

2. Laboratorijska vježba

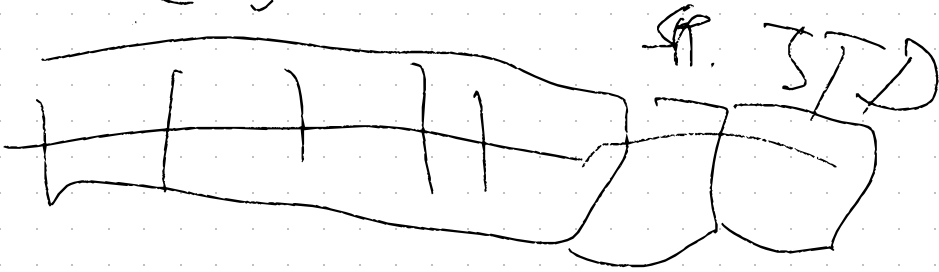
Nesigurnost mjerenja volumena: $V = \left(\frac{d}{2}\right)^2 \pi h$

$$u_v^2(h, d) = \left(\frac{\partial V}{\partial h}\right)^2 u_h^2 + \left(\frac{\partial V}{\partial d}\right)^2 u_d^2 \quad \frac{\pi}{4} d^2 h$$

$$u_v^2(h, d) = \left(\frac{d^2 \pi}{4}\right)^2 u_h^2 + \left(\frac{2\pi}{4} dh\right)^2 u_d^2$$

$$u_v^2(h, d) = \left(\frac{d^2 \pi}{4}\right)^2 u_h^2 + \left(\frac{hd\pi}{2}\right)^2 u_d^2$$

$$\bar{V} = \left(\frac{\bar{d}}{2} \right)^2 \pi \bar{h}$$



$$\bar{h} = \underline{\hspace{2cm}}$$

$$u_h = \sqrt{\frac{S(h)^2}{N}} = \underline{\hspace{2cm}}$$

$$\bar{d} = \underline{\hspace{2cm}}$$

$$u_d = \sqrt{\frac{S(d)^2}{N}} = \underline{\hspace{2cm}}$$

δ -vezdaci ja (rav. - 0,05 mm, Vaga 0,01 g)

$$u_{gd} = \sqrt{u_d^2 + u_g^2} = \underline{\hspace{2cm}}$$

$$u_{gh} = \sqrt{u_h^2 + u_g^2} = \underline{\hspace{2cm}}$$

$$d_{\text{mer}} = (u \pm u) / \text{cm} \quad h = \dots$$

$$u_v =$$

$$V_t = \frac{m_3 - m_0}{\rho_V} \quad \text{? } \rho_V \text{ temperaturu!}$$

$$U_{\phi}^2 = \sum_{i=1}^n \left(\frac{\partial \phi}{\partial x_i} \right)^2 U_{xi}^2$$

$$U_{\phi}^2 = \frac{\phi}{\sqrt{2}}$$

$$U_{m3} = U_{\phi}^2$$

$$U_{m0} = U_{\phi}^2$$

$$U_V^2 = \left(\frac{\partial V}{\partial m_3} \right)^2 U_{m3}^2 + \left(\frac{\partial V}{\partial m_0} \right)^2 U_{m0}^2$$

$$= \left(\frac{1}{\rho_V} \right)^2 U_{m3}^2 + \left(\frac{-1}{\rho_V} \right)^2 U_{m0}^2$$

$$= \left(\frac{1}{\rho_V} \right)^2 (U_{m3}^2 + U_{m0}^2)$$

$$V_{mjer.} = (\bar{V} + U)_{cm^3}$$

Priprema:

1.a) Volumen izračunat pomoću njezinih dimenzija tijela

→ Volumen se računa pomoću izmjerene visine h i promjera d , a tijelo je oblika valjka čiji medij je vrijednost volumena računamo kao:
$$\underline{\underline{V = \left(\frac{d}{2}\right)^2 \pi \cdot h}}$$

