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Development of an Apparatus for Observation of Fundamental Biomass Reaction

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Abstract

This research paper presents the concept, design and construction of the device to thermogravimetric measurements and the results of tests carried out on wood pellets. The purpose of this paper is to study the characteristics and thermal degradation behavior of wood pellet for biofuel production via gasification technology. The elemental properties of the feedstock were characterized by an elemental analyzer while thermal properties were investigated using thermogravimetric analyzer (TGA). The gasification processes were being carried out at room temperature up to 900°C in the presence of nitrogen and air as gasification agent, gas flowing at 500 ml/min. The investigated parameters are particle sizes and heating rate. The particle size used in the range of 425 to 500 um. The heating rates applied was 10°C/min. Sample weight varied from 0.5 to 1 gram, and stainless steel tray was used for the test. The further part of the paper contains the results of the tests carried out on wood pellet in the form of a thermogravimetric curves. These studies are conducted by looking at opportunities to improve the energy efficiency of the gasification process of biomass.

Keywords: Characterization, Gasification, Thermogravimetric analysis (TGA), Wood pellet

1. Introduction

The Electricity and thermal energy are two of the primary energy carriers needed in municipal economy. Traditionally these energy carriers are made from fossil fuels. These fuels as non-renewable are going to exhaust. At the moment, the emphasis is placed on increasing the use of renewable energy resources. The gasification process is endothermic and requires the delivery of thermal energy. The source of this energy is the partial combustion of the fuel. Successive stages of gasification of fuel are drying, pyrolysis, partial combustion and gasification of carbon residue. For the purpose of drying and pyrolysis waste heat can be used which will increase the energy efficiency of the conversion process of solid fuel into gas. The drying process takes place at a little more than 100 ° C. In order to determine the level of the temperature necessary for the process of the partial thermal decomposition, thermogravimetric research of fuels can be used. They will allow to specify for which temperatures and to what extend solid fuel will undergo degassing. This paper presents thermo-chemical decomposition behavior of wood pellet using thermogravimetric analysis.

2. Experiment

2.1. Experimental setup

The experiments were conducted using a reactor in a batch process at atmospheric pressure. The height and inside diameter of the reactor were 400 and 52.7 mm respectively. Figure 1 showed the experimental apparatus. This unit consists of the nitrogen bottle, the air bottle, desiccator, semi micro balance, small computer, petit logger, reactor, sample cup with the sample on it and thermocouple to control the sample temperature, heater, thermocouple to control the heater temperature, regulators, gas flow meters to supply gases such as nitrogen and air and evaporation device, control system with integrated power switch and two temperature regulators type PID.

2.2. Experimental procedures

Thermogravimetric Analysis (TGA) is an essential laboratory tool used for obtaining weight loss of the biomass sample versus temperature or time. In this experiment, the weight of the wood pellet sample is determined as a function of time and temperature as it is subjected to a controlled temperature program. TGA was carried out in the presence of nitrogen at the flowing rate of 500 ml/min. Wood pellet samples between 0.5 and 1.0 g were gasified to a maximum temperature of 900°C. The sample was first heated to 110°C and kept at that temperature for 30 minutes to remove any moisture. After that, the samples were individually heated at 10°C/min until 900°C.The temperature is held room temperature to 107˚C for 10 min, then kept 107 ˚C for 1hr. And then 107˚C to 900˚C for 1hr and 20 min, then kept 900˚C for 7 min, then reduced to

815˚C.Air is introduced at 900˚C after 7 min until the oxidation reaction is complete and no further weight loss is observed. The experiment was repeated for each weight.

3. Results and Discussion

3.1. Blank test

In blank test, without sample, air is passed at 500ml/min, and the temperature is raised up to 1000˚C at heating rate of 10˚C/min. By this blank test, the general condition of the apparatus can be known. The TGA curve can drift slightly as the temperature is increased. When noise appears in the TG curve, the possible cause may include contact between sample tray and reactor. The result of the blank test showed in figure 2.

