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AN ANALYSIS OF BIODIESEL REQUIREMENT, PRODUCTION AND POLICIES IN TURKEY

ABSTRACT

The development of alternative fuels from renewable resources, like biomass, has gained considerable attention in recent years. A biodiesel program would give many benefits in terms of generation of employment for poor/rural people, farmers, accelerate of starting many type of industries for developing countries like Turkey. This paper investigates current status of biodiesel in Turkey, advantages and disadvantages of biodiesel in diesel engines, annual diesel fuel consumption, import and export ratings and annual diesel fuel demand. The main focus of this paper is on Turkey's current fuel status and to clarify Turkey's biodiesel demand as alternative to fossil diesel fuel. Results show that Turkey is highly in need of alternative energies such as bio-fuels. That's way it is recommended that Turkey should promote oilseed crops farming to the rise production of biodiesel.

Keywords: Biodiesel, Diesel Engine, Alternative Fuels, Exhaust Emissions

TÜKİYEDE, ALTERNATİF YAKIT OLARAK BİYODİZEL GEREKSİNİMİ, ÜRETİMİ VE POLİTİKALARI

ÖZET

Son yıllarda yenilenebilir kaynaklardan, biokütle gibi, alternatif yakıtların gelişimi önemli derecede dikkat çekmeyi başarmıştır. Türkiye gibi gelişmekte olan ülkeler için, birçok iş alanının ortaya çıkmasını sağlayacak, kırsalda yaşayan dar gelirli insanlara ve çiftçilere yeni iş olanakları sağlayacak bir biyodizel programı birçok yarar sağlayacaktır. Bu çalışmada, Türkiye'de biyodizelle ilgili şu anki durum, dizel motorlarda kullanılacak biyodizelin avantajları ve dezavantajları, yıllık dizel yakıtı tüketimi, ithalat ve ihracat oranları ve yıllık dizel yakıtı ihtiyacı yer almaktadır. Çalışmanın ana konusu fosil kökenli dizel yakıtına alternatif olarak Türkiye'nin biyodizele olan ihtiyacını ortaya çıkarmaktır. Sonuçlar Türkiye'nin biyo-yakıtlar gibi enerji kaynaklarına gereksinim duyduğunu göstermektedir. Bu nedenle Türkiye biyodizel üretiminin artırmak için yağlı tohum yetiştiriciliğine teşvik etmelidir.

Anahtar Kelimeler: Biyodizel, Dizel Motor, Alternatif Yakıt, Egzoz Emisyonu

1. INTRODUCTION (GİRİŞ)

Majority of the world's energy requirements are supplied through petrochemical sources, coal and natural gases, with the exception of hydroelectricity and nuclear energy. These sources are finite and at current usage rates will be consumed shortly [1]. However new resources have been introduced to overcome this problem. The use of vegetable oils as alternative fuels has been around for 100 years when the inventor of the diesel engine Rudolph Diesel first tested peanut oil, in his compression ignition engine [2].

Biodiesel is one of the most important alternative fuels that could be easily adapted to Turkey by the current Turkey's situation. Diesel vehicles are utilized in most part of the overland transportation and marine transportation in Turkey as well as in the world. Also, significant amount of diesel fuel is consumed in generators in industry. It is a fact that just about 15% of total petroleum consumption in Turkey could be met by domestic production. A decrease in petroleum consumption can be observed as a result of the utilization of biodiesel. Utilization of biodiesel will help Turkey to reduce the exhaust emission and greenhouse emissions that is one of the important standards in European Union countries.

The oils always contain free fatty acids, phospholipids, sterols, water, odorants and other impurities. Therefore, the oil cannot be used as fuel directly. To overcome these faults and to reduce viscosity, the oil requires slight chemical modification mainly transesterification, pyrolysis and emulsification. Among these, the transesterification is the most important step to produce the cleaner and environmentally safe fuel from vegetable oils [3]. Transesterification appears to be the most promising technique which is a chemical process of converting vegetable oil into biodiesel fuel [4, 5, 6 and 7]. The obtained biodiesel is quite similar to conventional diesel fuel in its main characteristics.

It was mentioned in the literature that biodiesel containing oxygen(O_2) reduces exhaust emissions such as unburned Hydro Carbon(HC), smoke and Carbon Monoxide (CO) mainly due to the effect of complete combustion [4, 8, 9, 10, 11, 12, 13 and 14]. Since biodiesel contains little sulphur compared to the diesel fuel, a significant reduction in Sulphur Dioxide (SO_2) emission was obtained.

