Edited by

Guangxi Yue
Hai Zhang
Changsui Zhao
Zhongyang Luo

Proceedings of the 20th International Conference on Fluidized Bed Combustion

(II)

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PREFACE

The Proceedings of the 20th International Conference on Fluidized Bed Combustion (FBC) collect 9 plenary lectures and 175 peer-reviewed technical papers presented in the conference held in Xi'an China in May 18-21, 2009. The conference was the 20th conference in a series, covering the latest fundamental research results, as well as the application experience from pilot plants, demonstrations and industrial units regarding to the FBC science and technology. It was co-hosted by Tsinghua University, Southeast University, Zhejiang University, China Electricity Council and Chinese Machinery Industry Federation.

A particular feature of the proceedings is the balance between the papers submitted by experts from industry and the papers submitted by academic researchers, aiming to bring academic knowledge to application as well as to define new areas for research.

The authors of the proceedings are the most active researchers, technology developers, experienced and representative facility operators and manufacturers. They presented the latest research results, state-of-the-art development and projects, and the useful experience.

The proceedings are divided into following sections:

- CFB Boiler Technology, Operation and Design
- Fundamental Research on Fluidization and Fluidized Combustion
- CO_2 Capture and Chemical Looping
- Gasification
- Modeling and Simulation on FBC Technology
- Environments and Pollutant Control
- Sustainable Fuels

The proceedings can be served as idea references for researchers, engineers, academia and graduate students, plant operators, boiler manufacturers, component suppliers, and technical managers who work on FBC fundamental research, technology development and industrial application.

The editors would like to take this opportunity to thank our FBC colleagues around the world who devoted much of their time to review the manuscripts to keep the scientific standard of the proceedings.

Xi'an, China
May 2009
Guangxi YUE
Hai ZHANG
Changsui ZHAO
Zhongyang LUO

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Fundamental Research on Fluidization and Fludized Combustion

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Gasification

Modling and Simulation

Environmentals and Pollution Control

Sustainable Fuels-Combustion and New Concept

OPTIMIZATION OF BIOMASS GASIFICATION PROCESS FOR F-T BIO-DIESEL SYNTHESYS

Jae Hun Song, Yeon Kyung Sung, Tae U Yu, Young Tae Choi, Uen Do Lee

Korea Institute of Industrial Technology, Cheonan, Korea

Abstract: The characteristics of biomass steam gasification were investigated to make an optimum syngas for Fischer Tropsch (F-T) synthesis of bio-diesel. Korean pine wood chip was used as a fuel and the experiment was conducted in a lab scale bubbling fluidized bed (0.1m I.D. x 3.0m height). Gas composition was evaluated by changing operating parameters such as gasifier temperature, and steam to fuel ratio. Major syngas was monitored by on-line gas analyzer (ND-IR spectroscopy) and gas chromatography (GC). As the temperature of gasifier increases hydrogen in the syngas increases while CO in the product gas decreases. The low concentration of sulfur compound and nitrogen in the product gas shows the potential advantages in the purification process of the syngas for F-T process. Optimum operating condition of the gasifier was found concerning the following gas cleaning and F-T process; H_2-CO ratio and total gas yield increase while decreasing methane and CO_2 concentrations in the syngas.

Keywords: steam gasification, biomass, syngas, bubbling fluidized bed, F-T synthesis

INTRODUCTION

With the depletion of fossil fuel as well as the global warming issues, people have a renewed interest in biomass as an alternative for fossil fuel. Regarding the economic feasibility and application area, making bio-syngas from biomass is the most competitive technology. The bio-syngas mainly composed of H_2, CO, CH_4 and CO_2 can be used as a gas fuel, ingredient for chemical synthesis or bio-diesel. Due to the recent sky-rocketing oil price, synthesis of liquid fuel with bio-syngas becomes very promising technology of biomass to energy. With the help of gas to liquid (GTL) technologies, better known as Fisher-Tropsh (F-T) process we can synthesis alcohol, dimethylether (DME), and bio-diesel. Liquid fuel, obtained from F-T process, offers important emission benefits compared with conventional diesel, reducing nitrogen oxide, carbon monoxide, and particulate matter. In general, F-T process synthesis reacts one mole of CO with two moles of H_2 to form hydrocarbons over catalysts (Boerrigeter and Den Uil, 2002). Hence, proper composition of syngas is essential to optimize the F-T synthesis and highly purified syngas is necessary for avoiding any contamination of catalyst. Some recent studies indicated that possibility for production of F-T liquid via biomass gasification (Tijmensen et al., 2002) and F-T technology application for biomass conversion to synthetic hydrocarbons (Srinivas et al., 2007). Tristantini et al. (2007) studied the effect of syngas composition on F-T synthesis over catalysts. The proper condition of gasification is important in attempts to provide a desirable gas for the effective synthesis of liquid fuel from F-T technology. In this paper, we investigated the optimum condition of biomass gasification using steam which increases hydrogen content in the syngas to meet the necessary condition for F-T bio-diesel synthesis.

