ME 3007 – Energetics
Analysis Project – Fall 2008
Due 11/24/2008

Background

Understanding azeotropy allows for the design of a variety of thermodynamic processes and cycles. These processes include the use of alternative refrigerants, microscale heat transfer phenomena, and industrial flash processing.

In the U.S., methanol is produced primarily by high-pressure synthesis of hydrogen and carbon monoxide. A strong advantage of the process is the high purity of methanol: there are essentially no side reactions.

However, this method requires considerable mechanical energy because the reactants must be compressed to reactor pressure, typically on the order of 300 bars. Therefore, it is of interest to consider once again an older method for making methanol: the oxidation of butane. In this oxidation process, a variety of products are obtained (primarily acetaldehyde) and, therefore, it is necessary to separate the product stream into its components. The key separation is to separate a stream containing (approximately) 73 weight percent methanol and 27 weight percent acetone. Unfortunately, at pressures close to one bar, the acetone-methanol mixture has an azeotrope. This azeotrope contains 83 mole percent acetone. At one bar, azeotropy for this system is positive, which means that a plot of boiling temperature versus composition is a minimum at the azeotropic composition.

Is it possible, upon distillation at some pressure not near one bar, to obtain pure methanol and pure acetone? In other words, is there a pressure where the acetone-methanol mixture does <u>not</u> have an azeotrope? If that pressure is reasonable for distillation, it may then be economically attractive to produce methanol by oxidation of butane.

Problem

Find the pressure range(s) for which the binary acetone-methanol system exhibits azeotropy or, in other words, find the region(s) of pressure where no azeotrope exists in this system, allowing complete separation by distillation. FULLY JUSTIFY the method you use, and include the appropriate references. If you choose to use an equation of state approach, the Peng-Robinson EOS is particularly well-suited to modeling a mixture of methanol and acetone.