Coal ignition behaviour of bituminous and sub-bituminous coal in Thermogravimetric Analyser

Cahyadi, Yulianto S. Nugroho*

Mechanical Engineering Department, University of Indonesia, Depok 16424.
INDONESIA
*Corresponding author: yulianto@eng.ui.ac.id

Abstract

Ignition of coal particle is an important preliminary step in coal combustion process. Ignition behaviour of Indonesian coal using thermogravimetric analyser (TGA) has been done with bituminous, sub-bituminous and its blended coal. The ignition time and temperature of maximum derivative thermo gravimetric (DTG) were varying from 29 to 38 min and from 400 to 475 °C, respectively. The result is important to review existing coal fired power plant that using blended coal as fuel. Based on test shows, that fuel ratio will affect to the ignition time and temperature of DTG max. Fast ignition and low temperature DTG max will make the flame stable.

Keywords: coal, ignition behavior, activation energy, DTG max, TGA

Introduction

Now days, blending coal is usually required to meet the requirement of coal specification in a coal fired power plant. Coal fired power plant is designed in the certain range of coal between the worst and the best coal. Power plant is usually designed for long life time until 30 years and, in many cases, the “design coal” is no longer available. Fuel switching or coal blending with other alternative coal needs an investigation whether the new coal is in the range of design coal.

In Indonesia, many existing coal power plants are burning not only a single coal, but also burning with co-firing or blended with other alternative coal. The power plant is usually only refer to coal analysis such as proximate and ultimate analysis in case of burning blended coal. Further study in laboratory and pilot scale is highly recommended for minimizing the problem while burning in the full scale.

In the lab scale, thermo gravimetric analysis (TGA) is commonly used for combustion analysis. Studies on thermo gravimetric analysis (TGA) profiles contribute to enhance the knowledge of burning blended coal and, to establish the optimum operational conditions in full scale.

In general, mechanism of ignition of coal particles has classified ignition into three types, (Bandyopadhyay & Bhaduri, 1972; Essenhigh et al. (1989); Gururajan et al. (1990); Fu & Zeng (1992); Chen et al. (1996)):

1) homogeneous ignition, or the ignition of the volatile matter released from coal;
2) heterogeneous ignition, or the ignition of the coal particle surface; and
3) hetero-homogeneous ignition, which results from simultaneous ignition of the coal particle surface.

The coal quality increases from lignite through bituminous coal to anthracite, ignition type changes from the homogeneous through the hetero-homogeneous to heterogeneous ignition.

The objective of the presented study has been to investigate the ignition behavior of blended coal by TGA. Different fuel ratio from blended coal has been investigated to observe different ignition time and temperature. Faster in ignition time indicates that the coal will have better flame stability while burning in the boiler (Sua et al., 2000).

Materials and Methods

A bituminous coal (b) and sub-bituminous coal (sb), which is available in Kalimantan, are used in this study and the data for the corresponding proximate and ultimate analysis are listed in Table 1. After crushed and sieved to 74 um, the coal powder is dried at 105°C for the elimination of the outer water. Then, the sample is sealed from the air at room temperature for use.

The experiments are conducted by LECO 501 thermo gravimetric analyzer, which could record the mass loss percentage (TG signal) continuously with the sample temperature increasing linearly from 105 to 750°C at the heating rate of 15°C/ min.

Figure 1 is typical of TG–DTG curves to evaluate the coal combustion properties. Ti, the ignition temperature, is described in Fig. 1 and it is constructed as follows (Ma et al., 2006). A line is drawn across the peak of DTG curve and produces...