

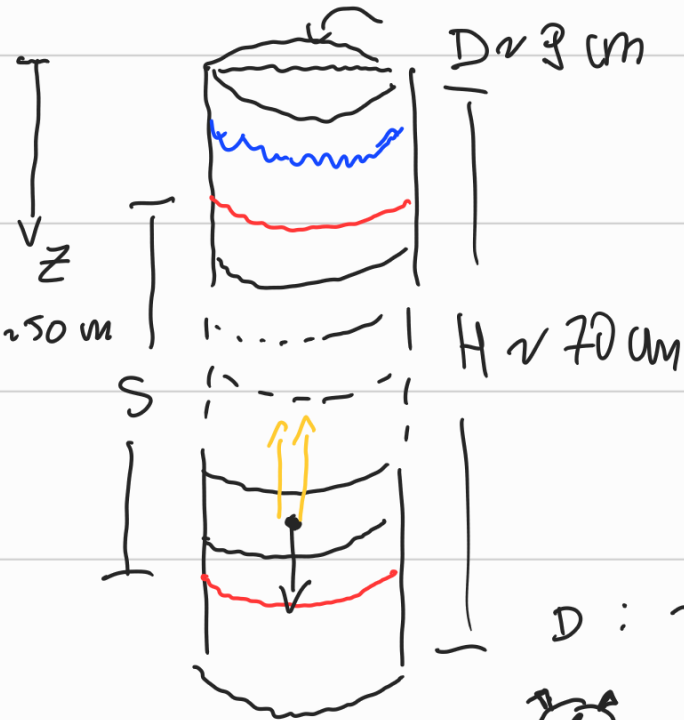
15/03/21

SFA

1) Stokes

2) η

misura diretta

 t, s $\rightarrow v$ 

liquido separato

$$\rho_0 = (1.032 \pm 0.001) \text{ g/cm}^3$$

$$\rho = (7.870 \pm 0.005) \text{ g/cm}^3$$

set di palline

$$D: \approx 0.1 \text{ cm}$$

$$\approx 0.7 \text{ cm}$$

$$\delta_D = 0.001 \text{ cm}$$

cronometro al millesimo di secondo

$$\sum_i \vec{F}_i = \vec{F}_g + \vec{F}_A + \vec{F}_V = m \vec{a}$$

$$mg - m_a g - 6\pi r \eta v = m \frac{dv}{dt}$$

$$m = \rho V; \quad V = \frac{4}{3} \pi r^3$$

$$V(\rho - \rho_0)g - 6\pi r \eta v = \rho V \frac{dv}{dt}$$

$$\left(\frac{\rho - \rho_0}{\rho}\right)g - \frac{g}{2} \frac{1}{r^2} \frac{\eta v}{\rho} = \frac{dv}{dt}$$

$$\frac{dn}{dt} = -\frac{g}{2} \frac{1}{r^2 \rho} \left[n - \frac{2}{g} \frac{r^2 \rho}{\eta} \left(\frac{p-p_0}{\rho} \right) g \right] =$$

$$= -\frac{1}{\tau} [n - n_L] ; \quad \tau = \frac{2}{g} \frac{r^2 \rho}{\eta}$$

$$n_L = \frac{2}{g} \frac{r^2}{\eta} (p-p_0) g$$

$$\frac{dn}{dt} = -\frac{1}{\tau} [n - n_L] ; \quad \int_{n_0}^n \frac{dn}{n - n_L} = -\frac{1}{\tau} \int_0^t dt$$

$$\left[\ln n - n_L \right]_{n_0}^n = -\frac{t}{\tau} ; \quad \ln \frac{n - n_L}{n_0 - n_L} = -\frac{t}{\tau}$$

$$n - n_L = (n_0 - n_L) e^{-t/\tau} ; \quad n(t) = n_L + (n_0 - n_L) e^{-t/\tau} =$$

$$= n_L (1 - e^{-t/\tau}) \quad \text{at } t=3\tau \quad \approx n_L (1 - e^{-3}) \approx n_L (1 - 0.05)$$

$$\approx n_L \quad \Rightarrow \quad n(3\tau) = n_L \quad \text{cost} \quad \text{m. r. u.}$$

$$S(t) = \int_0^t n(t) dt = n_L \int_0^t (1 - e^{-t/\tau}) dt =$$

$$= n_L \left[t + \tau e^{-t/\tau} \right]_0^t = n_L (t + \tau e^{-t/\tau} - \tau) \quad \text{at } t=3\tau$$

$$= n_L (3\tau + \tau e^{-3} - \tau) \approx n_L 2\tau \quad n_L \propto \frac{r^2}{\eta}$$

