Vežba 3

SAGOREVANJE U STALNOJ ZAPREMINI

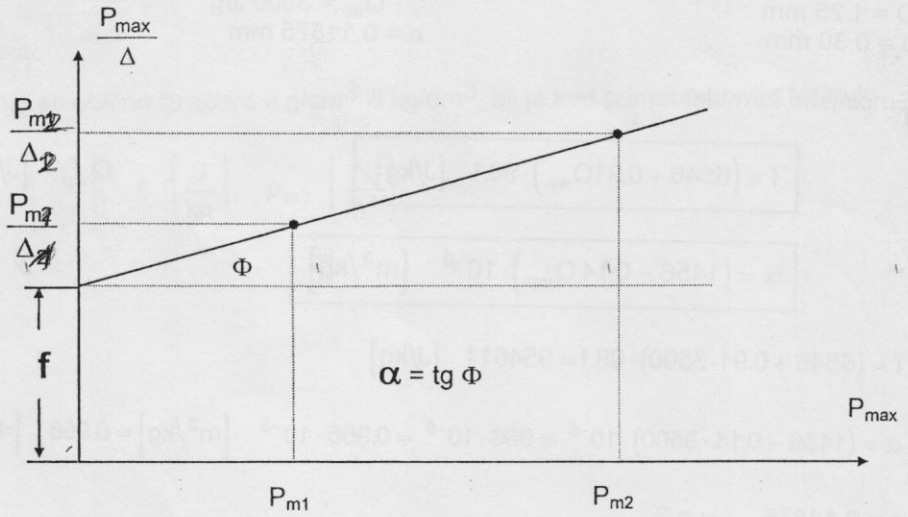
ZADATAK 1

Ispitivanjem baruta u manometarskoj bombi dobijeni su sledeći rezultati:

- pri gustini punjenja $\Delta_1 = 0.15$ kg/dm^3 dobijen je $p_{m1} = 1435$ bar,
- pri gustini punjenja $\Delta_2 = 0.25$ kg/dm^3 dobijen je $p_{m2} = 2760$ bar.

Odrediti "silu" baruta f i kovolumen barutnih gasova α.

Rešenje:



$$\alpha = \frac{\frac{p_{m2}}{\Delta_2} - \frac{p_{m1}}{\Delta_1}}{p_{m2} - p_{m1}} = \frac{\frac{2760 \cdot 10^5}{0.25 \cdot 10^3} - \frac{1435 \cdot 10^5}{0.15 \cdot 10^3}}{2760 \cdot 10^5 - 1435 \cdot 10^5} = \frac{1104000 - 956666}{1325 \cdot 10^5} = 1112 \cdot 10^{-5} \left[\frac{m^3}{kg}\right]$$

$$\boxed{\alpha = 1112 \left[\frac{dm^3}{kg}\right]}$$

$$f = \frac{p_{m1}}{\Delta_1} - \alpha p_{m1} = \frac{1435 \cdot 10^5}{0.15 \cdot 10^3} - 1112 \cdot 10^{-5} \cdot 1435 \cdot 10^5 = 956666 - 159572 = 797094 \left[\frac{Nm}{kg}\right]$$

$$\boxed{f = 797094 \left[\frac{J}{kg}\right]}$$

(jedinice: $p_m \left[\frac{N}{m^2}\right]$, $\Delta \left[\frac{kg}{m^3}\right]$, $\alpha \left[\frac{m^3}{kg}\right]$, $f \left[\frac{Nm}{kg}\right] \equiv \left[\frac{J}{kg}\right]$)

ZADATAK 2

U manometarskoj bombi zapremine 700 cm^3 sagoreva 140 g NC baruta u obliku cevčice sledeći karakteristika: spoljni prečnik cevčice 1.25 mm, prečnik kanala 0.3 mm, dužina cevčice 6.5 mm. Gustina baruta je δ = 1.6 g/cm^3 i toplotna moć baruta Q_{wp} = 3500 J/g (voda u parnom stanju). Izračunati pritisak u bombi kada izgori 0.11875 mm baruta.

