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Characterization of Products Obtained by Co-Liquefaction of Elbistan Lignite and Apricot Kernel Shell

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Abstract. In this study, the characterization of products obtained with the co-liquefaction of Elbistan lignite and biomass is made by using the apricot kernel shell as the biomass. The liquefaction tests were carried out in an inert atmosphere in non-catalytic conditions. The calorific value, proximate and elemental analyses of the solid products and the calorific value, elemental analyses and the qualitative and quantitative analysis of the liquid products obtained with the liquefaction were made. The qualitative and quantitative analysis were made by the gas chromatography-mass spectrometry. After the characterization process, the effect of the process parameters on the composition of solid and liquid products were also determined.

1. Introduction

The direct use of coal with high ash and sulfur content is not preferable due to environmental pollution and the fact that it is not economic. High ash and sulfur-containing fuels can be enriched by processing them in a variety of ways before they are used or liquefied to obtain n fuel alternative to the petroleum. Besides, the reserves of fossil fuels are limited. Therefore, it is of utmost importance to obtain a new fuel as a basic chemical raw material and in place of conventional energy sources, i.e. as an alternative to the petroleum. The biomass as a renewable resource sets an important research topic of today, because it is relatively advantageous to fossil fuels in terms of continuous energy demand and environmental pollution. Use of biomass as diverse raw materials like plants, household wastes, animal wastes and microorganisms is considered to be a potential resource for energy generation. Our country has an important share in world apricot production. The apricot seed shell is thought to be a useful biomass source for the liquefaction process, due to high carbon content and the relatively small amount of ash and moisture contained therein. Some of the processes applied to convert biomass resources into a fuel effectively alternative to the petroleum are gasification, liquefaction, supercritical gas extraction and pyrolysis [1, 2]. Coal conversion and coal liquefaction products (preasphaltene, asphaltene and oils) are obtained at different rates by applying various methods in the coal liquefaction studies. These products are obtained in solid, liquid and gaseous forms [3].

2. Experimental Section

In this study, the effect of biomass particle size, reaction temperature and coal/biomass ratio on the composition of solid and liquid products were investigated. The coal particle size, the initial pressure, and the solid/solvent ratio was taken as constant and the liquefaction process was carried out in inert atmosphere and non-catalytic conditions.

The basic and auxiliary chemicals used in liquefaction are Tetralin (98%, Sigma aldrich), nitrogen gas (N_2 gas) and tetrahydrofuran (THF) (Merck). The experiments were carried out in a batch reactor (Parr, 500 ml). Only the structure of the solid and liquid products to be obtained by the experiments with apricot kernel shell and the solvent (tetralin) in 1:3 ratios was examined. In addition, coal and biomass will be liquefied separately to determine optimum process parameters and qualitative and quantitative

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analyzes of the solid and liquid products to be obtained was made with the calorific value, elemental analysis and various instrumental methods.

3. Results and Discussions

The proximate and ultimate analysis of E. Lignite and biomass are given in Table 1. The effects of process parameters on elemental analysis of chars are shown in Table 2.

Table 1. Analysis of the lignite and biomass samples.

	Elbistan lignite	Biomass
Proximate analysis (wt % as used)		
Moisture	14.7	6.0
Ash	34.6	5.1
Volatile matter	17.2	16.3
Fixed carbon*	33.5	72.6
Ultimate analysis (wt % daf) C	27.3	46.47
H	3.094	6.447
N	0.591	0.787
S	3.622	0.148
O*	65.393	46.148

* by difference

While comparing carbon, hydrogen and nitrogen content in lignite and biomass before and after (chars) liquefaction between Table 1 and Table 2. The carbon, hydrogen and nitrogen content of the chars were getting rich when using biomass liquefaction alone only at 375 ºC reaction temperature, however were getting poor while lignite combined with biomass co-liquefaction since the radicals that were obtained by degradation of biomass switching to high molecular weighed products.

Table 2. The effects of process parameters on the elemental analysis of chars.

Exp. No	Lignite/biomass ratio	Time (min.)	T (ºC)	C%	H%	N%	S%	*O%
1	Biomass	60	325	70.580	5.574	0.648	1.013	22.185
2	Biomass	60	350	68.710	4.606	0.941	0.857	24.886
3	Biomass	60	375	74.300	4.474	0.536	1.367	19.323
4	Biomass	60	390	54.850	4.089	0.366	1.005	39.690
5	1/1	60	350	22.070	2.441	0.760	2.679	72.050
6	1/1	60	375	23.640	1.479	0.592	2.722	71.567
7	1/1	60	400	19.490	2.174	0.603	2.352	75.381
8	1/1	60	425	16.000	1.427	0.571	2.773	79.229

* by difference

The sulphur (S) content of the chars was found with a higher ratio with the liquefaction of lignite alone and combined with lignite at all parameters. It was expected from the higher sulphur content of lignite with biomass than biomass alone, combining mixture of 1/1 that will be used in the liquefaction of the coal to both increase the yield of light liquid products and to perform desulphurization significantly. As mentioned above, he lower hydrogen biomass hydrochemical transfer of hydrogen only when the hydrogen content obtained from biomass liquefaction is liquefied together with coal has emerged as shown in similar studies made earlier [4].

Table 3. The effects of process parameters on the calorific value, proximate analysis and total conversion of chars.

Exp. No	Lignite /biomass ratio	Time (min.)	T (°C)	Calor. value (cal/g)	Ash (%)	V.M. (%)	*F.C. (%)	Char yield (%)	Total conv.(%)
1	Biomass	60	325	7460	-	-	-	13.080	86.920
2	Biomass	60	350	7080	-	-	-	12.630	87.370
3	Biomass	60	375	7890	-	-	-	6.950	93.050
4	Biomass	60	390	7920	-	-	-	6.900	93.100
5	1/1	60	350	2580	40.480	26.347	33.173	49.600	50.400
6	1/1	60	375	1390	24.102	21.357	54.541	55.000	45.000
7	1/1	60	400	1900	30.374	25.651	43.975	47.260	52.740
8	1/1	60	425	1440	23.754	17.400	58.846	48.420	51.580

Qualitative and quantitative analyses of the solid and liquid products obtained with the liquefaction were determined by the process parameters. The possibility of combustion of solid products as direct fuel or with biomass was explored as well as the possibility of liquid products to be evaluated both as heavy and light product compositions and as light fuel alternatives to petroleum products. Compared with Table 1 and Table 3, it is understood that the calorific values increase only in the biomass liquefaction of the solubilized solids in the THF solubilized solid after liquefaction, so that the calorific value compounds are understood to be less calorific value cadmium and reduced $(O/C)_{atomic}$ ratio through hydrogen biomass of the free radicals in the coal. Therefore, it can be said that free radicals formed in low reaction temperature cause an increase in the higher heating value of char by combining with other free radicals and/or atoms. Due to the high oxidation of the vapors, it can be expected that the decline in the higher heating value of the car remains as a result of the increase in reaction temperature.

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