Fuel Processing Technology 137 (2015) 333–338

Contents lists available at ScienceDirect

Fuel Processing Technology

journal homepage: www.elsevier.com/locate/fuproc

The relation between hydrophobic flocculation and combustion characteristics of coal

S. Duzyol [a,*], C. Sensogut [b]

[a] Department of Mining Engineering, Selcuk University, 42075 Konya, Turkey
[b] Department of Mining Engineering, Dumlupinar University, 43100 Kutahya, Turkey

ARTICLE INFO

Article history:
Received 15 January 2015
Received in revised form 18 March 2015
Accepted 24 March 2015
Available online 7 April 2015

Keywords:
Coal
Hydrophobic flocculation
Contact angle
TGA
DTGA

ABSTRACT

The hydrophobic flocculation of the lignite obtained from the Ermenek region was investigated under the different operating parameters such as pH, sodium silicate concentration and kerosene concentration in the present work. Determination of combustible recovery, ash content and zeta potential values were utilized in order to make sense of the hydrophobic flocculation behavior. To specify indirectly the hydrophobicity degree of the coal, contact angle measurements were performed on the flocks obtained from the experiments.

The combustion characteristics of coal such as thermogravimetric analysis (TGA) and differential thermogravimetric analysis (DTGA), ignition temperature, and peak temperature were analyzed and correlated with the hydrophobic flocculation.

In consequence, optimum pH value was determined as to be 4; optimum sodium silicate and kerosene concentration were also ascertained as to be 1 kg/t and 16 kg/t, respectively. When experimental conditions were set up optimally, the flocks were obtained with combustible recovery of 90% and ash content of 9.8%. The strong correlation was observed between the hydrophobic flocculation results and ignition temperatures and peak temperatures acquired from the DTGA curves. The surface tension of solution, however, showed no remarkable changing. It was confirmed that the contact angle values ranged from 114° to 130° and the surfaces were highly hydrophobic.

1. Introduction

Hydrophobic flocculation is one of the aggregation methods based on the flocculation of hydrophobic fine particles in aqueous suspension. A particular mineral can be flocculated using specific collector/flocculant which is preferentially absorbed onto it, leaving the remainder of the particles in a suspension to achieve the selectivity. Sufficient kinetic energy is provided mechanically for the collision of hydrophobic particles to each other and surmount energy barrier between them owing to the electric double layer repulsion and water films. In addition, particle hydrophobicity can be enhanced by adding non-polar oil for hydrophobic surfaces. Owing to that, the hydrophobic flocs occurred and separated from the undesired dispersed materials [1]. The separation of fine coal from the impurities relies on the differences of surface properties between organic and mineral matter. Dispersants are usually used to increase the selectivity of the particles from being flocculated with the hydrophobic particles. Sodium silicate, sodium polystyrene sulfonate, tannic acid, sodium hexametaphosphate, sodium phosphate and sodiumpyrophosphate are some common dispersants.

Selective flocculation of coal from impurities has been studied by a number of authors [2–6].

Thermogravimetric analysis (TGA) is an analytical technique used to determine the characterization of coal for combustion. This analytical technique is based on the mass change of a sample as a function of temperature in the scanning mode or as a function of time in the isothermal mode [7]. This mechanism also provides the information about the purity of the sample, as well as its water, carbonate and organic content. When the material is subjected to heating or cooling, its chemical composition and crystal structure undergo such changes as reaction, oxidation, decomposition, fusion, expansion, contraction, crystallization or phase transition [8]. All these changes can be uncovered using differential thermal analysis. A derivative weight loss curve can be used to find out the points of the ignition temperature and peak temperature at which the weight loss is most apparent [9,10].

TGA has been extensively used by several researchers for investigation of basic combustion properties of solid fuels [11–14].

The purpose of the present work is to investigate the hydrophobic flocculation of coal in association with the other physical properties of coal such as zeta potential and hydrophobicity and to analyze the combustion characteristics of flocks. The correlation between hydrophobic flocculation and ignition temperatures, and DTG peak temperatures were also investigated and the results were interpreted comparatively.

* Corresponding author. Tel.: +90 332 2232043; fax: +90 332 2410635.
E-mail address: selmad@selcuk.edu.tr (S. Duzyol).