3.2. Test results

After placing the sample in the sample tray of the heating chamber it is washed out with inert gas (N2) in order to remove the oxygen. The presence of oxygen in the air would cause that, instead of the pyrolysis process, combustion process would occur. Then the process of heating of the sample begins to the assumed temperature controlled by PID-type controller. In the course of the study the change of the mass of the sample is recorded and the temperature value. The results of the technical analysis of these fuel was presented in table 1. Thermobalance tests were carried out by heating the weighed sample of fuel to the required temperature by keeping on this temperature for some period of time. In the course of the research the change of temperature and the mass of the sample were recorded. The results of the research in the form of thermogravimetric curves are shown in figure 3.

Table.1. Proximate analysis of Wood Pellet (wt %)

Sample	Moisture	Volatile Matter	Fixed Carbon	Ash
Wood Pellet	2.18	8.62	81.66	7.54

Fig1. Overall construction of experimental apparatus

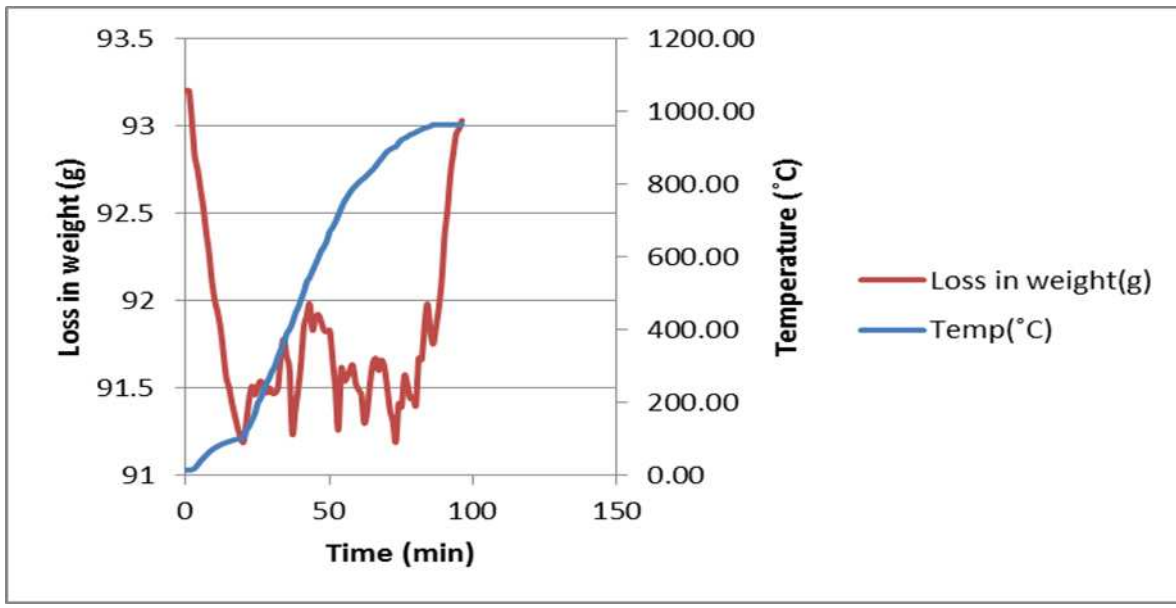
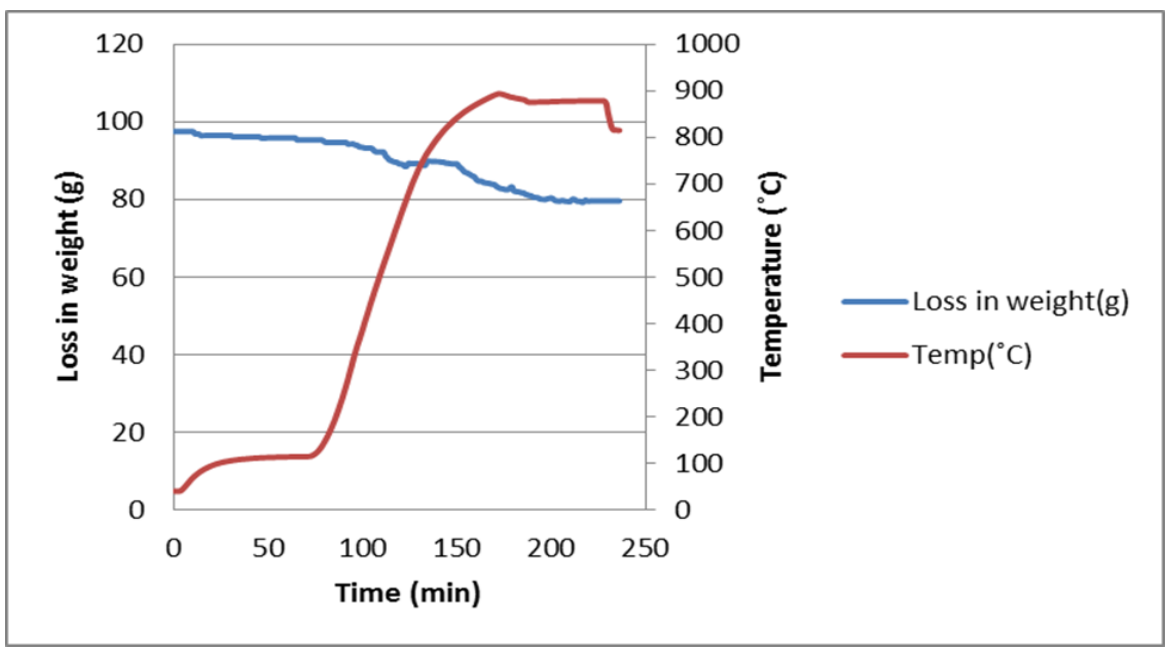
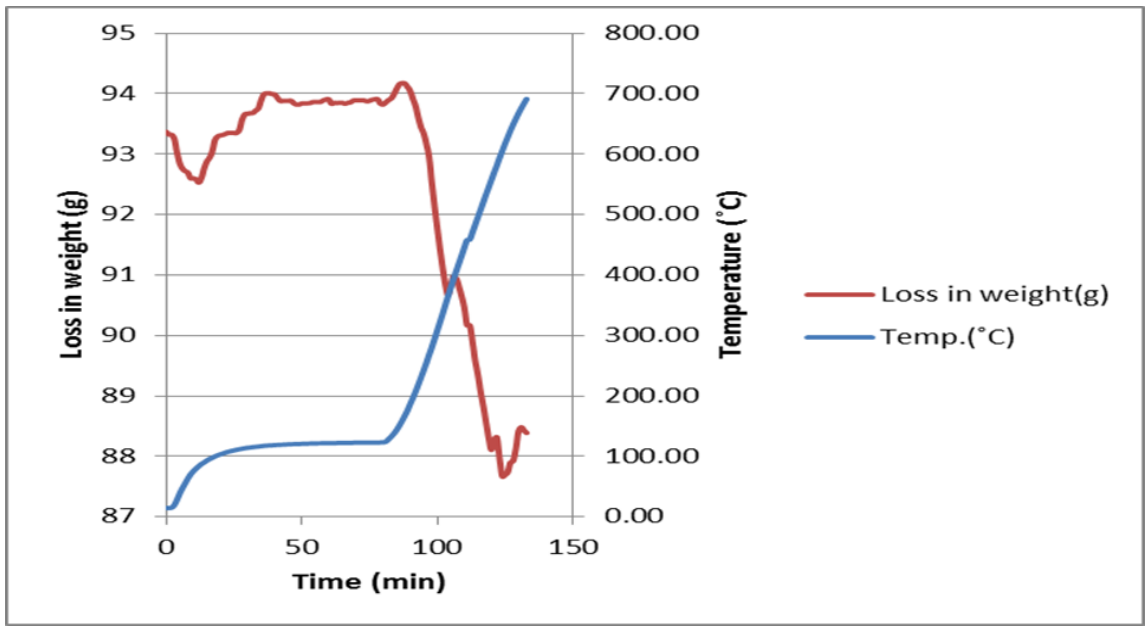


