RESERVOIR MODEL

This subject presents an approach to building an integrated reservoir model based upon geological, geophysical, petrophysical, and engineering data. The integrated reservoir model requires a thorough knowledge of the geology, rock and fluid properties, fluid flow and recovery mechanisms, drilling and well completion, and past production performance.

ROLE OF RESERVOIR MODEL:

The simulation can simulate many life's of the reservoir under different scenarios and thus provide a very powerful tool to optimize the reservoir operation. Historically, reservoir simulations have been used for studying large fields and those undergoing complex recovery processes. Figure (20) presents key steps involved in reservoir simulation.

The process of developing a sound reservoir because:

- It requires integration among geoscientists and engineers.
- It allows geoscientists interpretations and assumptions as to be compared to actual reservoir performance as documented by production and pressure tests.
- It provides a means of understanding the current performance and predicts the future performance of a reservoir under various " What if" conditions so that better reservoir management decisions can be made.

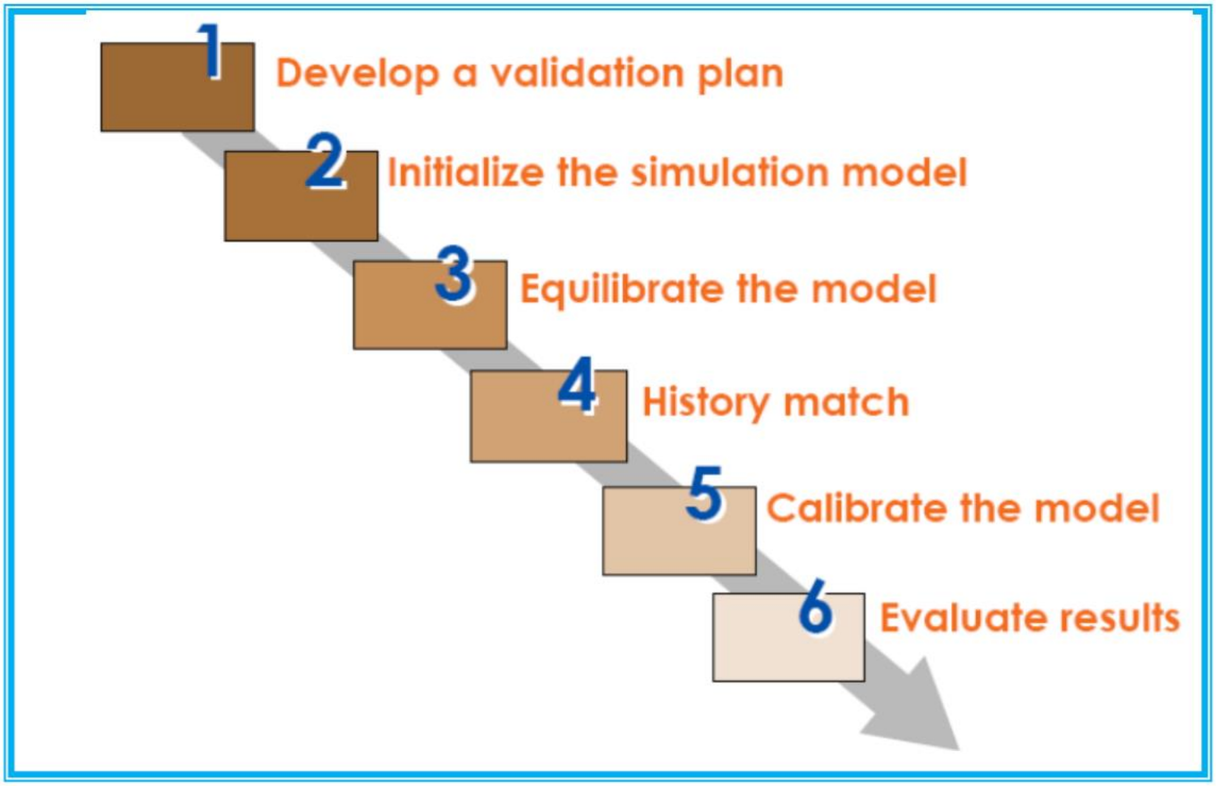


Figure (20) Reservoir Simulation Steps

In addition, the reservoir model should be developed jointly by geoscientists and engineers because:

- An inter play of effort results in better description of the reservoir and minimize the uncertainties description of a model. The geoscientists‟ data assist in engineering interpretations, where the engineering data sheds new light on geoscientists‟ assumptions.
- The geoscientists – engineers' team can correct contradictions as they arise, preventing costly errors later in the field's life.
- In a fragmented effort (i.e., when engineers and geoscientists do not communicate), each discipline may study only a fraction of the available data, thus, the quality of the reservoir management can suffer and adversely affect drilling decisions and depletion plans throughout the life of the reservoir.
- Utilizing reservoir models developed by multidisciplinary teams can provide practical technique of accurate field descriptions to achieve optimal production.

Thus, it is important that we prepare a simulation model that takes into account realistic geology and other rock – fluid characteristics, with a realistic simulation model; we can do or obtain guidance on the following;

- Determine the performance an oil field under water injection or gas injection, or under natural depletion.
- Judge the advisability of flank waterflooding as opposed to pattern waterflooding.
- Calculate the total gas field deliverability for a given number of wells at certain specified locations.
- Estimate the lease-line drainage in heterogeneous oil or gas fields.

