Journal of International Scientific Publications:
Materials, Methods & Technologies, Volume 7, Part 1
ISSN 1313-2539, Published at: http://www.scientific-publications.net

MODIFICATION OF COAL FLY ASH BY TWO STEPS: HEAT AND ACID TREATMENT

Mehmet Burçin Pişkin[1], Ozgul Dere Ozdemir[2], Aysel Kantürk Figen[1]
[1]Department of Bioengineering, Yıldız Technical University
34210 Davutpasa, Istanbul, Turkey
[2]Department of Chemical Engineering, Yıldız Technical University
34210 Davutpasa, Istanbul, Turkey

Abstract

In order to fulfill the future world energy demand, all energy resources may need to be utilized. Despite the efforts and the commitment for renewable power to account for a significant share of the total electricity supply, coal is still one of the most important electricity producing fuels.

Coal fly ash (CFA) is generated during the combustion of pulverized coal in coal fired power stations; as such it is an industrial by-product that if not put to beneficial use, is a recognized environmental pollutant.

This study investigated the chemical modifications of coal fly ash treated by two steps with heat and acid treatment for the environmental applications. Modification of coal fly ash observed in this study influenced changes in property of treated fly ashes. The effect of the modification of fly ash was determined by XRD and SEM techniques.

Key words: *Coal Fly Ash, Modification, Acid and Heat Treatment*

1. INTRODUCTION

Coal is a valuable and plentiful natural global resource. Not only does coal provide electricity, it is also an essential fuel for steel and cement production, and other industrial activities [1].

Coal is also commonly used in electrical power plants. Because of the inevitable decline in world reserves of petroleum and natural gas and rising demand for energy, coal is a major alternative along with nuclear power to meet these needs. Coal is a major fuel source for Turkey, used primarily for power generation, steel manufacturing, and cement production. Total lignite and hard coal reserves are estimated as 8075 and 1130Mtoe, respectively (Yılmaz and Uslu, 2007).

As per data position at year's end-2005, 30.5% of worldwide lignite reserves of 207 Gt were located in Asia (63.2 Gt), 20.5% (42.5 Gt) in Oceania, 19.5% (40.5 Gt) in Europe, 17.8% (37 Gt) in North America, 8.9% in the CIS (18.4 Gt), 2.7% (5.6 Gt) in Central and South America, 0.1% (0.2 Gt) in Africa, with very small quantities in the Middle East (Fig. 1). Depending on the growth scenario assumed for lignite mining, different quantities of reserves will be transferred to the category "already produced" until the year 2100 (Thielemann et. al., 2007).

Rich lignite deposits are spread all over the country. Afsin-Elbistan, Mugla, Soma, Tuncbilek, Seyitomer, Beypazarı and Sivas basins constitute the most important lignite reserves (Fig.2)

