

Lezione 11

28.10.2022

Calendario lezioni mese di Novembre: RECUPERI

VEN 4.11 AULA VM12 15.30-17.00

MER 9.11 AULA VM 18 8.45-10.15 ZAPPALORTO
10.30-12.00 BIASETTO

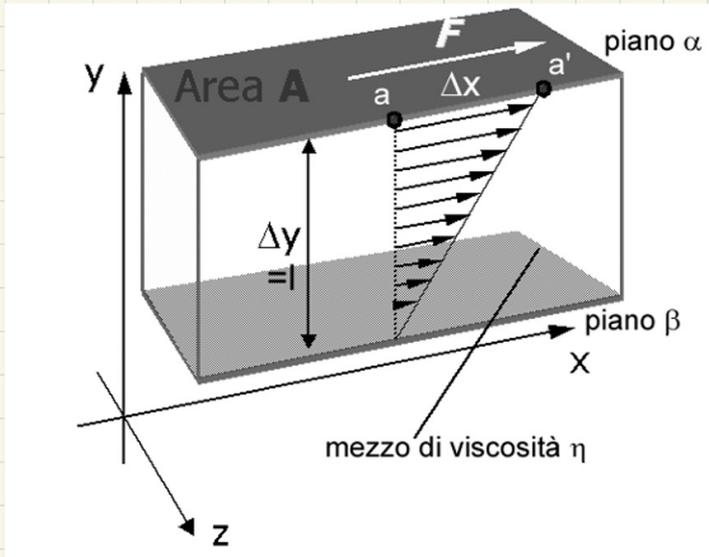
VEN 11 AULA VM10 15.30-17.00

VEN 18 AULA VM12 15.30-17.00

VISCOSITA' DEI FLUIDI POLIMERICI

- DEFINIZIONE DI VISCOSITA'
- DIPENDENZA DELLA VISCOSITA' DA T E P
- FLUIDI NEWTONIANI E FLUIDI NON NEWTONIANI
- PSEUDOPLASTICITA'
- METODI DI MISURA DELLA VISCOSITA'

LEGGE DI NEWTON



$$F \propto \frac{\Delta v}{\Delta y} \quad \Delta y = l$$

$$F = \left(\eta \cdot \frac{dv}{dy} \right)$$

↳ viscosità [Pa·s]

$$\frac{dv}{dy} = \frac{d}{dy} \left(\frac{dx}{dt} \right) = \frac{dx}{dy} \frac{1}{dt} = \frac{dx}{dy} = \dot{\gamma}$$

$$\frac{F}{A} = \tau$$

$$\tau = \eta \frac{d\gamma}{dt} \quad \text{Legge di Newton}$$

❖ Fluidi Newtoniani

$$\tau = \eta \frac{d\gamma}{dt} \quad [Y = MX]$$

MISURA dell'ATRITO INTERNO
del MATERIALE

$$\eta = \text{cost} \quad T, P \text{ cost}$$

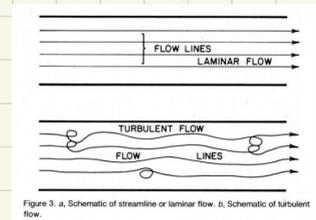
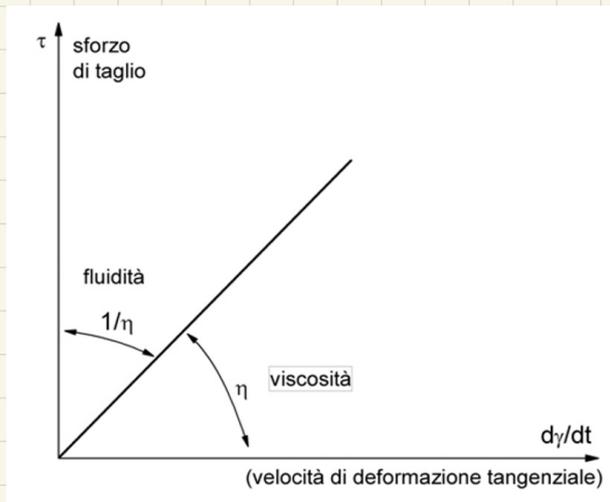


Table 1. Viscosity Values of Some Fluids (From Cogswell (1)).