Rešenje:

$$p_\psi = \frac{f\omega\psi}{W_0 - \frac{\omega}{\delta} - \omega\left(\alpha - \frac{1}{\delta}\right)\psi} \equiv \boxed{p_\psi = \frac{f\omega\psi}{W_0 - \omega\alpha\psi - \frac{\omega}{\delta}(1-\psi)}}$$

$W_0 = 700\ cm^3 = 700\cdot10^{-6}\ m^3$ $\quad$ $L = 2c = 6.5$ mm

$\omega = 140\ g = 0.140\ kg$ $\quad$ $\delta = 1.6\ g/cm^3 = 1600\ kg/m^3$

$D = 1.25$ mm $\quad$ $Q_{wp} = 3500$ J/g

$d = 0.30$ mm $\quad$ $e = 0.11875$ mm

Empirijske formule:

$$\boxed{f = \left(6546 + 0.91Q_{wp}\right)\cdot 98.1 \quad [J/kg]} \qquad Q_{wp} \quad [J/g]$$

$$\boxed{\alpha = \left(1456 - 0.14\,Q_{wp}\right)\cdot 10^{-6} \quad [m^3/kg]}$$

$$f = (6546 + 0.91\cdot 3500)\cdot 98.1 = 954611 \quad [J/kg]$$

$$\alpha = (1456 - 0.14\cdot 3500)\cdot 10^{-6} = 966\cdot 10^{-6} = 0.966\cdot 10^{-3}\ [m^3/kg] = 0.966\ [dm^3/kg]$$

$e = 0.11875 \qquad \psi = ?$

$\psi = \kappa z(1+\lambda z)$ $\quad$ (cevčica: $\mu = 0$)

$$\beta = \frac{2e_0}{2c} = \frac{0.475}{6.5} = 0.0731 \qquad \kappa = 1+\beta = 1+0.0731 = 1.0731$$

$$\lambda = -\frac{\beta}{1+\beta} = -\frac{0.0731}{1.0731} = -0.0681$$

$$\boxed{\psi = 1.0731\cdot z\cdot(1 - 0.0681\cdot z)}$$

$$e_0 = \frac{D-d}{4} = \frac{1.25 - 0.30}{4} = 0.2375 \qquad z = \frac{e}{e_0} = \frac{0.11875}{0.2375} = 0.5$$

$$\underline{\psi(0.5) = 0.5183}$$

$$p_\psi = \frac{954611\cdot 0.140\cdot 0.5183}{700\cdot 10^{-6} - 0.140\cdot 0.5183\cdot 0.966\cdot 10^{-3} - \frac{0.140}{1600}\cdot(1 - 0.5183)} =$$

$$= \frac{69268.48}{(0.7 - 0.0701 - 0.0421)\cdot 10^{-3}} = 117843.6 \cdot 10^{3} \quad \left[\frac{N}{m^2}\right]$$

$$\boxed{p_{\psi} = 1178 \quad [bar]}$$

$$p_{max} = \frac{f\omega}{W_0 - \omega\alpha} = \frac{954611 \cdot 0.140}{0.7 \cdot 10^{-3} - 0.140 \cdot 0.966 \cdot 10^{-3}} = 236641 \cdot 10^{3} \quad \left[\frac{N}{m^2}\right]$$

$$\boxed{p_{max} = 2366 \quad [bar]}$$

!!! Obratiti pažnju na jedinice kod izračunavanja p_{max} u manometarskoj bombi preko gustine punjenja (Δ):

$$p_{max} = \frac{f\Delta}{1 - \alpha\Delta}$$

Gustina punjenja se obično izražava u g/cm^3 ili kg/dm^3, ali je kod primene gornje formule:

$$\Delta \left[\frac{kg}{m^3}\right], \quad \alpha \left[\frac{m^3}{kg}\right], \quad f \left[\frac{J}{kg}\right], \quad p_m \left[\frac{N}{m^2}\right]$$