

**Example Problem 4:**  
**Calculation Procedure To Convert TPH Data From Soil Samples To Hydrocarbon Saturations**

TPH analysis results for soil samples may be converted to hydrocarbon saturation by the following equation:

$$S_o = TPH \frac{(1-f)r_{gr} \times 10^{-6} \frac{kg}{mg}}{f r_o}$$

where:

- $S_o$  = total hydrocarbon saturation (dimensionless)
- TPH = total petroleum hydrocarbon concentration in mg/kg
- $r_{gr}$  = grain density (typically 2.65 g/cm<sup>3</sup>)
- $f$  = porosity (dimensionless)
- $r_o$  = density of the hydrocarbon, liquid (g/cm<sup>3</sup>).

This equation applies to both the unsaturated and saturated zones.

The amount of free hydrocarbon present can be calculated if residual hydrocarbon saturation is known or estimated. Usually residual saturations are not known or measured, but literature values (*e.g.*, Mercer and Cohen, 1990) can be used as estimates. The free hydrocarbon saturation is given by:

$$S_{of} = S_o - S_r$$

where:

- $S_{of}$  = free hydrocarbon saturation
- $S_r$  = residual hydrocarbon saturation.

**Example Problem 4 (continued):**

The following data are for a site with a silty sand aquifer contaminated with diesel fuel. Convert the TPH data to total hydrocarbon saturation values,  $S_o$ , and free hydrocarbon saturation values,  $S_{of}$ . Literature values of residual hydrocarbon saturation,  $S_r$ , for middle distillates in silty sands suggest a value of 0.16. Assume a grain density of  $2.65 \text{ g/cm}^3$  and a free product density of 0.83.

<b>Total Petroleum Hydrocarbons (mg/kg)</b>	<b>Total Hydrocarbon Saturation, <math>S_o</math></b>	<b>Free Phase Hydrocarbon Saturation, <math>S_{of}</math></b>
1,000		
10,000		
30,000		
60,000		
90,000		

Plot the calculated total hydrocarbon and free phase hydrocarbon saturations versus TPH.

**Solution to Example Problem 4:**

Substitute the known and assumed values into the equation for calculating  $S_o$ :

$$S_o = 30,000 \times \frac{(1 - 0.25) \times 2.65 \text{ g/cm}^3 \times 10^{-6} \text{ mg/kg}}{0.25 \times 0.83 \text{ g/cm}^3}$$

$$S_o = 0.29$$

$$S_{of} = 0.29 - 0.16 = 0.13$$

<b>Total Petroleum Hydrocarbons (mg/kg)</b>	<b>Total Hydrocarbon Saturation, <math>S_o</math></b>	<b>Free Phase Hydrocarbon Saturation, <math>S_{of}</math></b>
1,000	9.58e-03	-
10,000	0.10	-
30,000	0.29	0.13
60,000	0.57	0.41
90,000	0.86	0.70