There are many educational values of simulation models:

1. Too often we tend to demand accurate determination of all types of input data before we accept the computed results as meaningful or reliable. On the other hand, interest in accuracy of input data should be proportional to the sensitivity of computed results to variations in those data.
2. Sensitivity to errors in reservoir description data can be determined by performing simulation runs with variations in those data covering a reasonable range of all uncertainty.

A general guide for developing a model is to “select the least complicated model and grossest reservoir description that will allow the desired estimation of reservoir performance.

Incorporation of geologic model into a simulation requires recognition and capture of detailed reservoir heterogeneities. With the advent of advanced simulation and the understanding of complex subsurface structure, these heterogeneities can be recognized early in the life of a field and incorporated into the simulation model. Geoscientists and engineers need feedback from each other throughout their work. Core analysis provide data for identifying reservoir rock types, whereas well tests studies assist in recognizing flow barriers and fracture. Simulation studies can be utilized to validate the geologic model against pressure - production performance. Often adjustments are required in the model to history match to actual performance. Figure (21) shows results of a simulation case.

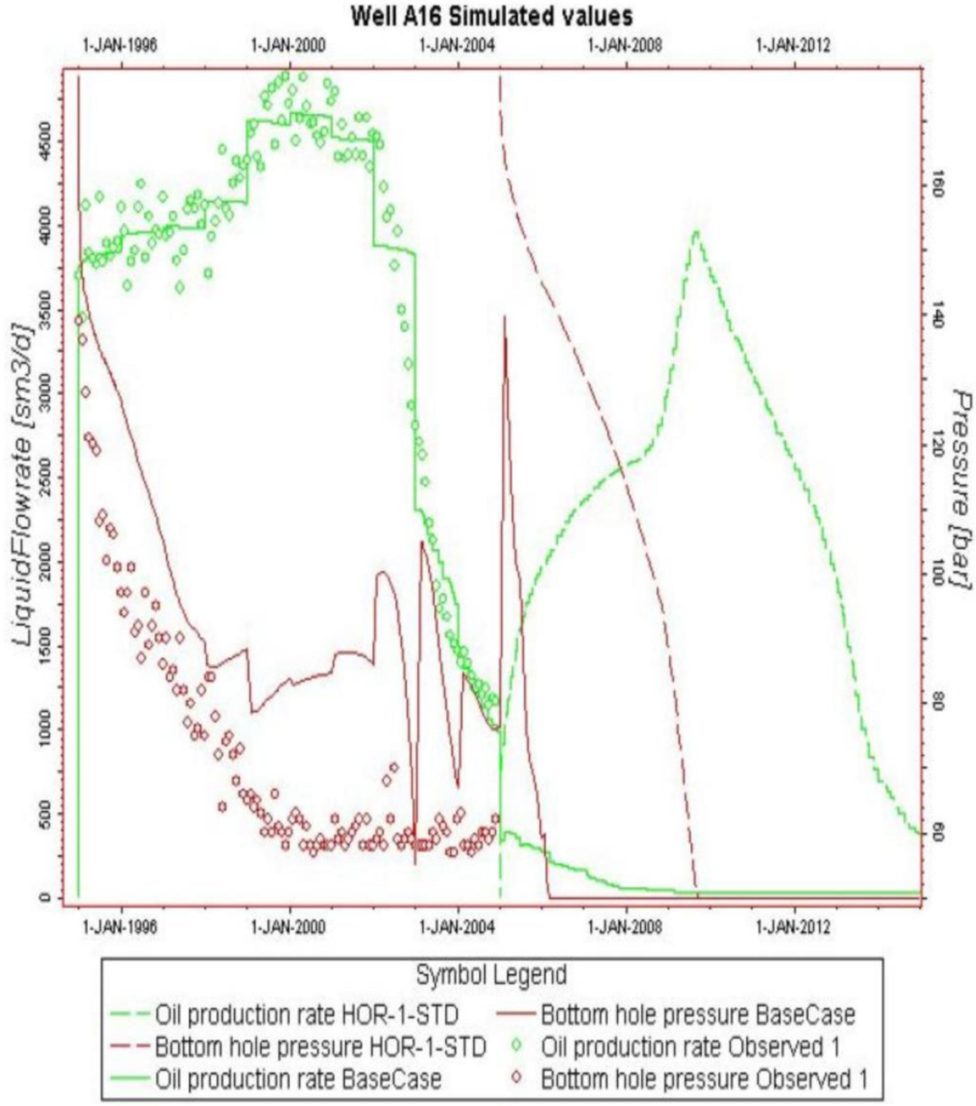


Figure (21) Simulation case

As a conclusion; constructing the reservoir model includes:

✓ Zoning the geological model.
✓ Layering the zone.
✓ Making local grid refinement.
✓ Model the attached aquifer to reservoir.
✓ Model the faults.
✓ Model the wells and add in wells data.

