Determination of kinetic parameters for the torrefaction of coconut endocarp –*Acrocomia aculeata*– in the temperature range 230–320 °C

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Introduction

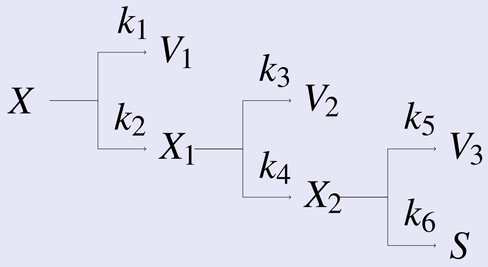
Coconut endocarp was thermally decomposed under isothermal conditions at temperature stages between 230 and 320 °C. Multi-step and distributed activation energy models were fitted to the thermogravimetric data, using nonlinear least squares optimization to obtain kinetic parameters for each model.

Objectives

- To determine kinetic parameters for models commonly used for lignocellulosic biomass ([1, 2]).
- To evaluate different types of kinetic models proposed in the literature.

Models

Multi-step model



Distributed activation energy model (DAEM) [3]

$$V/V_i^{\infty} = 1 - exp(-\int_0^t k_i dt)$$

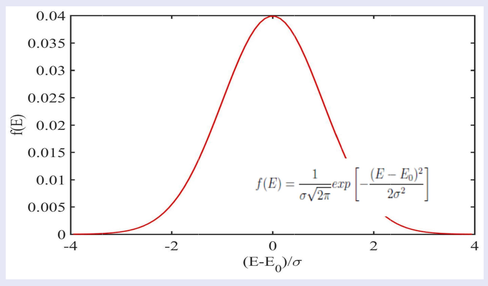


Figure 1: Gaussian distribution

Results and discussion

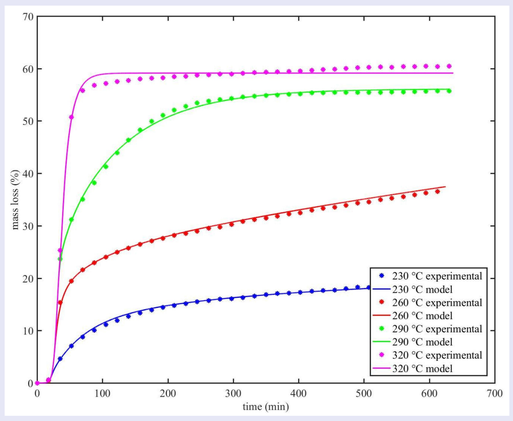


Figure 2: 3-step model data fit

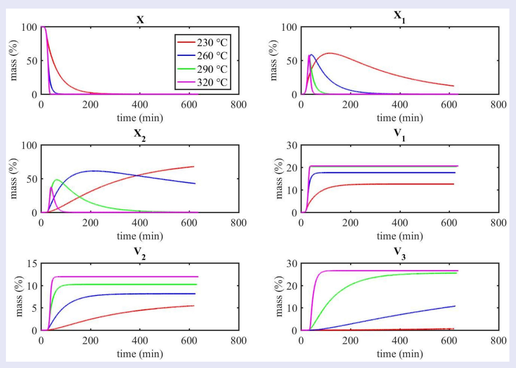


Figure 3: 3-step model released volatile and solid fractions

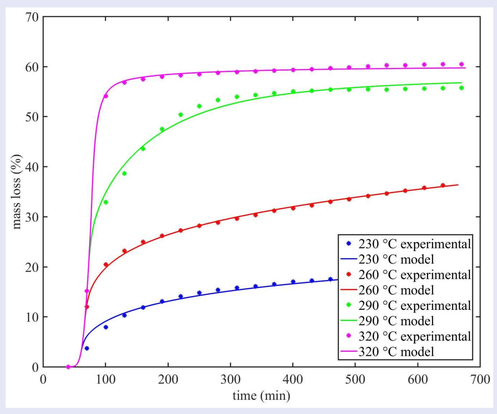


Figure 4: DAEM data fit using two Gaussian distributions

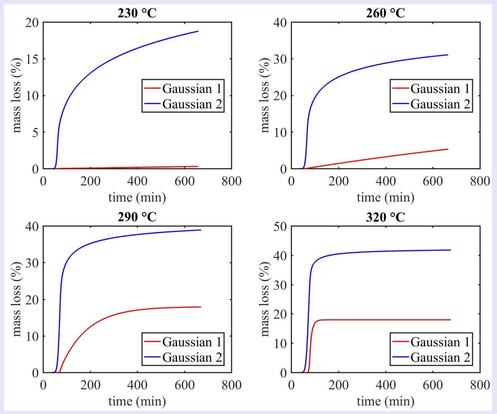


Figure 5: Released volatile for each Gaussian distribution

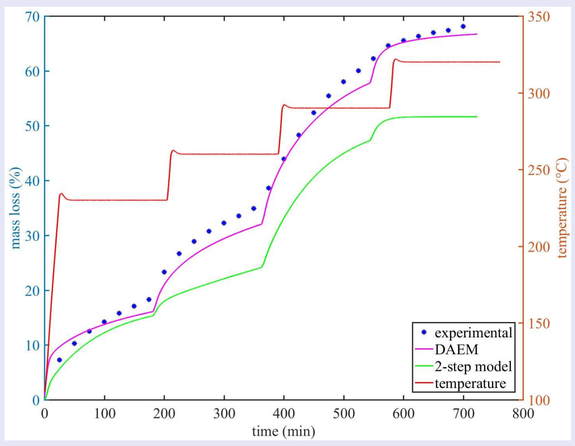


Figure 6: Simulation with different operation conditions

- The kinetic parameters identified using 2- and 3-step models (Fig.2) and the DAEM with two Gaussian distributions (Fig. 4) fit correctly the anhydrous mass loss.
- Fig. 3 suggests different number of steps for different temperatures.
- Fig. 5 suggests different Gaussian distributions for different temperatures.
- Applying solved models to different temperature programs and heating rates, the DAEM simulates experimental data better than multi-step models (Fig. 6).

Conclusion

Kinetic models were evaluated for thermal decomposition of coconut endocarp under isothermal and long time period conditions. Two or more steps were found to describe experimental data with good accuracy. Using the distributed activation energy model, it was found that at least two Gaussian distributions are necessary to fit the data well.

References

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