## Conference Proceedings

Facebook

- HOME

  BROWSE

- INFO

  FOR AUTHORS

- FR ORGANIZERS

**SIGN UP FOR ALERTS**

- # Mathematical modelling and kinetics of thermal decomposition of corn stover using thermogravimetry (TGA-DTG) technique

M. Mafamadi[2], O. O. Sadare[1], S. Bada[2], A. O. Ayeni[3], *and* M. O. Daramola[1,a)]
more...View AffiliationsView Contributors

## ABSTRACT

Lignocellulosic biomass could be pyrolytically converted into value-added products and one of the steps during the pyrolysis is thermal decomposition which involves multiple reactions. Therefore, mathematical modelling of thermal decomposition could provide molecular insight into thermal degradation reactions by providing accurate prediction of the phases of the multi-component reactions in particular nucleation, growth and boundary-phase reactions occurring under different working conditions. In this study, thermal decomposition behaviour of Corn Stover was explored using thermogravimetry technique (TGA-DTG) at heating rates of 20, 30, 40 and 50 °C/min under nitrogen gas flow (55 mL/min) and oxygen gas flow at 15 mL/min. The Flynn-Wall Ozawa (FWO) and Kissinger Akahira Sunose (KAS) models were used to estimate the kinetic parameters such as apparent activation energy, pre-exponential factor and order of reaction so as to be able to design the pyrolytic reactor that could be used for the biomass conversion. The hemicellulose maximum mass loss rate was at 300 °C, cellulose at 410 °C and lignin decomposition from 190 °C to 620 °C. The apparent activation energies calculated ranged from 44.39 -134.81 kJ/mol using the FWO method while the KAS method gave 87.83 - 282.41 kJ/mol.

The variation of the apparent activation energy represents the four different stages occurring during the thermal decomposition process for the corn stover. The Friedman's model was used with reaction- order model to estimate the order of reaction. The predicted model fitted well with the experimental data showing that the complex degradation process followed a first-order reaction.

## REFERENCES

1. 1.Danje, S. (2011). Fast pyrolysis of corn residues for energy production.( Master's Thesis, Stellenbosch University, South Africa). Retrieved from http://core.ac.uk/reader/37344796. Accessed 15th October 2019. **Google Scholar**

2. 2.Vamvuka, D., Kakaras, E., Kastanaki, E. & Grammdis, P. (2003). Fast pyrolysis of corn residues. Fuel, **82**, 1949–1960. https://doi.org/10.1016/S0016-2361(03)00153-4, **Google ScholarCrossref**

3. 3.National Matter (2003). Agriculture grains corn production. Retrieved from http://www.nationamatter.com/red/pie/agr_gra_cor_pro_agriculture-grains-corn-production. Accessed 12 April, 2019. **Google Scholar**

4. 4.Sittisun, P., Tippayawong, N. & Wattanasiriwech, D. (2015). Thermal degradation characteristics and kinetics of oxycombustion of corn residues. Advance Material Science and Engineering, 1–8. **Google Scholar**

5. 5.Wilhelm, W.W., Johnson, J.M.F., Hatfield, J.L., Voorhees, W.B. & Linden, D.R. (2004). Crop and Soil Productivity Response to Corn Residue Removal: A Literature Review. Agronomy Journal, **96**, 1–17. **Google Scholar**

6. 6.Onsree, T., Tippayawong, N., Zheng, A. & Li, H. (2018). Pyrolysis behaviour and kinetics of corn residue pellets and eucalyptus wood chips in a macro thermogravimetric analyser. Case study in Thermal Engineering, **12**, 546–556. DOI: https://doi.org/10.1016/j.csite.2018.07.011, **Google ScholarCrossref**

7. 7.Morais, L.C., Domingos, M.A., Guandique, M. & Rosa, A.H. (2017). Pyrolysis and Combustion of Sugarcane bagasse. Journal of Thermal Analysis and Calorimetry, **129**, 1813–1818. https://doi.org/10.1007/s10973-017-6329-x, **Google ScholarCrossref**

8. 8.Poletto, M., Zattera, A.J. & Santana, R.M.C. (2012) Thermal decomposition of wood: Kinetics and degradation mechanism. Bioresource Technology, **126**, 7–12. https://doi.org/10.1016/j.biortech.2012.08.133, **Google ScholarCrossref**

9. 9.Aboyade, A.O., Hugo, T.J., Carrier, M., Meyer, E.L., Stahl, R., Knoetze, J.H. & Gorgens, J.H. (2011). Non-isothermal kinetic analysis of the devolatilization of corn cobs and sugar cane bagasse in an inert atmosphere. Thermochimica Acta. **517**, 81–89. https://doi.org/10.1016/j.tca.2011.01.035, **Google ScholarCrossref**

10. 10.Ali, I., Naqvi, SR. & Bahadar, A. (2018). Kinetic analysis of Botryococcus braunii pyrolysis using model-free and model-fitting methods.

Fuel, **214**, 369–380. https://doi.org/10.1016/j.fuel.2017.11.046, **Google ScholarCrossref**

11.      11.Jutakriidsada, P., Rattanoporn, N., Patikarnmonthon, N. & Kamwilaisak, K. (2016). Comparison study of Sugarcane Bagasse leaves and Corn Stover as potential energy source in pyrolysis source. Energy Procedia, **100**, 26–29 https://doi.org/10.1016/j.egypro.2016.10.142, **Google ScholarCrossref**

12.      12.Varhegyi, G., Jakab, E., Till, F. & Szekely, T. (1989). Thermogravimetric-mass spectrometric: Characterization of the thermal decomposition of sunflower stem. Energy and Fuels, **3**(6), 755–760. https://doi.org/10.1021/ef00018a017, **Google ScholarCrossref**

13.      13.Sonobe, T., Pipatmanomai, S. & Worasuwannarak, N. (2006). Pyrolysis Characteristics of Thai-agricultural Residues of Rice Straw, Rice Husk, and Corncob by TG-MS Technique and Kinetic Analysis. The 2nd Joint International Conference on Sustainable Energy and Environment, Thailand. C-044, 21–23. **Google Scholar**

14.      14.Mohan, D., Pittman, C.U. & Steele, P.H. (2006). Pyrolysis of Wood/biomass for bio-oil: A critical review. Energy and Fuels, **20**, 848–889. https://doi.org/10.1021/ef0502397, **Google ScholarCrossref**