BIOETHANOL BLENDED DIESEL FUELS (E-DIESEL) AS ALTERNATIVE FUELS

Asli ISLER
Istanbul Technical University
isleras@itu.edu.tr

Filiz KARAOSMANOGLU
Istanbul Technical University
filiz@itu.edu.tr

Abstract
Bioethanol is the leading engine biofuel over the world and it is also the first engine biofuel, which has a commercial application area in Turkey. It has a lot of environmental and economical advantages. Bioethanol can be used directly or as a fuel blend. This study summarizes the present position of bioethanol in the world and in Turkey. Application alternatives and impacts to the fuel sector of using bioethanol are presented, too. In the experimental part, 2% and 5% v/v bioethanol are blended with diesel fuel (E-Diesel) and the fuel properties are determined according to the standard TS 3082 (EN 590). As a result, E-Diesel's are presented as alternative diesel fuel candidates.
Keywords:*Biofuel, Bioethanol, E-Diesel, Engine fuel, Turkey*

1. Introduction

Bioethanol is a clean burning renewable fuel with its economical and environmental advantages. It is a high-octane fuel with high oxygen content which results in fewer emissions and more completely combustion. History of bioethanol as an engine fuel rely on the history of internal combustion engines. N.A. Otto has used bioethanol in the studies with engines and Henry Ford has taken the combustion of alcohols into account. Scientific studies were intensified especially during the second world war and research and application studies have increased after oil crisis.

Production and use of bioethanol has a lot of advantages on local, state and national levels. Ethanol production contributes additional income to the local economy and household and a new job area is created. Benefits to the agriculture and rural economy has a big importance for the countries where bioethanol can be produced. Ethanol causes to increase the energy security and independence by displacing a part of the imported fuels with domestic resources, so energy consumption based on imported fuels will be decreased and energy variation will be ensured.

Environmental effects of bioethanol is another important advantage. Ethanol reduces carbon monoxide and particulate matter. Carbon monoxide emissions can be reduced by between 10-30% and greenhouse emissions by between 12-19% when using 10% ethanol blends and by between 35-46% when using ethanol as an engine fuel. Reducing carbon monoxide emissions and hydrocarbons leads to the decrease in ozone forming potential. There is a slight increase in nitrous oxide emissions which comes from fertilizer use in the agricultural production for bioethanol but these emissions are decreased with research and advances in agricultural grain production technology. Biodegradability makes bioethanol environmentally friendly fuel, too. In order to increase the octane rating using bioethanol blends is a safer and environmental option[1-6].

One of the main aim of this study is introducing the present position of bioethanol and bioethanol blended engine fuels and also alternatives for applications of bioethanol in Turkey and other countries. The second purpose, which is given in the experimental part, is to present E-Diesel as an alternative diesel fuel candidate. Fuel properties of E-Diesel's are determined according to the EN standards. Usage opportunities and impacts to the national fuel sector of E-Diesel candidates for Turkey are also examined.

2. Bioethanol

Bioethanol can be produced from biomass sources by fermentation or acidic hydrolysis. Bioethanol can be produced from sugar cane, sugar beet, molasses, corn, wheat, rice, potato, rye, barley by fermentation and from any cellulosic biomass by acidic hydrolysis. 95% of world bioethanol production is achieved by fermentation, today. But for the reasons of that starchy and sugar materials are used in the human chain and are thus expensive there are a lot of researches about the production of ethanol from cellulose, which can be achieved by acidic hydrolysis, enzymatic hydrolysis and thermochemical processes. The most common is acidic hydrolysis. However, although a lot of cellulosic bioethanol production seem to be feasible, cost effective processes have not been reached yet.

Starch in the corn, which is about 70% of the kernel, is used for bioethanol production and all the remaining nutrients form the dried distillers grain with solubles (DDGS) which is an important coproduct and it can be used as a good and economical feed for livestock. Carbon dioxide is another important coproduct which is collected during fermentation stage and sold to the other industries after cleaning and compression. In Table 1 a summary for coproducts which are produced during ethanol production is given.

