

## Hukum Newton I

Dengan:  $F = \text{gaya}$ ,  $m = \text{massa}$ ,  $a = \text{percepatan}$

$$\begin{array}{l} F = m \times a \\ \downarrow \quad \downarrow \quad \downarrow \\ \text{Definisi: SI} \quad 1 \text{N(ewton)} = 1 \frac{\text{kg}}{\text{det}^2} \times 1 \frac{\text{m}}{\text{det}^2} \\ \downarrow \\ \text{MKS} \quad 1 \frac{\text{kg}}{\text{df(force)}} = 1 \frac{\text{kg}}{\text{det}^2} \times 1 \frac{\text{m}}{\text{det}^2} \end{array}$$

Jadi:

$$\boxed{1 \frac{\text{kg}}{\text{df}} = g \text{ N} \quad \text{dengan } g = 9.8}$$

Contoh: Berapa gaya yg harus diberikan kepada sebuah benda dg massa  $10 \frac{\text{kg}}{\text{det}^2}$  agar percepatan benda  $10 \frac{\text{m}}{\text{det}^2}$ .

Jawab:  $F = m \times a$

$$\begin{aligned} &= 10 \times 10 \frac{\text{kg}}{\text{det}^2} \times \frac{\text{m}}{\text{det}^2} = 100 \frac{\text{kg}}{\text{det}^2} \frac{\text{m}}{\text{det}^2} \\ &= 100 \frac{\text{N}}{\text{df}} = \frac{100}{9.8} \frac{\text{kg}}{\text{df}} \end{aligned}$$

Contoh: Berapa berat benda yang mempunyai massa  $10 \frac{\text{kg}}{\text{det}^2}$ .

Jawab:  $F = m \times a \rightarrow N = m \times g$

$$\begin{aligned} &= 10 \frac{\text{kg}}{\text{det}^2} \times 9.8 \frac{\text{m}}{\text{det}^2} \\ &= 10 \frac{\text{kg}}{\text{df}} = 10g \text{ N} \end{aligned}$$

Contoh : Suatu benda mempunyai berat  $10 \text{ kg}_f$  di bumi.

Berapa berat benda di bulan dan matahari jika  $g_{\text{bulan}} = 1.7 \text{ m/det}^2$  dan  $g_m = 270 \text{ m/det}^2$ .

Jawab :  $N = m \times g$  (di bumi)

$$10 \text{ kg}_f = m \times 9.8 \text{ m/det}^2 \rightarrow m = \frac{10 \text{ kg}_f}{9.8 \text{ m/det}^2} = 10 \text{ kg}_f \cdot \frac{1 \text{ m/det}^2}{9.8 \text{ m/det}^2}$$

Di bulan :  $N_{\text{bulan}} = m \times g_{\text{bulan}}$

$$= 10 \text{ kg}_f \cdot \frac{1.7 \text{ m/det}^2}{9.8 \text{ m/det}^2} = 17 \text{ kg}_f \cdot \frac{\cancel{m/det}^2}{\cancel{m/det}^2}$$
$$= 17 \text{ } \underline{\underline{N}} = \frac{17}{9.8} = 1.735 \text{ kg}_f \quad \underline{\underline{N}}$$

Di matahari :  $N_m = m \times g_m$

$$= 10 \text{ kg}_f \cdot \frac{270 \text{ m/det}^2}{9.8 \text{ m/det}^2} = 2700 \text{ kg}_f \cdot \frac{\cancel{m/det}^2}{\cancel{m/det}^2}$$
$$= 2700 \text{ } \underline{\underline{N}} = \frac{2700}{9.8} = 275.51 \text{ kg}_f \quad \underline{\underline{N}}$$