Figure (22) shows how to construct the geologic model

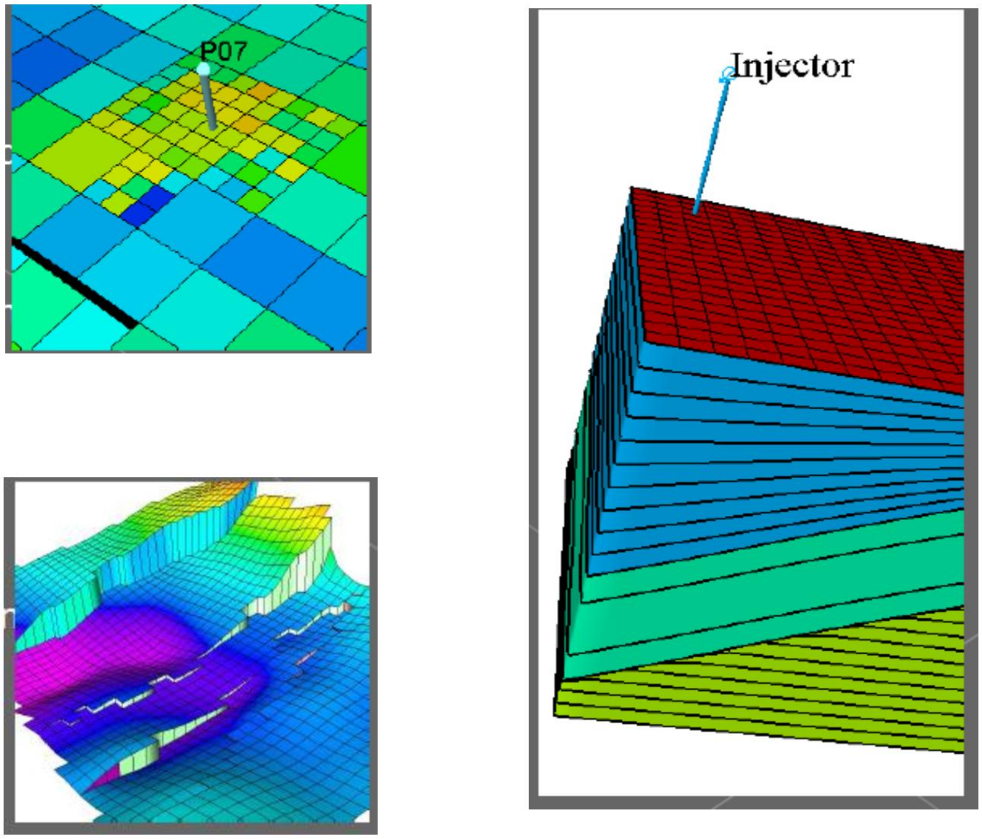


Figure (22) constructing the reservoir Model

RESERVOIR PERFORMANCE ANALYSIS AND FORECAST

A major reservoir management activity involves:

❖ Estimation of the original hydrocarbon in-place in the in the reservoir.

❖ Prediction of the future performance under the prevailing reservoir conditions.

❖ Additionally, estimation of the reserves and recovery rates under various other producing methods that are presently known, or that may become practical and economical in the future.

❖ Periodic updating of the previous items as the quality and quantity of the data improve during the life of the reservoir.

This subject presents:

1. A brief reviewing of natural producing mechanisms which influence reservoir performance.
2. Technique used for reservoir performance analysis and reserves forecast.

NATURAL PRODUCING MECHANISMS:

Primary reservoir performance of oil and gas is dictated by natural viscous, gravity, and capillary forces. It is characterized by variations in reservoir pressure, production rates, gas- oil and water – oil ratios, aquifer influx, and gas cap expansion. Factors influencing the reservoir performance are geological characters, rock and fluid properties, fluid flow mechanisms, and production facilities. The natural producing mechanisms influencing the primary reservoir performance are listed as follow:

OIL RESEVOIR (see figure 23)

1. Liquid and rock expansions (A – B)
2. Solution gas drive (B – C)
3. Gas cap drive.
4. Aquifer water influx.
5. Gravity segregation.
6. Combination drive.

GAS RESEVOIR

1. Gas depletion or expansion (D – E – F)
2. Aquifer water influx.
3. Combination drives.

Figure (24) shows the influence of primary producing mechanisms on reservoir pressure and recovery efficiency.

