Flash calculation for 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

【Associated Web Modules】

- http://biofuelsacademy.org/web-modules/process/pyrolysis/pyrolysis-of-plastic/

【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 the pyrolysis process of waste plastics [3].

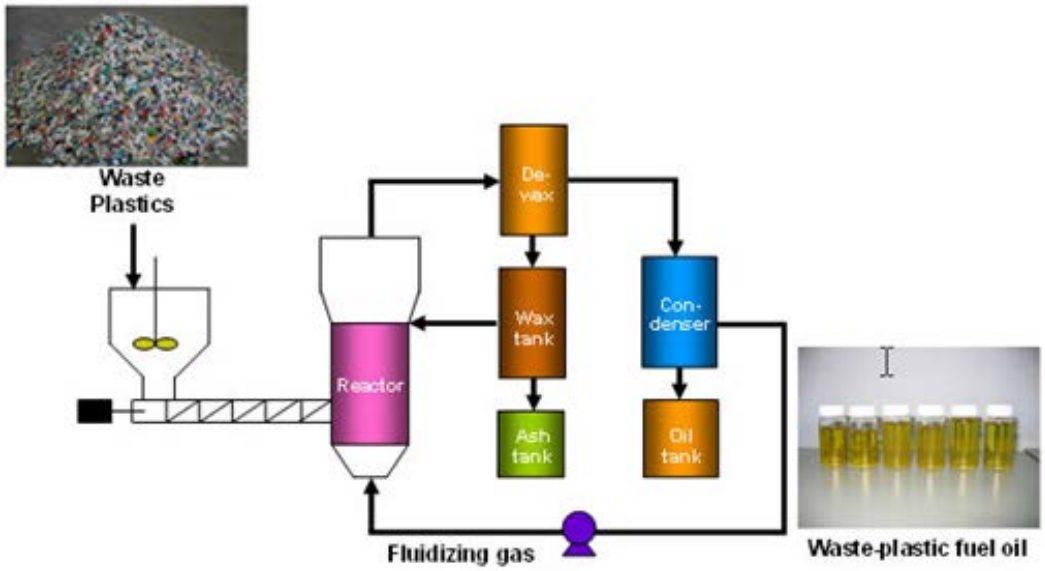

Figure 1 Process of pyrolysis of waste plastics technology [3]

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 containing 20 mol-% methane, 30 mol-% ethane, 50 mol-% propane (and traces of other species that are negligible) is condensed to -10ºC (14°F) and 300 psia, determine what fraction of the system is vapor and what the compositions of the equilibrium vapor and liquid phases are.

The K-values are given by Fig. 10.13 and 10.14 of reference [1].

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] SOHADHRA UK LTD, "Waste to Energy Technologies," [Online]. Available: http://www.sohadhra.co.uk/testimonials.html.