European Union candidate countries are coming to realize the importance of renewable energy resources, finance biodiesel research and development studies and investments. Turkey as one of the European Union candidate countries has an agricultural and a technical potential for biodiesel production and consumption. Since five years, the importance and the probable contribution of the biodiesel to Turkey's economy started to be understood by the government and by the national private sectors.

Turkey is a country, totally dependent on external resources in petroleum. Biogas, biodiesel and bioalcohols as fossil fuel alternatives were considered during the petroleum crisis in Turkey in 1970's. None of the responsible government has taken alternative fuels to their projections and programs since 1980's. Moreover as the years preceded natural gas consumption become highly dependent on external resources, because of wrong energy politics [15].

2. RESEARCH SIGNIFICANCE (ÇALIŞMANIN ÖNEMİ)

The energy utilization from biosources has received much attention since 1990's. The energy supply from domestic vegetable oils is especially not only enhances fuel diversification, but also eliminates the environmental pollution. The energy obtained from vegetable oils is a form of renewable energy and, in principle,

utilizing this energy does not contain CO emissions, which is one of the major gases, to risk human health and to the atmospheric environment, in contrast to fossil fuels. The objectives of this paper will give a comprehensive review on the potential, feasibility and regulatory incentives for promoting biodiesel production from vegetable oils in Turkey. The main subjects covered in this paper are, current status of total energy supply, diesel fuel supply and consumption, regulations and policies for encouraging biodiesel fuel, economic policies for financing biodiesel fuel and energy policies for promoting biodiesel fuel in Turkey.

3. TURKEY'S PRESENT FUEL DEMAND (TÜRKİYENİN YAKIT İHTİYACI)

In the past decade, energy consumption related to environmental pollution and supply diversification has been the focus of environmental protection and economic development for pursuing sustainable development and creating renewable energy in Turkey. Because of the limited petroleum reserves and increased environmental concerns, alternative fuels from agricultural resources have become increasingly important.

Turkey has imported about 24 Mt's of crude oil (85% of its requirement) and petroleum products during the year 2005 causing a heavy burden on foreign exchange and the country's energy dependence of oil is about 75% [16]. The demand of crude oil year by year and the Turkey's consumption of crude oil and petroleum fuels are given in Table 1. The known worldwide reserves of petroleum are 100 billion barrels and these petroleum reserves are predicted to be consumed in about 40 years [17]. So, the availability of petroleum is uncertain in future. Renewable fuels particularly biodiesel gets more attention in Turkey. The main driving forces behind the implementation of these biofuels in the country are rural economy, energy self-sufficiency and environmental concerns.

Table 1. The demand of crude oil year by year and the Turkey's consumption of crude oil and petroleum fuels [17]
(Tablo 1. Türkiye'nin yıllara göre ham petrol gereksinimi ve petrol yakıtları tüketimi [17])

Fuel Type/Year	2002	2003	2004	2005	2006
Crude oil production (Mt's)	2.65	2.59	2.41	2.40	2.41
İmport(Mt's)	22.56	23.15	23.42	24.72	25.17
Consumption of some petroleum fuels					
Gasoline	2.72	2.61	2.68	2.74	2.68
Diesel	7.84	7.89	7.85	7.92	9.75
Fuel-oil	6.51	6.45	6.32	6.21	6.14
Kerosene	1.42	1.53	1.47	1.53	1.46
Others	6.98	7.12	7.24	7.45	6.87
Total	25.38	25.6	25.56	25.85	26.9

The diesel fuel consumption in Turkey is about three times higher than gasoline fuel as shown in Table 1. The demand of diesel has been estimated to be for the year 2011–2012, which would be 1.6 times higher than that of current demand.

The cost of the diesel fuel increases due to the increase in crude oil price and high tax rates. Therefore, it is necessary to take appropriate policy decisions in the country to fulfill future demand of diesel fuel as well as other petroleum products. Therefore, biodiesel is being considered to be supplementary fuel to the diesel in the country. In addition to that, these biofuels are being looked

to provide employment generation to rural people through plantation of vegetable.

