(1) Justify gas in place volume and recovery Estimation.

Gas in place volumes:

Original gas in place (OGIP) can be estimated volumetrically with geological and petrophysical data

$$G = \frac{A h \phi S_{gi}}{B_{gi}}$$

In oilfield units with gas measured in Bscf and $B_{gi}$ in $ft^3/Mscf$.

$$G = \frac{1}{22.957} \frac{A h \phi S_{gi}}{B_{gi}}$$

$$= \frac{1}{22.957} \frac{T_{sc}}{P_{sc}} \frac{A h \phi S_{gi} (P/z)}{T}$$

$$= \frac{1}{649.21} \frac{A h \phi S_{gi} (P/z)_i}{T}$$

In SI units with gas measured in Std $m^3$ and A in $m^2$.

$$= \frac{T_{sc}}{P_{sc}} \frac{A h \phi S_{gi} (P/z)_i}{T}$$

$$= 2.8438 \frac{A h \phi S_{gi} (P/z)_i}{T}$$

Recovery Estimation:

To better understand reserves estimation; a few important terms require definition.

Original oil in place (OOIP) & original gas in place (OGIP) refer to the total volume of hydrocarbon stored in a reservoir prior to production.

Reserves or recoverable reserves are the volume of hydrocarbons that can be profitably extracted from a reservoir using existing technology.

Resources are reserves plus all other hydrocarbons that may eventually become producible. This includes known oil and gas deposits present that cannot be technologically or economically recovered.

Following methods may be used to estimate reserves.

- ✓ Volumetric
- ✓ material Balance
- ✓ production history
- ✓ Analogy

(2) Define Basic well testing theory

Well Testing is a technique and method for the evaluation of well conditions and reservoir characteristics. It involves producing a well at constant rate or series of rates, while simultaneously taking a continuous recording of changing pressure in the well bore.

Types of well Test

- Practical well Test
  1. Productivity well Test
  2. Descriptive well Test.
- Transient well Test
- Gas well Test

parameters to be considered for the well testing:

well Testing is done to determine the following parameters.

i) Initial pressure (p)
ii) Average pressure within the drainage boundary ($P_A$)
iii) permeability (K)
iv) product of permeability and height
v) Skin factor (S)
vi) Area drainage
vii) Shape Factor ($C_A$)

pressure transient well testing is designed to provide quantitative analysis of reservoir properties. The transient test is conducted by creating a pressure in the reservoir the pressure response at the well bore ie. bottom hole well pressure.

There are different types of transient well testing which are mentioned below.

- ✓ pressure drawdown
- ✓ pressure build up
- ✓ multirate
- ✓ injection / fall off
- ✓ Interference - pulse

In the petroleum Industry, a well test is the execution of a set of planned data acquisition activities.

The well test also provide information about the state of the particular well used to collect data. The overall objective is identifying the reservoir's capacity to produce hydro carbons.

such as oil, Natural Gas and condensate.

③ How gas volume is estimated by volumetric method? Derive relationship. What are the problems do you observe when formation test is conducted?

Gas volume is estimated by volumetric method. The simples form of material balance equation on volumetric basis can be written as,

Initial volume = Volume remaining + Volume removed.

The generalized material balance equation can be written as,

[(Pv occupied by oil initially at $P_i$) + (pv occupied by gas cap initially at $P_i$)] = [pv occupied by remaining]

Where, P = Reservoir pressure

$P_i$ = Initial pressure

$P_v$ = pore volume

Volumetric Method Applications

OOIP, OGIP, recoverable reserves.

Use early in life of field

OOIP - Original Oil In place

OGIP - original Gas In place.

Dependent on quality of reservoir description. Reserves estimates often high because this method does not consider problems of reservoir.

formation testing has a broad disciplines involved in drilling & evaluating rock.

The first adopts the traditional testing approach associated with drillstem tests. In one manifestation, dual inflatable packers are mounted on one outside of the tester.

Two different approaches have been taken to the problem of acquiring the data

✓ Traditional approach associated with drillstem tests

✓ Traditional wireline approach.