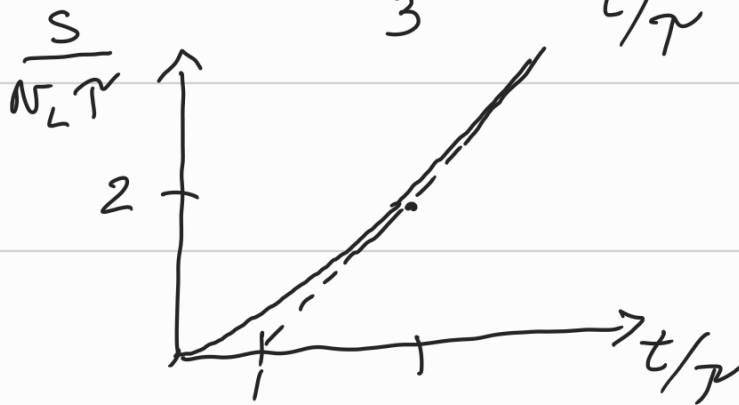
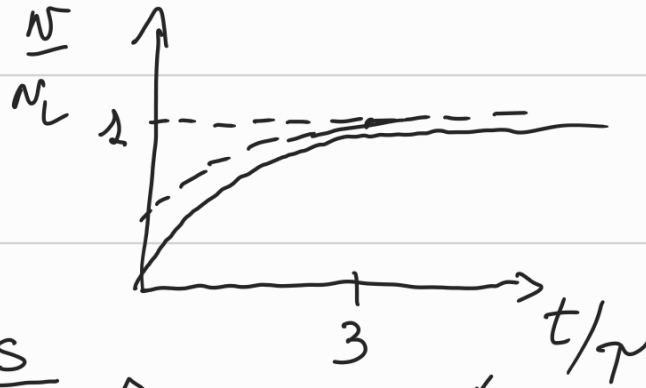
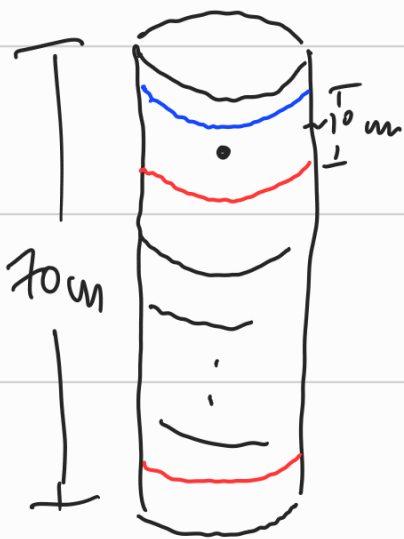
\uparrow
 $\text{cost} \Rightarrow r \gg \rightarrow n_L \gg$

$$r > 0.5 \text{ cm}$$

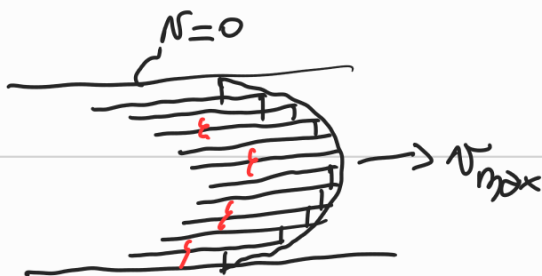
$$N_L \sim 10 \text{ cm}^2/\text{s}$$

$$\tau \sim 10^{-2} \text{ s}$$

$$s(3\tau) \approx 2\tau N_L \approx 0.2 \text{ cm} = 2 \text{ mm}$$



MOTO FLUIDO $\left\{ \begin{array}{l} \text{LAMINARE} \\ \text{TURBOLENTO} \end{array} \right.$

