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DESIGN AND ANALYSIS OF PRE MIXED AND NON PREMIXED COMBUSTION OF FBC GASIFIER USING WOODEN CHIPS BLENDED WITH WASTE TRANSFORMER OIL

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ABSTRACT

Gasification is seen as an important technology for expanding the use of biomass and waste oil as an alternate fuel. The Fluidized Bed Combustion is used to efficiently combusts low-grade solid fuels, significantly reduces NO_X and SO_X emissions, and increases the heat recovery efficiency between solids and gases discharged from the process. The blending ratio was calculated by using practical analysis method. The FBC Gasifier of capacity 4 kg has been designed, and fabricated. Locally available wood chips blended with waste oil and used for gasification with proper blending ratio. Then the proximity and ultimate analysis of fuel has carried out for the fuel. The fuel was filled in the FBC gasifier then the fuel was burnt by supplying air from the air blower and it produces the smokes. This smokes are contains the producer gases. Finally composition of producer gas was analysed and temperature profile of reactor was also analysed under this study.

Keywords: fluidized bed combustion, gasifier, producer gases.

1. INTRODUCTION

Gasification is the process of producing the gas such as producer gas by the partial combustion of the particular biomass used and it can be operated to a temperature of about 900-1000^{0}C. Fluidized bed system is used for getting the uninterrupted supply of biomass and it mainly works on the principle that the char produced is combusted separately to get the required amount of heat required[1]. Obtaining the producer gas at the proper state such as prescribed physical and chemical properties is more difficult when compared with the normal productivity as the impurities may vary time to time [2]. The attraction between the particle fluid in the fluidized suspension aggravates the hydrodynamic property in the fluidized beds [3]. The main area of applications of fluidized bed combustion chambers are such as denitrification process in drinking water and waste water [4]. The aim of designing gasifier is to generate useful conditions such as reduction of biomass into charcoal and production of CO and H2 at suitable temperatures [5]. NO_X and CO emissions can be lowered upto the level of 140ppm by using the down draft gasifier [6]. Gasification is one of the effective way of hydrogen production as well as the preferred best and safest way of waste disposal mechanism [7]. A high degree of recirculation is compulsory for obtaining an affordable efficiency in combustion [8]. By practicing the combustion in two stages the harmful pollutants like nitrous oxide and sulphur di oxide can be lowered [9]. The high pressure and temperature flue gas has the chance for achieving higher efficiency when compared with the flue gas normal conditions [10].

2. DESIGN AND OPERATION OF FBC GASIFIER

The FBC Gasifier of capacity 4 kg has been designed, and fabricated. With the locally available woodchips are blended with waste transformer oil and used for gasification with proper blending ratio. Then the proximity and ultimate analysis of fuel has been done for the fuel. The fuel was filled in the FBC gasifier then the fuel was burnt by supplying air from the air blower and it produces the smokes. This smokes are contains the producer gases. Finally composition of producer gas was analysed and temperature profile of reactor was also analysed under this study.

The temperature profiles and the composition of the producer gas of the gasifier have been measured at 0.7 m3/min air inlet velocity on the basis of equivalence ratio. The temperature ranged from 300°C to 800°C in the combustion zone. The gasifier was operated and the air flow and gas compositions were measured. Carbon mono oxide (CO) is the major component of the producer gas was measured. The temperature of the raw gas was measured about 120°C at outlet. Air-fuel ratio shows operation in a combustion mode at start-up, a gasification mode for the middle part of the run and a charcoal gasification mode at the end of the run. The quality producer gas was burnt. The producer gas easily caught fire and the flame showed a sustainable burning of gas.