EXPERIMENTAL

Korean pine wood chips were used as fuel for the gasification. The properties of wood chip used in this work is given in Table 1. The experiment was carried out at atmospheric, on a lab scale bubbling fluidized bed (0.1m I.D.×3.0m height) gasifier. A schematic diagram of the experimental set-up is shown in Fig. 1. The gasifier was placed inside an electric furnace, which provided necessary heat to maintain the gasifier temperature for each case. Steam was used as fluidizing/gasifying agent and introduced into the reactor through the distributor and the flow rate of the steam was measured by a voltex flowmeter. Gas composition was evaluated by changing various operating parameters such as gasifier temperature, and steam to fuel ratio. The gasification conditions of this work were as follows: reaction temperature 700 ~ 900℃, steam flow rate 2.7 ~ 8.0kg/hr (steam to biomass ratio 0.5 ~ 1.6), fuel size $\leq$ 10 mm. The gas produced from gasification was cooled through a quenching system to remove condensable compounds. The composition of major syngas was monitored by gas analyzer(ABB CO. Ltd., Germany, Model: AO2020).

Table 1 Properties of wood chip used in the experiments

Proximate analysis(wt.%, wet basis)		Ultimate analysis (Dry basis)	
Moisture	6.4	C (wt %)	50.8
Volatile matter	75.9	H (wt %)	5.37
Fixed carbon	17.4	O (wt %)	43.6
Ash	0.3	N (wt %)	0
LHV(J/g)	19700	S (mg/kg)	61.8

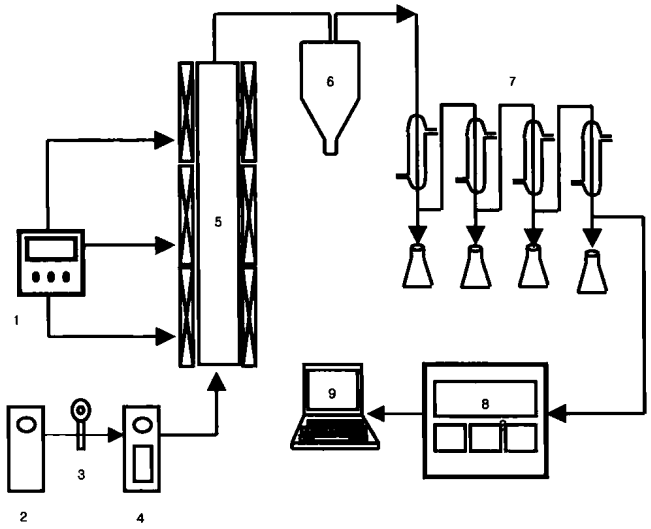

Fig. 1 Schematic diagram of the experimental set-up for the gasification

1—Temperature Controller; 2—Steam Generator; 3—Voltex Flowmeter; 4—Superheated Heater; 5—Gasifier; 6—Cyclone; 7—Tar & Water Trap; 8—Gas Analyzer; 9—DAQ system

RESULTS AND DISCUSSION

Effect of temperature

Figure 2 illustrates effect of temperature, ranging from 700 to 860℃ on the syngas composition while keeping the amount of steam and biomass (S/B: 0.5). As shown in Fig. 2, H_2 increases with increasing the temperature while CO decreases on the contrary. As temperature increases, CH_4 slightly decreases and there is no significant changes in CO_2 content which was around 15%. This result can be explained by the influence of water-gas shift reaction above 700℃, as suggested by Walawender et al.(1985), Brink and Massoudi(1978), and Franco et al.(2003) also reported that the presence of steam favoured that reaction leading to an increase in H_2 and a decrease in CO content with the rise of temperature. H_2/CO ratio of the syngas varies from 0.87 to 1.15 as the temperature changes from 770 and 860℃.

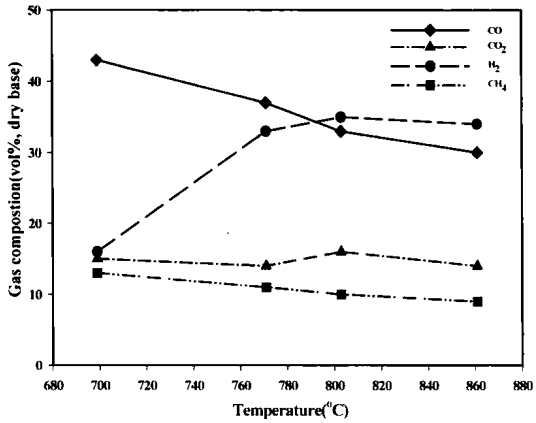

Fig. 2 Effect of temperature on syngas composition (steam/biomass ratio = 0.5)