# Important Petrophysical Equations

**1. Volume of oil in place :** $OIP = 7758 \times A \times h \times \phi \times (1 - S_w)$ bbls

**2. Volume of gas in place :** $GIP = 43560 \times A \times h \times \phi \times (1 - S_w)$ cu.ft.

**3. Porosity :**

$$\phi = \frac{V_p}{V_b} = \frac{V_b - V_{ma}}{V_b} = \frac{V_b - (W/\rho_{ma})}{V_b}$$

**4. Permeablity flow formula :**

$$Q = \frac{k \times A \times \Delta P}{\mu \times L}$$

**5. Capillary pressure :**

$$P_C = P_1 - P_2 = h \times g \times (\rho_w - \rho_o) \quad \text{oil}$$

$$P_C = P_1 - P_2 = h \times g \times (\rho_w - \rho_g) \quad \text{gas}$$

**6. Height above FWL :**

$$h = P_C / g \times (\rho_w - \rho_o) = P_C / g \times (\rho_w - \rho_g)$$

**7. Mercury capill. pressure :**

$$P_{C(a/Hg/s)} = 10\, P_{C(o/w/s)} = 10 \times \Delta\rho \times g \times h$$

$$P_{C(a/Hg/s)} = 5\, P_{C(g/w/s)} = 5 \times \Delta\rho \times g \times h$$

**8. Fluid gradient determination :**

$$p = p_0 + \rho_{oil} \times g \times (z - z_0)$$

$$p = p_1 + \rho_{gas} \times g \times (z - z_1)$$

$$p = p_2 + \rho_{water} \times g \times (z - z_2)$$

**9. Resistivity and Conductivity :**

$$R = \frac{1000}{C} \text{ ohm.m}; \qquad C = \frac{1000}{R} \text{ mS/m}$$

**10. First Archie equation :**

$$F = \frac{R_o}{R_w} = \phi^{-m}$$

**11. Second Archie equation :**

$$I = \frac{R_t}{R_o} = S_w^{-n}$$

**12 .Combined Archie equations :**

$$R_t = R_w \times \phi^{-m} \times S_w^{-n}$$

**13. Calculation of shale content** (Gamma Ray) :

$$I_{GR} = \frac{GR_{log} - GR_{min}}{GR_{max} - GR_{min}}$$

The GR Index is then entered in the appropriate chart

**14. Calculation of shale content** (Spectral Gamma Ray):

$$(V_{sh})_{Th} = \frac{Th_{log} - Th_{min}}{Th_{max} - Th_{min}}; (V_{sh})_K = \frac{K_{log} - K_{min}}{K_{max} - K_{min}}; (V_{sh})_{CGR} = \frac{CGR_{log} - CGR_{min}}{CGR_{max} - CGR_{min}}$$

**15. Sonic Log Travel time, delta T :**

$$\text{delta T} = 10^6 / V$$

**16. Sonic LogTravel time integrator check :**

$$\Delta t\ (\mu s/ft) \times h\ (ft) = t\ (\text{millisecs})$$

**17. Time average equation :**

$$\Delta t = \phi \times \Delta t_{fl} + (1 - \phi) \times \Delta t_{ma}$$

**18. Porosity from time average equation :**

$$\phi_S = \frac{\Delta t_{log} - \Delta t_{ma}}{\Delta t_{fl} - \Delta t_{ma}}$$

**19. Compaction correction :**

$$B_{cp} = \Delta t_{sh}/100$$ when $\Delta t_{sh} > 100\ \mu s/ft$

**20. Compaction corrected porosity :**

$$(\phi_S)_c = \frac{\Delta t_{log} - \Delta t_{ma}}{\Delta t_{fl} - \Delta t_{ma}} \times \frac{1}{B_{cp}}$$

**21. Raymer-Hunt porosity equation :**

$$\frac{1}{\Delta t_{log}} = \frac{(1 - \phi)^2}{\Delta t_{ma}} + \frac{\phi}{\Delta t_{fl}}$$

**22. Secondary porosity :**

$$\phi_2 = (\phi_N, \phi_D) - \phi_S$$

**23. Density Log equation :**

$$\rho_b = (1-\phi) \times \rho_{ma} + \phi \times \rho_{fl}$$

**24. Porosity from density log :**

$$\phi_D = \frac{\rho_{ma} - \rho_b}{\rho_{ma} - \rho_{fl}}$$

**25.Fluid density hydrocarbon-bearing zone :**

$$\rho_{fl} = \rho_{mf} \times S_{XO} + \rho_{hc} \times (1 - S_{XO})$$

**26. Neutron log porosity :**

$$\phi_N = \phi \; [\, HI_{mf} \times S_{XO} + HI_{hc} \times (1 - S_{XO}) \,]$$

**27. Lithology : M - N plot :**

$$M = \frac{\Delta t_{fl} - \Delta t_{log}}{\rho_b - \rho_{fl}} \times 0.01 \; ; \qquad N = \frac{\phi_{N(fl)} - \phi_{N(log)}}{\rho_b - \rho_{fl}}$$

**28. Gas Effect on Density Log :**

$$\Delta\rho_b = -\phi \times (1 - S_{XO}) \times (\rho_{mf} - \rho_{a\,gas}) \qquad (g/cm^3)$$

$$\Delta\rho_b = +\,60 \times \phi \times (1 - S_{XO}) \times (\rho_{mf} - \rho_{a\,gas}) \qquad (p.u.)$$

**29. Gas Effect on Neutron log :**

$$\Delta\phi_N = -\,100 \times \phi \times (1 - S_{XO}) \times (H_{Imf} - HI_{gas}) \qquad (p.u.)$$

**30. Excavation effect :**

$$\Delta\phi_{Nex} = K\,(\,2\,\phi^2 \times S_{wH} + 0.04 \times \phi\,)\,(1 - S_{wH})$$

**31. Shale Effect on Density log :**

$$\rho b = (1 - \phi_e - V_{sh}) \times \rho_{ma} + \phi_e \times \rho_{fl} + V_{sh} \times \rho_{sh}$$

**32. Shale Effect on Neutron log :**

$$\phi_N = \phi_e + V_{sh} \times \phi_{sh}$$

**33. "Simandoux" equation :**

$$S_w = \left[ A \times R_w \times \phi^{-m} \left( \frac{1}{R_t} - \frac{V_{sh} \times S_w}{R_{sh}} \right) \right]^{1/n}$$

**34. "Waxman - Smits" equation :**

$$S_w^{\,n^*} = \frac{R_t}{R_o} \left( \frac{1 + R_w \times B \times Q_V / S_w}{1 + R_w \times B \times Q_V} \right)$$