Figures 25 through 32 show the type of reservoir and its performance

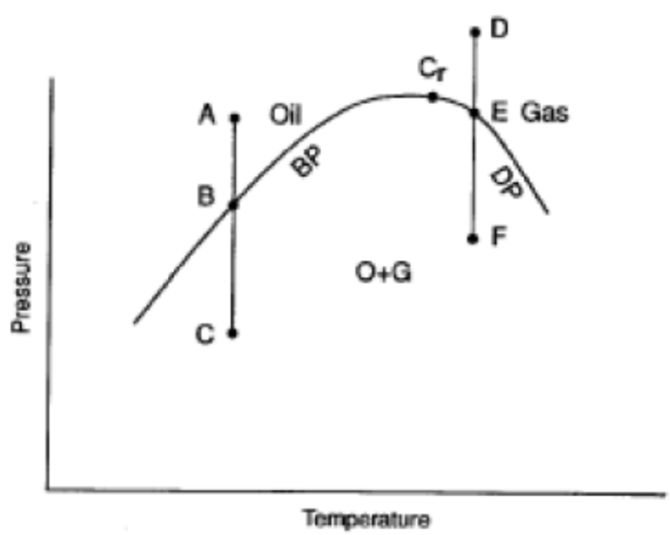


Figure (23) Hydrocarbon phase behavior

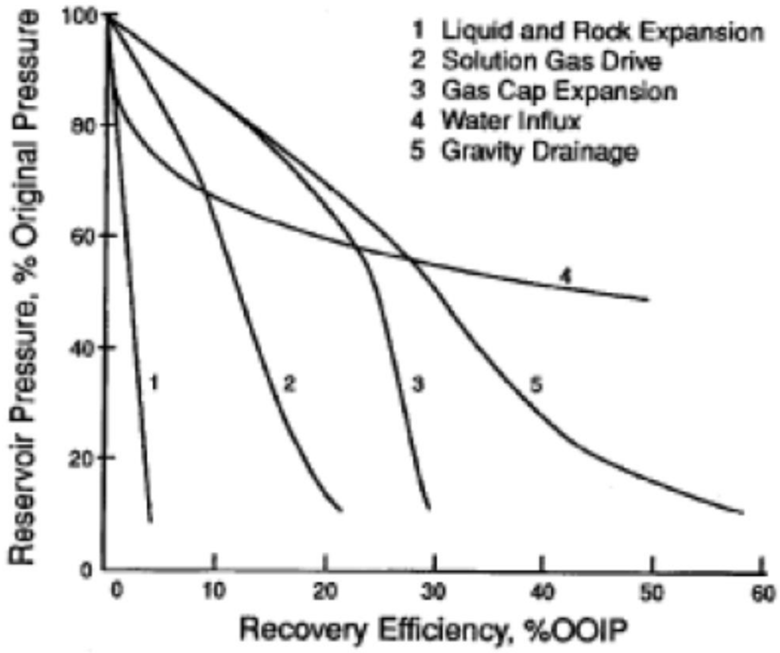


