6-6

$$\Delta p = f(d, \ell, K, \rho, \mu, V)$$

فهرست نویسی $\rightarrow \Delta p = f(d^a, \ell^b, K^c, \rho^d, \mu^e, V^f) \Rightarrow b=1$ چون رابطه مناسب است.

ابعاد $\rightarrow \Delta p = FL^{-2}$, $d = L$, $\ell = L$, $\rho = FL^{-4}T^2$, $\mu = FL^{-2}T$, $V = LT^{-1}$

$$\Rightarrow FL^{-2} = L^a (L)(FL^{-4}T^2)^d (FL^{-2})^e (LT^{-1})^f$$

$$\begin{cases} F: 1 = d+e \\ L: -2 = a+1-4d-2e+f \\ T: 0 = 2d-f \end{cases} \Rightarrow a = f-3,\ e = 2-f,\ d = f-1$$

$$\Rightarrow \Delta p = \frac{\ell \mu^2}{\rho D^3} \left\{ f\left[\left(\frac{D\rho V}{\mu}, K \right)^f \right] \right\}$$

(5)

$\Delta p = f(D_1, D_2, V, \rho, \mu)$ $\quad \Delta p = FL^{-2}$ $\quad n=6, j=3$ **6-11**

$D_1 = D_2 = L$, $V = LT^{-1}$, $\rho = FL^{-4}T^2$, $\mu = FL^{-2}T$

$$n-j=3 \Rightarrow \begin{cases} \pi_1 = \Delta p\, D_1^{a_1} V^{b_1} \mu^{c_1} \\ \pi_2 = D_2 D_1^{a_2} V^{b_2} \mu^{c_2} \\ \pi_3 = \rho D_1^{a_3} V^{b_3} \mu^{c_3} \end{cases} \Rightarrow \begin{cases} \pi_1 = \dfrac{\Delta p}{D_1 V \mu} \\ \pi_2 = D_2/D_1 \\ \pi_3 = \dfrac{D_1 V \rho}{\mu} \end{cases}$$ (5)

$n=4$, $Q = L^3T^{-1}$, $H=L$, $g=LT^{-2}$, $V_0 = LT^{-1}$ **6-18**

$j=2 \Rightarrow n-j=2$

$$\begin{cases} \pi_1 = Hg^{a_1} Q^{b_1} \\ \pi_2 = V_0 g^{a_2} Q^{b_2} \end{cases} \Rightarrow \begin{cases} \pi_1 = H\sqrt[5]{g/Q^2} \\ \pi_2 = \dfrac{V_0}{\sqrt[5]{g^2 Q}} \end{cases}$$ (5)

ب) $F: \dfrac{FD}{\mu} = f_1(V, \rho/\mu, D) = \dfrac{FD}{\mu} = f_1(V, D)$, $\dfrac{FD}{V\mu} = f_2\left(\dfrac{V}{V}, D\right)$ **6-25**

ج) $f_2(D)$, $\dfrac{FD}{\mu V D} = f_3\left(\dfrac{D}{D}\right) = C$

د) $F: h = f_1\left(D, \dfrac{\sigma}{\gamma}, \dfrac{\gamma}{\gamma}\right) = f_1\left(D, \dfrac{\sigma}{\gamma}\right)$, $L: \dfrac{h}{D} = f_2\left(\dfrac{D}{D}, \dfrac{\sigma}{\gamma D^2}\right)$ (6)

$\dfrac{h}{D} = f_3\left(\dfrac{\sigma}{\gamma D^2}\right)$

2.) $F: \Delta h = f_1\left(t, \dfrac{\rho}{\rho}, D, \dfrac{\gamma}{\rho}, h\right) = f_1\left(t, D, \dfrac{\gamma}{\rho}, h\right)$

$T: \Delta h = f_2\left(t/t, D, \dfrac{\gamma t^2}{\rho}, h\right) = f_2\left(D, \dfrac{\gamma t^2}{\rho}, h\right)$, $L: \dfrac{\Delta h}{D} = f_3\left(\dfrac{\gamma t^2}{\rho D}, \dfrac{h}{D}\right)$

$q = f(H, \rho, g)$ $\quad q = L^2T^{-1},\ H = L,\ g = LT^{-2}$ (32_6

$\left.\begin{matrix} H \doteq L \\ g = LT^{-2} = HT^{-2} \end{matrix}\right\} \rightarrow T \doteq \sqrt{\frac{H}{g}}$