http://dx.doi.org/10.1016/j.fuproc.2015.03.021
0378-3820/

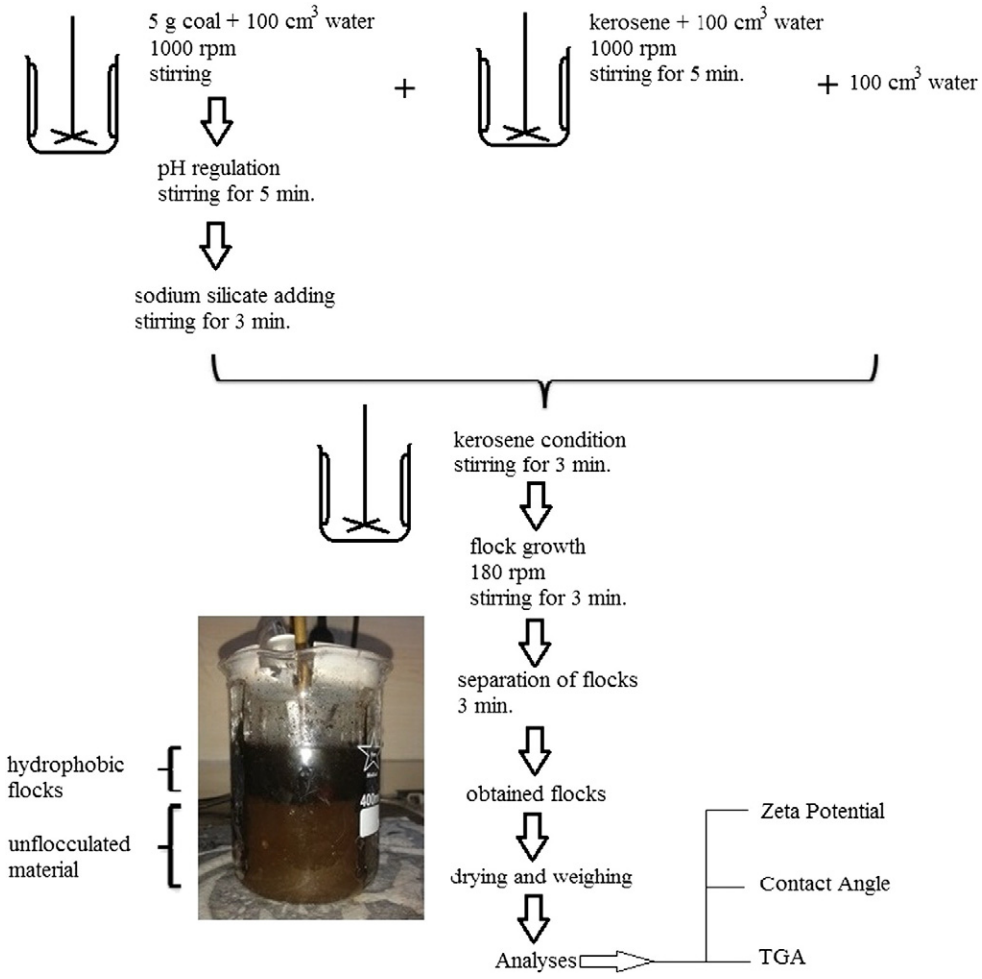

Fig. 1. Schematic representation of experimental procedure.

2. Experimental

2.1. Materials

Coal sample from Ermenek region was used to realize the hydrophobic flocculation experiments. The whole coal collected from the underground mine was ground by a steel ball mill. Cone and quarter and gridding methods were utilized to obtain representative sample. The particle size of the coal was −200 μm with an ash content of 16.4%. Sodium silicate (Na_2SiO_3) was used as a dispersant and kerosene was employed as a collector. Sodium hydroxide (NaOH) and hydrochloric acid (HCl) were prepared as 1% and 5% (w/w) solutions for modification of pH values of the suspensions and measured by a Jenco 6230 model digital pH meter. The stirring of suspension was achieved by a

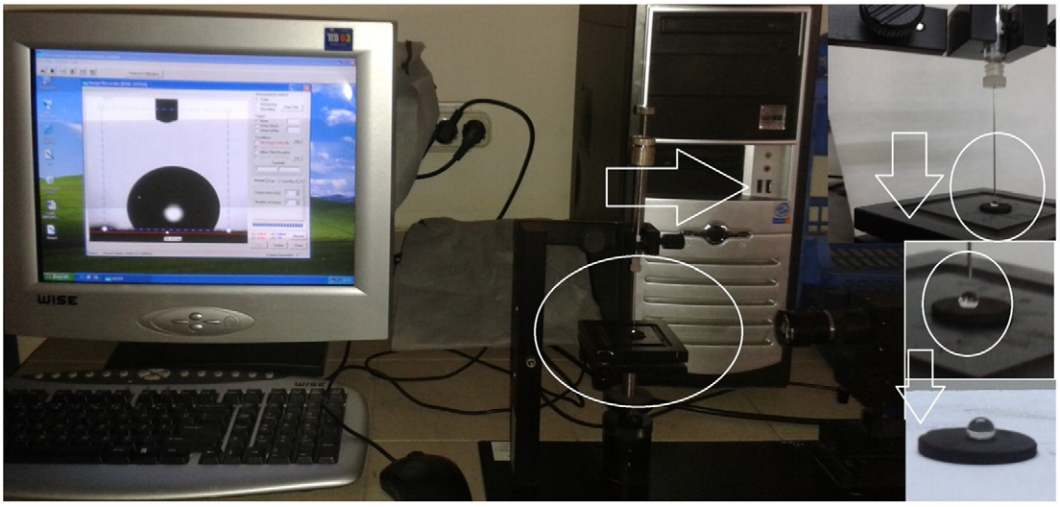

Fig. 2. The contact angle apparatus and the drop of water on the pellet surface.