CHEN 1703 - HOMEWORK 11

Problem 1 (20 pts) - No report required.

The Redlich-Kwong equation of state is given by

$$p = \frac{RT}{\bar{V} - b} - \frac{a}{\sqrt{T}\bar{V}(\bar{V} + b)}, \tag{1}$$

where $\bar{V}$ is the molar volume (units m^3/mol), $R = 8.314$ J/(mol·K) is the gas constant, T is the temperature (in K), and p is the pressure (Pa).

Using equation (1), solve for the molar volume for methanol at 10 atm pressure (1,013,250 Pa) and temperatures ranging from 273.15 K (0 C) to 1000 K. Use at least 50 temperature entries between 300 and 1000 K. Plot the molar volume versus temperature. Also plot the ideal-gas molar volume for methanol. The parameters for use in equation (1) for methanol are $a = 21.7130$ Pa and $b = 4.5608 \times 10^{-5}$ $\frac{\text{mol}}{\text{m}^3}$.

1. (10 pts) Solve this problem using MATLAB.

2. (10 pts) Solve this problem using Excel.

Hint: set up the residual equation $r(T) = p - \frac{RT}{\bar{V}-b} + \frac{a}{\sqrt{T}\bar{V}(\bar{V}+b)}$ for pressure for each temperature. Then choose a reasonable guess for the molar volume (you could use the ideal gas law to get a good guess) and use solver to solve all of the equations at once.

NOTE: In equation (1) use pressure in Pa to maintain consistent units.

Submit your Matlab and Excel files. No report is required for this problem.