Figure (24) Natural producing Mechanisms

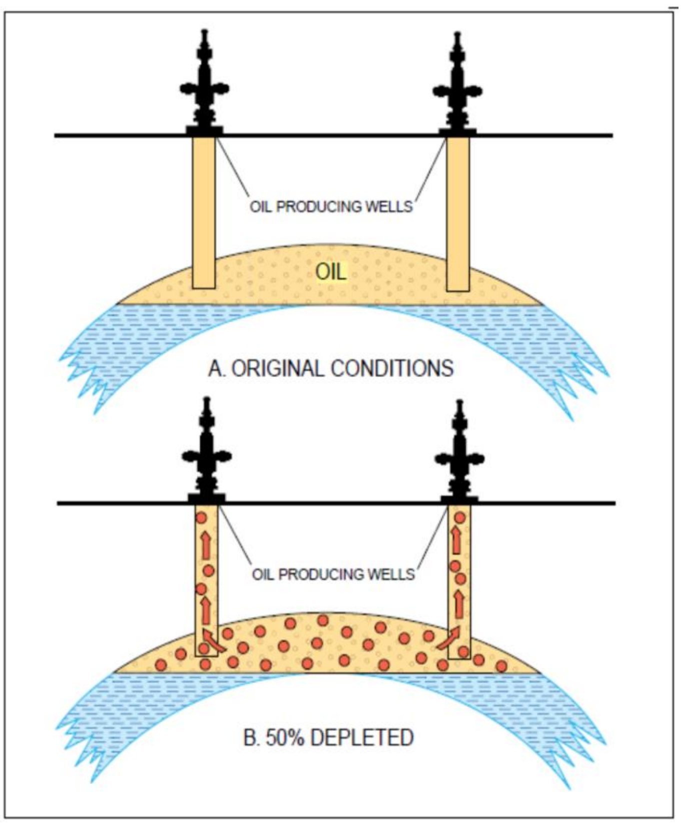


Figure (25) Solution Gas Drive Reservoir

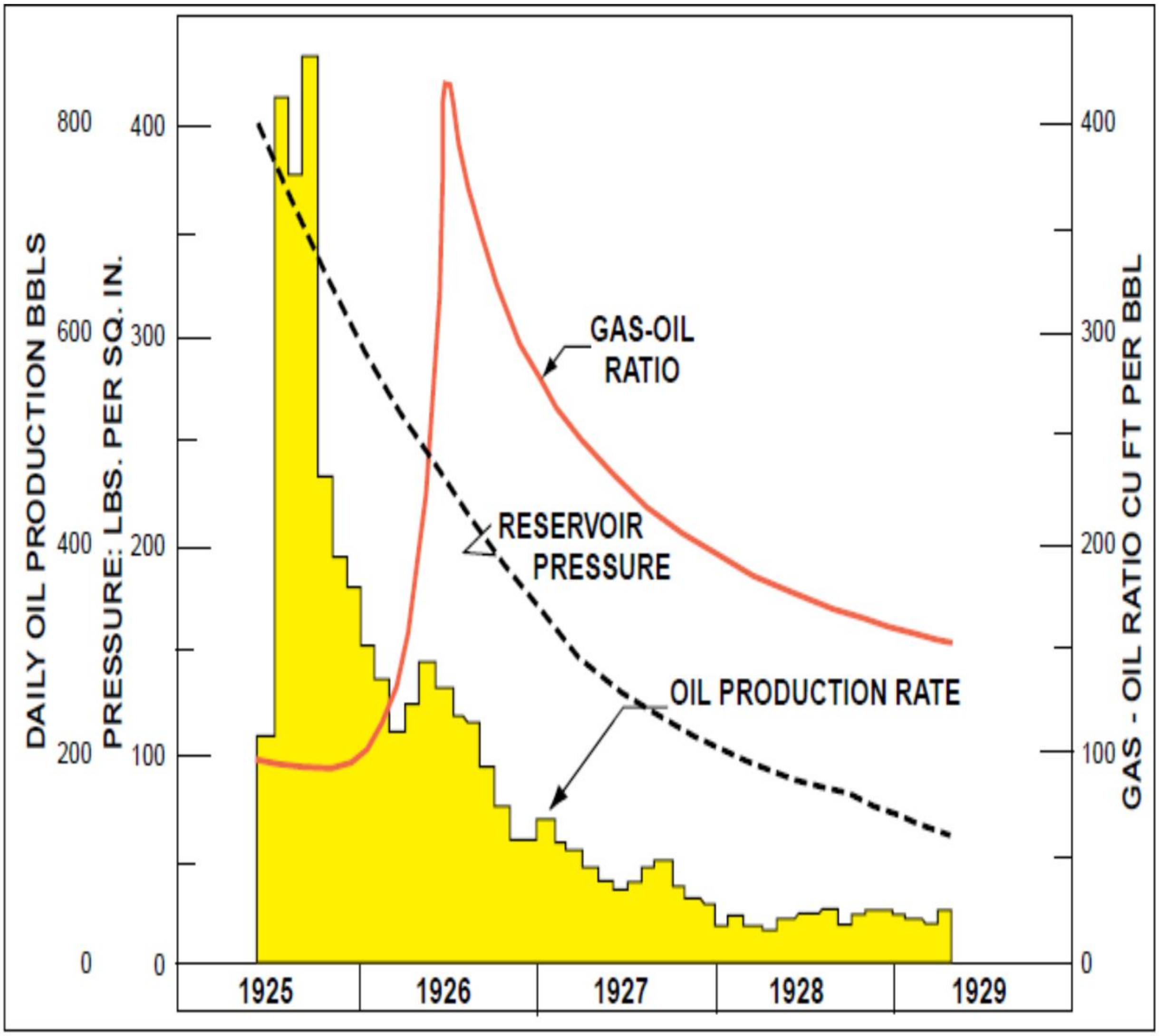
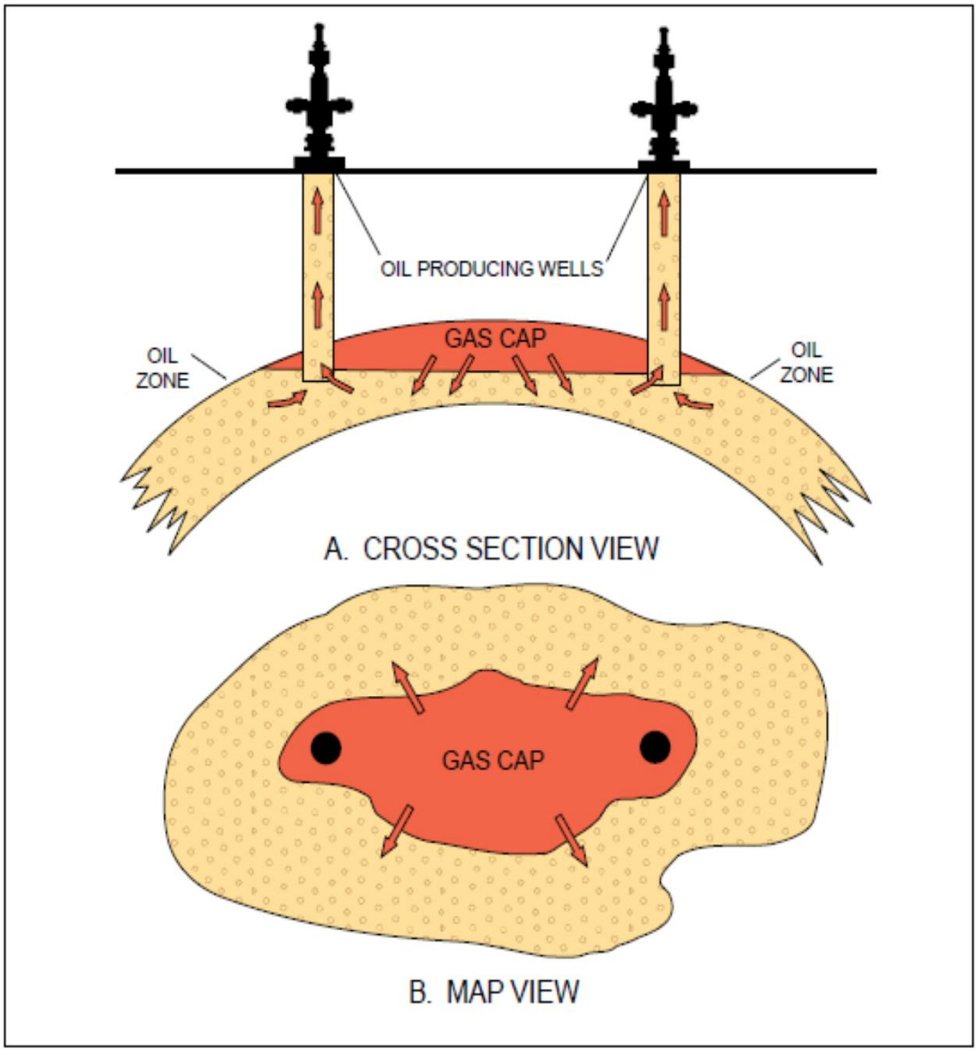


