Tikrit University

The College of Petroleum Processes Engineering

Petroleum Systems Control Engineering

Department

Petroleum Refining Processes

Fourth Class

Lecture 9

By

Jasim I. Humadi

Example 1

Find the PTB of a crude oil having 10% by volume remnant water if its concentration is estimated to be 40,000 ppm at 25°C.

Solution

The example is solved using two approaches: One is based on Figure 1 and the other approach utilizes basic calculations.

1. Using Figure 1, the PTB of crude oil having 0.1% remnant water with 40,000 ppm salinity is found to be 14 PTB. For crude oil containing 10% remnant water, the value of PTB obtained from the figure should be multiplied by 100; therefore, the given crude contains 1400 PTB.

2. Take a basis of 1000 bbl of wet oil; the B.S.&W. = 10%, and the saline water concentration = 40,000 ppm = 4%. Then,

$$\text{Quantity of water in oil} = (1000)0.1$$
$$= (100 \text{ bbl})(5.6 \text{ft}^3/\text{bbl}) = 560 \text{ ft}^3$$

Now, the density of the saline water is estimated using Table 3. For 4% concentration and at 25°C, the density is 1.0253 g/cm^3, or 63.3787 lb/ft^3. Hence,

$$\text{Mass of water} = (560 \text{ ft}^3)63.3787 \text{ lb/ft}^3$$
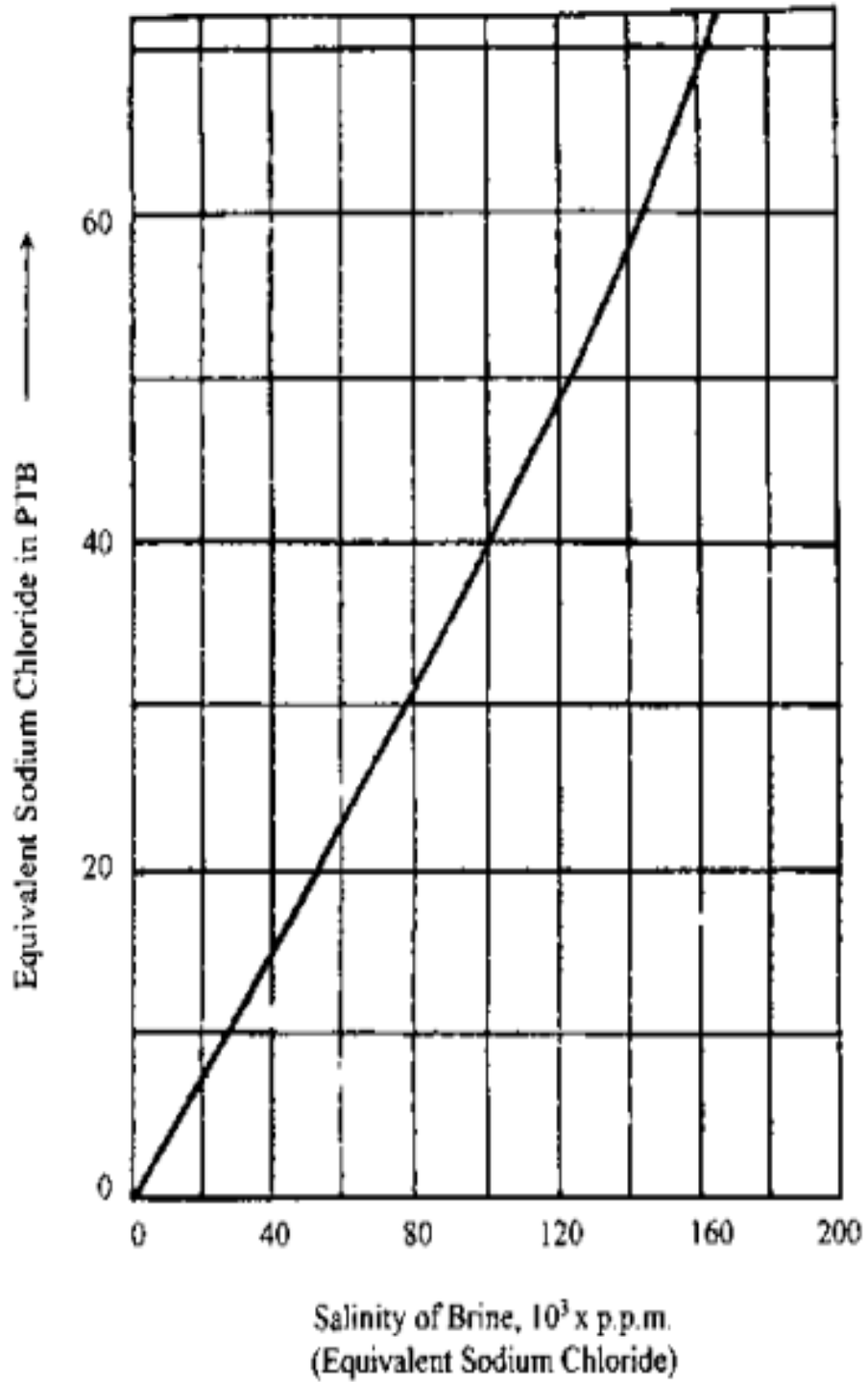$$= 35,828 \text{ lb}$$

Figure 1: Salt content of crude oil (PTB) as a function of salinity of its remnant water 0.1% (1/1000) by volume remnant water.

Table 3 Densities of Aqueous Inorganic Solutions [Sodium Chloride (NaCl)]

%	0°C	10°C	25°C	40°C	60°C	80°C	100°C
1	1.00747	1.00707	1.00409	0.99908	0.9900	0.9785	0.9651
2	1.01509	1.01442	1.01112	1.00593	0.9967	0.9852	0.9719
4	1.03038	1.02920	1.02530	1.01977	1.0103	0.9988	0.9855
8	1.06121	1.05907	1.05412	1.04798	1.0381	1.0264	1.0134
12	1.09244	1.08946	1.08365	1.07699	1.0667	1.0549	1.0420
16	1.12419	1.12056	1.11401	1.10688	1.0962	1.0842	1.0713
20	1.15663	1.15254	1.14533	1.13774	1.1268	1.1146	1.1017
24	1.18999	1.18557	1.17776	1.16971	1.1584	1.1463	1.1331
26	1.20709	1.20254	1.19443	1.18614	1.1747	1.1626	1.1492

The quantity of NaCl salt found in this mass of water is $(35{,}828)(40{,}000)/10^6 = 1433\,$lb. Since our basis is 1000 bbl of oil, the salt content is 1433 PTB.

3. Using Eq. (1) we get

$$\text{PTB} = 350\gamma_{\text{Brine}}\frac{1000W_R}{100 - W_R}\left(\frac{S_R}{10^6}\right)$$

$$\text{PTB} = (350)\,(1.0253)\frac{1000(10)}{100 - 10}\left(\frac{40000}{10^6}\right)$$

$$\text{PTB} = 1595$$