ISSN 1313-2539, Published at: http://www.scientific-publications.net

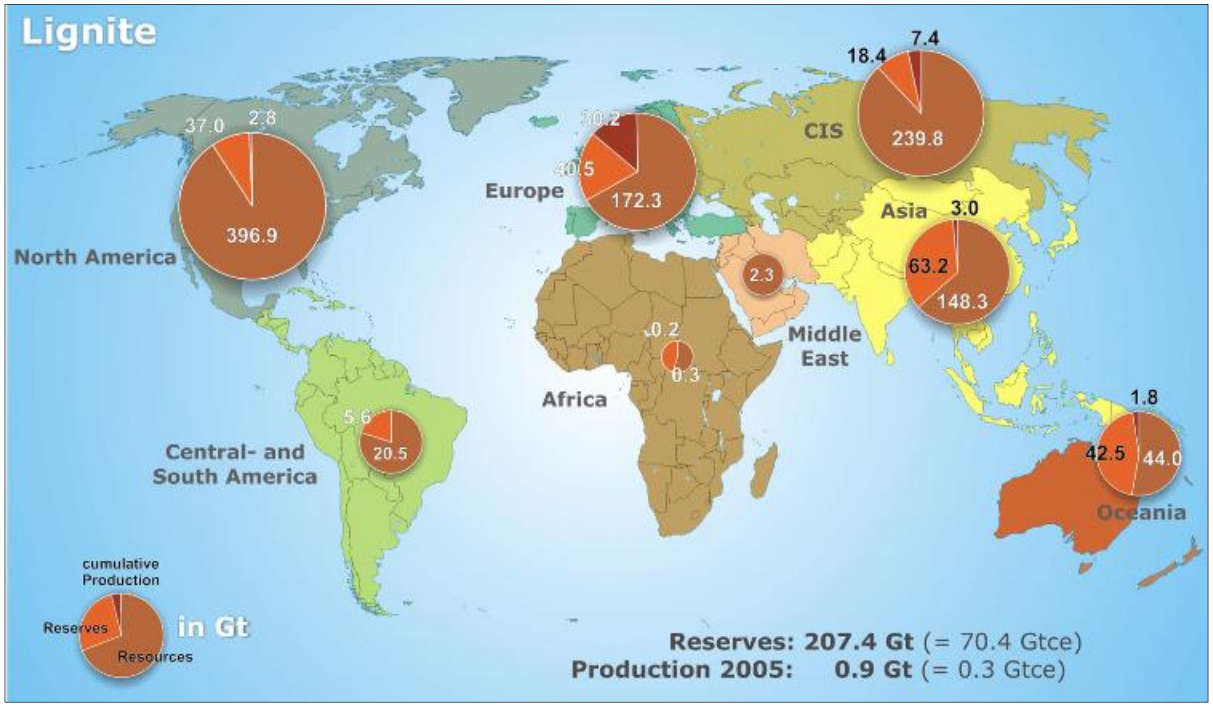


Fig. 1 Worldwide distribution of lignite's total potential in 2005 (Thielemann et. al., 2007)

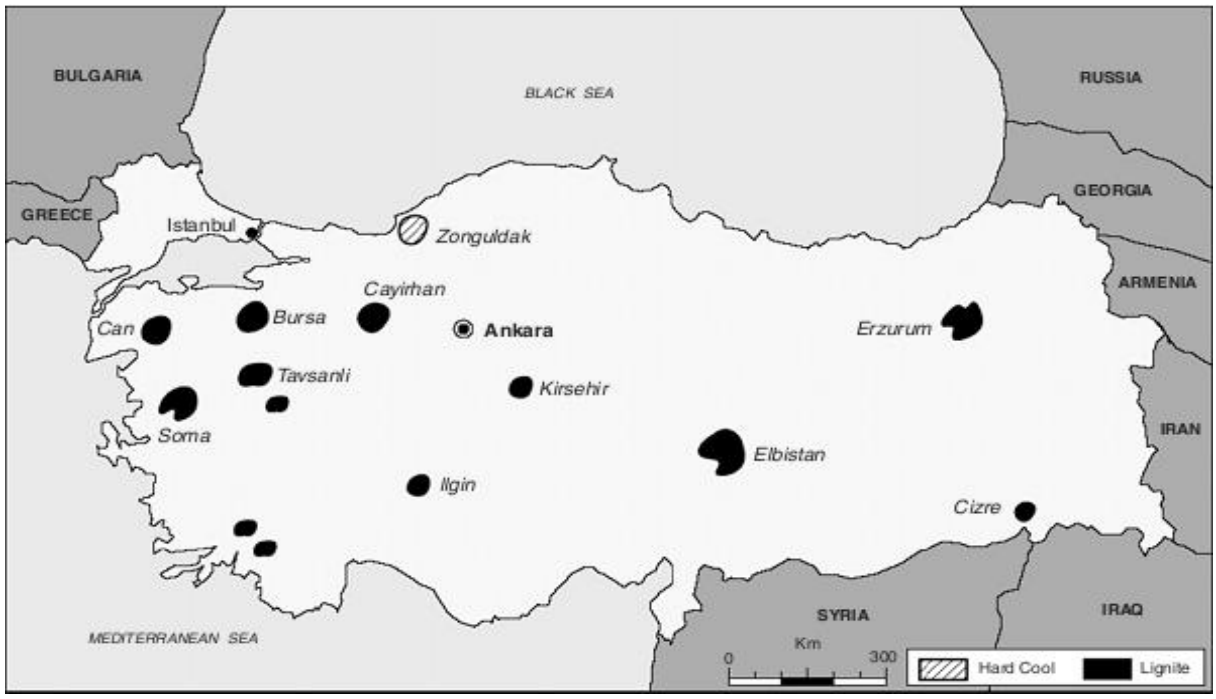


Fig. 2 Coal Deposites in Turkey (Yılmaz and Uslu, 2007)

ISSN 1313-2539, Published at: http://www.scientific-publications.net

Coal fly ash is generated during the combustion of pulverized coal in coal-fired power stations; as such it is an industrial by-product that if not put to beneficial use, is a recognized environmental pollutant (Blissett and Rawson, 2012). Hundreds of millions of tons fly ash are produced around the world every year. Fly ash is important material which has found several industrial applications. But it needs modification so the purpose of this study is to investigate the morphologic and crystal properties of fly ash after two step treatment.