Figure (26) performance of Depletion Drive Reservoir



Figure(27) Gas Cap Drive Reservoir

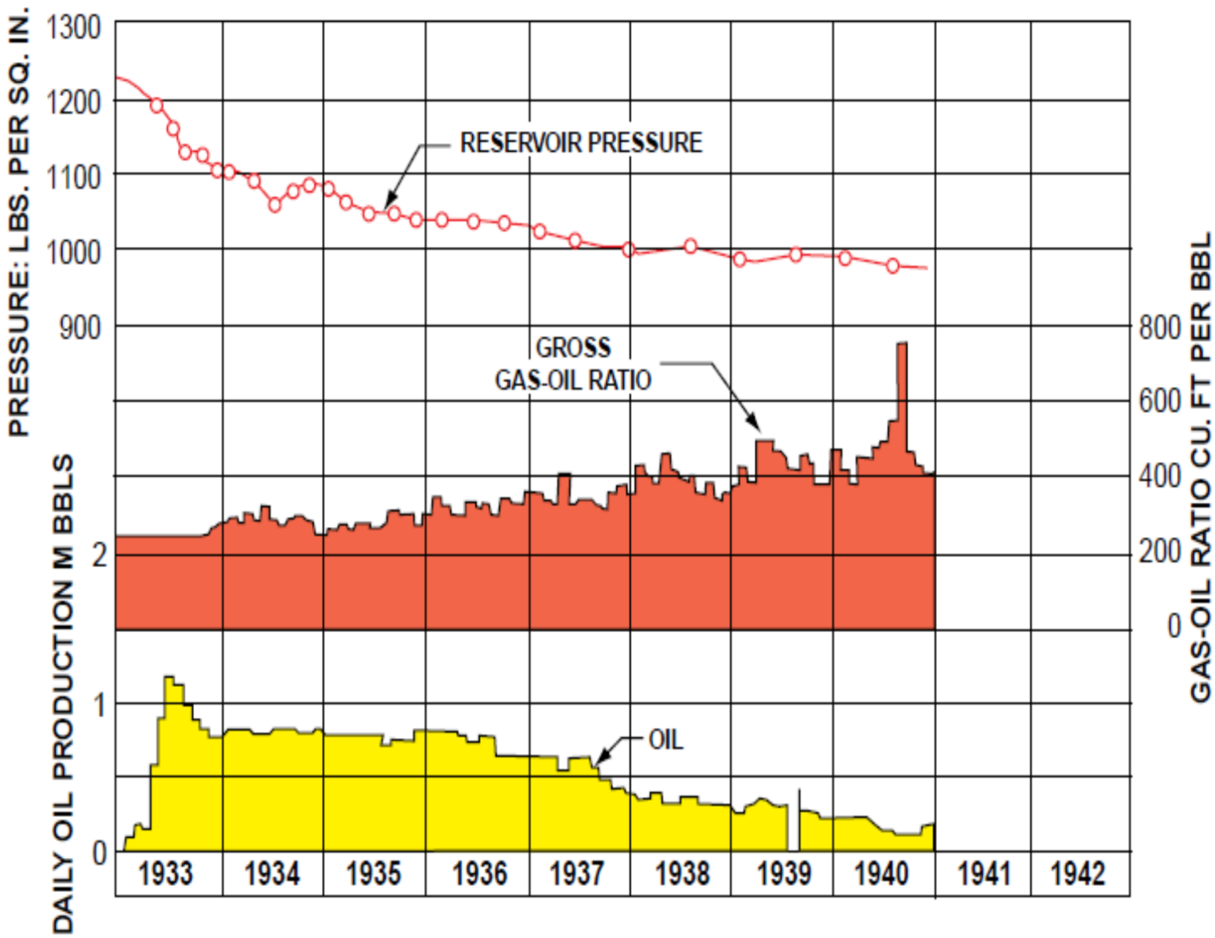


Figure (28) performance of Gas cap Drive reservoir