(5) A gas reservoir has the following characteristics

$A = 3000$ acres $\quad h = 30ft \quad \phi = 0.15 \quad S_{wi} = 20\% \quad T = 150^\circ F$

$P_i = 2600$ psi, $\quad Z_i = 0.82$

| P | Z |
|---|---|
| 2600 | 0.82 |
| 1000 | 0.82 |
| 400 | 0.92 |

Calculate cumulative gas production and recovery factor at 1000 and 400 psi.

Solution:

Calculate the reservoir PV

$$PV = 43560\, Ah\phi$$

$$= 43560 \times 3000 \times 30 \times 0.15$$

$$= 588.06\ MMft^3$$

Calculate $B_g$ at every given pressure by using eqn.

$$B_g = 0.2827 \frac{ZT}{p}\ ft^3/scf$$

| p | z | $B_g$ ($ft^3$/scf) |
|---|---|---|
| 2600 | 0.82 | 0.0054 |
| 1000 | 0.88 | 0.0152 |
| 400 | 0.92 | 0.0397 |

Calculate initial gas in place at 2600 psi

$$G_i = \frac{43560 A h \phi (1-S_{wi})}{B_{gi}} = \frac{(PV)(1-S_{wi})}{B_{gi}}$$

$$= 588.06(10^6)(1-0.2)/0.0054$$

$$= 87.12 \text{ MMMscf}$$

Since the reservoir is assumed volumetric calculate the remaining gas at 1000 psi

$$G_{1000\,psi} = \frac{(PV)(1-S_{wi})}{(B_g)_{1000\,psi}}$$

$$= 588.06(10^6) \times (1-0.2)/0.0152$$

$$= 30.95 \text{ MMMscf}$$

Remaining gas @ 400 psi

$$G_{400\,psi} = \frac{(PV)(1-S_{wi})}{(B_g)_{400\,psi}}$$

$$= 588.06(10^6)(1-0.2)/0.0397$$

$$= 11.95 \text{ MMMscf}$$

Calculate cumulative gas production $G_p$ and the recovery factor RF @ 1000 and 400 psi

At 1080 psi

$$G_p = (G - G_{1080\,psi})$$

$$= (87.12 - 30.95) \times 10^9$$

$$= 56.17 \text{ MMMscf}$$

$$RF = \frac{56.17 \times 10^9}{87.12 \times 10^9}$$

$$\boxed{RF = 64.5\ \%}$$

At 400 psi

$$G_p = (G - G_{400\,psi})$$

$$= (87.12 - 11.95) \times 10^9$$

$$= 75.17 \text{ MMMscf}$$

$$RF = \frac{75.17 \times 10^9}{87.12 \times 10^9}$$

$$\boxed{RF = 86.3\ \%}$$

The RF for volumetric gas reservoir will range from 80% to 90%.

(b) How is gas well different from oil well? How are gas well tested.

A oil well is boring in the earth that is designed to bring petroleum oil. hydrocarbons to the surface. Usually some Natural Gas is released as associated petroleum gas along with the oil.

A well that is designed to produce only gas may be formed a gas well.

most wells produce both liquids and gas, and the general approach to installing down-hole equipment is the same whether you expect to produce predominantly oil or gas.

