1 Methodology

The objective of this assignment is to find hydrate formation pressure at known temperature and composition. The K-factor method is used to obtain a solution to this problem and it can be defined as the distribution of the component between the hydrate and gas as follows

$$K_i = y_i/s_i$$

Where y_i and s_i are the component's mole fraction in vapor and hydrate phase, respectively. [1] In this case, the objective function is:

$$f(P) = 1 - \sum y_i/K_i$$

Sloan's (1998) correlation is used to obtain the K-factor for each of the components. The 'A' coefficients of the correlation are from Table 4.4a of his book. [2]

1.1 Computer Program Development

The algorithm to solve assignment #8 is in the following manner:

1. Input the temperature
2. Input vapor composition
3. Assume an initial guess for pressure
4. Given P and T, obtain K-factors for all components using Sloan (1998) correlation
5. Calculate the summation $\sum y_i/K_i$
6. If summation does not equal to one correct pressure estimate and go to 4.
7. If summation equal to 1 convergence occurs and current P is hydrate pressure, Stop.

For improved accuracy and faster convergence at each temperature, built-in MATLAB function is used for optimization instead of shifting the pressure manually. Therefore some function needs to be introduced in order to be optimized. This function is called *getHydratePressure* and returns the difference of the above-mentioned summation and 1 which needs to be minimized.

2 Results

The results consists of two figures which represent the hydrate formation P-T diagram and summation errors. The first two curves are drawn for the case of initial pressure estimate equal to 100 psi and the second two are plotted for the case in which initial estimate for pressure was 400 psi. Temperature step-size for both cases were 0.1 degree Fahrenheit.

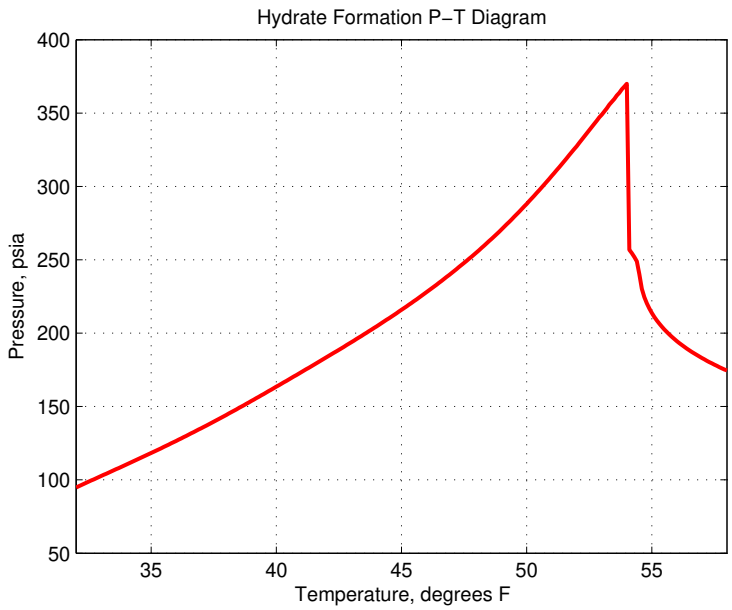

Figure 1: P-T diagram for hydrate formation at initial guess of 100 psi.

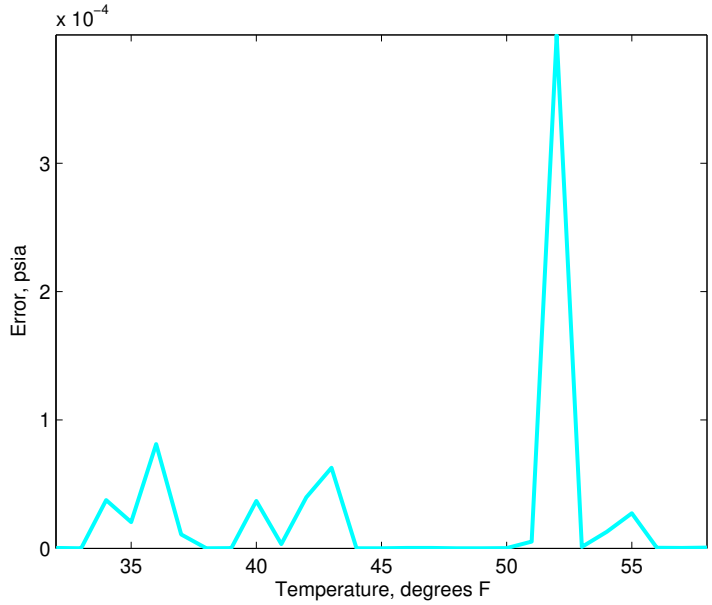

Figure 2: Hydrate formation pressure error at initial guess of 100 psi.

