Aspen Plus® simulation of fractional condensation of lumped oil produced by waste tyre pyrolysis

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Introduction

Pyrolysis burns waste tyres at 400-600°C to produce liquid, gas, and char. The liquid is of interest because it can be fractionated into commercial fuels [1]. Production of liquid fractions instead of lumped pyrolysis oil must be assessed economically through techno-economic analysis (TEA). Aspen plus ® (version 11) software can assist with TEA.

Aims and Objectives

- **Aim**: Determine if the aspen simulation software can make predictions about pilot-scale liquid fractions. Consequently, TEA can make use of the simulation results.
- **Objective**: A fractional condensation network with three flash drums and three heat exchangers will produce three liquid fractions to compare with pilot-scale ones.

Method

- Figure 1 shows how waste tyre pyrolysis and fractional condensation occur.

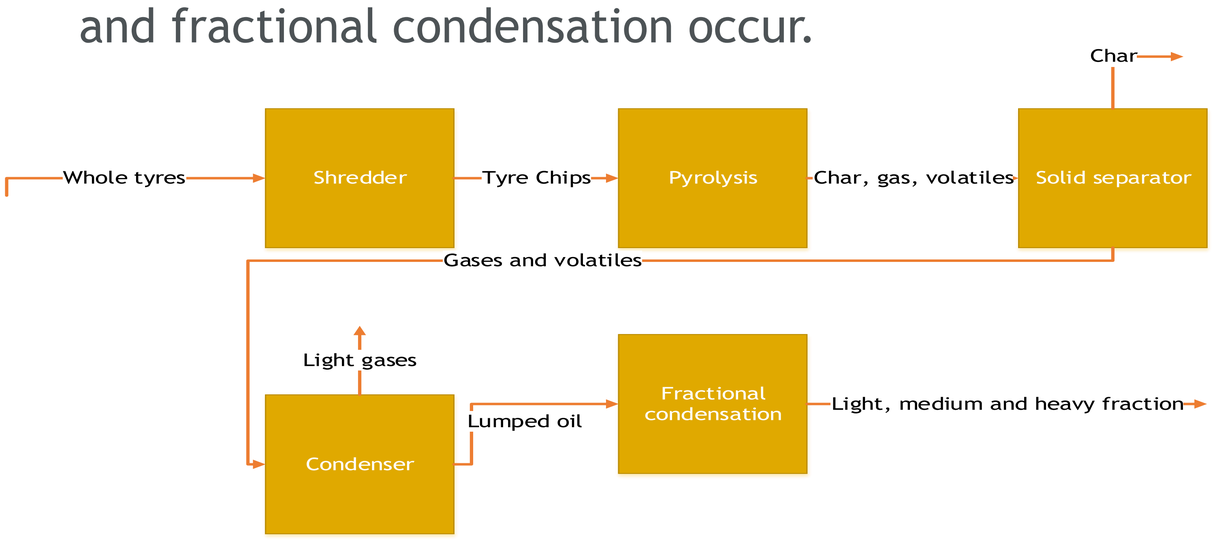

Figure 1: Processes that are involved in the production of three different liquid fractions

- For the simulation, Peng-Robinson equation of state with Boston-Mathias modifications will be used.
- Gas chromatography-mass spectrometry identified chemical compounds in lumped oil, which were entered into aspen simulation software.
- Simulated distillation curves for the liquid fractions will then be compared with those of pilot scale estimated via thermal gravimetric analysis (TGA)

Results

- In Figure 2, distillation curves for liquid fractions produced by aspen simulation and pilot scale experiments are compared.

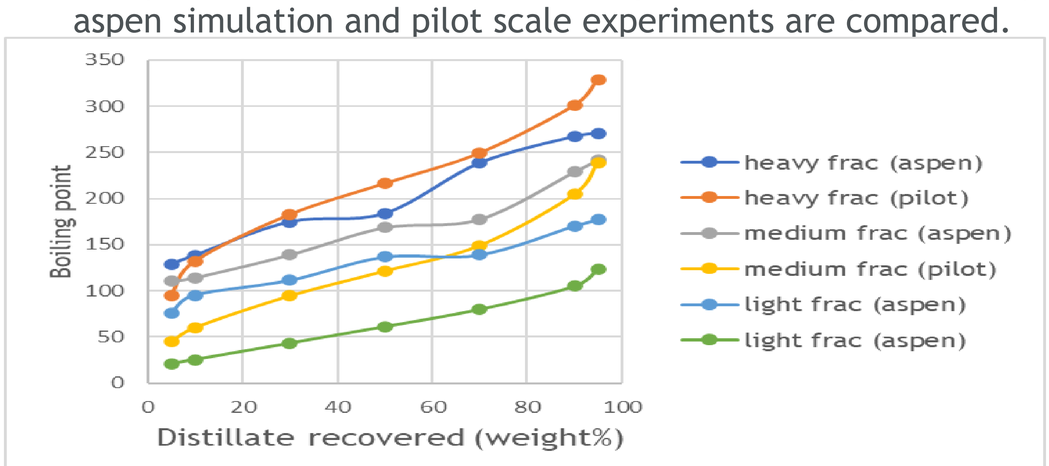

Figure 2: distillation curves for liquid fractions produced via fractional condensation.

Discussion

- For most heavy fraction distillate recoveries, the graphs overlap. Final boiling point of heavy fraction (aspen) shows that GC-MS cannot identify components of boiling points above 300°C, as is the case for the light fraction (aspen) components with boiling point below 60°C.
- The liquid fractions generated using Aspen exhibit a similar trend to those generated using pilot scale, thus indicating the potential of using aspen for fractional condensation.

Conclusion and recommendation

- More chemical components found in the waste tyre pyrolysis oil will allow Aspen to predict the liquid fractions generated by fractional condensation more accurately.
- A more complex chemical analysis method such as gas chromatography-vacuum ultraviolet spectroscopy can be tested on waste tyre pyrolysis oil to identify more components.

Acknowledgements
This research work is supported by the National Research Foundation of South Africa
The author would like to thank Aspen technology inc for providing Aspen plus® academic licenses to carry out the research work

References
1. Stander, A. J., Görgens, J. F., & Knoetze, J. H. (2022). Fractional condensation of pyrolysis volatiles produced from desulphurised waste tyre feedstock. https://scholar.sun.ac.za