→ mjeri se pomoću Verinerovog pomičnog mjernika ($\delta = 0,05 \text{ mm}$) (najveća preciznost mjernika)

• 5 mjerenja za $h \rightarrow \bar{h} = \frac{1}{5} \sum_{i=1}^5 h_i$, $s(\bar{h}) = \sqrt{\frac{1}{20} \sum_{i=1}^5 (h_i - \bar{h})^2} = U_h$

• 5 mjerenja za $d \rightarrow \bar{d} = \frac{1}{5} \sum_{i=1}^5 d_i$, $s(\bar{d}) = \sqrt{\frac{1}{20} \sum_{i=1}^5 (d_i - \bar{d})^2} = U_d$

$\underbrace{\hspace{10em}}_{\text{srednja vrijednost}} \quad \underbrace{\hspace{10em}}_{\text{std. dev. sred. vrijed.}}$

→ $U_\delta = \frac{\delta}{\sqrt{12}} = \frac{0,005}{\sqrt{12}} \text{ cm}$ } pripadna nesigurnost rezolucije

→ kombinirana nesigurnost mjerenja

$U_{cd} = \sqrt{U_d^2 + U_\delta^2} = \underline{\hspace{2cm}} \rightarrow d_{\text{mjer}} = (\bar{d} \pm U_{cd}) \text{ cm}$ srednja vrijednost i pogreška

$U_{ch} = \sqrt{U_h^2 + U_\delta^2} = \underline{\hspace{2cm}} \rightarrow h_{\text{mjer}} = (\bar{h} \pm U_{ch}) \text{ cm}$

→ izračunamo Volumen preko \bar{V} i pogrešku U_V

kako bismo zapisali u istom obliku → $\underline{\underline{V_{\text{mjer}} = (\bar{V} \pm U_V) \text{ cm}^3}}$

$U_V = \sqrt{\left(\frac{\partial V}{\partial h}\right)^2 U_h^2 + \left(\frac{\partial V}{\partial d}\right)^2 U_d^2} \dots \text{u skripti}$

2. dio Volumen preko sile uzgona

Pokus se svodi na to da uranjamo tijelo u vodu (i posudu koja je na vagi. Vaga pokazuje ukupnu masu vode i posude

Uronimo tijelo \rightarrow razina se podigne \rightarrow veći pritisak nadmo

\rightarrow sila koja djeluje (bez tijela) $N_1 = g(m_p + m_v)$

$$\text{-- II --} \text{ --} \text{ --} N_3 = F_u + g(m_p + m_v)$$

$$\Rightarrow F_u = N_3 - N_1$$

Znači, prema Arhimedu $\rightarrow F_u = g \cdot \rho_v \cdot V_t \Rightarrow V_t = \frac{N_3 - N_1}{g \rho_v}$

a otud slijedi, jer vrijednost koju pokazuje vaga je zasnovana na kalibriranju vage već poznatim standardima mase,

da je $V_t = \frac{m_3 - m_0}{\rho_v}$ funkcija po masi

$\rho_v \rightarrow$ ovisi o temperaturi

$\rightarrow m_3$ i m_0 imamo jedno mjerenje

$$\hookrightarrow m_{m3} = u^2 g$$

$$m_{m0} = u^2 d$$

\rightarrow jer s obzirom da je jedno mjerenje, std. dev. sred. vr. je 0

1. napuniti čašu vodom do 380ml
2. očitati masu ($m_v + m_p = m_0$)
3. uroniti tijelo i ponoviti 2. korak

$\rightarrow \rho_v$ očitamo iz tablice

$\rightarrow \bar{V}_t \rightarrow$ uvrstimo u formulu $\bar{V}_t = \frac{m_3 - m_0}{\rho_v}$

$$\rightarrow u_v^2 = \left(\frac{\partial V}{\partial m_3} \right) u_{m_3}^2 + \left(\frac{\partial V}{\partial m_0} \right) u_{m_0}^2 =$$

\Rightarrow zapisati $V_{\text{vjer}} = (\bar{V} \pm u_v) m^3$