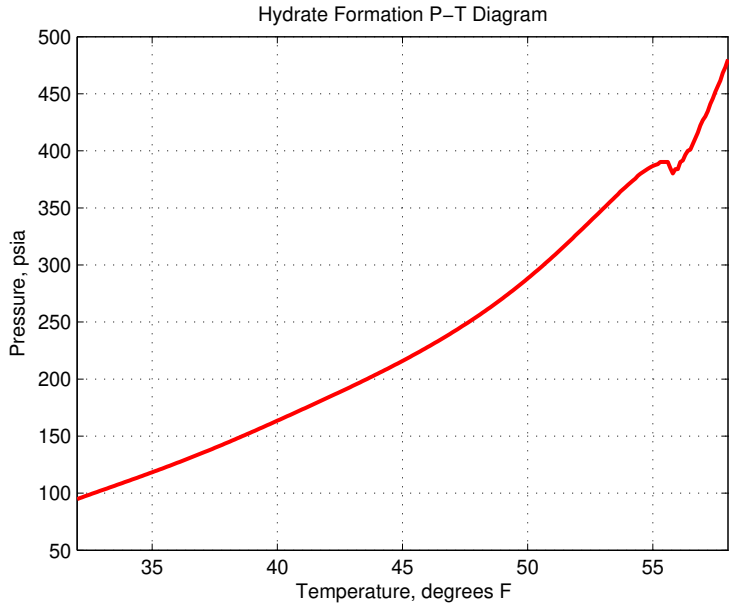

Figure 3: Hydrate formation pressure error at initial guess of 400 psi.

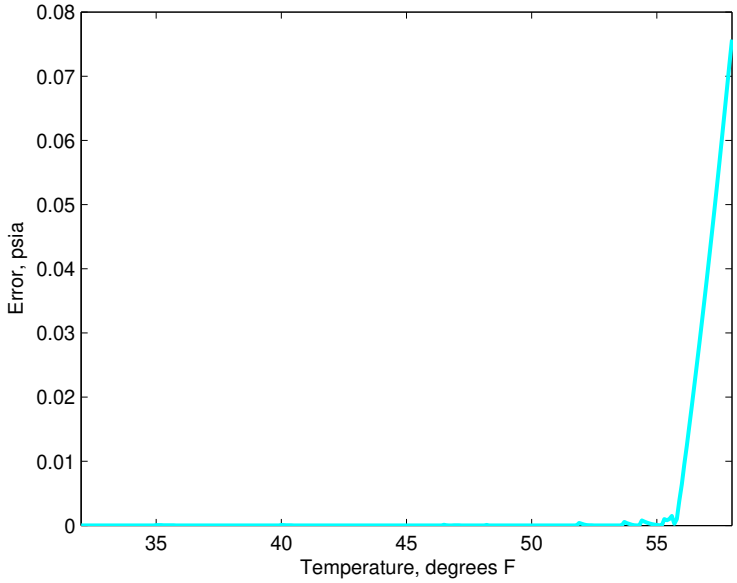

Figure 4: Hydrate formation pressure error at initial guess of 400 psi.

References

[1] John J. Carroll. Chapter three - hand calculation methods. In John J. Carroll, editor, *Natural Gas Hydrates (Second Edition)*, pages 51 – 93. Gulf Professional Publishing, Burlington, second edition edition, 2009.

[2] E Dendy Sloan Jr, Carolyn A Koh, and Carolyn Koh. *Clathrate hydrates of natural gases*. CRC press, 2007.

Course notes, lectures and sent documents.