CE420 IRRIGATION AND DRAINAGE

HOMEWORK # 1

1. Particle size analyses is the most sure method of determining the textural properties of a soil. Given the following results of soil sample retained on various size sieves, what is the soil texture of the sample?

Sieve Size (mm)	Mass (gr)
2	0
1	0
0.5	5
0.25	4
0.1	8
0.05	15
0.002	30
Not caught	40

2. A tube 5 cm diameter was used to remove one sample of soil which was trimmed to 5.0 cm length; the soil, after trimming, weighted 156.68 gr. It was dried and reweighed and found to have lost 31.33 gr. Compute (assuming no shrinkage)
   a) θ_m b) ρ_b c) θ_v d) n if particle density is 2.67 g/cm^3

3. What is the matrix potential of a soil which has drained until pores with an equivalent diameter of 0.00020 mm remain filled?

4. What would the equivalent diameter of capillarity drained to –1/3 bar matrix potential be? Assume pure water and give your answer in mm.

5. What solute concentration would yield an osmotic potential equal to –1/3 bar?

6. What is the water potential in bars of a soil water at –1/3 bar if the water contains an active solute concentration of 2×10^{-4} moles/cm^3 at a temperature of 290 K?

7. Compute a characteristic curve for the soil in example 3.4 in the lecture notes.

HW1 SOLUTION

1) Mass of Soil = 5 + 4 + 8 + 15 + 30 + 40 = 102 gr

	SAND		SILT		CLAY	
	Mass (gr)	% (Mass/Soil Mass)	Mass (gr)	% (Mass/Soil Mass)	Mass (gr)	% (Mass/Soil Mass)
$d \geq 0.05$mm	32	31.4				
0.002 mm $\leq d \leq 0.05$mm			30	29.4		
$d \leq 0.002$ mm					40	39.22

⇓ ⇓ ⇓

From Piper Diagram (%Sand=31.4, % Silt =29.4, %Clay= 39.2)

The Sample is **CLAY LOAM**

2.) $V_{soil} = \frac{\pi D^2}{4} \cdot L = \frac{3.14 \cdot 25}{4} \cdot 5 = 98.175 cm^3$

a) m_{soil} = 156.68gr

m_{water}= 31.33 gr

m_{dry}= m_{soil} – m_{water} = 156.8 - 31.33 = 125.35 gr

$\theta_m = \frac{m_{soil} - m_{dry}}{m_{dry}} = \frac{31.33}{125.35} \cdot 100$ $\quad \theta_m$= 25%

b) $\rho_b = \frac{m_{dry}}{V_{soil}} = \frac{125.35}{98.175} \cong 1.28 gr/cm^3$

c) $\theta_v = \theta_m \cdot \rho_b = 25\% \cdot 1.28 \cong 32\%$

d) $n = 1 - \frac{\rho_b}{\rho_s} = 1 - \frac{1.28}{2.67} = 0.521 \Rightarrow$ n=52.1 %

3.) $\psi_m = -h = -2\frac{\gamma}{\rho g r}$ $\quad \gamma$=0.073 N/m , g=9.807 m/s^2 , ρ=1000 kg/m^3

2r= 0.0002 x10^{-3} $\Rightarrow$ r = 1 x10^{-7} meter

$$\psi_m = -2\frac{0.073 N/m}{9.807 m/s^2 \cdot 10^{-7} \cdot 1000 kg/m^3} = -148.8m = -14.5bar$$

(1 bar = 10.35m)

4.) $\psi_m = -1/3 bar = -10.33m/3 = -3.44 H_2O$

$$\psi_m = -2\frac{\gamma}{\rho g r} \qquad -3.44m = -2\frac{0.073N/m}{1000kg/m^3 9.807m/s^2 \cdot r}$$

r = 4.33 x 10^{-6}m $\Rightarrow$ d= 2r = 8.655 x 10^{-6}m $\Rightarrow$ **d = 0.0087 mm**

5.) $\psi_0 = -RTC_s \qquad \psi_0 = -1/3bar$

T= 290^0K (assumed)

R = 8.314 bar-cm^3/K-mole x 290 K x C_s $\Rightarrow$ **C_s= 1.38 x 10^{-4} moles/cm^3**

6.) $\psi_m = -1/3bar$

$\psi_0 = -RTC_s$; T=290^0K ; R =8.314 bar-cm^3/K-mole ; C_s=2 x 10^{-4} moles/cm^3

$$\psi_0 = -8.314 \cdot 290 \cdot 2 \cdot 10^{-4} = -0.482bar$$

$\psi_T = \psi_m + \psi_0 = -\frac{1}{3} + (-0.482)$ **ψ_T= - 0.816 bar**

7.) Based on Example 3.4

20% Clay $\Rightarrow$ C= 20 ; OM = 2.1%

50% Silt ρ_b= 1.33 kg/cm^3

30% Sand S=30

$$\frac{\theta}{100} = a_0 + a_1 S + a_2 C + a_3 OM + a_4 \rho_b$$

ψ_m (bar)	**θ_v (%)**
-0.1	-
-0.2	36
-0.33	32
-0.6	29
-1.0	26
-2.0	23
-4.0	20
-7.0	19
-10.0	18
-15.0	16