Faculty of engineering – misurata- university petroleum- department

final exam autumn 2022-2023 gas engineering

time : hours 3 open sheet Data:14-02-2023

**Problem one** : a flow after flow test has been performed and the date is tabulated below:

| q (MMscf/d | 0 | 4.288 | 9.265 | 15.552 | 20.177 |
|---|---|---|---|---|---|
| $P_{wf}$(psia) | 407.6 | 403.13 | 393.03 | 375.79 | 359.87 |

(A) plot( $\Delta p)^2$ vs q on log. log paper.

(B) Use squared pressure method - Rawlins and schellhardt analysis to estimate the initial absolute open flow (AOF) numerically.

(C) if the static drainage area pressure has decrease to 300 psia after certain period time estimate the absolute open flow (AOF).

(D) plot($(\Delta p)^2/q$ ) vs q on Cartesian graph paper.

(E) Use squared pressure method – houpeurt analysis technique(LIT) to estimate numerically the:

(i) inertial turbulent flow coefficient.

(ii) laminar flow coefficient

(iii) calculate the gas flow rate when the bottom hole flowing pressure reduce to 320 psia.

**Problem two:** ( A) $20ft^3$ of tank at 100°F is pressured to 200 psia with a pure paraffin gas. 10 pound of ethane ($C_2H_6$) are added, and specific gravity of gas mixture is measured to be 1.68. Assume that the gasses act as ideal gases. What was the gas originally in tank?

(B) Assume the following weight fractions of volumetric gas reservoir:

| component | Weight fraction | $M_w(lb/lbmole$ | $T_c(R)$ | $P_c$(psia) |
|---|---|---|---|---|
| $C_1H_4$ | 0.6 | 16.04 | 343.33 | 666.4 |
| $C_2H_6$ | 0.17 | 30.07 | 549.92 | 706.5 |
| $C_3H_8$ | 0.13 | 44.11 | 666.06 | 616.4 |
| $n-C_4H_{10}$ | 0.06 | 58.1 | 765.62 | 550.6 |
| $n-C_5H_{12}$ | 0.04 | 72.2 | 845.6 | 488.6 |

If the initial pressure and temperature of reservoir are 3000 psia and 130°F with pore volume 590 MM$ft^3$ and initial gas saturation is 80%. Calculate

(i). apparent molecular weight of the gas.

(ii) gas formation volume factor at 3000 psia and 130°F

(iii) gas initial in place of reservoir.

(iv).if the reservoir open to production what is the remaining of gas when the recovery factor reaches to 70%. .

**Problem three:** (A) Given the viscosity and gas deviation factor data sample from a dry gas reservoir as following

| P(psia) | 0 | 2000 | 2500 | 3000 | 3500 | 4000 |
|---|---|---|---|---|---|---|
| $\mu(cp)$ | 0.0135 | 0.0138 | 0.0146 | 0.0175 | 0.0183 | 0.0192 |
| Z | 1 | 0.952 | 0.854 | 0.832 | 0.819 | 0.795 |

Additional data are available:

K= 60 md h = 25 ft T= 150°F $r_w$ = 0..25 ft , S= – 0.35

The reservoir producing under the pseudosteady state condition. Assume cylindrical gas reservoir with drainage area is 72.121 acres and neglect the turbulent effect. Calculate the gas flow rate if the average reservoir pressure and the bottom hole flowing pressure are 4000 psia and 3000 psia respectively. Use:

(i) m(p).exact solution method.

(ii) $p$ - approximation method.

(iii)What the error percentage results with using $p$ - approximation method .

(B) the daily gas production rate of natural sweet gas well is 8 MMscf/day , stream pressure is 1500 psia and the stream temperature is 100 °F and the gravity of gas is 0.6 if the temperature is lowered to 75°F . Calculate the total amount of free water condensing in the stream per each hour.

*Good luck*