$q = L^2T^{-1} = (H)^2\left(\sqrt{\frac{H}{g}}\right)^{-1} = H^{\frac{3}{2}}\sqrt{g}$ $\quad \pi_1 = \frac{q}{H^{3/2}\sqrt{g}}$ (6)

$\rho \doteq L \doteq H$, $\quad \pi_2 = \frac{\rho}{H}$, $\quad \frac{q}{H^{3/2}\sqrt{g}} = f\left(\frac{\rho}{H}\right)$ $\quad q = H^{\frac{3}{2}}\sqrt{g}\, f\left(\frac{\rho}{H}\right)$

$F_D = f(D, V, \rho, \mu)$ $\quad Q = L^3T^{-1},\ A = L^2,\ \varepsilon = L$ (35_6

$g = LT^{-2}$ $\quad \pi_1 = S_0 = F^0L^0T^0$

$A \doteq L^2$

$g \doteq LT^{-2} \doteq \sqrt{A}\,T^{-2}$ $\left\{\begin{matrix} L \doteq \sqrt{A} \\ T \doteq \frac{\sqrt[4]{A}}{\sqrt{g}} \end{matrix}\right.$ $\left\{\begin{matrix} Q = L^3T^{-1} = (\sqrt{A})^3\left(\frac{\sqrt[4]{A}}{\sqrt{g}}\right)^{-1} = A^{\frac{5}{4}}\sqrt{g} \\ \varepsilon \doteq L \doteq \sqrt{A} \end{matrix}\right.$

$\pi_2 = \frac{Q}{A^{5/4}\sqrt{g}}$ $\quad \pi_3 = \frac{\varepsilon}{\sqrt{A}}$ (5)

(E1-6

$T_w = F(D, Q, \mu, \rho)$ $\quad T_w \doteq FL^{-2}$ $\quad D \doteq L$ $\quad Q \doteq L^3 T^{-1}$ $\quad \rho \doteq F L^{-4} T^2$

$\mu \doteq FL^{-2}T$

$F: \frac{T_w}{\rho} \rightarrow F_1(D, Q, \mu/\rho)$ $\quad L: \frac{T_w}{\rho D^2} \rightarrow F_2\left(\frac{Q}{D^3}, \frac{\mu}{\rho D^2}\right)$

$T: \frac{T_w}{\rho D^2}\left(\frac{D^3}{Q}\right)^2 \rightarrow F_3\left(\frac{Q}{D^3}\left(\frac{D^3}{Q}\right), \frac{\mu}{\rho D^2}\left(\frac{D^3}{Q}\right)\right)$ $\quad \frac{T_w D^4}{\rho Q^2} = F'\left(\frac{VD}{Q}\right)$

$\left(\frac{VD}{Q}\right)_m = \left(\frac{VD}{Q}\right)_p$ $\quad \frac{Q_m}{Q_p} = \frac{D_m V_m}{D_p V_p} = \frac{D_m}{D_p}$ $\quad \left(\frac{T_w D^4}{\rho Q^2}\right)_m = \left(\frac{T_w D^4}{\rho Q^2}\right)_p$

$T_{wp} = T_{wm}\left(\frac{D_m}{D_p}\right)^4\left(\frac{Q_p}{Q_m}\right)^2\left(\frac{\rho_p}{\rho_m}\right) =$

$T_{wm}\left(D_m/D_p\right)^4 \times \left(\frac{D_p}{D_m}\right)^2 \times \left(\frac{\rho_p}{\rho_m}\right)$

(3)

$T_{wp} = T_{wm}\left(\frac{D_m}{D_p}\right)^2\left(\frac{\rho_p}{\rho_m}\right) =$

$T_{wp}(0,17)\left[\frac{0,2}{0,3}\right]^2 \times 1 \rightarrow T_{wp} = 0,1076$ ✓

(E9-6

$V_m = \left(\frac{V_m}{V_p}\right)\left(\frac{D_p}{D_m}\right)V_p \rightarrow \frac{1}{50}(15 \times 1) = 0,3\ m/s \rightarrow$ ✓

$V_m = \left(\frac{V_m}{V_p}\right)\left(\frac{D_p}{D_m}\right)V_p = \frac{1.46 \times 10^{-5}}{1.12 \times 10^{-6}} \times \frac{1}{50} \times 15 = 3,91\ m/s \rightarrow$ ✓

(5)

