EXAMPLE

Drilling Hydraulics

Pressure losses Due to friction

You are drilling a 9½ inch hole at 7000 ft using 5½ inch OD drill pipe (ID = 4.778 inch) and 500 ft of 6.5" x 2.5" drill collars. The well has 10¾ in, 40.5 lb/ft (ID =10.05 in) casing set at 3500 ft. Mud is pumped down the drill pipe at the rate of 850 gal/min. Mud properties are:

density = 10 ppg, viscosity = 2- cp,
yield point = 20 lb/1.00 sq. ft. The bit has three 0.343 in ID nozzles.

1. Calculate the pressure drop in the drill pipe

Solution:-

$$\bar{V} = \frac{q}{A} = 850\frac{gal}{\min} x \frac{ft^3}{7.48\,gal} x \frac{1\min}{60\sec} x \frac{4x144}{\pi(4.778)^2} = 15.21\ ft/\sec.$$

$$N_{R_e} = \frac{928\rho\bar{V}d}{\mu} = \frac{928x10x15.21x4.778}{20}$$

$$33729 > 2100$$

$\therefore$ Flow is turbulent

From chart (Fig. 4.31)

$$f = 0.005$$

$$\Delta P_F = \frac{f\ \rho\bar{V}^2 L}{25.8\ d} = \frac{0.005x10x(15.21)^2\,x6500}{25.8\ x\ 4.778}$$

= 609.9 Psi

2. Calculate the flowing pressure at the top of the drill pipe if the pump pressure is 8000 psi.

Solution:-

From eq. 4.29

$$P_1 + .052\rho(D_2 - D_1) - 8.074x10^4\,\rho(V_2^2 - V_1^2) + \Delta P_p - \Delta P_f = P_2$$

$P_1 = 0$ $\quad V_1 = 0$, $\quad D_1 - D_2 = 0$

$\Delta P_p = 8000\ psi$

$\rho = 10\ ppg$ $\quad V_2 = 15.21$ $\quad ft/\sec$

$\Delta P_f = 0\ (surface\ lines)$

$$P_2 = 8000 - 8.074\ x\ 10^{-4}(10)\,(15.71)^2$$

= 8000 – 2 = 7998 psi

3. Calculate the flowing pressure at the bottom of the drill pipe if the pump pressure is 8000 psi.

Solution:-

Using Eq. 4.24

$P_1 = 0$, $\quad V_1 = 0$, $\quad V_2 = 15.21\ \ ft/\sec$ $\quad D_1 = 0$, $D_2 = 7000\,ft$

$\Delta P_p = 8000\ psi$

$\Delta P_f = \Delta P_s + \Delta P_{dp} = 0 + 609.9 = 609.9\ \ psi$

$$P_2 = 0 + 0.052(10)(7000 - 0) - 8.074x10^{-4}(10)\,(15.21)^2 + 8000 - 609.9$$

$$= 0 + 3640 - 2 + 8000 - 610$$

= 11,028 psi