Material	η (Pa-s)	Consistency
Air	10^{-5}	gaseous
Water	10^{-3}	fluid
Olive Oil	10^{-1}	liquid
Glycerine	10^0	liquid
Syrup	10^2	thick liquid
Polymer Melts	$10^2 - 10^6$	viscous fluids
Pitch	10^9	stiff
Glass	10^{21}	rigid

$$1 \text{ Poise} = 10^{-3} \text{ Pa.s}$$

G.L. Wilkes: An Overview of the basic rheological behaviour of polymer fluids with an emphasis on polymer melts
Journal of Chemical Education, 1981 vol.58

FLUIDI NEWTONIANI

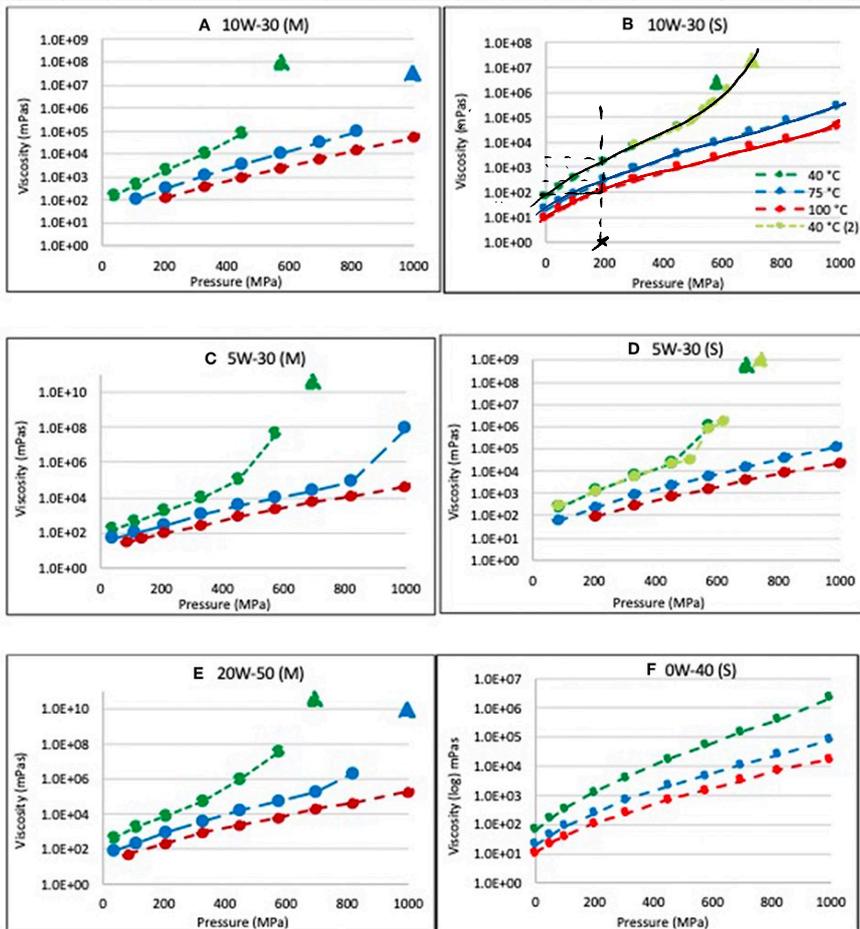
$$\eta = \eta(T, P)$$

$$\eta(T) = e^{+\frac{E_{att}}{RT}}$$

energia di ATTIVAZIONE del FLUIDO VISCOSO