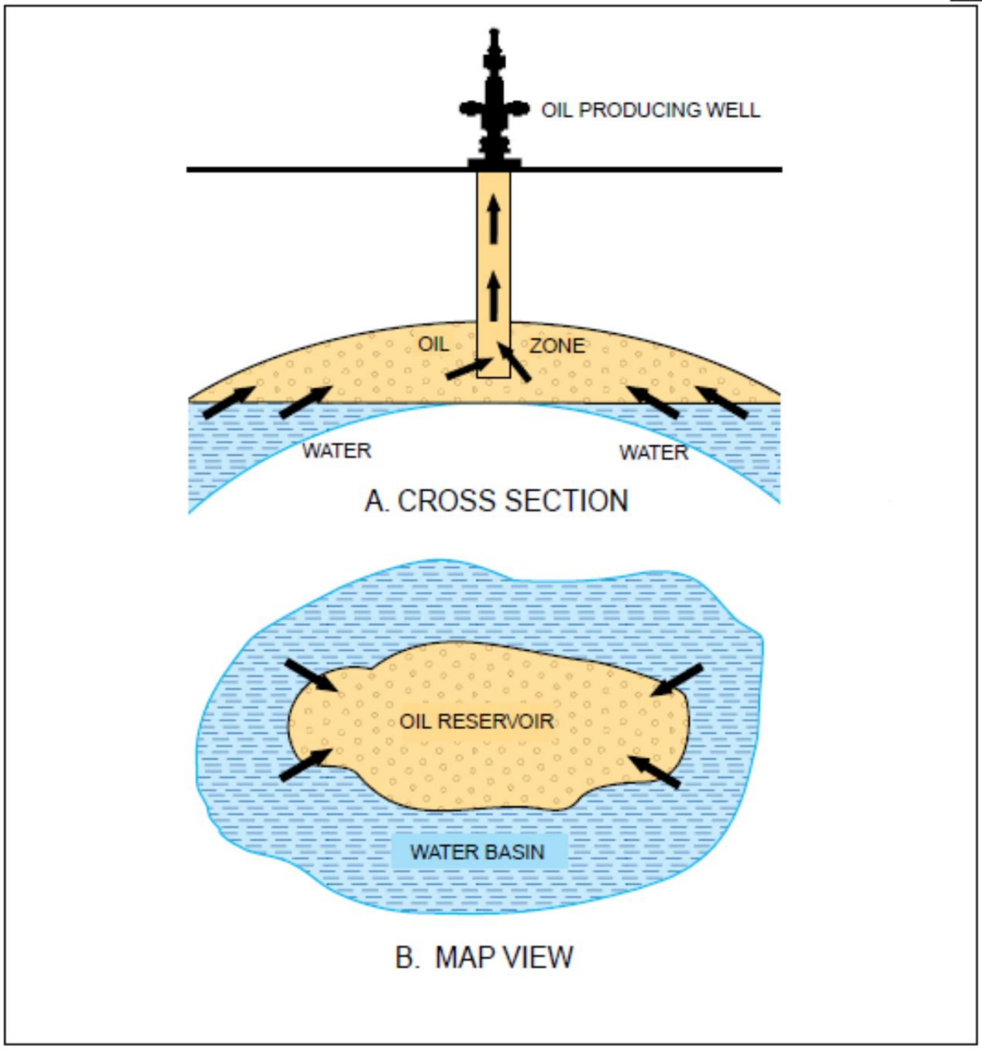


Figure (29) Water Drive Reservoir

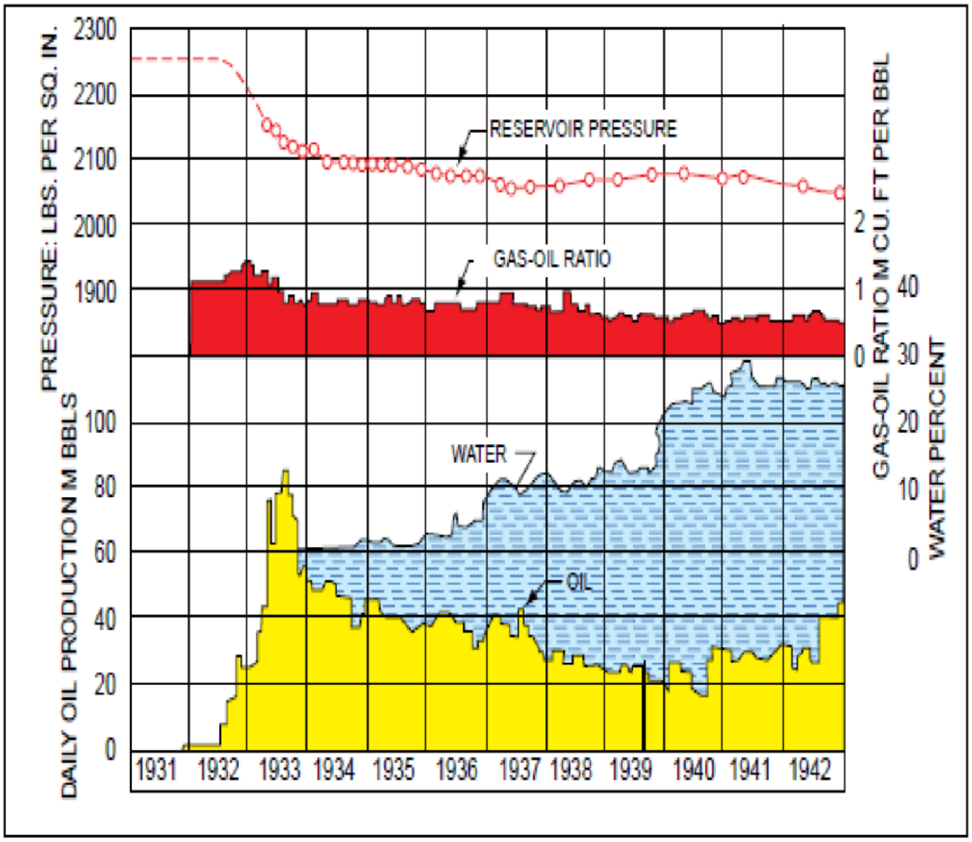


Figure (30) performance of Water Drive Reservoir