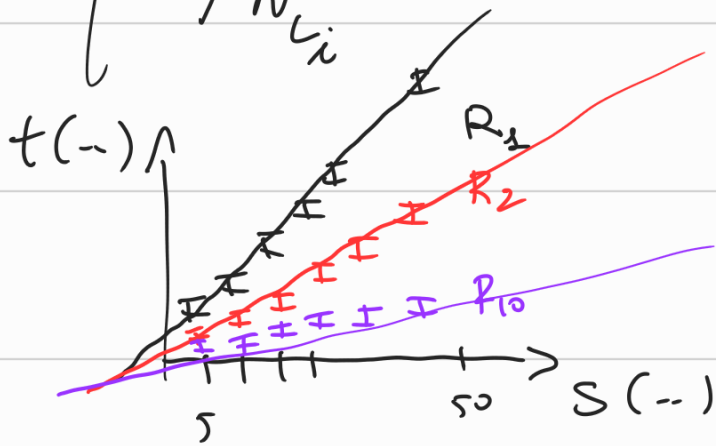


$$R = \frac{\text{inerzia}}{\text{viscoso}} = \frac{F_i}{F_v} \approx \frac{r \rho v}{\eta} \ll$$

$$R \sim 1$$

STIMA DELLA VISCOSITÀ

$$\textcircled{1} \quad \eta = \frac{2}{9} \frac{r_i^2}{N_{Li}} (P - P_0) \sigma$$



selezioni i

$$y = a + bx$$

$$b \pm \sigma_b \rightarrow N_{Li} \pm \sigma_{N_{Li}}$$

$$\eta_i \pm \sigma_{\eta_i}$$

$$y = a + bx$$

$$y = a + bx$$

$$\eta_i \pm \sigma_{\eta_i} \implies \eta_{\text{pes}} \pm \sigma_{\eta_{\text{pes}}}$$