2. MATERIALS AND METHODS

Steam turbines needs to burned coal to provide water vapor which is necessary to produce electrical energy. Thus the thermal energy of coal converted to the electrical energy (Fig. 3). For this purpose, lignite and anthracite coal types are used (Tokyay, 2013).

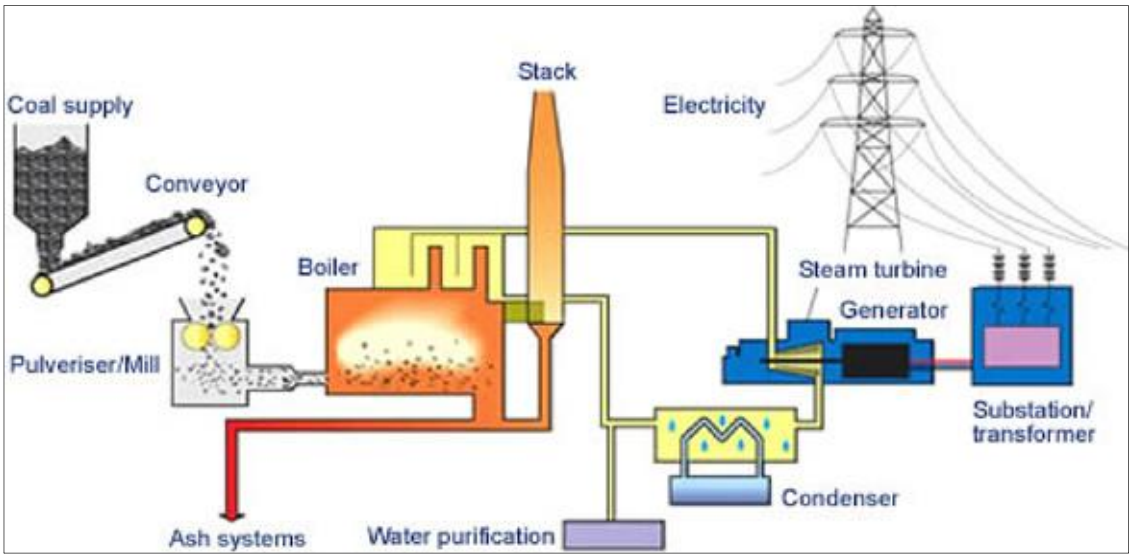


Fig.3 Coal converted to electricity [2]

The coal fly ash utilized in this study was obtained from the Tunçbilek Thermal Power station located at Kütahya, Turkey (Fig. 4). The studied fly ash is a residue from lignite combustion using a pulverized coal firing with the furnace exit gas high temperature.



Fig. 4 Tuncbilek location, Turkey(Sensogut and Cinar, 2007)

A large part of (%50-85) fly ash which is carried by flue gasses were amorphpus as a result of rapid cooling. In thermal power plants burning temperature is between of 1000-1400 ° C. The mineral phases of fly ash which obtained from the burning of this range of coal have different types and terms of quantity. The shape of caol ash can be spherical, angular, irregular depends on the type of coal, granulometry of coal and the burning temperature of thermal power plant. If burning temperature is less than the 1100 ° C, non-uniform shaped particles occurs. At high temperatures (> 1600 ° C), the impurities which contained from the coal melt and formed hollow spheres that named as senosfer. At times smaller spheres particles can be fill in the large spherical particles. This type is called plerosfer grains. Combustion temperatures round 1300-1500 °C rounds, hollow, outer surface rough or smooth of fly ash particles are obtained (Tokyay, 2013).

2.1 Methods

The sample was oven-dried at 105 °C overnight before use. The raw fly ash samples were first screened through 80-mesh size to eliminate the larger particles. The unburnt carbon (4–6%) along with other volatile materials present in fly ash were removed by calcination at 800 °C for 2 h. Fly ash samples were further treated with hydrochloric acid to increase their activity. The acid treat-ment helped to dealuminate the fly ash and removed iron to a certain extent. At the end of the treatment, the mixture was filtered, washed thoroughly and oven-dried at 105 °C for overnight. The final solid products were then subjected to physical and chemical analysis (Fig. 5).