The FBC Gasifier has been designed and fabricated with following specifications such as, Diameter of the shell =300 mm; Length of the shell=500 mm; Thickness of the shell=3 mm; Diameter of air inlet nozzle=¾"; Length of the inlet nozzle=100 mm; Diameter of air outlet nozzle=¾"; Length of the outlet nozzle =100 mm; Grating hole size=5 x 5 mm; Size of the flexible hose=¾"; Capacity of the blower = 2.3m³/min at 1200 rpm. Initially wood chips are blended with waste transformer oil and kept aside for 24 hours. After that proximate and ultimate analysis is done and this blended mixture is combusted in gasifier. During combustion gases evolved at this time producer gas test is carried out and results are noted. The gasifier shell and nozzle is made of

mild Steel, and the flexible hose is made of Plastic materials.

Figure-1. Experimental setup.

3. BLENDING PROCESS

The transformer oil is blended with wood chips in the ratio of 5:1(5 times of wood and 1 time of waste transformer oil). This blended mixture is kept for 24 hrs

3.1Proximate analysis

Proximate analysis of waste transformer oil blended with wood chips is done to determine the percentage of moister content, volatile matter, fixed carbon and ash in fuel

3.2 Ultimate analysis

Ultimate analysis of waste transformer oil blended with wood chips is done to determine the chemical composition of fuel in terms of carbon, oxygen, nitrogen, sulphur and nitrogen.

Figure-2. Wood chips with waste transformer oil.

3.3 Combustion process

The blended mixture is used as a fuel in gasifier and combusted. A pump is used to supply air during the combustion until the gases are come out. These gases are taken for producer gas test.

3.4 Producer gas test

During the combustion gases are evolved these gases are tested by using flue gas analyzer (Kane) and values for carbon dioxide, carbon monoxide, oxygen, SO_X and NO_X are noted.

4. RESULTS AND DISCUSSIONS

A. Before combustion properties of wood has been noted as Carbon (50%), Hydrogen (5.75%), and Oxygen (44%), Nitrogen (0.25%).

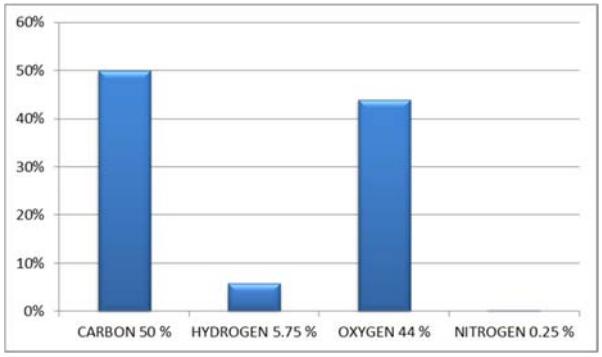

Figure-3. Properties of wood.

B. Proximate analysis of waste transformer oil blended with wood is noted for moister content (0.83%), ash (1.92%), volatile matter (22.9%), fixed carbon (68.5%).

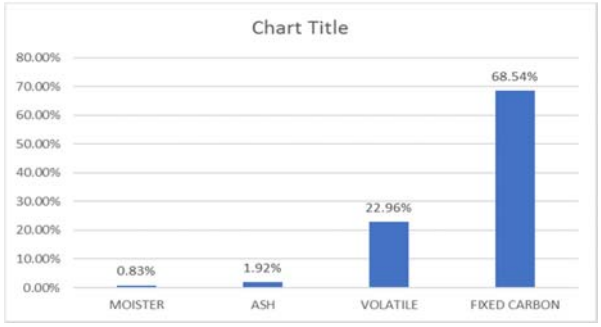

Figure-4. Proximate analysis of waste transformer oil with wood chips.

C. Ultimate analysis of waste transformer oil blended with wood chips is noted for carbon (52.36%), oxygen (39.25%), sulphur (0.03%) and nitrogen (0.17%)

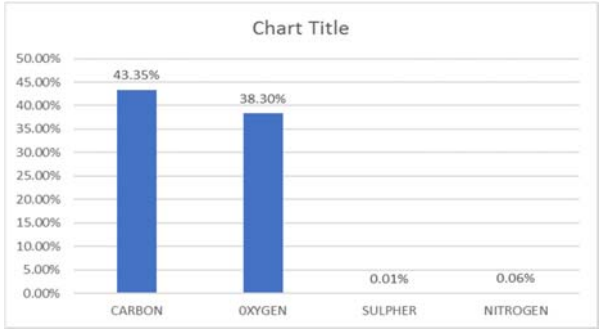

Figure-5. Ultimate analysis of waste transformer oil with wood chips.