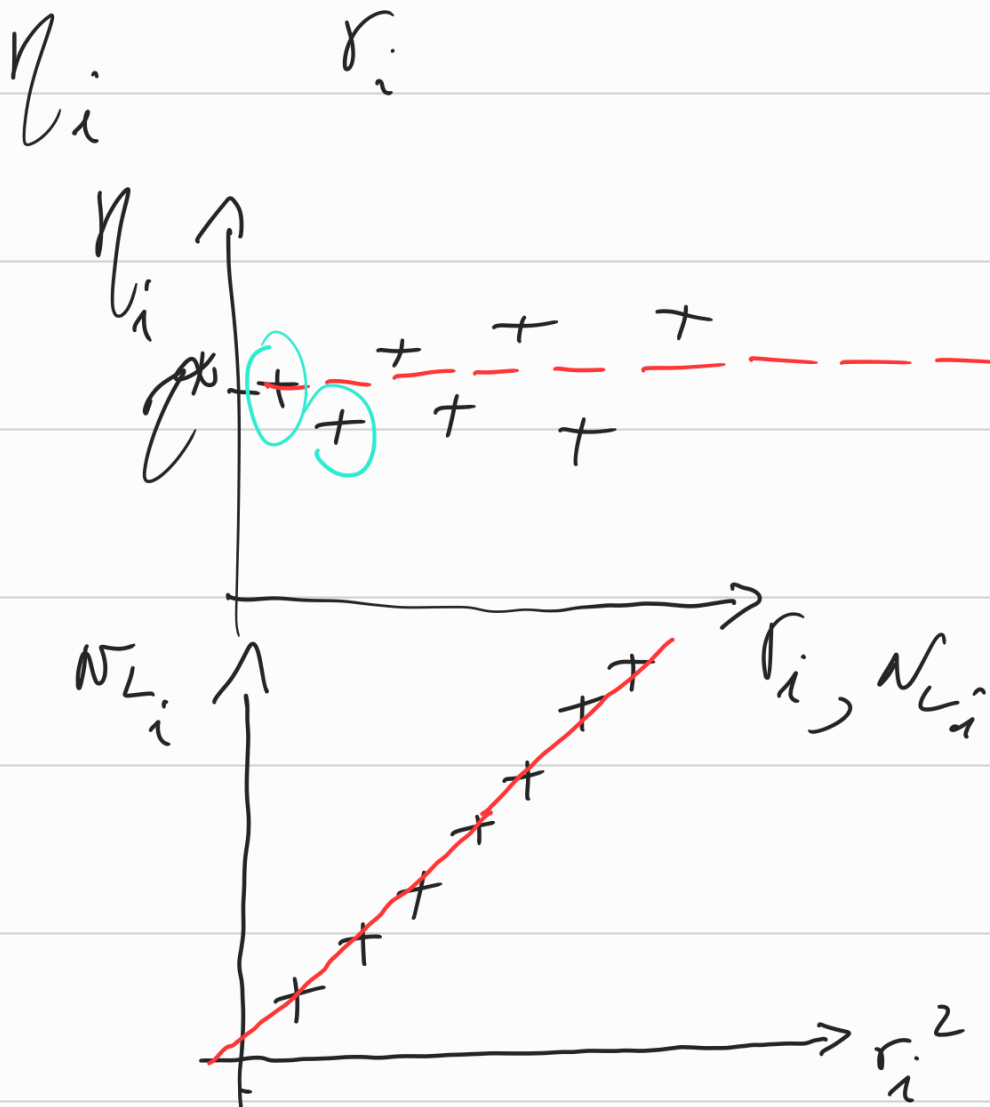
$i = 1, \dots, 10$

22/03/21

$$\eta \approx \frac{r^2}{\sigma_L} (\rho - \rho_0) z$$

$$\left. \begin{array}{l} s \pm \sigma_s \\ \underline{t \pm \sigma_t} \end{array} \right\} \sigma_L \pm \sigma_{\sigma_L}$$

repetute \rightarrow dev std campione
singole \rightarrow distrib \rightarrow ime stat