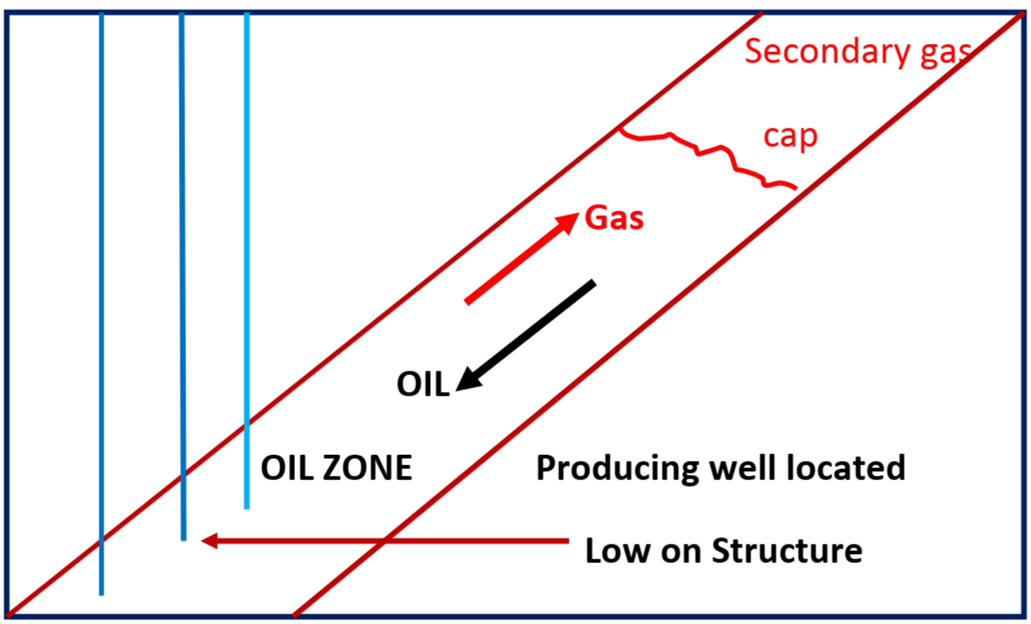


Figure (31) Gravity Drainage Reservoir

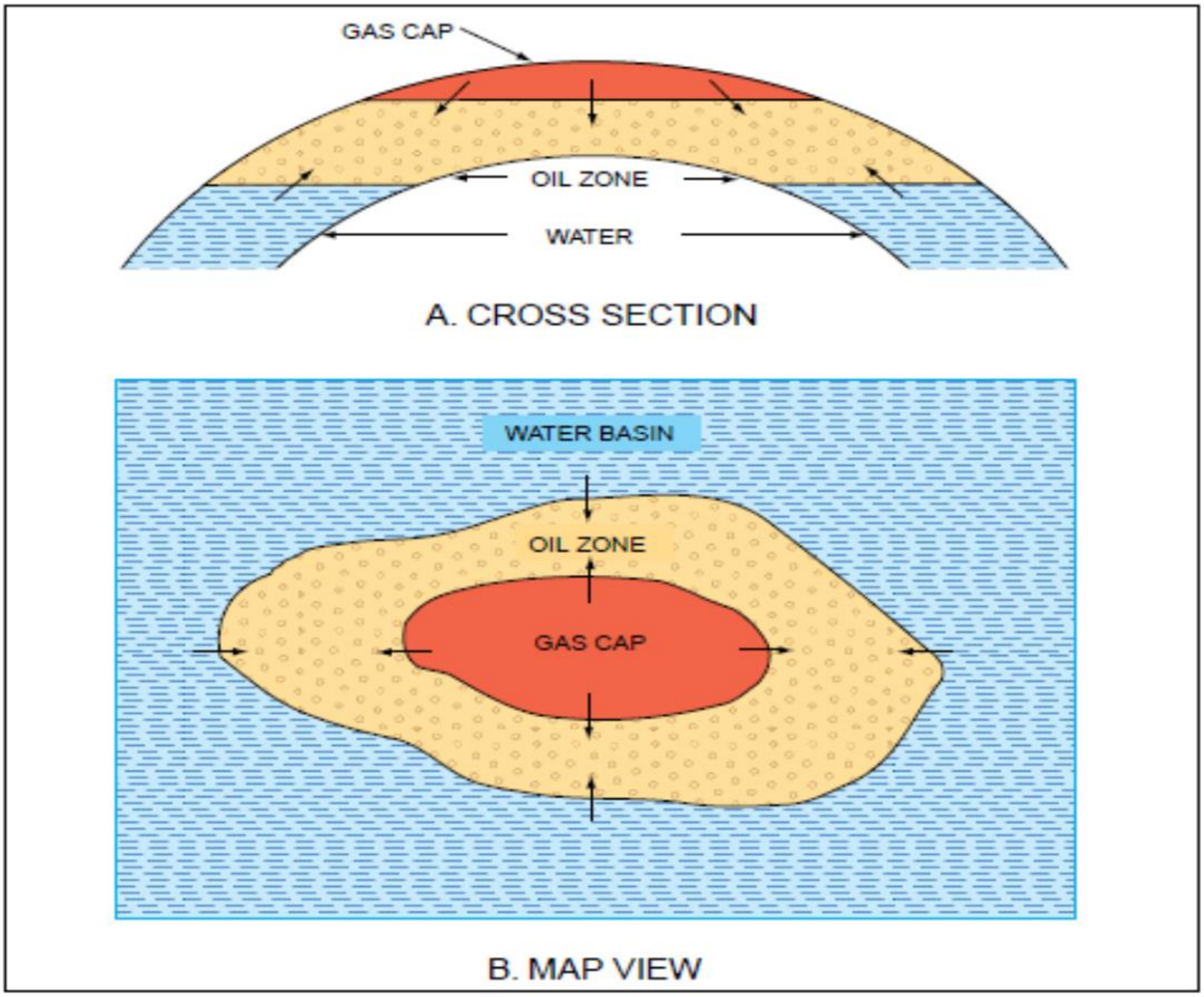


Figure (32) Combination Drive Reservoir