Resource Estimation

RESOURCE ESTIMATION

01

The oil potential of a deposit depends on:

- the pressure and temperature of the formation,
- the surface tension,
- the density and viscosity of the oil,
- the porosity and permeability of the rock, and so forth.

02

The quantum of oil and/or gas present in the reservoir pores is called oil and/or gas in place.

03

The amount of hydrocarbon oil that can be economically produced and marketed is called reserve.

04

The oil and gas volume/quantities can be estimated by the volumetric method.

Resource Estimation

- Volumetric oil in metric tons:

$$AH\,\theta(1 - s_w)\rho_0 / b_0,$$

where:

A: area of oil pool in square kilometres
H: oil pay thickness in metres
θ: porosity of the reservoir rocks
ρ_0: density of oil
b_0: volume fraction of oil in the formation
s_w: fraction saturated by water in the pores

- Volumetric gas in place:

$$AH\,\theta(1 - s_w)\, p_r T_r / (Z p_s T_s),$$

where:

A: area of oil pool in square kilometres
H: oil pay thickness in metres
θ: porosity of the reservoir rocks
s_w: fraction saturated by water in the pores
p_r: reservoir pressure in the formation
p_s: pressure at the surface of earth
T_r: absolute temperature in the formation
T_s: absolute temperature at the surface

RESOURCE ESTIMATION

- Effect of Pressure
- Connate water
- Effect of Temperature
- Effect of viscosity

Effect of Pressure

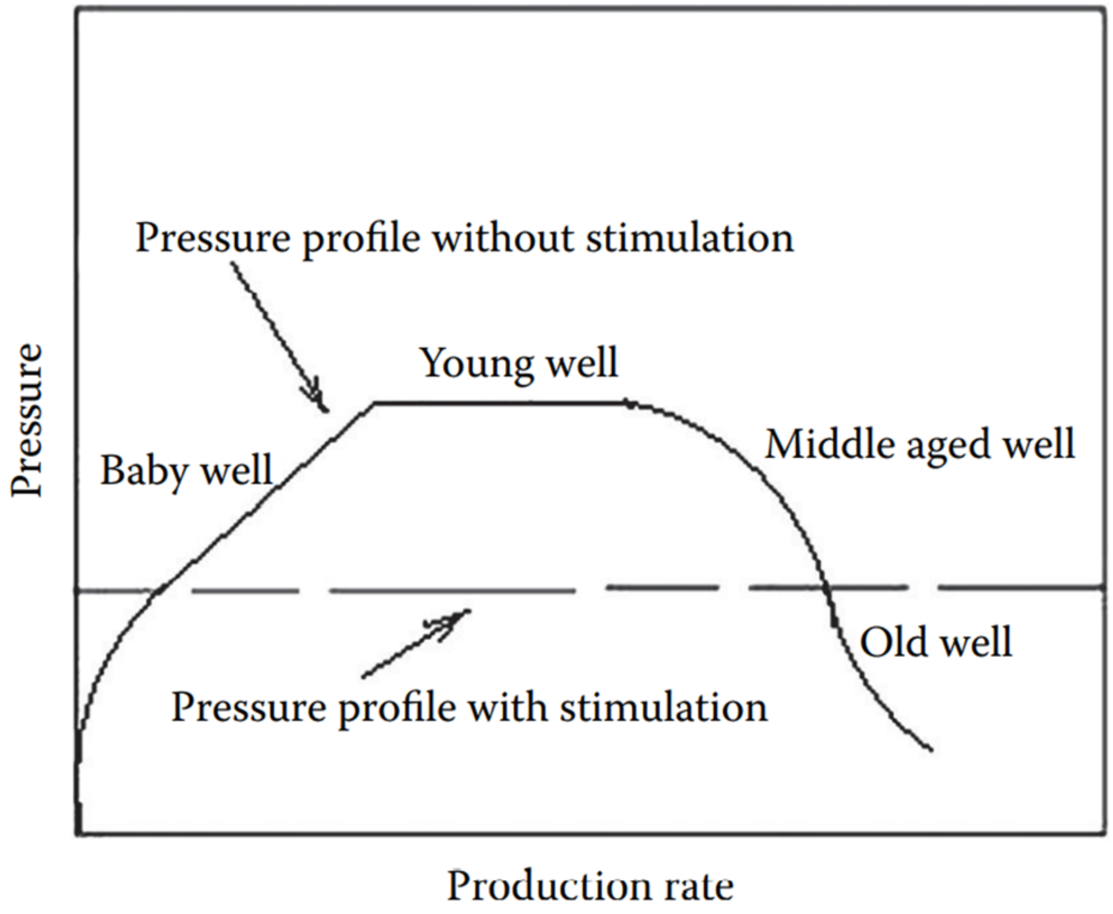
- At high reservoir pressure, the gas density is high and is dissolved in the liquid oil and is thus amenable for the production of oil and gas without the aid of additional means of power for external pressurization.