Chemical composition of the initial and treated fly ashes was analyzed by energy dispersive X-ray fluorescence (XRF) (Philips). The fly ash samples were characterized by X-ray Diffraction (XRD) using Phillips X'Pert diffractometer with Cu K radiation. The samples were scanned over the 5–50 °2h interval. Scanning electron microscopy (SEM) (CamScan, Apollo 300 model) was performed on the samples.

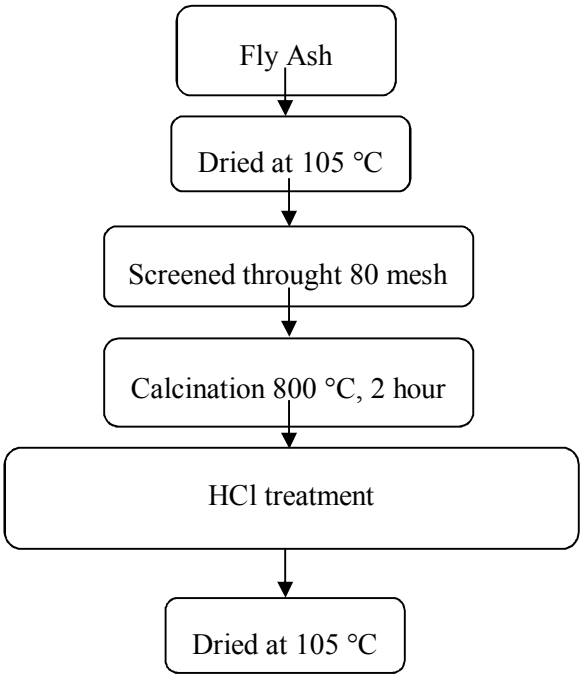


Fig. 5 Process flow diagram for fly ash modification

3. RESULTS AND DISCUSSION

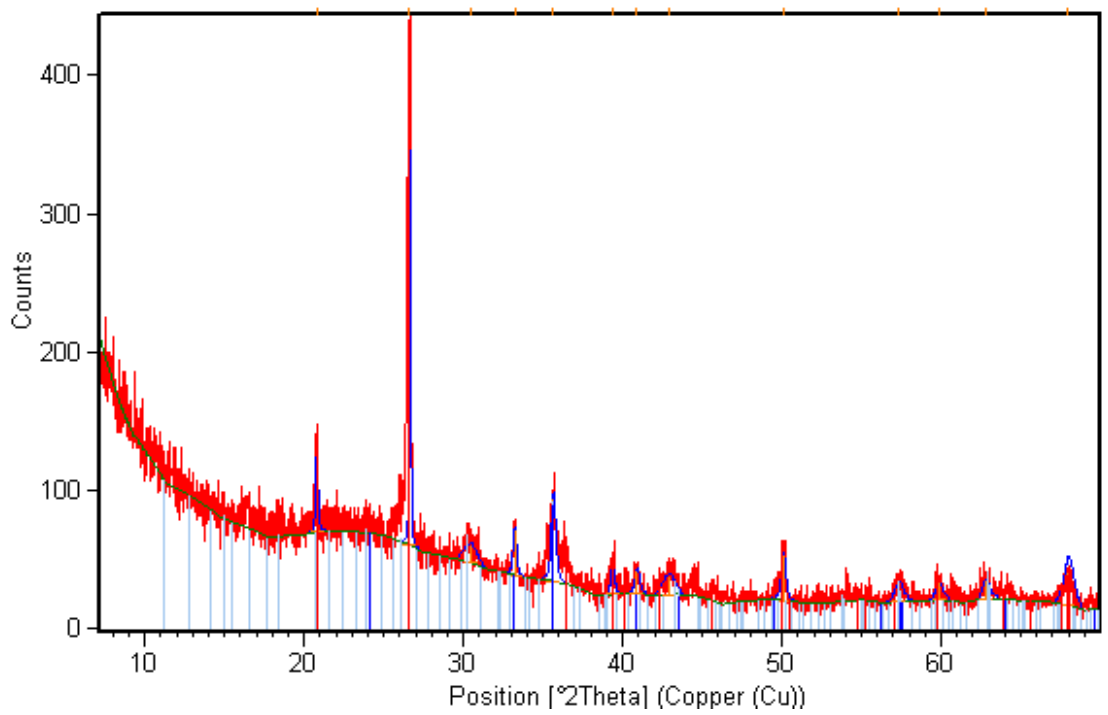
Chemical composition of the fly ash showed in Table 1. The major components of all fly ash were oxides of Si and Al, and various other oxides.