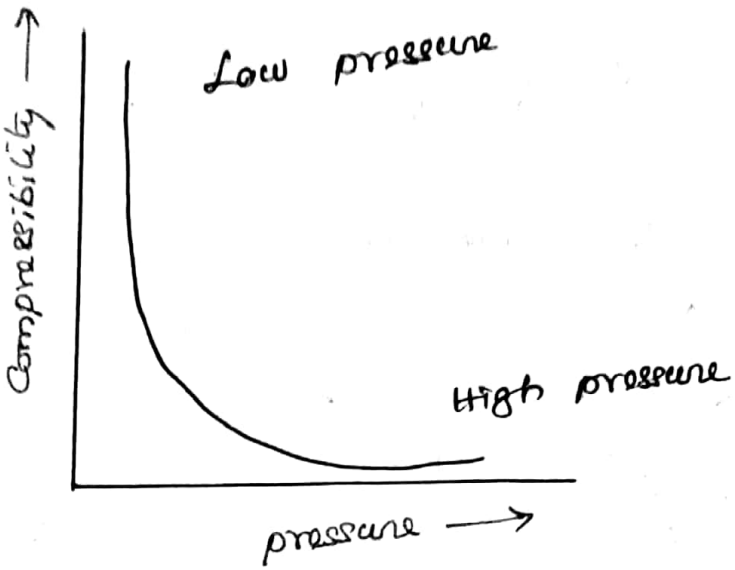
Gas well Test:

There are three types of well test

1. pseudo pressure
2. pseudo Time
3. pseudo Skin

pseudo pressure.

In the reservoir the fluid is slightly compressible and both viscosity & compressibility are independent of pressure.




For gas well test analysis, the pressure terms are completely based on pseudo pressure.

According to Ideal Gas Law

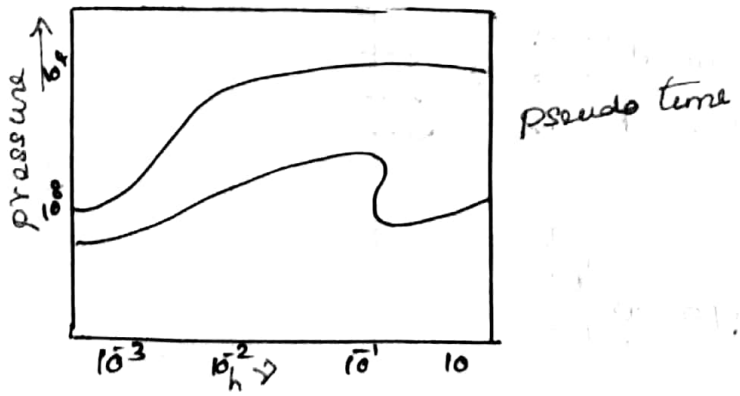
$$PV = nRT$$

Since it is the gas compressibility

$$PV = ZnRT$$

Pseudo Time:

In tight reservoir with large drawdown the assumptions that $\mu C_t$ is constant which leads to early time & log-log plot.

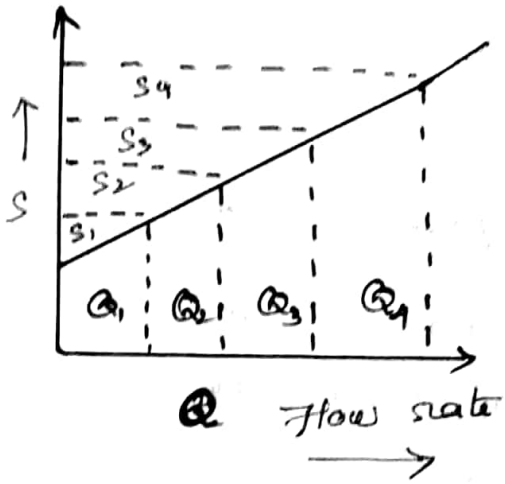


pseudo skin

$$S' = S_0 + Dq$$

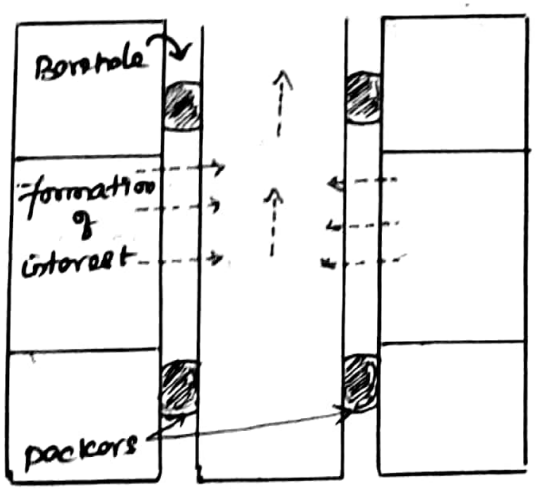
where

$S_0$ - True skin




⑦ What is formation Testing? Discuss formation interval testing in detail.