Table 1 : Co-products of bioethanol production

Co-product	Application Area
Flour, Corn Oil, Meal, Grit	Food for human
Fibrotein	High fibre and protein food additive
Corn Gluten Meal and Feed	Animal feed additive
DDGS	Animal feed
Carbondioxide	Different industries

Bioethanol can be used as an alternative engine fuel, as an additive for fuels (blend fuel), as a fuel cell fuel and as a raw material for biodiesel and bioethyl-tertio-butyl-ether production. Blending bioethanol with gasoline and diesel fuel decreases the fuelôs cost and emissions of the fuel and it increases the octane rating of the fuel. Any amount of bioethanol can be blended with gasoline and diesel fuel but the most common used forms of bioethanol as a blending component are:

- Gasohol : 10% alcohol + 90% gasoline
- E25 : 25% alcohol + 75% gasoline
- E85 : 85% alcohol + 15% gasoline
- E-Diesel: Diesel fuel which contains maximum 15% alcohol (Oxydiesel, Diesohol)

Gasohol is the prior alternative for gasoline because of its high performance and clean burning characteristics and E-Diesel for diesel fuel. Up to 5% bioethanol any modification for the vehicles are needed within OEM guarantee. E85 is gaining importance especially in parallel with the application of vehicles with flexible fuels. According to the ñOptimal Ethanol Blend-Level Investigationò report there is an optimal blend level of ethanol and gasoline on vehicle fuel economy and emission testing and this ratio can be E20 or E30[5,7-12].

2.1 Bioethanol Around The World

Bioethanol is the leading engine biofuel over the world. Figure 1 shows the bioethanol production amounts through the years 1996-2006. In 2006, world production of bioethanol have reached 20198 thousands tonnes of oil equivalent (Ttoe). Brasil and US are the leader countries in the bioethanol production with the share about 89,4% of the total production all around the world. In 2006, USA have produced 9178 Ttoe and Brasil 8871 Ttoe. In Brazil 15% of the vehicles with spark ignition engines use bioethanol and 85% of the vehicles use E20 and in US 12% of the total gasoline market is achieved by bioethanol. China and India draw attention towards bioethanol production. China grew rapidly, it is in the third place for global ethanol production and it has researches especially for the cellulosic bioethanol production. In 2006, production of biofuels in EU was 1592 million liter/year and bioethanol has the share about 20%. The reason for that biodiesel is favoured over bioethanol with a share about 80% is the rapid growth of diesel cars in Europe especially in Germany and France. On the other hand Sweden is developing its bioethanol technology in the transport sector and it has over 400 busses using ethanol. According to the EU directives usage target of biofuels is for 2005 2%, for 2010 5.75%, for 2015 8% and for 2020 10% [13-18].

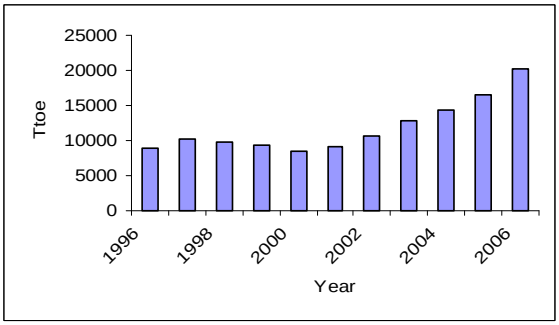

Fig. 1: World bioethanol production[18].

2.2 Bioethanol in Turkey

In 1931, bioethanol came into question in Agriculture Congress as the first time in Turkey. In 1942, 20% bioethanol was blended with the gasoline which was used in the army. In parallel to the studies over the world after oil crisis, Turkey Sugar Plants initiated studies about bioethanol production with the aim of using it as fuel, but this subject has stayed limited within the scientific research studies.