Table 1. Chemical Composition of fly ash

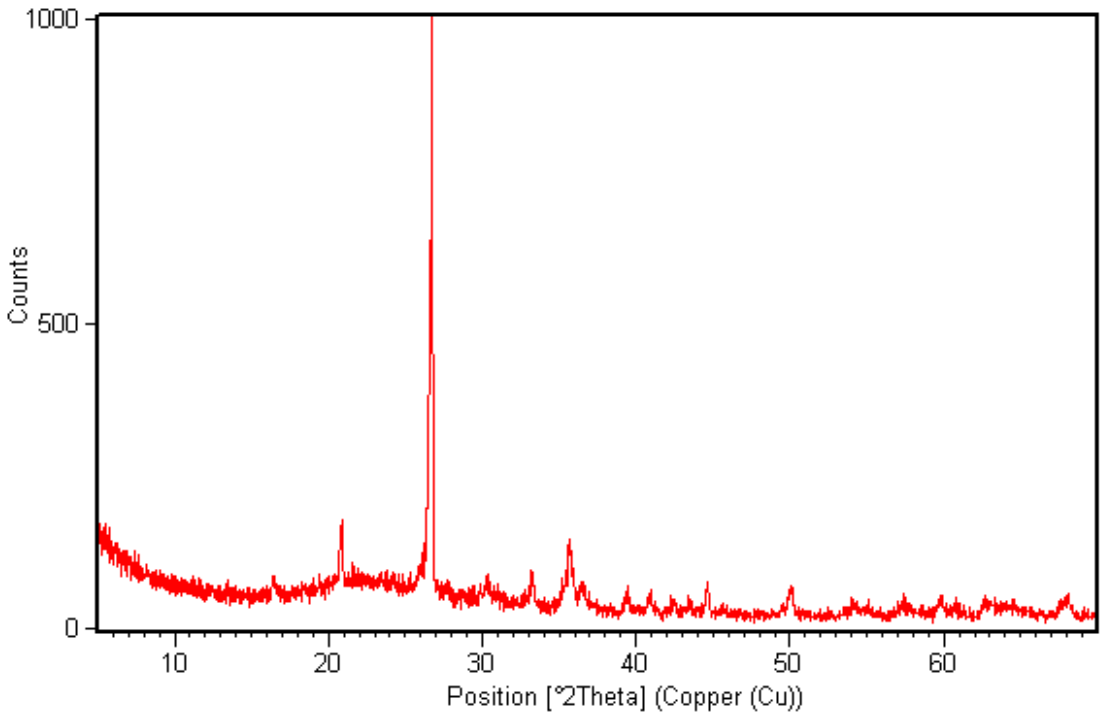
Compound	%
SiO_2	61.5
Al_2O_3	22
Fe_2O_3	8
MgO	3.4
CaO	2.01
K_2O	1.4
TiO_2	0.74

XRD patterns of the samples were presented in Fig. 6. The XRD pattern of the fly ash showed the presences of quartz, iron oxide (Fig.6 a).

