Paddy Husk Pyrolysis in a Small Scale Down Draft Double Chamber (DDDC) Pyrolyser: Heat of Pyrolysis

A. M. Y. W. Alahakoon[1*], E. P. R. H. H. W. Nilmalgoda [1], A. K. Karunarathna[2] and R. S. Dharmakeerthi [3]

[1]Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya 20400, Sri Lanka
[2]Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Peradeniya 20400, Sri Lanka
[3]Department of Soil Science, Faculty of Agriculture, University of Peradeniya, Peradeniya 20400, Sri Lanka
**yushaniamyw@gmail.com*

Conversion of biomass wastes into energy rich resources by thermochemical treatment methods like pyrolysis has been identified as one of the most sustainable solution for energy and resource recovery. Understanding the thermal behavior of these thermochemical processes is very important in developing energy efficient pyrolysis technologies. The heat of pyrolysis can be described as the energy released or absorbed during the chemical conversion of biomass into pyrolysis products. In the absence of micro-scale thermogravimetric analysis, the stoichiometric method with the use of macromolecular conversions can alternatively be used in finding the heat of pyrolysis. In this research, an overall stoichiometric equation was developed for producing biochar from the pyrolysis of rice husk. The stoichiometric equation was developed using experimental and literature data while the heat of pyrolysis was calculated by the difference of total Higher Heating Values (HHV) (kJ/mol) of pyrolysis products and biomass inputs. Subsequently, heat of pyrolysis for paddy husk in a small scale down draft double chamber (DDDC) pyrolyser unit was estimated. The mean compositional formulas for paddy husk and biochar were found with the help of elemental analysis in literature and the syngas composition was estimated experimentally using a Gasboard 3100P syngas analyzer. The remaining mass was estimated as the tar fraction derived during the thermal decomposition. The developed stoichiometric equation for reaction of 1mol ($CH_{1.556}O_{0.617}$) of paddy husk yields biochar ($CH_{0.26}O_{0.134}$), H_2, CO, CH_4, C_2H_4, CO_2, H_2O and tar ($CH_{0.801}O_{0.375}$) in the molar ratios of 0.516, 0.017, 0.051, 0.009, 0.0004, 0.033, 0.285, 0.389, respectively. Calculated heat of pyrolysis was +31.64 kJ/mol_{feed} at an average pyrolysis temperature of 823 K. This positive energy value indicated that the pyrolysis of paddy husk in the used DDDC reactor was an endothermic reaction requiring an external energy supply to initiate and continue the pyrolysis process.

Key words: Endothermic reaction, Heat of Pyrolysis, Paddy Husk, Pyrolysis

Financial support given by the National Research Council of Sri Lanka under the NRC Grant No. To 16- 07, is greatly acknowledged.