Table 2. Demand of gasoline and diesel fuel in Turkey [16]
(Tablo 2. Türkiye'nin benzin ve dizel yakıtı ihtiyacı [16])

Year	Gasoline demand in (Mt's)	Diesel fuel demand in (Mt's)	Ratio of diesel/gasoline
2002-2003	2.72	7.84	2.88
2003-2004	2.61	7.89	3.02
2004-2005	2.68	7.85	2.92
2005-2006	2.74	7.92	2.89
2006-2007	2.85	8.65	3.03
2011-2012*	3.56	12.65	3.55

* Estimated

A rapid increase in diesel fuel consumption is expected after 2008-2010 in Turkey [16]. The world diesel fuel consumption in 2000's will be doubled in 2020. Domestic fossil fuel resources in European countries and Turkey don't meet the energy demand and constrain the countries to be dependent on foreign resources.

As can be seen in table 2, more fuel consumption will occur in the transport sector. If we consider that all vehicles but automobiles operate with diesel fuel, it can be said that 2.8 millions vehicles operate with diesel fuel, which makes 36% of all. Since rail transportation is not sufficient enough in Turkey and diesel engine vehicles are commonly used for commercial purposes and long distance transportation in Turkey, the fuel consumption of diesel vehicles has a significant economical and environmental importance.

Turkey has sufficient and appropriate research & development opportunities, technological substructure, experience and demand to produce and use biodiesel. The production of some oil seed plants such as rapeseed, soybean and sunflower in the concept of energy agriculture is quite possible in Turkey. In the scope of last saving measures taken by the last government, it was decided to support only rapeseed and soy planting in agriculture.

Rapeseed and soybean planting should be supported by an additional price to encourage energy agriculture. There is a possibility of agriculture by 1000000 hectares of area in Southeastern Anatolia Region. Energy farming can be performed under the name of Turkey's biggest agricultural project SAP (Southeastern Anatolia Project [18]. By this application, energy requirement for agriculture can be obtained from region's domestic resources. In the region, soy and rapeseed as well as cotton could be planted, alternately.

Turkey's diesel fuel consumption increased to 14,2 million's tons at 2006. The increasement was about 8,4% compared to 2005. It is because of that number of diesel fuel engines were increased dramatically at 2006 about 38%.

Biodiesel can also be used instead of fuel-oil especially in marine transportation and heating systems. According to statistics prepared by Republic of Turkey there are 903224 house heated by fuel oil heating systems. It is also known that 7% of consumed energy in house is obtained from diesel fuel.

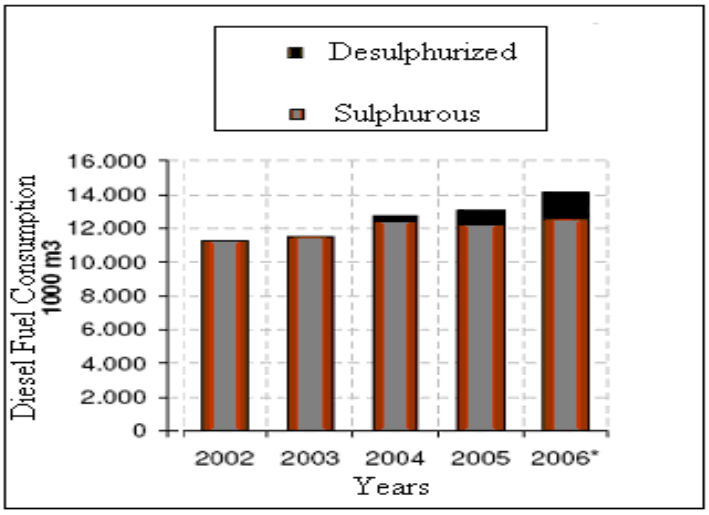

Figure 1. Turkey's diesel fuel consumption between years of 2002-2006 [19]
(Şekil 1. 2002-2006 yılları arası Türkiye'nin dizel yakıtı tüketimi [19])

Table 3. Production and import of crude oil in Turkey [20]
(Tablo 3. Türkiye'nin ham petrol üretimi ve ithalatı [20])

Year	Production (Mt's)	Import (Mt's)	Total (Mt's)	Import as % of total	Petroleum product Import(Mt's)	U.S. Dollar($) (Billion)
2002	2.4	23.6	26.0	90.7	7.5	5.1
2003	2.3	24.1	26.4	91.3	8.2	6.0
2004	2.1	25.2	27.3	92,3	9.4	7.2
2005	2.1	25.7	27.8	92.5	9.6	7.5
2006	1.9	24.3	26.2	92.74	N/A	5.9

Note: The value of one U.S. Dollar ($) is approximately equal to 1.35 New Turkish Lira

4. ADVANTAGES AND DISADVANTAGES OF BIODIESEL (BİYODİZELİN AVATAJLARI VE DEZAVATAJLARI)

Biodiesel is better than diesel fuel in terms of sulfur content, flash point, aromatic content and biodegradability [21].
Biodiesel is an efficient, clean, 100% natural energy alternative to petroleum fuels. Among the many advantages of biodiesel fuel include the following: safe for use in all conventional diesel engines, offers almost the same performance and engine durability as petroleum diesel fuel, non-flammable and non-toxic [22].