According to the legal legislations bioethanol is a blending component with liquid fuel and maximum 5% bioethanol can be blended with gasoline according to the standard EN 228. Established bioethanol plants in

Turkey are Tarkim, Çumra and Tezkim. According to the official data total potential capacity of bioethanol production in Turkey is 160 million liter/year. In 2005, bioethanol of Tarkim was blended 2% v/v with unleaded gasoline of POAS and it was offered with the trademark ñBioBenzinò. In 2008, it is expected that the products of the other trademarkts will be offered in liquid fuel sector, too.
Turkey has a wide potential for the production of the first and second generation biofuels, especially for bioethanol production. As diesel fuel is used extensively in Turkey, use of diesel fuel blended with bioethanol has a special importance. In Turkey, accomplishing the legal regulations for the alternative engine fuels with blended bioethanol will be very useful and it must be organized immediately[1,19].

3. Experimental Part

In the experimental part, 2% and 5% v/v bioethanol are blended with diesel fuel in order to obtain alternative diesel fuels, E-Diesel. Fuel properties of E-Dieselôs and diesel fuel are determined according to the standard TS 3082 (EN 590) and is shown in Table 2. All the properties except the flash point of E-Dieselôs are in accordance with TS 3082 (EN 590) standard limits. Lower sulphur content and cold filter plugging point, higher oxidation stability can be listed as the advantages of bioethanol blended diesel fuel with comparison of diesel fuel. As a result, E-Diesel can be presented as an alternative diesel fuel candidate.

4. Results

Today, bioethanol is the biorefinery product with the biggest production capacity. There are a lot of studies for increasing bioethanol production and usage all around the world and support of government and research studies especially for cellulosic bioethanol production are available. Turkey has a positive position with academic research studies, available plants and new plant projects and increasing interest for bioethanol production. Official interest and support are available, too. Use of diesel fuel blended with bioethanol is very important because diesel fuel is used extensively in Turkey. In Turkey, accomplishing the legal regulations for the alternative engine fuels with blended bioethanol will be very useful and usage of E5 will be possible. The legal regulations for bioethanol blended fuels and E-Diesel must be organized and taken into operation immediately.
Turkey has a big potential with its climate and agriculture
power for bioethanol production. Utilizing the appropriate lands in energy agriculture will have many advantages. The number of bioethanol plants is increasing, too. E-Diesel and bioethanol blended fuels must take part in the fuel sector as alternative fuels. The main benefits of using bioethanol blended diesel fuel and E-Diesel can be summarized as utilizing the national sources, providing the source variety, creating new employment area, increasing energy supply security, economic aspects and strategic importance. This study has a big importance for Turkey and other countries, which can produce bioethanol from domestic renewable sources.

Table 2: Properties for diesel fuel E-Dieselôs

PROPERTIES	TS 3082 (EN 590)	Diesel fuel	Diesel fuel blended with 2% bioethanol	Diesel fuel blended with 5% bioethanol
Density, 15 ^{0}C, kg/m^3	820-845	824.5	825.7	826.8
Kinematic Viscosity, 40 ^{0}C, cSt	2.0-4.50	2.102	1.989	1.823
Polycyclic Aromatic Hydrocarbon, wt %, max.	11	1.4	1.4	1.6
Sulfur Content, mg/kg, max.	50	40	38	32
Flash Point, ^{0}C, min.	55	81	22	15
Residue Carbon, wt %, max.	0.3	0.013	0.012	0.011
Ash Content, wt %, max.	0.01	0.0022	0.0020	0.0016
Water Content, mg/kg, max.	200	30	53	65
Total Pollution, mg/kg, max.	24	4	4	4
Copper Corrosion Test, min.	No:1	1A	1A	1A
Oxidation Stability, 110 ^{0}C, g/m^3, max.	25	1.2	1.0	0.8
Fatty Acid Methyl Ester, v/v %, max.	5	-	-	-
Distillation Test: Distillate in 250^{0}C, v/v%, max. Distillate in 350^{0}C, v/v%, max. Temperature, 95% v/v is obtained, ^{0}C, max.	 65 85 360	 34 99.5 321	 35 99.5 319	 36 99.5 321
Cold Filter Plugging Point, ^{0}C, max. Type A Type B Type C Type D Type E Type F	 5 0 -5 -10 -15 -20	 -19 	 -20 	 -21

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