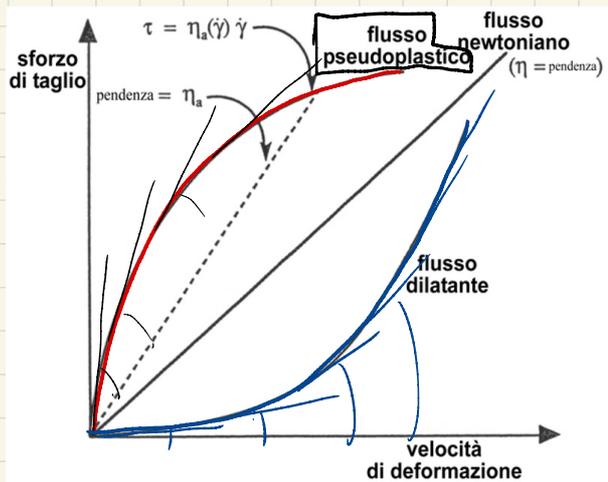
$$\eta(P) = e^{PE_{att}}$$

DIPENDENZA DELLA VISCOSITA' DALLA TEMPERATURA E DALLA PRESSIONE



❖ Fluidi Newtoniani vs Fluidi Non-Newtoniani

FLUIDI NON-NEWTONIANI $\eta = \eta(T, P, \dot{\gamma})$



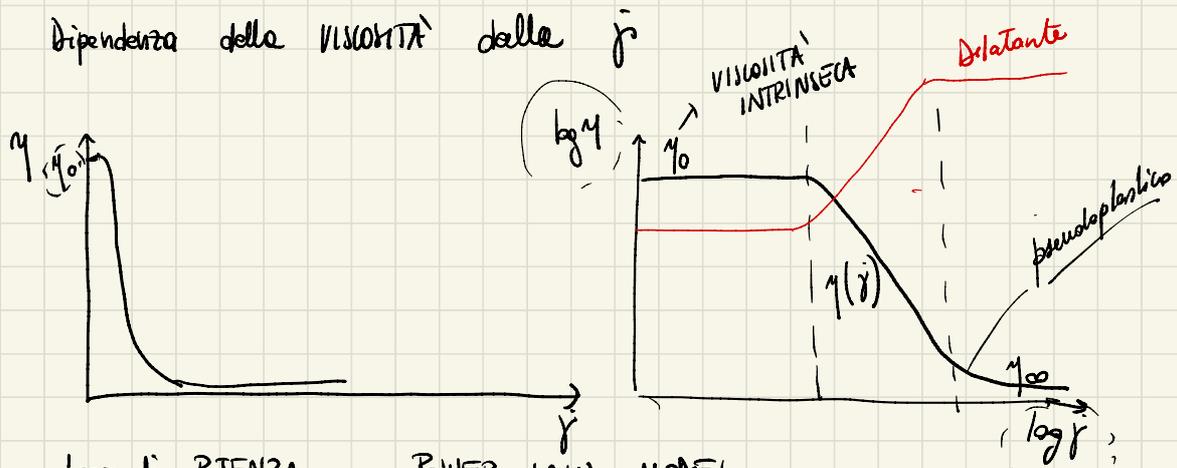
- FLUIDI PSEUDOPLASTICI → SHEAR THINNING

$$\frac{d\tau}{d\dot{\gamma}} < 0 \quad \text{LA VISCOSITÀ DIMINUISCE} \uparrow \text{DELTA } \dot{\gamma}$$

- FLUIDI DILATANTI

$$\frac{d\tau}{d\dot{\gamma}} > 0 \quad \text{LA VISCOSITÀ} \uparrow \text{ con } \uparrow \text{ della } \dot{\gamma}$$

