

Biomass torrefaction for cofiring in coal power plant

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ABSTRACT

Torrefaction is a thermochemical process used to enhance the energy content of biomass. This study is based on torrefaction of wood materials with different qualities. The suitable ranges of temperatures for torrefaction were evaluated using TGA analysis. Type of biomass, temperature residence time for torrefaction plays a vital role in an effective torrefaction process. The torrefaction process is then carried out according to the results obtained via TGA analysis to obtain an efficient torrefaction process.

Keywords: Torrefaction, TGA, Residence Time

INTRODUCTION

Progress techniques from fossil to sustainable power source are taken into consideration everywhere throughout the world with the point of diminishing the ecological effect. Out of different sorts of choices, utilization of biomass is viewed as one of the straight forward ones. Utilizing biomass for power generation is similarly manageable arrangement since it is a carbon neutral fuel. In this way, expanding the part of biomass in the vitality supply adds to lessening unfavourable ecological effects of CO₂. (Basu, 2018). Coal power plants still record for a colossal offer of the worldwide power supply and the scenario is similar in Sri Lanka as well. At the point Lakwijaya Powerplant in Norochcholai provides 900MW to the national network. Thusly, co-firing torrefied biomass with coal can assume a huge job to build the utilization of sustainable sources and furthermore to decrease the ozone harming substance outflows.

METHODOLOGY

Materials: Rubber Wood, Albesia Wood, Torrefaction Reactor, TGA Analyzer, Muffle Furnace, Oven

TGA Analysis Procedure

In order to get an idea of the mass yield in the different stages of the torrefaction TGA analyzing is planned prior to the torrefaction reaction process. TGA analyzing process for the biomass samples were done in the following conditions (Janssen, 2012)

- Start of experiment: 30°C for 1 minute
- Heating to drying temperature: 15°C/min
- Drying: 105°C for 15 minutes
- Heating to torrefaction temperature: 25°C/min
- Torrefaction: T°C for 60 minutes
- Cooling with nitrogen: <30°C

Calibration of the Reactor

Temperature of heating elements is an important characteristic and it should be controllable when being used. Torrefaction is a process which increases the dry mass of the wood while reducing the moisture content of it. This process requires temperature of the oven to be maintained precisely at 3000C. The oven

is used to identify the minimum temperature required for the process of torrefaction. Generally, PID (proportional–integral–derivative) controllers are used for the temperature controlling of the industrial and domestic equipment. The general PID formula is given by:

Even though the PID controlling is used, there are occasions where the set point is difficult to be achieved due to the large time constant which is given by the system. In this occasion maintaining the temperature of the oven at 300C is difficult due to the very high thermal inertia of the system. Hence PID controlling incorporated with a control logic algorithm is used to generate PWM (pulse width modulation) signals for the heater input of this application.

Torrefaction Procedure

- About 30g of wood samples were pelletized and contained in the reactor tray.
- Then the sample is place in the tray of the cylindrical reactor
- Reactor was assembled, and the outer cylinder is connected to the N₂gas inlet
- Initially N₂waspurged through the reactor to remove the O₂remaining in the reactor.
- Heating rate of the sample was kept at a constant value and allowed to reach the required level without inserting the sample.
- Sample was inserted after it reaches the required temperature.
- Torrefaction time is measured from the time the samples were inserted.
- Temperature in the reactor is kept at the constant value that is required.
- After the desired residence time sample was cooledusing N₂purging.

- Then the torrefied sample was taken to the relevant testing procedures (Luo, 2011)

RESULT AND DISCUSSION

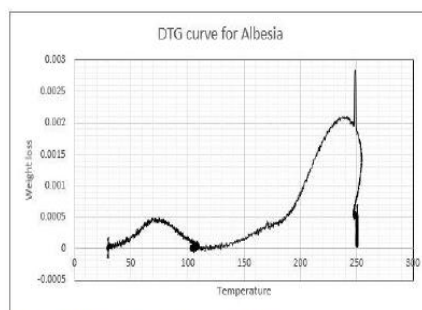


Figure 1 DTG for albesia 250 C

TGA Analysis

TGA analysis was performed for temperatures of 250 C and 275 C. Here the mass loss of the samples was taken into consideration. At 250 C 76 % of mass was retained and at 275 C 54 % mass was retained. Then in order to analyse the decomposition of structures DTGA curves were analyzed. At the first peak of the both curves the moisture content has been removed and at the next visible peaks of the curves decomposition of hemicellulose are visible.

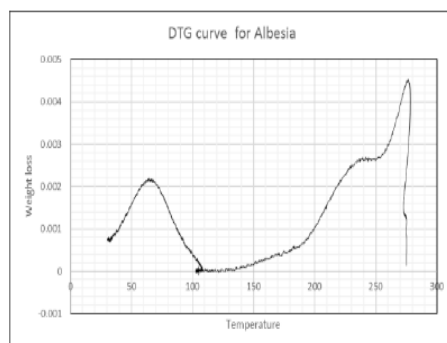


Figure 2 DTG for albesia 275 C

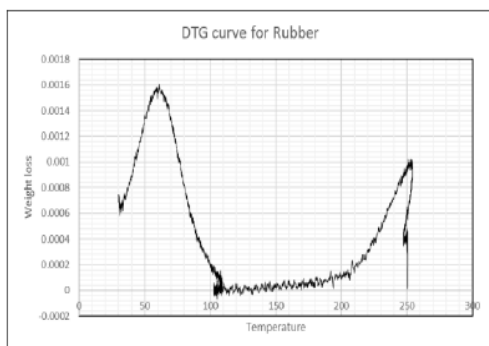


Figure 3 DTG for rubber 250 C

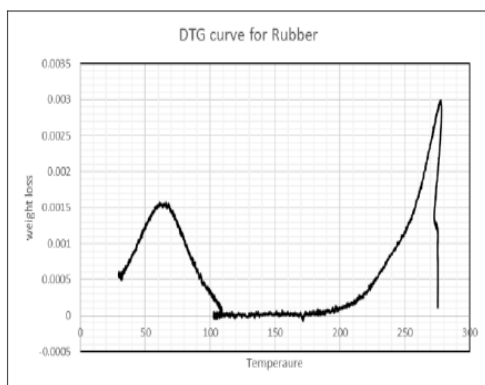


Figure 4 DTG for rubber 275 C

Similarly, TGA was performed for rubber samples as well. Here mass retained in respective samples were 77% and 61%. In the DTGA curves of the samples two clear peaks were visible indicating moisture releasing and the decomposition of hemicellulose structures.

CONCLUSION

According to results obtained by TGA it was quite evident that the process of decomposition has occurred in the temperature ranges of 200-300 C. The peaks of each curves of DTGA confirm the scenario. Even more analysing the weight loss along with time after it

reaches the torrefaction temperature for rubber weight loss/ time was negligible after 30 minutes of constant temperature of 275 C. For the Albesia sample after it reaches the constant temperature of 250 C at the end of 30 minutes weight loss/ time was almost constant. Taking this into consideration a conclusion of torrefaction conditions were made as follows.

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Table 1 Torrefaction condition

Sample	Temperature	Residence Time
Rubber	250 C	30 minutes
Albesia	275 C	30 minutes

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