Petroleum and Natural Gas Reserves Calculation

1. The summary of the reserves calculation method

Reserves estimation is one of the most essential tasks in the petroleum geology and petroleum engineering. It is the process by which the economically recoverable hydrocarbons in a field, area, or region are evaluated quantitatively.

Petroleum and natural gas reserves refer to the amount of oil and gas buried in the ground, which are expressed by numerical value of the ground state. The reserves are the results of the exploration and the basis of reservoir development as well as the important basis to evaluate reservoir and make the development plan.

There are many calculation methods of oil and gas geological reserves, such as volumetric method, analogy method, production decline method, material balance method. Volumetric and performance methods are the more elaborate techniques, and the main difference between the two is the type of data used relating to pre- and post- production phases.

The volumetric method is suitable for the different stages of exploration and development, with being applied more widely than other methods. The method is the preferred method for estimation of reserves of oil and gas field. Volumetric method which uses the reservoir static data to calculate reserves can work out different types of sand body geological reserves. No matter it is in exploration or development stage, geological reserves has been the focus of the state. Because reserves are reflected in the study area development potential, is the foundation and the power of future development plan. Calculation of the geological reserves can be a good foundation for the development of oil and gas fields

Volumetric Method，as the name suggests, it requires the volume of the reservoir to be calculated through maps and data of the drilled wells. This method is carried out in the early phases of exploration to find the amount of oil and gas in place and the likely corresponding reserves.

Volumetric method of reserve estimation is a technique that employs geological observations and information to estimate original fluids-in-place. It is often referred to as a “static method” as it primarily sources its data from core samples, wireline logs, and geological maps. Volumetric calculations are typically used prior to production to estimate reserves, and after considerable production to determine the efficiency of recovery, the areal extent of the reservoir, and as a basis for advanced studies such as reservoir simulations.

The performance methods to calculate reserves include material balance method, pressure drop curve, decline curve analysis et al.

Material Balance Method is carried out in the intermediary stages of the exploration and thus the production of oil and gas is estimated.

Pressure drop curve is suitable for constant volume gas reservoirs, the pressure drop curve is linear, and the dynamic reserves can be determined by linear extrapolation.

Decline curve analysis is carried out in the late life of the field when most of the oil and gas has already been produced and the field production rate is on the decline. The future production forecast gives the reserves.

2. Practice purpose and practice method

There are two main types which are statics method and dynamic method to calculate reserves.

Master the methods to calculate the reserves with the static method and dynamic method and evaluate the reserves.

(1) Volumetric method

Estimating hydrocarbon reserves is a complex process that involves integrating geological and engineering data. Depending on the amount and quality of data available, the volumetric method of reserve calculation is one of the most important methods of reserves calculation.

A comprehensive geologic study of the prospective area is necessary to increase the confidence and reliability of determined reservoir properties such as volume, porosity, and fluid saturations. In calculating the volume of the reservoir, accurate determinations of the oil-bearing area and effective thickness must be made with respect to the geological structure and depositional environment. The use of isopach maps is a commonly used method in the determination of reservoir volume. Conclusions drawn concerning lithofacies and depositional settings are used to provide an assessment of porosity, while well logging and core data provide the geologists and engineers with measurements of fluid saturations.

The volumetric method calculates reserves with the geological parameters, such as oil-bearing area, net pay thickness, effective porosity, initial oil saturation, average density and volume factor. It is one of the most important methods to calculate reserves and widely used.

The formula

$$Q=F\bullet h\bullet \Phi\bullet Soi\bullet ro/Boi \qquad (1)$$

Where

Q---- initial oil reserves in place in standard ground conditions, t

F ---- oil-bearing area, m^2

h---- net pay thickness, effective thickness, m

Φ---- effective porosity, active porosity

Soi ---- initial oil saturation

ro ---- average density

Boi ---- volume factor

(2) Pressure drop method

The pressure drop method is essentially a specific material balance method, or linear extrapolation method, for a constant volume closed gas field. At present, it is a widely used reserves calculation method for gas fields (especially fractured carbonate gas fields). The pressure drop method is applicable to closed gas reservoirs with a recovery rate greater than 10%. It can also be used for complex gas fields such as fault blocks, fractures and lithologic traps with inactive edge and bottom water. The calculation results for reserves of gas reservoirs with poor connectivity are relatively small. It is not suitable for gas reservoirs with active edge and bottom water. The reserves calculated by this method are generally developed proven reserves, and the reserves calculated after deducting abandonment pressure can be taken as recoverable reserves.

