Assignment No. 4: Winter 2023
Due Date: 5:00 PM on March 22, 2023

The Peng-Robinson equation of state can be used to calculate the vapour pressure of pure substances and saturation pressure of gas-liquid mixtures under equilibrium conditions:

1) Calculate the vapor pressure of propane together with the densities of the liquid and gas at 104°F. Compare your answers with values from Figures 2-7, 2-12, and 3-4 (McCain Jr., W.D. *The Properties of Petroleum Fluids* (2nd Edition). PennWell Publishing Company, Tulsa, OK, 1990.).
2). Calculate the compositions and densities of the equilibrium liquid and gas of the mixture given below at 160°F and 2000 psia. Use binary interaction coefficients of 0.021 for methane-n-butane, 0.032 for methane-*n*-decane, and 0.0 for *n*-butane-*n*-decane. The pre-specified tolerance is for 0.098. **Note: The first trial must be done manually; then use your own coded program to perform the necessary iterations.**

Component	Composition, mole fraction
Methane	0.5523
n-Butane	0.3630
n-Decane	0.0838
	1.0000

Compare your answer with experimental results shown below.

Component	Composition, mole fraction	
	liquid	gas
Methane	0.485	0.826
n-Butane	0.412	0.167
n-Decane	0.103	0.0063
	1.000	0.9993

3). As for the crude oil sample in Assignment #2, the experimentally measured saturation pressures (P_b) for the two feeds are listed as follows:

Feed	CH_4 mol%	C_3H_8 mol%	Heavy oil mol%	T, °C	P_b, kPa	Swelling factor	Viscosity at P_b, cP
#1	0	57.94	42.06	20.7	664.9	1.304	31.6
#2	13.81	49.52	36.67	20.5	4368.5	1.362	/

1) With $\alpha = \left[1+\left(0.37464+1.54226\omega-0.26992\omega^2\right)\left(1-T_r^{0.5}\right)\right]^2$ and your own coded computer program, calculate the saturation pressure for either Feed #1 or Feed #2 by treating heavy oil sample as one pseudocomponent (PC) and compare your result with the WinProp module.
2) With the modified $\alpha = \exp\left\{\begin{array}{l}\left(0.13280-0.05052\omega+0.25948\omega^2\right)\left(1-T_r\right)+\\ 0.81769\ln\left[1+\left(0.31355+1.86745\omega-0.52604\omega^2\right)\left(1-\sqrt{T_r}\right)\right]^2\end{array}\right\}$ and your coded computer program,
   (1) Determine the saturation for either Feed #1 or Feed #2 by treating heavy oil as 4-6 PCs.
   (2) Compare your results with the CMG WinProp module with your justification.
   (3) Submit your own coded computer program.