RESUME :  $1 \text{ kg}_f = 2 \text{ Newton}$

$$1 \text{ kg}_f = 1 \text{ kg}_f / \frac{9.8 \text{ m/det}^2}{1 \text{ N} / \text{m/det}^2} = 1 \text{ N} / \text{m/det}^2$$

berat

$$1 \text{ kg}_f \Leftrightarrow$$

$$\Leftrightarrow 1 \text{ kg}_f$$

massa

## Q Rapat massa ( $\rho$ )

$$\rho = \frac{m}{V}$$

## Q Rapat relatif ( $s$ )

$$s_x = \frac{\gamma_x}{\gamma_{air}} = \frac{\rho_x}{\rho_{air}}$$

## Q Berat jenis ( $\gamma$ )

$$\gamma = \frac{W}{V} \rightarrow \gamma = \frac{mg}{V} = \rho g$$

dengan  $W$  = berat benda

$m$  = massa benda

$V$  = volume benda

**Contoh:** Setu liter minyak mempunyai berat  $0.70 \text{ kg}_{gf}$ . Hitung berat jenis, rapat massa dan rapat relatif. ( $\gamma_{air} = 1000 \text{ kg}_{gf}/\text{m}^3$ )

Jawab:  $\frac{V}{m} = 1 \text{ l} = 1 \text{ dm}^3 = 0.001 \text{ m}^3$

$$W_m = 0.70 \text{ kg}_{gf} \rightarrow \text{massa}_m = 0.70 \text{ kg}_{gm}$$

Jadi:  $\rho_m = \frac{m}{V} = \frac{0.70 \text{ kg}_{gm}}{0.001 \text{ m}^3} = \underline{\underline{700 \text{ kg}_{gm}/\text{m}^3}}$

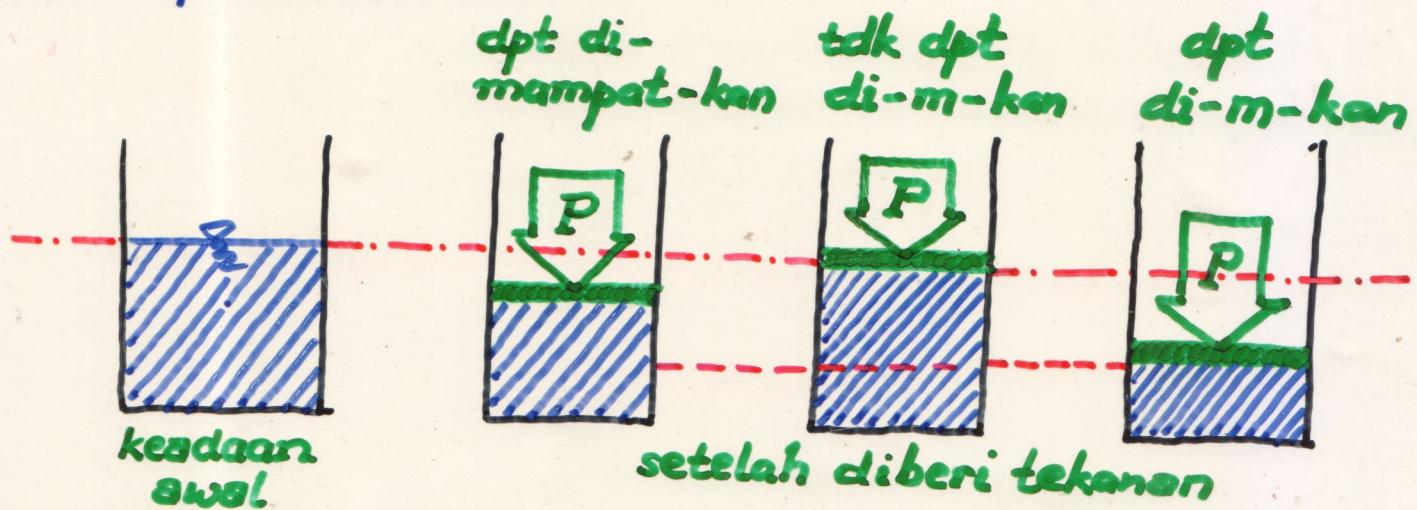
$$\gamma_m = \frac{W}{V} = \frac{0.70 \text{ kg}_{gf}}{0.001 \text{ m}^3} = \underline{\underline{700 \text{ kg}_{gf}/\text{m}^3}}$$

$$= 700 \times 9.8 \text{ N/m}^3$$

$$= \underline{\underline{6860 \text{ N/m}^3}}$$

$$S_m = \frac{\rho_m}{\rho_{air}} = \frac{700}{1000} = \underline{\underline{0.70}}$$

## I Kemampuan Zat Cair.



Kemampuan suatu cairan ditandai dg kemampuan cairan tersebut merubah volumenya krn adanya perubahan tekanan.

