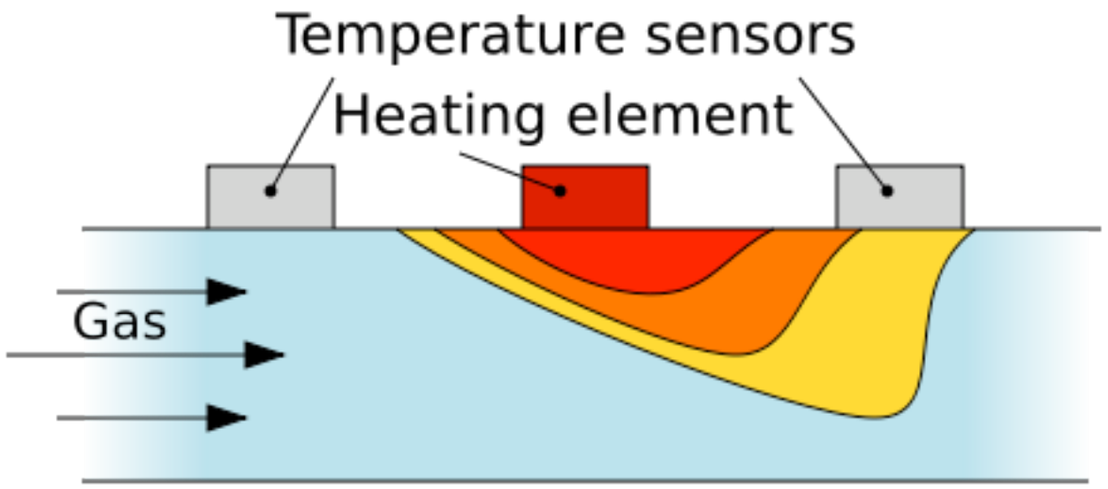


Ecuacion deBernoulli

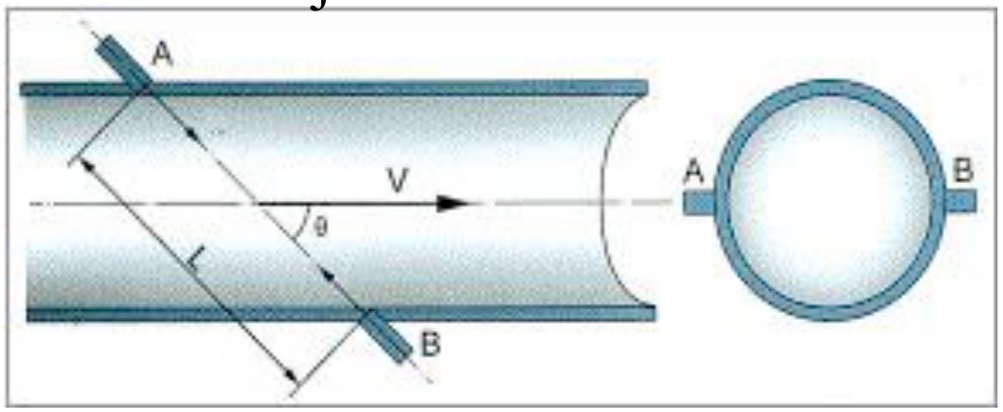
$$Q = k\sqrt{P_2 - P_1}$$



Venturi meter



Metro de flujo ultrasónico



$$Q_v = \frac{L}{\sin\theta} \frac{t_{UP} - t_{DOWN}}{t_{UP} \times t_{DOWN}}$$