PET-342E Reservoir Engineering
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Project#1
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Given : 14 Mar 2008
Due : 28 Mar 2008

Project Description

In this project you are required to compare the gas deviation factors obtained from two different correlations: Dranchuk-Purvis-Robinson and Dranchuk AbuKaseem. You will compare the gas deviation factors for the composition of a gas given below:

Comp	y_i	M_i	p_{ci}	T_{ci}	z_{ci}
C_1	0.93	16.043	667.8	343.1	0.289
C_2	0.0329	30.07	707.8	549.8	0.285
C_3	0.0136	44.097	616.3	665.7	0.281
n-C_4	0.0037	58.124	550.7	765.4	0.274
i-C_4	0.0023	58.124	529.1	734.7	0.283
n-C_5	0.0010	72.151	488.6	845.4	0.262
i-C_5	0.0012	72.151	490.4	828.8	0.273
C_6	0.0008	86.178	436.9	913.4	0.264
C_{7+}	0.0005	128.259	332.0	1070.4	0.263
N_2	0.0140	28.013	493.0	227.3	0.304

Please compare the gas deviation factors from the two correlations for two different temperatures of 400°R and 700°R. For each temperature prepare a p vs. z graph for the pressure range 14.7 – 10000 psi using the two correlations. Finally compare the difference of the gas deviation factors obtained from the two different correlations. Please do the comparison on the same graph. Basically you need to plot p vs. $|z_{AbuKaseem}-z_{Purvis}|$ for the pressure range mentioned above and for the two temperatures (all on the same plot).

Inorder to accomplish all of the above tasks, you will need to write a computer program. You are free to use any programing language. Below is an algorithm that may be useful:

Algorithm for comparing the two gas deviation factors

1- Read the composition and the various properties of the gas and compute the pseudo critical properties.

2- Compute the reduced properties that are necessary.

3- Start with an initial guess for the gas deviation factor (z=1.0).

4- Compute the reduced density ρ_r.

5- Compute $f(\rho_r)^k$ and $f'(\rho_r)^k$.

6- Compute ρ_r^{k+1} using the following equation. Here k represents the iteration step.

$$\rho_r^{k+1} = \rho_r^k - \frac{f(\rho_r)^k}{f'(\rho_r)^k}$$

7- Check if $\left|\rho_r^{k+1} - \rho_r^k\right| \le \varepsilon$ where you can take $\varepsilon=10^{-8}$.

8- If yes then STOP and compute the gas deviation factor using the following equation.

$$z = \frac{z_c p_r}{\rho_r T_r}$$

If no then set $\rho_r^k = \rho_r^{k+1}$ and GOTO step 5

The above algorithm needs to be implemented for both the Dranchuk-Purvis-Robinson and the Dranchuk-AbuKaseem correlations. You do not necessarily have to stick with the above algorithm. You may use any other algorithm that you can think of. It is advised that you use subroutines to compute the z factor. Then in the main program you can simply perform a do-loop for the pressure intervals and call the subroutine. Below you will find the details of the two correlations for computing the gas deviation factor.

Dranchuk-Purvis-Robinson

The gas deviation factor accorrding to Dranchuk-Purvis-Robinson is given as follows:

$$z = 1 + \left(A_1 + \frac{A_2}{T_r} + \frac{A_3}{T_r^3}\right)\rho_r + \left(A_4 + \frac{A_5}{T_r}\right)\rho_r^2 + \frac{A_5 A_6}{T_r}\rho_r^5 + \frac{A_7}{T_r^3}\rho_r^2\left[1 + A_8\rho_r^2\right]\exp\left(-A_8\rho_r^2\right)$$

