RESERVOIR FLUID PROPERTIES

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Gas Properties

Gas properties are measured in a variety of ways.

Gas samples are taken from the field to the laboratory and then subjected to tests in chromatographs and heated pressure cells.
Dew point

The **dew point** conditions occur when the first drop of liquid forms in a gas phase.

This occurs as a result of pressure and temperature change.
The formation of liquids (i.e., reaching the dew point) in petroleum fields as pressure decreases is known as retrograde conditions.
Gas Gravity

- Gas gravity is a measure of how “heavy” a gas is.

- Gas gravity = (gas molecular weight) / (air molecular weight).

- Gas gravities are usually less than one.
Gas Deviation Factor

*Gas deviation factor or z factor* represents the deviation of real gas behavior from the ideal gas law.
The real gas flow in oilfield units is:

\[ P V = Z n R T \]

Where:
- \( P \) = pressure, psia
- \( V \) = volume, cub. ft
- \( Z \) = deviation factor
- \( n \) = number of lb moles
- \( R \) = gas constant = 10.73 psia ft\(^3\)/lb mole \( \circ R \)
- \( T \) = absolute temperature, \( \circ R \)
The z factor can be:

- measured in the laboratory for a given natural gas measure.
- determined from correlations if laboratory data is not available.
- These correlations relate the z factor to gas gravity, pseudo-reduced pressure and pseudo-reduced temperature.
Gas Formation Volume Factor

Gas formation volume factors relate the volumes that fluids occupy at standard conditions to volumes that fluids occupy in the reservoir.

\[ B_g = 0.028 \frac{z \ T}{P} \]

in units Rcf / scf
Gas Viscosity

*Gas viscosities* are:
- much lower than liquids.
- estimated with correlations.
- The *correlations* relate gas viscosity to gas gravity, pressure and temperature.
Gas Density

Density is a measure of weight per unit volume of a gas at a particular temperature and pressure.

Gas density in lb/cub. ft can be calculated by:

$$\rho_g = 0.0136 \, \frac{Y_g}{B_g}$$
**Oil Properties**

- **Bubble point pressure:**

  When pressure reduced in an oil reservoir by oil production, gas bubbles form in the reservoir.

- The pressure at which these gas bubbles first appear is *called the bubble point pressure.*
The behavior of an oil reservoir changes dramatically as the pressures fall below the bubble point because the behavior of oil properties changes.
Solution Gas/Oil Ratio

This is a measure of how much gas an oil can keep in solution at a certain pressure.

The higher the pressure, the more gas that oil can hold.
**Saturated oil:**

- gas cannot all dissolved in the oil.

**Under-saturated oil:**

- oil can dissolve more gas but no free gas is available to be dissolved.
Oil Formation Volume Factor

- Is used to relate the volumes that fluids occupy at surface conditions to volumes that fluids occupy in the reservoir.
- Oil exhibits the opposite behavior of the gas.
Total Formation Volume Factor

Is the volume at reservoir conditions occupied by one stock tank barrel of oil, its gas in solution and liberated free gas.

**Above the bubble point:**

\[ B_t = B_o \]

**Below the bubble point:**

\[ B_t = B_o + B_g (R_{si} - R_s) \]
Oil viscosity is influenced by the amount of gas in solution. As pressure increases, increasing amounts of dissolved gas lower the oil viscosity until it reaches a minimum at the bubble point. Viscosity increases above the bubble point because the liquid is being compressed.
Oil Density

Oil densities are usually measured at surface conditions and reported as either specific gravity or API.

API = \( \frac{141.5}{\gamma_o} - 131.5 \)

or

\( \gamma_o = \frac{141.5}{(131.5 + \text{API})} \)
Oil density at stock tank conditions:

\[ \rho_{osc} = 62.4 \text{ Yo} \]

Oil density at reservoir conditions:

\[ \rho_o = \left( \frac{\rho_{osc}}{B_o} \right) + \left( \frac{R_s \rho_{gsc}}{5.61B_o} \right) \]
Water Properties

Water properties are similar in all reservoirs and thus may be estimated by correlations.
Water Salinity

*Can be:*

- measured in the laboratory.
- Estimated from well log resistivity readings in water saturated zones.
Solution Gas/Water Ratio

The water holds gas in solution, but the amount is very small.

Are estimated from charts.
Water Formation Volume Factor

Is used to relate the volumes that fluids occupy at surface conditions to volumes that fluids occupy in the reservoir.
Water Viscosity

Water viscosity as a function of temperature and salinity can be estimated from charts.