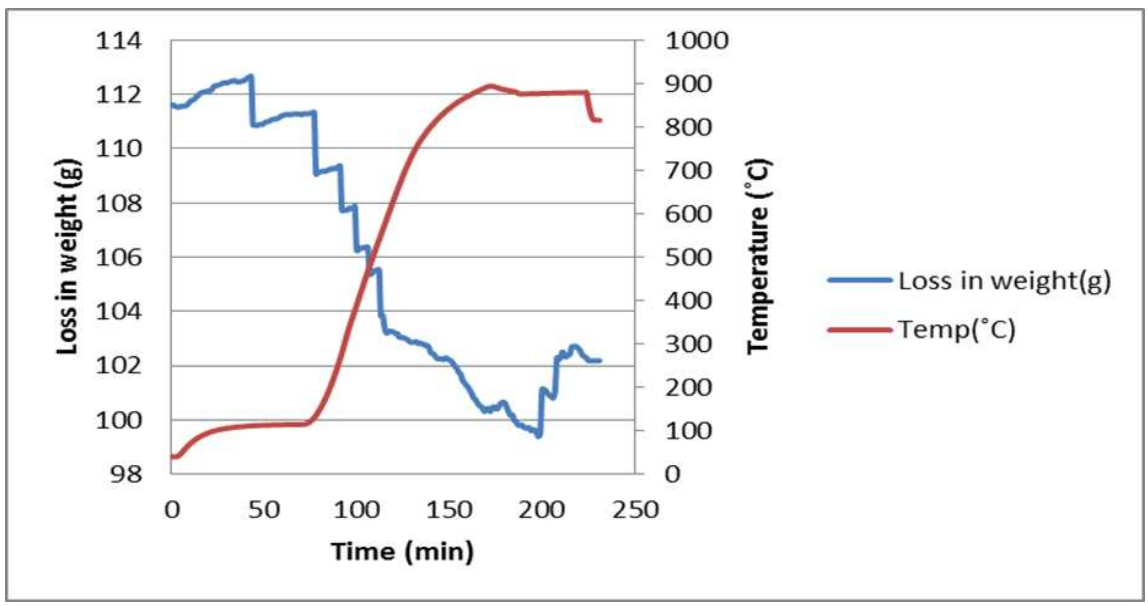
Fig2. Blank test



(a) 1 gram



(b) 1 gram



(c) 0.5 gram

Fig 3. Thermogravimetric curves for wood pellets used 1 gram and 0.5 gram

From the results obtain, sample weight 1g is better than 0.5g because of experimental apparatus by balance.

The problems observed they are mainly related to the stability of the process. The stable operation of the process were very thin thermocouple with sample tray, balance and petit LOGGER.

4. Conclusions

Constructed apparatus allowed to study thermal decomposition of solid fuels and obtained thermogravimetric curves are similar to those that can be performed on commercial thermo balances. The advantage of the device is definitely lower price than of commercial solutions. Preferred option seems to be also a larger size of a chamber and sample tray allowing the analysis of larger samples of fuel. Despite these imperfections it can be considered that building of such a device meets the goal of thermogravimetric testing of fuels. Finally, we concluded that this device will modify in Myanmar.

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References

Noorhaza Binti Aliasa, Norazana Ibrahima, Mohd. Kamaruddin Abd. Hamidb,"Pyrolysis of empty fruit bunch by thermogravimetric analysis", Universiti Teknologi Malaysia, 83130 UTM Johor Bahru, Johor, Malaysia, 2014.

Robert Wróblewski and Bartosz Ceran, "Thermogravimetric analysis in the study of solid fuels", Institute of Electrical Power Engineering, Poznan University of Technology, Poznan, Poland, 2016.

The Thermogravimetric Instrument Family, Thermogravimetric Analysis (TGA), A Beginner's Guide, 1960.