# Determination of dewpoint and bubblepoint pressures of a product mixture from a plastic waste pyrolysis process

【Module Learning Objectives】

- VLE calculation based on K-value correlations and DePriester chart.

【Associated Sections in Selected Textbooks】

- Introduction to Chemical Engineering Thermodynamics [1] Sec. 10.6

【Process Background and Problem】

Consumption of plastic products has increased many folds over the past few decades. This trend has resulted in the generation of large quantities of plastic waste that need to be properly managed to avoid environmental damage. The best option for sustainable plastic waste management is recycling. Catalytic pyrolysis, an advanced recycling technique, is a thermochemical conversion through which energy and feed stock chemicals are harnessed from wastes without affecting our environment negatively [2].

The essential steps in the pyrolysis of plastics include evenly heating the plastic to a narrow temperature range without excessive temperature variations, purging oxygen from the pyrolysis chamber, managing the carbonaceous char by-product before it acts as a thermal insulator and lowers the heat transfer to the plastic, and careful condensation and fractionation of the pyrolysis vapors to produce distillate of good quality and consistency. The flow diagram below shows a bench-scale pyrolysis process of waste plastics [3].

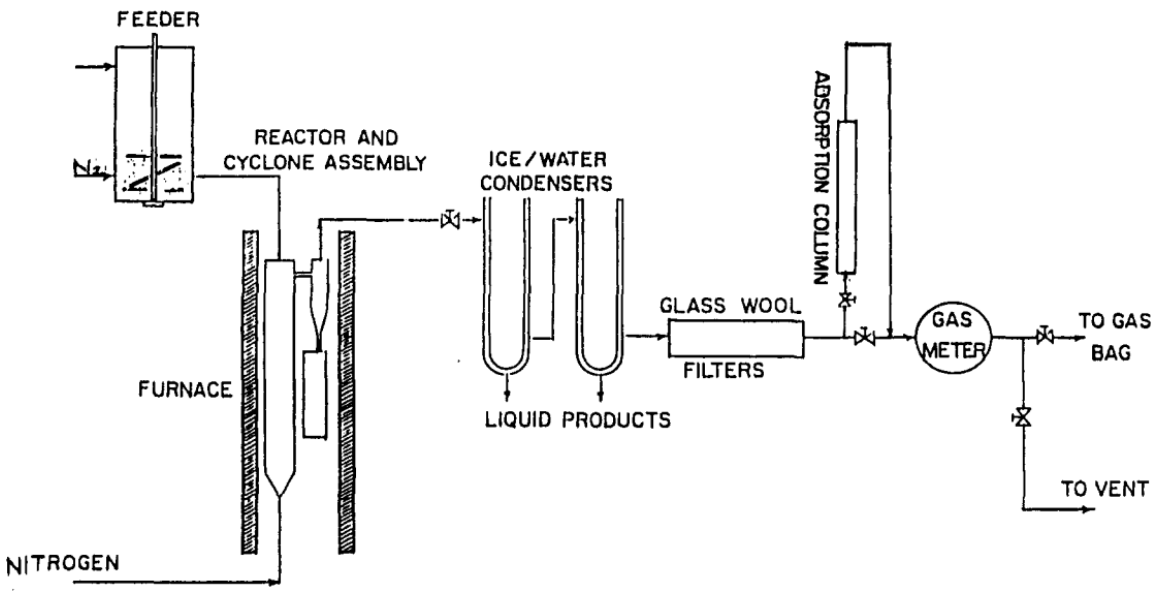


Figure 1 Process flow diagram of bench-scale fluidized-bed unit for pyrolysis of plastics [3]

Plastic is continuously treated in a cylindrical chamber (reactor) and the pyrolytic gases are condensed to yield a hydrocarbon distillate comprising of straight and branched chain aliphatics (like methane, ethane, and butane), cyclic aliphatics and aromatic hydrocarbons. The resulting mixture is essentially equivalent to petroleum distillate. The plastic is pyrolised at 370ºC-420ºC and the pyrolysis gases are condensed and liquid separated using fractional distillation to produce the liquid fuel products. In one particular batch, the mixture contains 20 mol-% methane, 30 mol-% ethane, 50 mol-% propane and traces of other species that can be ignored at 40 °F, determine:

(a) The dewpoint pressure.
(b) The bubblepoint pressure.

The K-values are given by the following figure [1].