ERRORI SISTEMATICI

1) LIQUIDO FINITO \leftrightarrow EFF PARETE FONDO

2) BOLLE, TUNNEL, $\rho(\vec{x})$
SCIÀ

3) STRATIFICAZIONE

$$\rho = \rho(H)$$



4) temp, $\eta = \eta(T)$

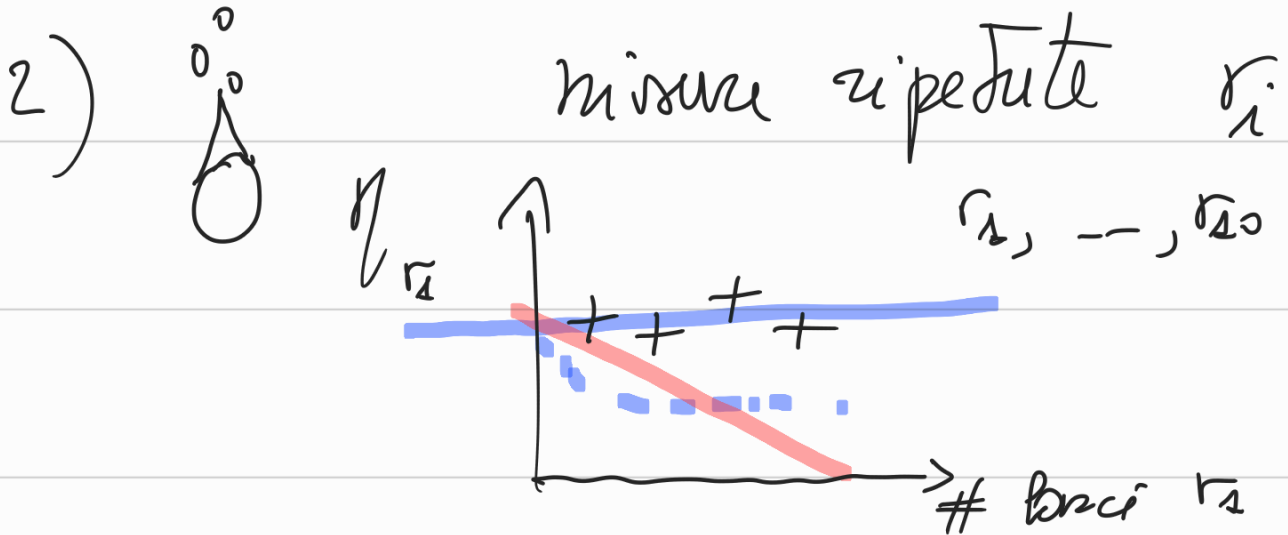
5) FLUIDO NON NEWTONIANO

$$\eta = \eta(\vec{x})$$

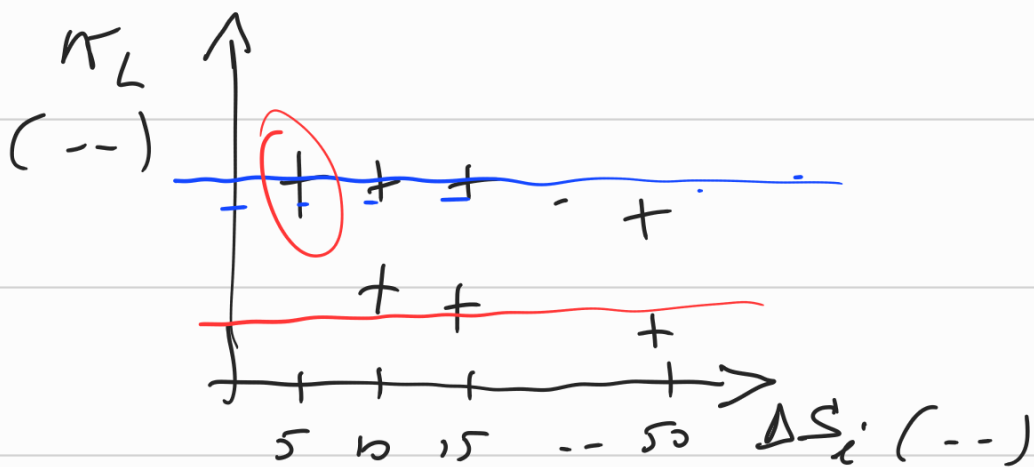
$$1) \quad \underline{\nu_D} = \underline{\nu_L} \left(1 + 2.4 \frac{\sigma_i}{R} \right) \times \left(1 + 3.3 \frac{\tau_i}{H} \right)$$

$$R \approx 4.5 \text{ cm} ; H \approx 70 \text{ cm}$$

$$\frac{\Delta v}{v} = \frac{v_0 - v_L}{v_L} \quad \gg \quad \text{mode statistico}$$



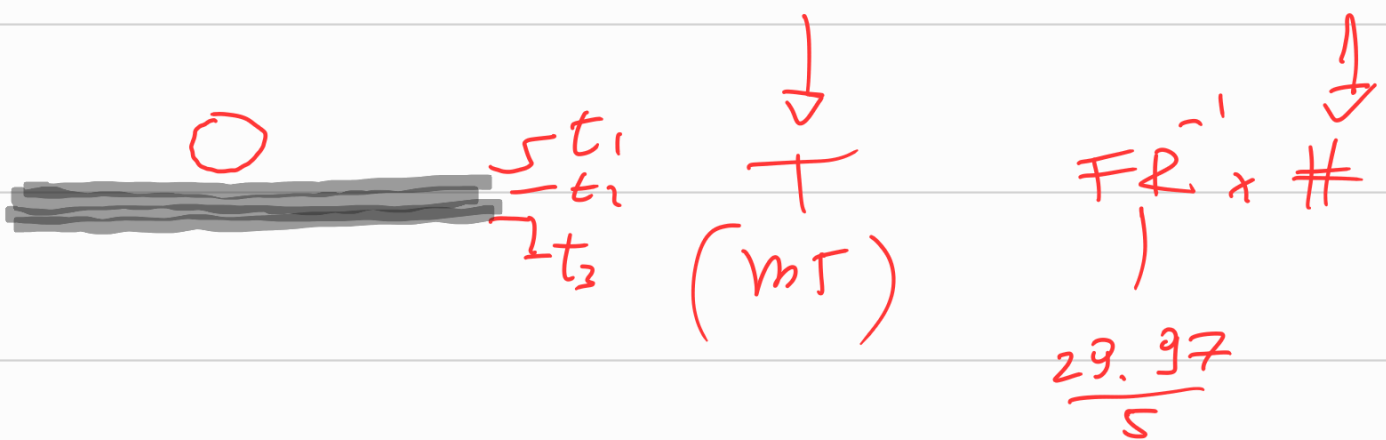
3) $\rho = \rho(H) \rightarrow v_L = v_L(H)$



4) v_L, v_{init} tempo, T
 v_L, v_{finale} tempo + $3h, T \gg$

5) LIQUIDO SAPRODO \leftrightarrow FLUIDO
NON NEWT.

$$\eta = \eta(\dot{\gamma})$$



Risol. $\xrightarrow{\dot{\gamma}}$ σ_{stat}