Kemampuan cairan dinyatakan dalam Modulus Elastisitas ( $K$ ) yg didefinisikan sebagai :

perbandingan antara perubahan tekanan dengan perubahan volume terhadap volume awal.

$$K = \frac{dp}{\frac{dv}{V}}$$

dengan  $p$  = tekanan

$$= \frac{\text{gaya}}{\text{luas}}$$

Contoh: Berapa perubahan volume  $1\text{ m}^3$  air dengan  $K = 2.24 \times 10^9 \text{ N/m}^2$  jika terjadi penambahan tekanan 20 bar ( $1\text{ bar} = 10^5 \text{ N/m}^2$ ).

Jawab:  $K = -\frac{dp}{dV} \rightarrow dV = -\frac{dp}{K} V$

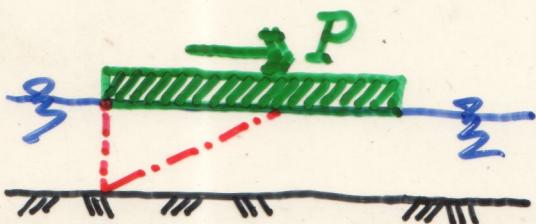
$$dV = -\frac{20 \times 10^5 \text{ N/m}^2}{2.24 \times 10^9 \text{ N/m}^2} \times 1\text{ m}^3 = \underline{-0.00089 \text{ m}^3}$$

(vol. berkurang)

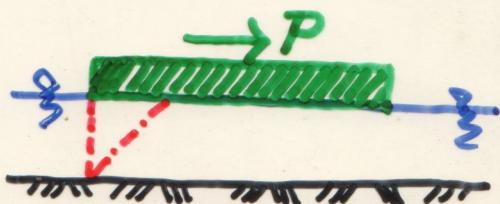
### » Kekentalan Zat Cair

Kekentalan suatu cairan ditandai dg adanya kemampuan melawan tegangan geser.

lebih encer



lebih kental



Kekentalan cairan dinyatakan dalam :

$\mu$  (mu) : kekentalan dinamik ( $\text{N.det}/\text{m}^2$ )

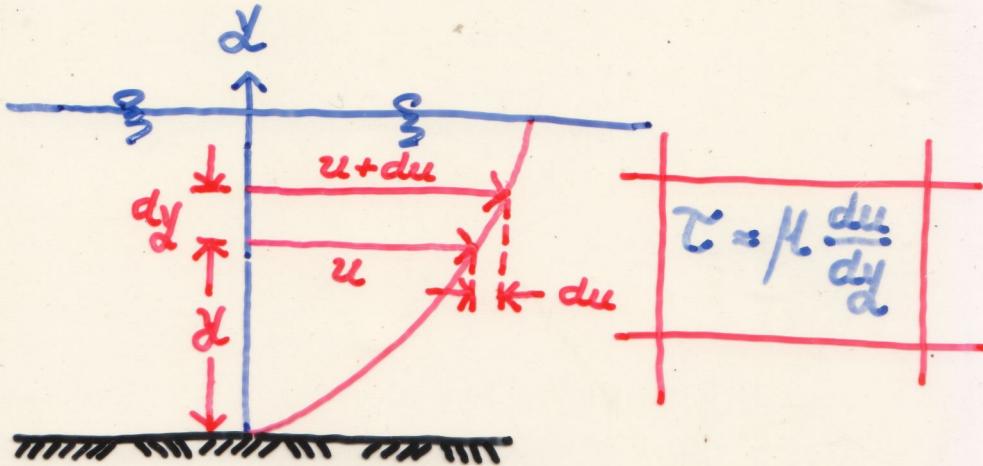
$\nu$  (nu) : kekentalan kinematik ( $\text{m}^2/\text{det}$ )

Korelasi antara kedua kekentalan :

$$\mu = \rho \nu$$

## ► Tegangan Geser ( $\tau$ )

Tegangan geser ( $\tau$ ) yg terjadi didalam cairan sebanding dengan laju perubahan kecepatan pada suatu vertikal.