$\frac{F_{Dm}}{F_{Dp}} = \frac{\rho_m}{\rho_p} \times \left(\frac{V_m}{V_p}\right)^2\left(\frac{L_m}{L_p}\right)^2 = 1 \times \frac{0,3^2}{15^2} \times 50^2 = 1 \rightarrow$ ✓

$\frac{F_{Dm}}{F_{Dp}} = \frac{\rho_m}{\rho_p} \times \left(\frac{V_m}{V_p}\right)^2\left(\frac{L_m}{L_p}\right)^2 = \frac{1.23 \times 3.91}{999 \times 15} \times 50^2 = \frac{1}{4,78} \rightarrow$ ✓

(۴۱-۷

$V = f(h, g, \rho, \sigma)$; $V = LT^{-1}$, $h \doteq L$, $g \doteq LT^{-2}$, $\rho \doteq FL^{-4}T^{2}$

$M \doteq FL^{-2}T$

$F: \underbrace{\frac{V}{LT^{-1}}} = f_1\left(\underbrace{h}_{L}, \underbrace{g}_{LT^{-2}}, \underbrace{\rho\sigma^{-1}}_{L^{-3}T^{2}}\right)$, $L: \underbrace{Vh^{-1}}_{T^{-1}} = f_2\left(\underbrace{gh}_{T^{-2}}, \underbrace{\rho\sigma^{-1}h^{3}}_{T^{2}}\right)$

$T: Vh^{-1}\sqrt{hg^{-1}} = f_3\left(\underbrace{(\rho\sigma^{-1}h^{3})(gh^{-1})}_{T^{2}}\right)$; $\frac{V}{\sqrt{gh}} = f_3\left(\frac{\rho g h^{2}}{\sigma}\right)$

حالت داده های مسئله مقادیر متغیر بی بعد را نسبت به آوردیم

$\frac{\rho g h^{2}}{\sigma}$	$3{,}3 \times 1^{4}$	$14{,}2 \times 1^{4}$	$29{,}18 \times 1^{4}$	$5\text{۲} \times 1^{4}$
متغیر بی بعد اولی به متغیر ۲ وابسته است ←				
$\frac{V}{\sqrt{gh}}$	1,4L	1,4(	1,41	1,41

$\Rightarrow \frac{V}{\sqrt{gh}} = 1{,}41 \rightarrow V = 1{,}41\sqrt{gh}$

(5)

۶_۶۶) گزینه ۴)

$$V_m = V_p\left(\frac{L_m}{L_p}\right)^{3/2} = V_p\,(0.02)^{3/2} = 125\,V_p$$

لزجت سینماتیکی آب با افزایش حرارت زیاد تغییر نمی‌کند ← گزینه ۲ (غ)

" " " هوا برابر آب است و با ↑ فشار ← کاهش می‌یابد ← گزینه ۱ (غ)

نوع سیال لزوماً مهم است چون لزجت سینماتیکی مدل باید حدود ۱۰۰ برابر نمونه اصلی باشد.

۹-۴۷) $\delta = f(\ell, A, \rho, V, E)$ $\quad \delta \doteq \ell \doteq L$, $A \doteq L^2$, $\rho \doteq FL^{-4}T^2$, $V \doteq LT^{-1}$, $E \doteq FL^{-2}$

$$\begin{cases} \ell \doteq L \\ V \doteq LT^{-1} \doteq \ell T^{-1} \\ \rho \doteq FL^{-4}T^2 = F\ell^{-4}(\ell V^{-1})^2 = F\ell^{-2}V^{-2} \end{cases} ; \begin{cases} L \doteq \ell \\ T \doteq \ell V^{-1} \\ F \doteq \rho \ell^2 V^2 \end{cases} \quad \begin{cases} \delta \doteq L \doteq \ell \\ A \doteq L^2 \doteq \ell^2 \\ E = FL^{-2} = (\rho \ell^2 V^2)\ell^{-2} \end{cases} ; \begin{cases} \pi_1 = \dfrac{\delta}{\ell} \\ \pi_2 = A/\ell^2 \\ \pi_3 = E/\rho V^2 \end{cases}$$

$$\frac{\delta}{\ell} = f'\left(\frac{A}{\ell^2}, \frac{E}{\rho V^2}\right) \rightsquigarrow V_m^2 = \frac{E_m}{E_p}\frac{\rho_p}{\rho_m} V_p^2 \; ; \; V_m^2 = V_p^2 \; ; \; V_m = 10 \; Km/hr$$