Operational Parameters Assessment of a Biomass-To-Fuel Gas Converter

K.H.Chong, P.L Law, A.R.H. Rigit, R.Baini , S.F.Saleh and A. A. R. Awangku Yussuf

***Abstract*—This study presents the assessment on the existing mini-sized biomass-to-fuel gas (B2F) converter. Operational parameters, such as composition of after filtered residual liquid (AFRL), composition of raw combustible fuel gases produced using wood chips and coal as feedstock, and nearby incremental levels of carbon monoxide and suspended particulate during operation, are determined. Analysis results of the raw (unburnt) combustible fuel gases from low grade Balingian-Mukah coal and wood chips found that there were approximately 23-29% gasoline constituents; 15-30% diesel constituents; 1-16% CO_2; 10-13% O_2, CO, SO, NO and H_2O; 46-71% combustible gases. It was observed that the phenol contained in the AFRL recorded approximately 5,310 mg/L. Moreover, by-products, such as 1.5% tars and 13% AFRL, were produced. The result shows that a B2F converter is suitable to harvest the combustible gases that can be used as fuel for internal combustion engines. However, the amount of organics indicated that the AFRL should not be discharged directly into watercourses without pre-treatment.**

***Keywords*:** Gasification, Combustible gas, Coal, Wood chips

I. INTRODUCTION

In Malaysia's logging industries in 2009, wood waste alone gave a total production of logs, based on the total land area, of 18.27 million m^3 [1]. From January to February 2009, Malaysia generated a free on board (FOB) value of more than RM 202 million through logging activities [2]. This generated a huge amount of wood waste that, potentially, could have given rise to sensitive environmental disposal issues. In 2013, the total current energy demand in Malaysia was 33.9 Mtoe; by 2020, the energy demand is expected to grow by 5.4% per annum to reach 83.5 Mtoe [3]. It is estimated that the oil reserves in Malaysia will last for 15 years and gas reserves for another 29 years [4]. Although efforts at renewable energy have been initiated by the Malaysian government, the response has not been positive [5]; regardless, renewable energy still has great growth potential.

It is well-known that gasification is a comparatively cheap method that can produce product gas with very low tar content [6]. According to Walawender's study of a model of gasifier (stratified and open top), the average composition of the gas on a dry basis is as thus: H_2 = 15.1%; CO = 19.1%; CH_4 = 2.5%; CO_2 = 15.8%; small quantities of C_2H_6, C_2H_2 and C_3H_4 and the remainder is N_2 [7]. Garcia-Bacaicoa built two stratified-closed top gasifiers: one for 50 kg/h and another for 200 kg/h of the same configuration. The average composition of the gas produced on a dry basis is in the following range of volume percentage: N_2 = 45-60%; CH_4 = 0.25-2.5%; H_2 = 10-22%; CO = 13-25%; CO_2 = 8-19% and traces of C_2H_2 and C_2H_4 [8]. In addition, the burning of biomass will introduce chemicals, such as polycyclic aromatic compounds (PAC) and heavy metals [9].

To date, various types of biomass combustor are available, such as updraft, downdraft, cross-draft, fluidised-bed design features and others [10]. However, treatment technologies for gasification in terms of cost-effectiveness, local availability and serviceability of materials and equipment that require low technical skills for operation and maintenance are not available [11]. Therefore this study aims to investigate the feasibility of a B2F converter for fuel production.

A. B2F Converter

A B2F converter (Figure 1) at the 12th Mile Oya Road, Sibu (Malaysia) was developed, constructed and tested for drying and heating purposes in commercialised industrial scale applications, the mushroom culture industry, egg tray manufacturing facilities, powdered coconut milk production, and paper recycling facilities. For this system, solid feedstock (wood chips

Chong, K.H.,Student, Department of Mechanical Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, Malaysia, isaackokhing@gmail.com

Law, P.L., Lecturer, Department of Civil Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, Malaysia, puonglaw@feng.unimas.my

Rigit, A.R.H ,Lecturer, Department of Mechanical Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, Malaysia arigit@feng.unimas.my

Baini, R. , Lecturer, Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak, Malaysia, ruby@feng.unimas.my

Shanti, F.S., Lecturer, Department of Chemical Engineering and Energy Sustainability, Faculty of Engineering, Universiti Malaysia Sarawak, Malaysia, sshanti@feng.unimas.my

Awangku Yusof, A.R.B.P.H., Lecturer, Faculty of Science and Technology, Universiti Science Islam Malaysia, Malaysia, awangku2011@usim.edu.my