Contoh :

Hitung  $\nu$  jika diketahui  $s$  cairan adalah 0.95 dan  $\mu = 0.0011 \text{ N.det/m}^2$ .

Jawab :

$$\begin{aligned}\nu &= \frac{\mu}{\rho} = \frac{\mu}{s\rho_{\text{air}}} = \frac{0.0011 \text{ N.det/m}^2}{(0.95) 1000 \text{ kg.m/m}^3} \\ &= 1.16 \times 10^{-6} \frac{\text{m/det}^2 \cdot \text{det/m}^2}{\text{m}^3} \\ &= \underline{\underline{1.16 \times 10^{-6} \text{ m}^2/\text{det}}}\end{aligned}$$

» Contoh : Dua buah plat horizontal // berjarak 12.5 mm. Ruang diantara plat diisi dg oli dg  $\mu = 1.4 \text{ N.det/m}^2$ . Hitung tegangan geser pd oli, bila plat atas mempunyai kecepatan 2.5 m/d.

Jawab :

Plat berjarak sangat dekat, sehingga distribusi kecepatan dpt dianggap linier,

$$\frac{du}{dy} = \frac{\Delta u}{\Delta y} = \frac{2.5 \text{ m/d}}{12.5 \text{ mm}} = 200 \text{ /det}$$

$$\begin{aligned}\tau &= \mu \frac{du}{dy} = 1.4 \text{ N.det/m}^2 \times 200 \text{ /det} \\ &= \underline{\underline{280 \text{ N/m}^2}}\end{aligned}$$

### » Tegangan Permukaan ( $\sigma_m$ )

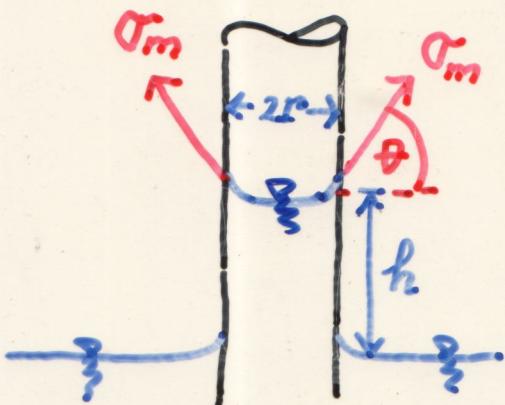
Suatu cairan, karena tdk mampu mengembang secara bebas, maka akan membentuk batas antara cairan dg cairan yg lain atau gas/udara.

Molekul cairan di permukaan saling tarik-menarik sehingga menimbulkan suatu gaya yg disebut tegangan permukaan.

Contoh kasus :



Contoh hitungan:



Berat air = Gaya tegangan muka

$$\text{tol} \times \gamma = \text{Lanjang} \times \sigma_m \times \sin \theta$$

$$\pi r^2 h \gamma = 2\pi r \sigma_m \sin \theta.$$

$$\underline{\underline{h = \frac{2\sigma_m}{r\gamma} \sin \theta}}$$

• Jika  $\theta > 0$ , maka cairan dikatakan membiasahi dinding  $\rightarrow h > \phi$ . contoh : air.

• Jika  $\theta < 0$ , maka cairan tak membiasahi dinding  $\rightarrow h < \phi$ , contoh: air raksa.

⇒ Utk tabung berdinding bersih :

$$\theta = 90^\circ \text{ utk air}, \theta = -50^\circ \text{ utk air raksa}$$

Contoh: Berapa kenaikan kapiler ( $h$ ) pd dinding gelas berdiameter 3 mm yg dimasukkan secara vertikal kedlm air. Diketahui dinding tabung bersih dan  $\sigma_m = 0.0736 \text{ N/m}$ .

Jawab:

$$h = \frac{2\sigma_m}{r\gamma} \sin \theta = \frac{2 \times 0.0736 \text{ N/m}}{(0.0015 \text{ m}) (1000 \text{ kg/m}^3)} \sin 90^\circ$$

$$\approx 0.0981 \frac{\text{N}}{\text{kg}_f} \cdot \text{m} = \frac{0.0981}{9.81} \text{ m} = \underline{\underline{10 \text{ mm}}}$$