3 Practice material

(1) There are two reservoirs which the parameters are defined by reservoir description. The parameters of calculated reserves are shown in table 6-1.

Calculate the two reservoirs oil reserves with volumetric method respectively. Compare their abundance evaluation of petroleum.

Table 6-1 Two reservoirs basic data table

Reservoir number	oil-bearing area km^2	net pay thickness m	effective porosity %	Water Saturation %	average density g/cm^3	Volume factor
1	15	10	28	45	0.8	1.1
2	15	18	36	30	0.8	1.2

Table 6-2 Petroleum abundance evaluation table

Petroleum abundance 10^4 t/ km^2	Evaluation
>300	high
100-300	medium
50-100	low
<50	special low

abundance evaluation of petroleum reserve----Reserves in place of per unit area in an oil field.

（2） Gas reservoir reserves calculation with pressure drop method

According to the table 6-3 which is production data of a gas reservoir, plotting the p/z and Gp pressure drop curve in Figure 6-1. The gas well abandonment pressure is 40MPa, infer gas recoverable reserve with extrapolation.

Table 6-3 A gas reservoir measured pressure data

time, year	1	2	3	4	5	6	7	8
Gp,10^8 m^3	0	0.2	0.6	0.9	1.3	1.8	2.5	3
P/z, MPa	52	51.5	50.7	50.5	50	49.5	49.3	49.2

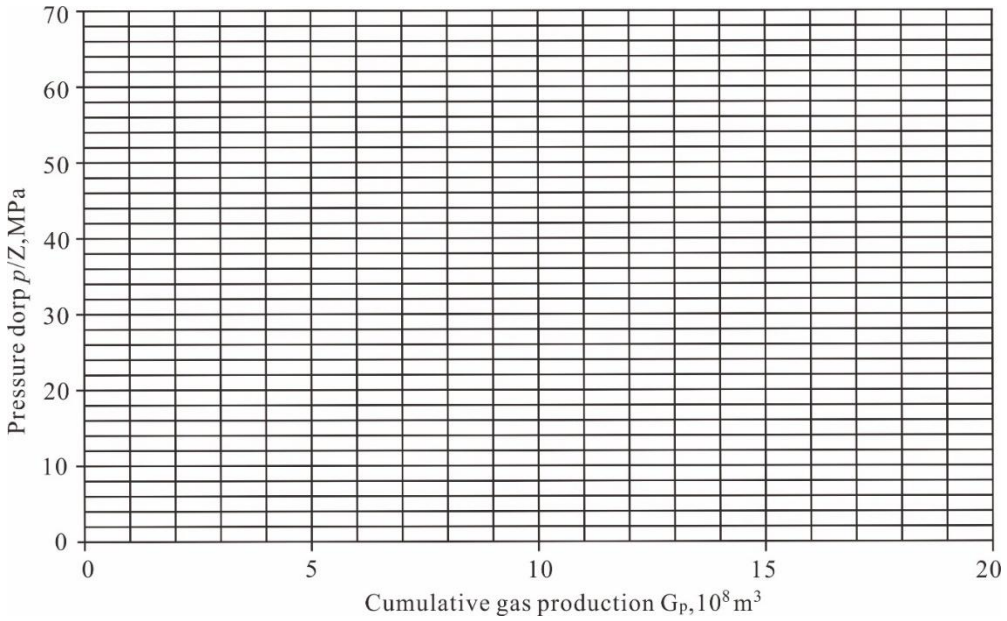

Figure 6-1 The relationship of accumulative gas production and pressure drop