Effect of pressure – Methane Hydrates

- In many reservoirs, methane is the major constituent of gas, which has a tendency to form hydrates with water at high pressure. Once formed, methane hydrates are difficult to disperse in the well and may damage the well piping due to abrasion. The formation of methane hydrates is also responsible for a reduction in the oil pressure of the reservoir. Methanol may be injected into such wells to disperse methane hydrates.

Pressure of the well

With the production of oil and gas, the pressure of the well falls with time (years), and to maintain production, water or high-pressure inert gas is injected into the surrounding wells to maintain the pressure of the producing well. Pressure in the bottom of the well at the formation can be measured with a remote access pressure gauge lowered through the well piping. Figure beside presents a pressure profile, rate of production, and water injection rate with age of the producing well.



Stages of Production

What we can do when the pressure of the well is reduced to maintain the production?

External pressurization with water or inert gas should planned from the beginning of stage 2 to maintain maximum pressures with controlled production. Water injection should gradually raised to maintain the same pressure up to stage 4 to compensate for the fall in well pressure.

Stage 1	• is the baby well, in which production is gradually rising and reaches its maximum.
Stage 2	• is the young well, which produces the oil at the maximum rate.
Stage 3	• is the middle-aged well when production starts decreasing
Stage 4	• is the old well, while production is very low and water cut is more than oil cut, it will continue until it becomes uneconomic to continue production.

Connate Water

- Gas occupies the upper space, followed by oil in the next layer, and water in the lower part. Water occupies the major space of the reservoir.
- Oil, gas, and water in the reservoir are also present in the interstices of the porous rocks simultaneously.
- This water in the pores is called connate or interstitial water.
- The greater the amount of this water, the lower the permeability for oil.
- Water in the reservoir usually contains mineral salts. Improper selection of sites in the surrounding wells for injection of external water or gas to pressurize the producing well may result in more water cut in the production

Effect of Temperature

- The temperature under the surface of Earth increases with depth.
- The rate of increase in temperature per 34 m of depth is called ***the geothermal gradient, which may be less than or greater than 1°C per 34 m.***
- The greater ***the thermal gradient***, ***the more permeability of oil.***

- ***Recently, attempts have been made to increase the bottom hole pressure by partial combustion of oil or injection of steam or hot gas into the surrounding wells***

Effect of Viscosity

$$\tau = k\,(-\,du\,/\,dx)^n,$$

- Reservoir crude oil is classified as a viscoelastic fluid that exerts normal stress in addition to tangential stress developed while in the flowing condition.

- However, for steady state flow, the relation for pseudoplastic fluid may be more applicable
  - where τ is the shear stress, u and x are the velocity and distance, du/dx is the corresponding shear rate, k is the consistency factor (but not Newton's viscosity), and n < 1.

- Production rate is ***inversely proportional*** to the viscosity of oil and ***directly to*** the pressure of the reservoir.

Recoverability of oil

$$\xi = \mu_{oil} / \mu_{water},$$

- In the well, recoverability of oil with respect to water is measured by the ratio
- (ξ) of viscosities of oil to water, which is

$$\xi = \mu_{oil} / \mu_{water},$$

  - where μ_{oil} and μ_{water} are the viscosities of oil and water, respectively.
- The lower the value of ξ, the greater the oil cut and vice versa.
- This value increases with the age of the well and thus increases the water cut in the production.
- Attempts are made to inject polymer or high viscous compounds, which is readily soluble in water and increases the viscosity of water in the well.
- It is common to maintain **a ξ value below 3** to have a greater oil cut in the production.