Where;

$$A_1 = 0.31506237 \quad A_2 = -1.0467099 \quad A_3 = -0.57832729 \quad A_4 = 0.53530771$$
$$A_5 = -0.61232032 \quad A_6 = -0.10488813 \quad A_7 = 0.61857001 \quad A_8 = 0.68446549$$

$$\rho_r = \frac{z_c p_r}{z T_r} \Rightarrow z = \frac{z_c p_r}{\rho_r T_r}$$

From the above two equations we can determine $f(\rho_r)$ and $f'(\rho_r)$ as follows:

$$f(\rho_r) = \rho_r T_r + \left(A_1 T_r + A_2 + \frac{A_3}{T_r^2}\right)\rho_r^2 + \left(A_4 T_r + A_5\right)\rho_r^3 + A_5 A_6 \rho_r^6$$
$$+ \frac{A_7}{T_r^2}\rho_r^3\left[1 + A_8\rho_r^2\right]\exp\left(-A_8\rho_r^2\right) - z_c p_r = 0$$

$$f'(\rho_r) = T_r + 2\left(A_1 T_r + A_2 + \frac{A_3}{T_r^2}\right)\rho_r + 3\left(A_4 T_r + A_5\right)\rho_r^2 + 6A_5 A_6 \rho_r^5$$
$$+\frac{A_7}{T_r^2}\rho_r^2\left[3 + A_8\rho_r^2\left(3 - 2A_8\rho_r^2\right)\right]\exp\left(-A_8\rho_r^2\right) = 0$$

Dranchuk and AbuKaseem

The gas deviation factor accorrding to Dranchuk-Purvis-Robinson is given as follows:

$$z = 1 + \left(A_1 + \frac{A_2}{T_r} + \frac{A_3}{T_r^3} + \frac{A_4}{T_r^4} + \frac{A_5}{T_r^5}\right)\rho_r + \left(A_6 + \frac{A_7}{T_r} + \frac{A_8}{T_r^2}\right)\rho_r^2 - A_9\left(\frac{A_7}{T_r} + \frac{A_8}{T_r^2}\right)\rho_r^5$$
$$+A_{10}\left(1 + A_{11}\rho_r^2\right)\left(\frac{\rho_r^2}{T_r^3}\right)\exp\left(-A_{11}\rho_r^2\right)$$

Where;

$$A_1 = 0.3265 \quad A_2 = -1.07 \quad A_3 = -0.5339 \quad A_4 = 0.01569 \quad A_5 = -0.05165$$
$$A_6 = 0.5475 \quad A_7 = -0.7361 \quad A_8 = 0.1844 \quad A_9 = 0.1056 \quad A_{10} = 0.6134 \quad A_{11} = 0.7210$$

From the above equation we can determine f(ρ_r) and f′(ρ_r) as follows:

$$f(\rho_r) = \rho_r T_r + \left(A_1 T_r + A_2 + \frac{A_3}{T_r^2} + \frac{A_4}{T_r^3} + \frac{A_5}{T_r^4}\right)\rho_r^2 + \left(A_6 T_r + A_7 + \frac{A_8}{T_r}\right)\rho_r^3 - A_9\left(A_7 + \frac{A_8}{T_r}\right)\rho_r^6$$
$$+A_{10}\left(1 + A_{11}\rho_r^2\right)\left(\frac{\rho_r^3}{T_r^2}\right)\exp\left(-A_{11}\rho_r^2\right) - z_c p_r = 0$$

$$f'(\rho_r) = T_r + 2\left(A_1 T_r + A_2 + \frac{A_3}{T_r^2} + \frac{A_4}{T_r^3} + \frac{A_5}{T_r^4}\right)\rho_r + 3\left(A_6 T_r + A_7\frac{A_8}{T_r}\right)\rho_r^2 - 6A_9\left(A_7 + \frac{A_8}{T_r}\right)\rho_r^5$$
$$+A_{10}\left(\frac{\rho_r^2}{T_r^2}\right)\left[3 + A_{11}\rho_r^2\left(3 - 2A_{11}\rho_r^2\right)\right]\exp\left(-A_{11}\rho_r^2\right) = 0$$

Good Luck!!