The test is an important measurement of pressure behaviour at the drill stem and is a valuable way of obtaining information whether a well has found a hydrocarbon reservoir.



Formation testing tools help

- ✓ Determine formation pressure
- ✓ Establish pressure gradients
- ✓ Identify reservoir fluid type
- ✓ Locate fluid contacts
- ✓ Calculate formation fluid mobility
- ✓ Collect representative reservoir fluid samples
- ✓ Analyse reservoir fluids in situ

Drill out new formation few feet, circulate bottom up and collect sample to confirm that new formation is drilled and then pull string onto casing.

Close annular preventor or pipe rams, line up a pump normally a smart pump

Stop the pump and close a choke valve.

Gradually pump small amount of drilling fluid into well with constant pump strike.

Bleed off pressure and open up the well.

Then proceed drilling operation.

④ Write notes on

Reservoir Testing and performance analysis.

It is a combination of various components of oil & gas well in order to predict flow rates and optimize the various components in the system. When considering the performance of oil wells it is often assumed that the well performance can be estimated by productivity index.

For reservoir pressure less than bubble point pressure, the reservoir fluid exist has two phases vapour and liquid and techniques other than productivity index must be applied

It provides,

Initial reservoir pressure ($p_i$)

permeability thickness ($kh$)

Skin ($s$)

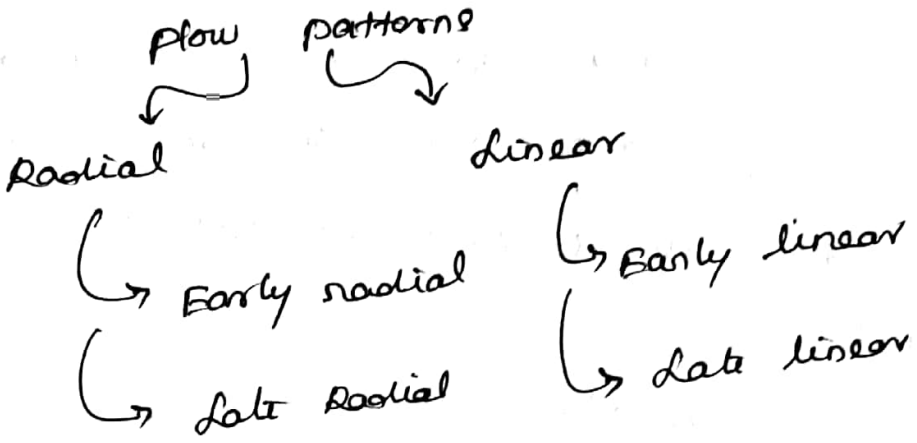
Wellbore perforated length ($h_w$)

Distance of horizontal wellbore

permeability

Effective permeability

The general flow patterns that are encountered in horizontal well testing




Write notes on

Gas in place volumes & recovery Estimations

To better understand reserves estimation, a few important terms require definition. Original oil in place (OOIP) and original gas in place (OGIP) refer to the total volume of hydrocarbon stored in a reservoir prior to production.

Reserves are the volume of hydrocarbons that can be profitably extracted from a reservoir using existing technology. Resources are reserves plus all other hydrocarbons that may eventually become producible.

Estimating hydrocarbon reserves is a complex process that involves integrating geological and engineering data.

Depending on the amount and quality of data available, one or more of the following methods may be used to estimate reserves.

Volumetric

material Balance

production history

Analogy

dependent on quality of reservoir description. Reserves estimates often high because this method does not consider problem of reservoir.

Highly dependent on quality of reservoir description & amount of production data available.

OGIP can be estimated volumetrically with geological & petrophysical data.

$$G = \frac{Ah\phi S_{gi}}{B_{gi}}$$