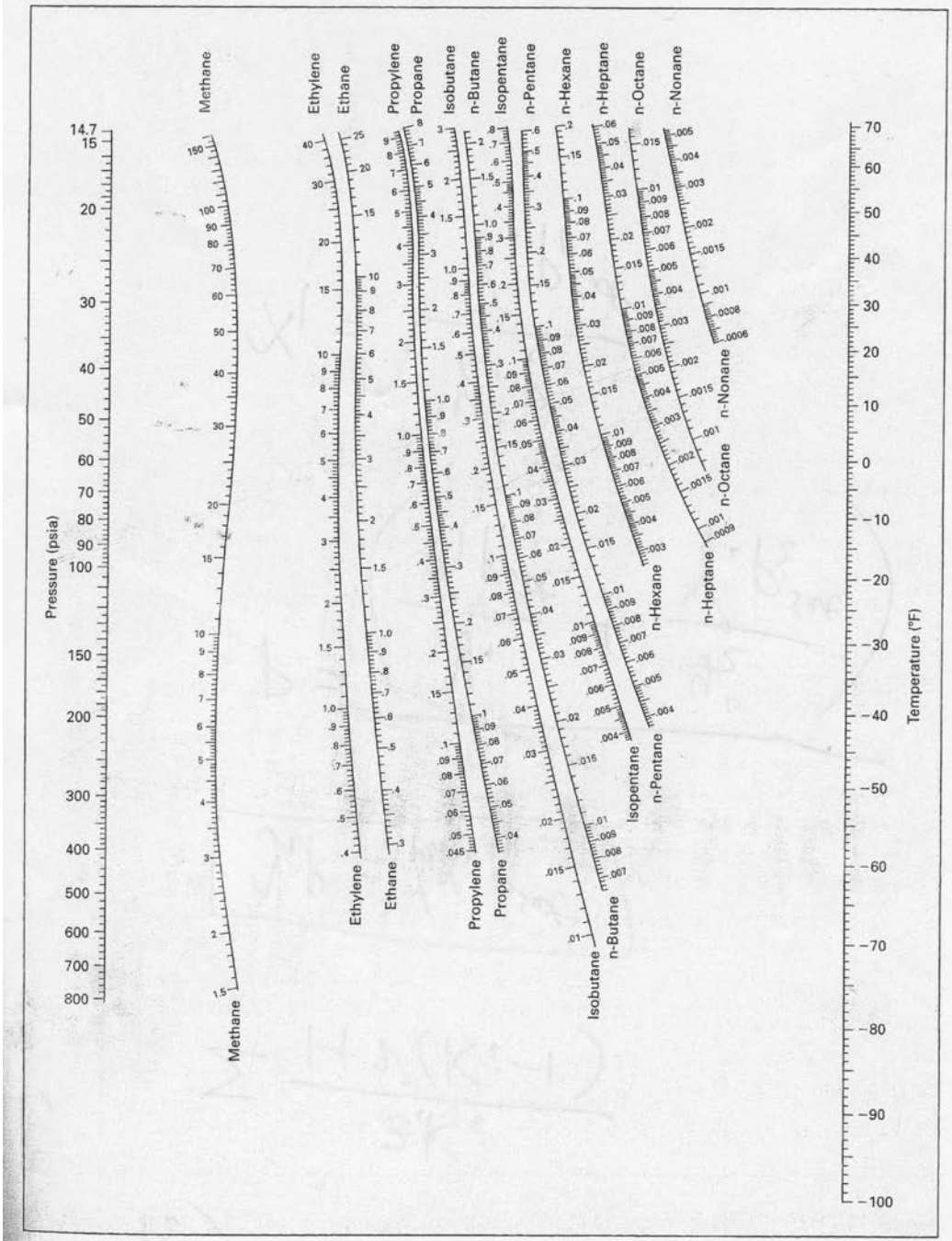


**Figure 10.13**: $K$-values for systems of light hydrocarbons. Low-temperature range. (Reproduced by permission from C. L. DePriester, *Chem. Eng. Progr. Symp. Ser. No. 7*, vol. 49, p. 41, 1953.)

# Bibliography


[1] J. Smith, H. Van Ness and M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th Ed. ed., New York: McGraw Hill, 2005.

[2] S. H. Shah, Z. M. Khan, I. A. Raja, Q. Mahmood, Z. A. Bhatti, J. Khan, A. Farooq, N. Rashid and D. Wu, "Low temperature conversion of plastic waste into light hydrocarbons," *Journal of hazardous materials,* vol. 179, pp. 15--20, 2010.

[3] D. S. Scott, S. R. Czernik, J. Piskorz and D. S. A. Radlein, "Fast pyrolysis of plastic wastes," *Energy & Fuels,* vol. 4, no. 4, pp. 407-411, 1990.