Dipendenza della VISCOSITÀ dalla $\dot{\gamma}$



Legge di POTENZA o POWER LAW MODEL

$$\log \eta = \log \eta_0 + n \log \dot{\gamma}$$

$$\eta = \eta_0 \dot{\gamma}^n$$

$\eta_0 = K$ INDICE di CONSISTENZA

$n =$ ESPONENTE della legge di potenza

$$\eta(\dot{\gamma}) = \left(\frac{K}{\rho} \right) \dot{\gamma}^{n-1}$$

se $n < 1 \Rightarrow$ FLUIDO PSEUDOPLASTICO

se $n = 1 \Rightarrow$ FLUIDO NEWTONIANO

se $n > 1 \Rightarrow$ FLUIDO DILATANTE

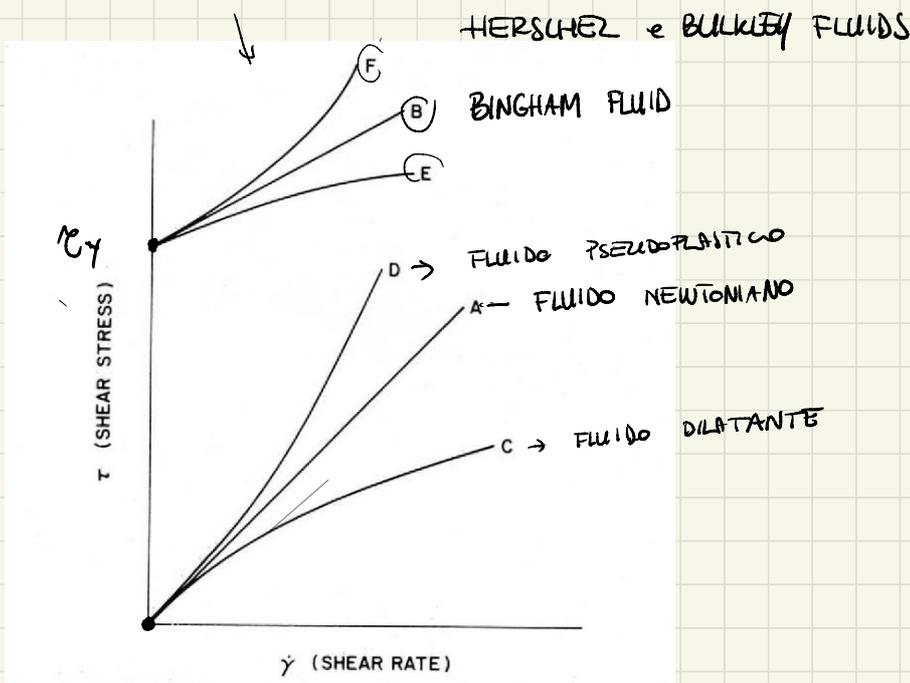


Figure 4. General plot of six different types of shear stress-shear rate behavior: A, Newtonian; B, Bingham Newtonian; C, Shear thinning (pseudoplastic); D, Shear thickening (dilatant); E, Bingham shear thinning; F, Bingham shear thickening.

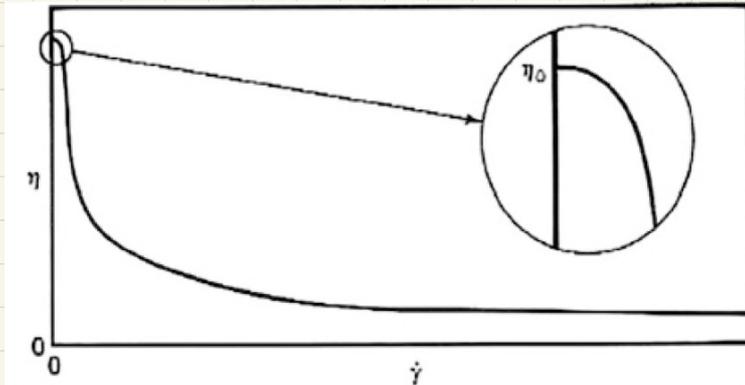
$$\tau = \tau_0 + k \dot{\gamma}^n$$

Herschel e Bulkley

k INDICE di CONSISTENZA

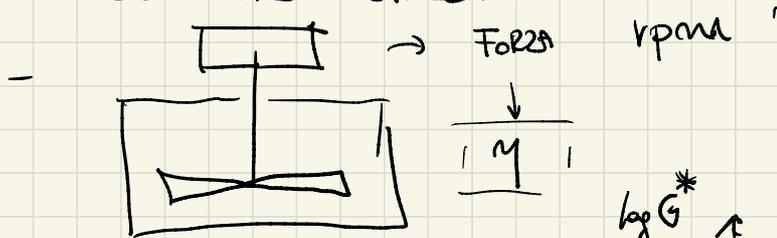
n ESPONENTE della legge di POTENZA

	τ_0	k	n	$\tau = k \dot{\gamma}^n$
FLUIDO NEWTONIANO	0	> 0	1	
FLUIDO POWER LAW MODEL	0	k > 0	n < 1	
FLUIDO DILATANTE	0	k > 0	n > 1	
FLUIDO BINGHAM	> 1	> 0	1	
FLUIDO HERSCHEL and Bulkley	> 1	> 0	n < 1	



