Part 2

**Procedure/Solution**

We have been tasked with identifying the primary empirical parameter in the Lockhart-Martinelli correlation and re-optimizing it in order to fit the data provided. The primary empirical parameter is the variable "C" in equation 2.0 to find the two phase multiplier phi\_l\_squared. The variable X\_tt\_squared is calculated in equation 2.1. Phi\_l\_squared can be converted to phi\_lo\_squared assuming n = 1.8 with the McAdams correlation in equation 2.2 and the correlated pressure gradient could then be obtained through the utilization of equation 2.3.

To begin optimization, we used EES to find the specific value of C for every respective experimental pressure gradient value provided. We then took the average of those C's to be 31.3 and used that value to develop bounds in order to iterate through the data to minimize the mean absolute error between the correlation and the experimental values in python. Iterating through the rows for C's of 0 to 100 with intervals of 0.01 returned a C value of 30.23 that minimized the mean absolute error to 6.99%. The code used to obtain these values is presented in appendix 2.

Upon re-optimizing C to equal 30.23 for the given data set, we calculated the mean error (me), the root mean square (rms), and the R^2 value comparing the correlated pressure gradient to the experimental pressure gradients. We generated an me of 1.22%, a rms of 8.96%, an R^2 value of 0.977, and an mae of 6.99%.

**Discussion**

In order to analyze the correlation and its suitability to the given data, two plots have been provided displaying some useful information regarding it. Figure 2.1 depicts the gaseous mass flow rate vs the correlated pressure gradient at various pipe diameters and figure 2.2 displays the correlated pressure gradient against the experimental pressure gradient at various pipe diameters. Figure 2.1 shows that the pressure gradient decreases significantly as gas mass flux and diameter increase. At a diameter of 8.8 mm, the correlated pressure gradient varies over a range of -6 to -50 kPa/m in a span of only about 5 g/s in change in gas mass flux, implying that small changes in mass flow rates at a small diameter can significantly affect pressure drop according to this correlation. Figure 2.2 portrays a positive, direct, relatively linear relationship between the correlated pressure gradient and the experimental pressure gradient, implying that there is a strong correlation between the two and that our re-optimization is relatively accurate. Figure 2.2 also demonstrates that regardless of pipe diameter, the Lockheart-Martinelli re-optimization appears to be accurate considering the linearity of each plot.