ISSN 1313-2539, Published at: http://www.scientific-publications.net



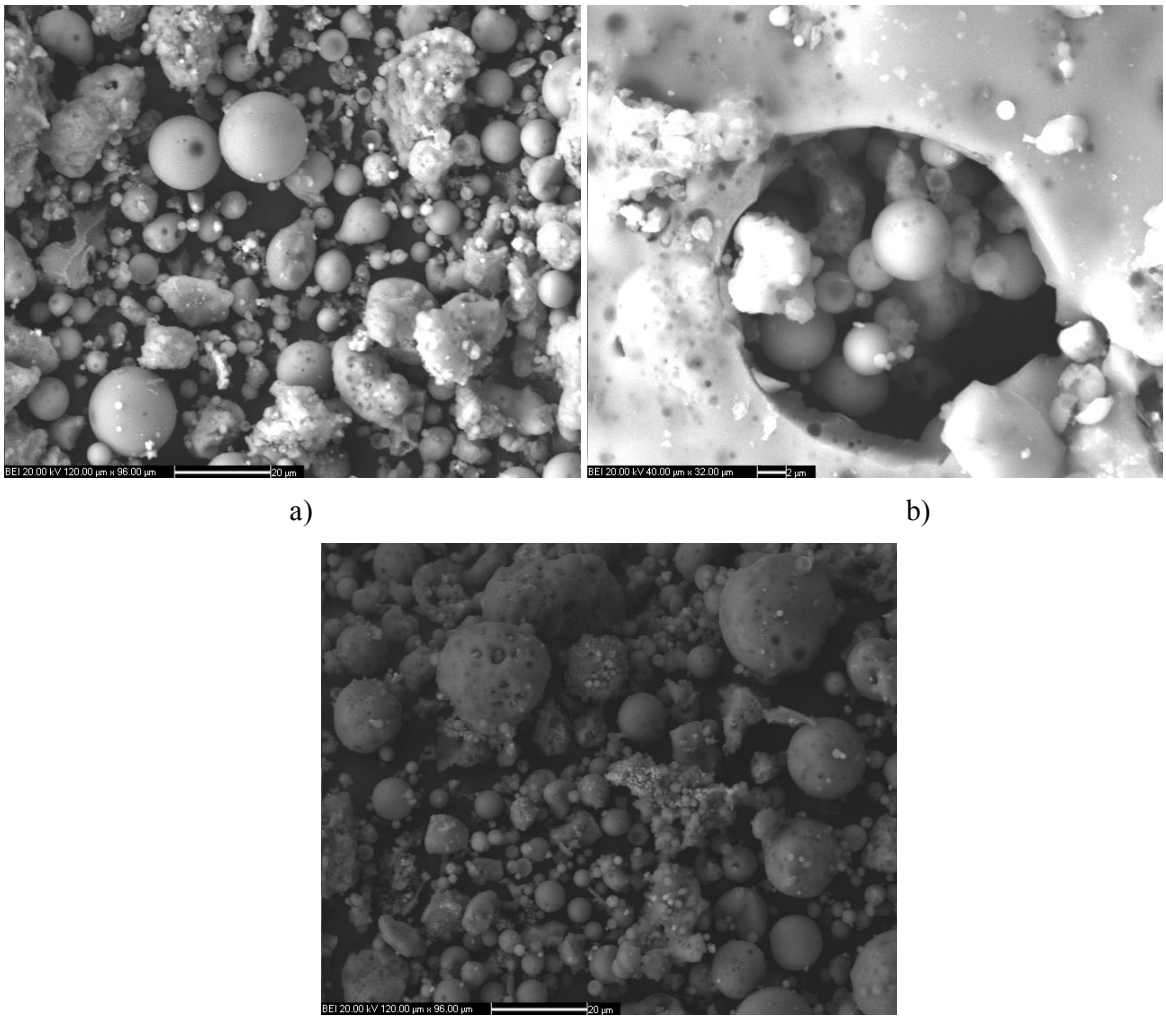
a) Untreated fly ash



b) Heat and Acid treated fly ash

ISSN 1313-2539, Published at: http://www.scientific-publications.net

The HCl treated fly as had a similar XRD pattern to the untreated fly ash (Fig.6 b). SEM images of the fly ash samples were shown in Fig. 7



a) b)

c)

Fig.7 a)Fly ash untreated x1000 b) Fly ash untreated x3000 c)Heat and HCl treated fly ash x1000

SEM observation of the fly ash showed the presence of micro-particles in the shape of smooth balls (microspheres) (Fig. 7a and b). After treating with HCl, the ball-shaped particles of fly ash were partly transformed into agglomerations of undefined shape with no observation of crystal formation (Fig. 7c).

REFERENCES

[1]http://www.worldcoal.org/coal/]

[2] http://www.worldcoal.org/coal/uses-of-coal/coal-electricity/]

A.O. Yılmaz, T. Uslu, The role of coal in energy production—Consumption and sustainable development of Turkey, Energy Policy 35 (2007) 1117 – 1128.

C . Sensogut and I. Cinar, An empirical model for the noise propagation in open cast mines – A case study, Applied Acoustics, 68 (9), 1026-1035, 2007.

M. Tokyay, Role of FA, GBFS And SF In Concrete: Present Accumulation of Knowledge, Beton 2013 Hazir Beton Kongresi, İstanbul, 201-208, 2013.

R.S. Blissett and N.A. Rawson, A review of the multi-component utilisation of coal fly ash, Fuel, 97, 1-23, 2012.

T. Thielemann, S. Schmidt, J.P.Gerling, Lignite and hard coal: Energy suppliers for world needs until the year 2100-An Outlook, International Journal of Coal Geology 72 (2007) 1–14