D. Calorific value of wood blended waste transformer oil is blended is compared

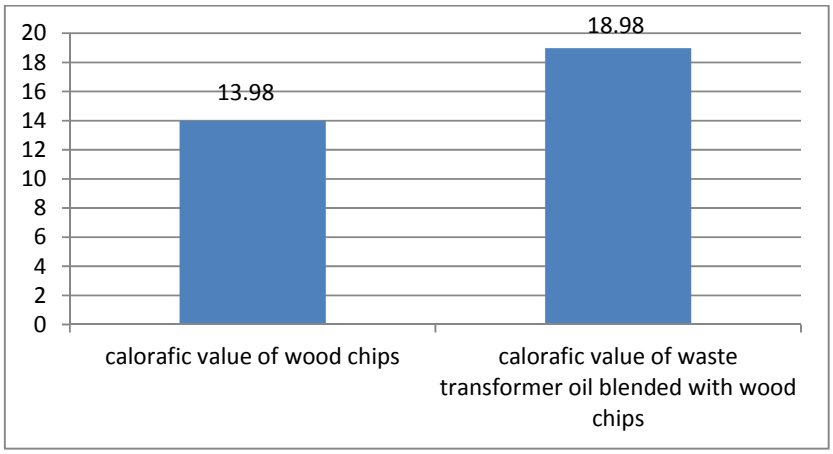

Figure-6. Comparison of calorific value of wood chips and waste transformer oil blended with wood chips.

E. After doing producer gas test results are being noted for oxygen (8.3%), carbon dioxide (11.96%), carbon monoxide (0.11%), NO_X (312ppm), SO_X (36ppm)

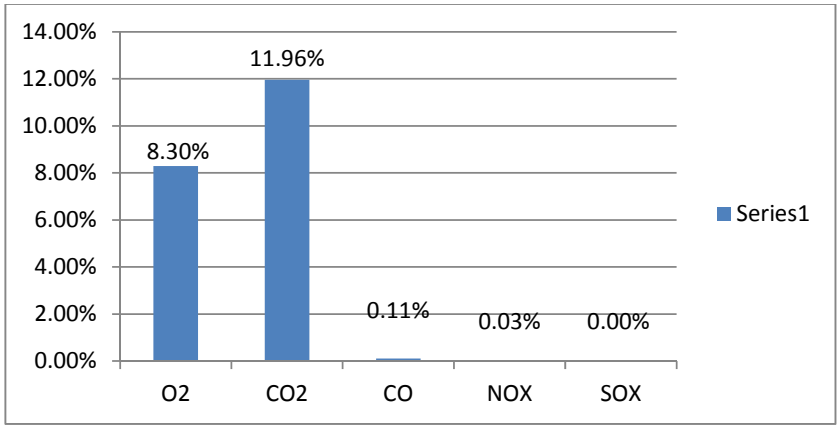

Figure-7. Producer gas test results.

7. CONCLUSIONS

a) The calorific value of waste transformer oil blended with wood chips was obtained 18.98 MJ/kg which is 35% higher than the calorific value of wood;

b) Waste Transformer oil also can be used as alternate fuel due to presence of low amount SO_X and NO_X;

c) The gases that evolved from this process contains lesser amounts of NO_X and SO_X which is less than the other bio mass gasifiers, also the waste oil blended with bio waste product gas composition is 7% richer than the wood gasification;

d) The successful results obtained can be used for development of this clean technology for the vaporization of agro industrial wastes and waste oil in India, specifically, by means of the use of the fluidized bed gasification technology.

e) Further we can enhance the efficiency and rate of combustion by using turbulence combustion technology.

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