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Practical lesson N1

Lesson topic: Determination of oil and petroleum gas reserves

The first method – volumetric method:

Oil reserves into the reservoir conditions can be calculated:

$$Q_{oil.res} = F \cdot h \cdot m_o \cdot S_{in} \cdot \rho_{oil} \qquad (1)$$

where

F – oil-drainage area, m^2;
h - formation thickness, m;
m_o – effective porosity coefficient;
S_{in} – initial oil saturation;
ρ_{oil} - oil density, kg/m^3;

Oil reserves into the surfase conditions can be calculated:

$$Q_{oil.res} = \frac{F \cdot h \cdot m_o \cdot S_{in} \cdot \rho}{B}, \qquad (2)$$

where

ρ- degassed oil density, kg/m^3;
b - formation volume factor.

Oil-associated gas reserves *into the reservoir conditions* can be calculated using equation:

$$Q_{gas} = F \cdot h \cdot m_o \cdot S_{in} \cdot G_o , \qquad (3)$$

G_o – initial gas factor of oil in reservoir condition, m^3/m^3.

Oil-associated gas reserves *into the surfase conditions* can be calculated using equation:

$$Q_{gas} = F \cdot h \cdot 1/b \cdot m_o \cdot S_{in} \cdot G_o , \qquad (4)$$

Task N1. Determine initial oil reserves in the field for reservoir and surface conditions for the data: reservoir radius - R= 8 km, effective oil-saturated thickness –h = 16m, open porosity coefficient - $m_{o=}$ 0.16, initial oil saturation - S_{in} =0.8, oil formation volume factor – b=1.15, degassed oil density - ρ=830 kg / m^3, oil density- ρ_{oil} =640 kg / m^3.

$F = \pi R^2 = 3{,}14 \cdot 8000^2 = 2 \cdot 10^8$ m^2

reservoir conditions

$Q_{oil.res} = F \cdot h \cdot m_o \cdot S_{in} \cdot \rho_{oil}$

$Q_{oil.res} = 2 \cdot 10^8 \cdot 16 \cdot 0.16 \cdot 0{,}8 \cdot 640 = 26{,}2 \cdot 10^{10}$ кg

surfase conditions

$$Q_{oil.res} = \frac{F \cdot h \cdot m_o \cdot S_{in} \cdot \rho}{B}$$

$Q_{oil.res}=2 \cdot 10^8 \cdot 16 \cdot 0.16 \cdot 0{,}8 \cdot 830 \cdot 1/1{,}15=29{,}56 \cdot 10^{10}$кg

The second method – method of material balance:

$Q_{oil.res} = Q_{oil.prod..} + Q_{oil.residual}$

$Q_{oil.prod..} = Q_{oil.res} \cdot \eta_{oil}$

$Q_{oil.prod..}$ - oil prodaction reserves

$Q_{oil.residual}$ - *residual oil reserves*

η_{oil} - oil recovery factor

Task N2. Determine the initial and cumulative petroleum gas reserves in the field for the following data: oil productive area – F= $6 \cdot 10^8$ m^2 , effective oil-saturated reservoir thickness – h=19 m, open porosity coefficient – m_0 = 0.15, oil saturation - S_{in} = 0.82, oil formation volume factor – b = 1.2, oil recovery factor - 0.6, solution gas-oil ratio - 97 m^3/m^3.

$Q_{gas} = F \cdot h \cdot 1/b \cdot m_o \cdot S_{in} \cdot G_o$

$Q_{gasinit.} = 6 \cdot 10^8 \cdot 19 \cdot 0{,}15 \cdot 0{,}82 \cdot 97 \cdot 1/1{,}2 = 1{,}13 \cdot 10^{11}\ m^3$

$Q_{gasprod.} = Q_{gasinit} \cdot \eta_{oil}$

$Q_{gasprod..} = 1{,}13 \cdot 10^{11} \cdot 0{,}6 = 0{,}678 \cdot 10^{11}\ m^3$

Task N3. Determine the cumulative oil production from deposits for the data: oil productive area – F=$9 \cdot 10^7$ m^2, effective oil-saturated thickness – h=15m, open porosity coefficient - m_0=0.14, initial oil saturation - S_{in} =0.76, oil formation volume factor – b=1.3, degassed oil density - ρ=840 kg / m3, oil recovery factor - η_{oil} =0.56.

$Q_{oilprod..} = 9 \cdot 10^7 \cdot 15 \cdot 0,14 \cdot 0,76 \cdot 840 \cdot 1/1,3 \cdot 0,56 = 5 \cdot 10^{10}$кg

Task N4. Determine the residual oil reserve for the data: the length of the oil deposit – L=6 km, the wigth of the oil deposit – B=2km, effective oil-saturated thickness – h=16m, open porosity coefficient - m_0=0.15, initial oil saturation - S_{in} =0.79, oil formation volume factor – b=1.2, degassed oil density – $\rho =$ 800 kg / m3, oil recovery factor - η_{oil} = 0.45.

$F = L \cdot B = 6000 \cdot 2000 = 12 \cdot 10^6 m^2$

$Q_{oilres.} = 12 \cdot 10^6 \cdot 16 \cdot 0,15 \cdot 0,79 \cdot 800 \cdot 1/1,2 = 1,52 \cdot 10^{10}$ kg

$Q_{oilprod..} = 1,52 \cdot 10^{10} \cdot 0,45 = 0,68 \cdot 10^{10}$ kg

$$Q_{oil.res} = Q_{oil.prod..} + Q_{oil.residual}$$

$$Q_{oil.residual} = Q_{oil.res} - Q_{oil.prod..}$$

$Q_{oil.resid.} = 1,52 \cdot 10^{10} - 0,68 \cdot 10^{10} = 0,84 \cdot 10^{10}$ kg