● METODI di MISURA

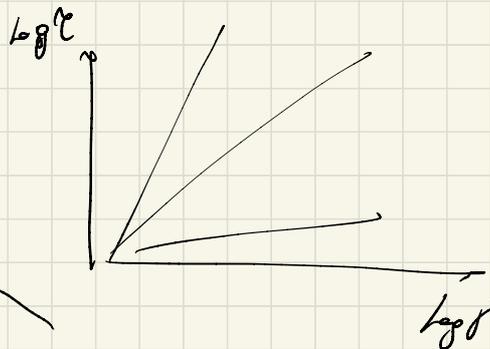
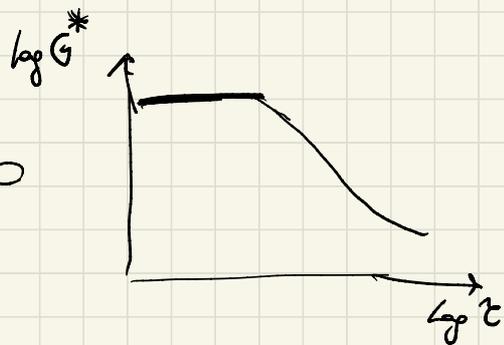
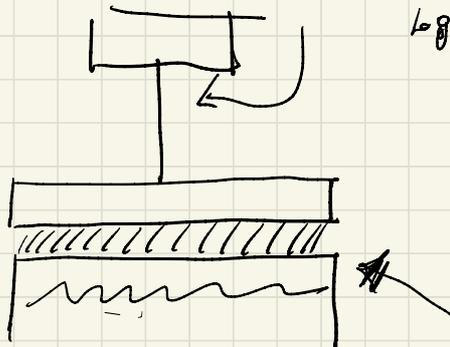
- VISCOSIMETRO CAPILLARE

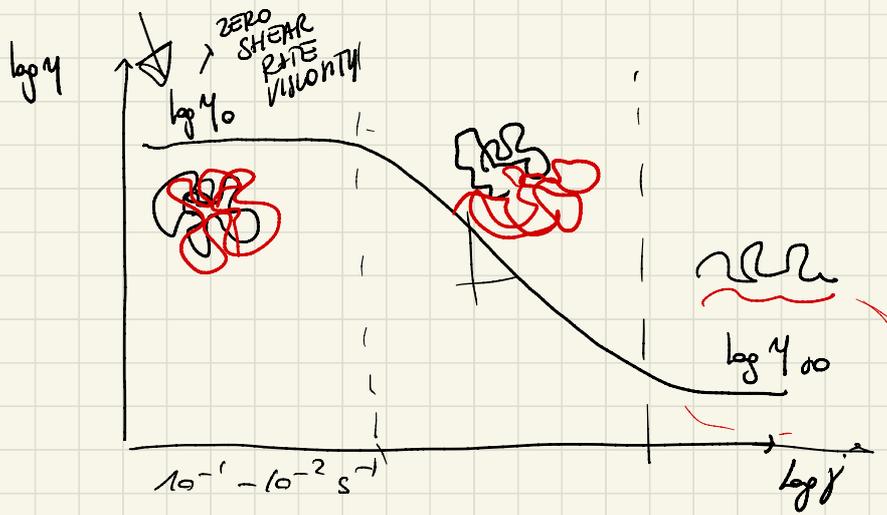


- REOMETRO A PIATTO

$$G^* = (G' + iG'')$$

↓
MODULO COMPLESSO





TISSOTROPIA