A number of technical advantages of biodiesel fuel are that it prolongs engine life and reduces the need for maintenance because biodiesel has better lubricating qualities than fossil diesel, it is safer to handle, being less toxic, more biodegradable, and having a higher flash point, it reduces some exhaust emissions although it may, in some circumstances, raise others, it always reduces CO emissions compared to diesel fuel [23].

Some technical disadvantages of biodiesel are; Because of the higher viscosity and high flash point of biodiesel, especially cold weather starting problems may occur, Because of the higher viscosity torque values and power of engine remain lower than those of petroleum based diesel fuel, Natural gums in some biodiesel may cause gumming of filters so plugging filters, injectors, and other fuel lines [24].

Very lower cetane number of some biodiesel and improper injection timing may cause combustion remain uncompleted and cause knocking phenomena.

Engine power and torque in use of biodiesel remain lower because heating values of biodiesel are lower than those of petroleum based diesel fuel. Because of uncompleted combustion of biodiesel use the piston heads and cylinder cover may deposit the carbon soot.

5. TURKEY'S BIOFUEL POLICY (TÜRKİYENİN BİYOYAKIT POLİTİKASI)

Biodiesel fuels have become more and more attractive engine fuel from 2000 to 2006. In Turkey, in this respect, farming plant that of biodiesel based oil is fiscally supported by government.

The Agricultural Reforms and Application Project which signed with World Bank by Government consist of four chapters;

- Direct Subventions
- Alternative Crops Project
- Renovation of Agricultural Sales Cooperatives
- Project sports and Presentation

One of the purposes of this project is to eliminate all of former useless project and is to make direct subventions. The other purpose is to limit cultivation of tobacco and to encourage raising plants those of source for biodiesel like rapeseed.

According to agreement signed by World Bank, Turkey has funded 161.6 millions $ to alternative crops production. The farmers those of started to produce alternative crops will be funded 80$ per month for each declare.

The last law arrangements for petroleum market were made in 2004 to clarify and legalize biodiesel production and selling. The arrangements contain funding biodiesel production, to make farmers to be aware of importance of biodiesel from new kind of plants like rapeseed. Total biodiesel production in Turkey can be seen in Table 4.

Table 4. Capacity of biodiesel production yearly in Turkey by November 2005 [25]
(Tablo 4. Kasım 2005 itibariyle Türkiye'nin yıllık biyodizel üretim kapasitesi [25])

City	Number of Company	Established Capacity (Tons/Per years)
Izmit	7	160.645
Gaziantep	16	158.004
Ankara	11	71.040
Mersin	4	70.534
Adana	7	58.745
Bursa	5	46.062
Izmir	6	35.588
Others	34	377.818
Total	90	978.436

In Turkey the first commercial biodiesel fuel plant was established in 2005.

6. CONCLUSIONS (SONUÇLAR)

Petroleum based fossil fuels are rapidly coming to an end; besides world energy demand is increasing more than expected. Therefore new energy sources like alternative fuels call researcher's attention. In this alternative fuels biodiesel is the most convenient engine fuel in view of reduce emissions and almost the same engine performance parameters with conventional diesel fuel.

This paper investigates current status of biodiesel in Turkey. This paper also clarifies current status of diesel fuel in Turkey. Production of biodiesel is grown rapidly last few years. In Turkey however the cost of biodiesel is still high because of the high cost price of installations biodiesel plants and high cost of oil.

Cost of biodiesel production is a generally accepted view of the industry in Turkey that biodiesel production is not profitable without funds. To greatly promote the use of biodiesel fuel as an alternative to petroleum-based fuels in Turkey, the following measures are recommended;

- to increase the subsidy to use biodiesel fuel in diesel engines under the support of special funds.
- to establish the national specification standards for biodiesel fuel.
- to build biodiesel production plant in Middle and Middle East of Turkey for the purpose of reducing transportation and production costs.
- to promote the cultivation of oilseed crops such as sunflower, rapeseed and cottonseed in response to the rise production of biodiesel.

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