Carbonization of Urban Bio Waste In Sri Lanka

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ABSTRACT: the research scope was set to study the compatibility of applying torrefaction for bio-waste of Sri Lanka. For this purpose, it was decided to analyze the before and after torrefaction properties of a sample with Sri Lankan municipal solid bio waste composition; with the use of ultimate and proximate analysis. A laboratory scale reactor was made to undertake the conventional torrefaction process with N2 purging. Heat was supplied for the reactor using a 3 kW heating coil and insulations were made around the reactor to minimize the heat loss during the torrefaction. The reactor temperature was controlled to maintain at desired temperature with a maximum of 350OC using LabVIEW software.

Keywords: torrefaction, municipal solid waste, bio-waste

INTRODUCTION

With the rapid urbanization takes place in Sri Lanka, the increased amount of Municipal Solid Waste (MSW) has become one of the biggest issues. It has been estimated and projected that the MSW generation in Sri Lanka is to be 1.0 kg/capita/day in 2025 which is 0.8 kg/capita/day at present. Since, most research and surveys have gathered data on waste collection at the dumpsite and not on total waste generation, no consensus could be found among various estimates with regard to the latter. And also, even though currently Sri Lanka has initiated some best practices in Solid Waste Management, such as Integrated Sustainable Waste Management (ISWM); the effectiveness of the application is questionable.

Torrefaction is a process which removes the moisture of a compound at elevated temperatures such as 260oC- 300oC. Basically, there are two torrefaction methods available; Namely, dry torrefaction and wet torrefaction. Torrefaction should be undergone in an Oxygen free environment to avoid combustion which can affect the energy density of the end product. For this purpose, an inert gas at an elevated pressure is purged to the reactor during the process. As a result of torrefaction the properties of the product can be enhanced to a level where it can be used as an alternative fuel. The high heating value, improved energy density, grindability and palatability are some main such properties. Also, torrrefaction is a viable solution for the waste disposal issue; as it can be implemented in small scale or pilot scale plants in island wide. Therefore, the costs and issues involved in transportation and storages can be minimized.

In this study, the main purpose was to check the viability of implementing torrefaction process for Sri Lankan urban bio waste. A proximate analysis and an ultimate analysis were carried out to identify the properties of waste before and after torrefaction. With the analysis, the

ultimate objective was to check the compatibility of applying torrefaction as a solution for the waste disposal which

has become a national concern in the present.

METHODOLOGY

We modified the existing torrefaction apparatus as per the requirements. Then waste samples were prepared according to the composition taken from the literature. (short term bio-degradable waste 54.5%, long term bio-degradable waste 5.9%, Slaughter house waste 2.3%, paper and cardboard waste 3.7%, wooden waste 6.1%) Then analyze the waste sample characteristics with proximate and ultimate analysis. Torrefaction process is then done for the prepared sample according to the optimum conditions found through the literature values. Temperature was maintained at the range 250oC-350oC and N2 gas was supplied continuously throughout the torrefaction process. Then the characteristics of the torrified sample was analyzed by the proximate analysis. With the available facilities within the university laboratory we were able to do only the proximate analysis. So that external laboratory service has to be taken for the ultimate analysis.

RESULTS AND DISCUSSION.

According to the results obtained from the proximate analysis experiment, a moisture content of 47.4% was observed for the wet based sample. When compared to the values of literature a typical bio waste sample of Sri Lanka normally has a moisture content of 59.213%. A significant deviation between the results obtained and the values in literature can be seen as a non-uniform heating was observed after the experiment. Therefore, a total removal of moisture cannot be assured by this current experimental setup and equipment. This can be mainly due to inefficiencies and experimental errors of the oven.

A 34% of volatile matter content was observed in the sample in the dry basis. According to the literature values of Sri Lankan bio waste volatile matter content, a value of 31.230% can be found. The deviation of resulted value from the literature value can be mainly due to the errors in the experimental setup.

Currently, the temperature control system is not functioning properly in the muffle furnace in our laboratory. Therefore, the temperature couldn't be properly managed and the end point of volatile emission couldn't be accurately obtained. Hence, initiation of ash formation might be a reason for the deviation.

As the obtained results 13.3% of ash content was observed there in the waste sample. But according to the literature values 5.07% ash content of Sri Lankan bio waste was found. Significant different of two results can be seen.

This can be happened due to the less performing of the muffle furnace of the laboratory. Actually, when finding the ash content through proximate analysis the sample should be placed in the muffle furnace for 30min with the constant temperature of 500oC and then for 30-60min with the temperature of 815oC (Proximate analysis procedure (IS 1350-Part I-1984), 2011). But the muffle furnace available in the laboratory gives the temperature only up to 450-500oC.And also there is no any temperature controlling system to let the sample at constant temperature foe certain time period. So that the accuracy of obtained results was very low. Hence the above deviation of results can be generated.

5.3% of fixed carbon was observed in the sample which results some higher value than the literature value for the fixed carbon of 4.465% in Sri Lankan bio

waste. Fixed carbon percentage of the weight sample was obtained by using above mentioned moisture content, volatile matter content and ash content results. Actually, those obtained results are also not at the well accurate situation. Therefore, that reason might be influence for the deviation of this fixed carbon result.

CONCLUSION

Since the research is in the ongoing state, following conclusions can be made on the trial proximate analysis carried out at department laboratory for the raw waste sample. In the raw waste sample, a moisture content of 47.4%, 34% of volatile matter content, 13.3% of ash content and 5.3% of fixed carbon content were found. There results have to be compared with torrified waste sample in the future.

Due to some failure in Nitrogen supply; the experiment couldn't be continued till the end several times. Therefore, the results of the ultimate and proximate analysis after torrefaction should be compared with respect to the before torrefaction properties.

During one of the experiments; complete torrefaction state could be obtained after 20 minutes when the reactor was operated at 300oC. Since the quantity of torrified sample was a less amount, the laboratory experiments couldn't be carried out. But the torrified samples were observed to be pellet like with a brittle nature. Also, the sample was dry and a coal like material.

As the future works, since the issue was with the nitrogen supply; a cylinder replacement or a regulator replacement should be done before the next experiment. Additionally, the sample size should be increased, as the weight loss during torrefaction is highly considerable.

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