CHAPTER 2

OVERVIEW OF ENERGY AND BIODIESEL

2.1 Introduction

Very high prices of crude oil have been observed in last 10 years. On July 11, 2008 world had noticed the highest ever price of crude oil as $147.27/barrel. Majorly this is because of assumptions and higher crude oil consumption by India and China [23].

Total number of vehicles is an indication of oil demand. Fig. 2.1 shows probable number of vehicles in Asia by the JIEE (Japan Institute of Energy Economics). In the period of twenty years (2000 to 2020) for the country Japan it is expected that the number of vehicles will increase by about 10 millions. Very high increase in vehicle numbers is expected for other Asian countries, like India and China. It is observed that the vehicles in Asian region may reach up 200 million in next 20 years. The total number of vehicles may be around 350 million in 2020. This shows that the volume of fuel required may be doubled. Also “World Energy Prospective” published by the International Energy Agency. According to the report sudden decrease in crude oil prices is a of time phenomena. The report clearly states that for a long term period higher increase in oil prices are expected. This indicates that by the end 2030 price may be $200/barrel. It seems to be end of cheap crude oil era. This forces all of us for the use of biomass fuels this is also important in view of CO₂ emission [23].

Fig. 2.2 shows how the fuels from various resources can be obtained. Heavily travelled paths are natural gas and crude oil. Very recently biodiesel (Fatty Acid Methyl Ester) has come into play. New researches in the energy shows a technological development in production of methanol, Di Methyl Ester (DME), and Gas to liquid (GTL) via synthesized gas. With the use of number of ingredients biomass fuels can be produced hence more consideration was given, Of course all this can be done while we are utilizing existing fuels. [23]
Fig 2.1 Vehicle Number Estimation in India [23]

Fig 2.2 Fuels [23]
Concept of carbon neural fuel was introduced by Kyoto Protocol. This means that carbon dioxide produced during the combustion of fuel will be absorb by the plants and these same plants can be used for the production of biodiesel. Thus the application of biofuels in an automotive engines will reduce the emissions and hence the problem of global warming.

Increased energy consumption and high oil prices forces the Asian countries for promoting the introduction of biofuels. Use of biofuels is also important for energy security and alternative fuels. South Asian countries started active promotions for the use of biodiesel fuel. These countries like India have the large potential for production of feed stocks for biodiesel fuel such as palm, coconuts, Jatropha, Karanja and so on.

Biodiesel fuel impurities and oxidation are the subjects worry since they directly affect the engine performance. Hence it is important to establish quality management principles for biodiesel fuel. Once these objectives are achieved biodiesel fuel can be of high quality, its distribution can be smooth and stabilize economy can be obtained [23].

2.2 Energy Situation in the World

Due to increased energy demand, high energy cost, and global warming issues, new and renewable energy sources has become more attentive. Biofuels has renewed interests which become more widespread. Now a day’s biofuels have been considered as alternative fuel that can be blended with petroleum. Source of bio-fuels and food are same hence focus is on sources which are non-food. The topic here will discuss the requirement perception and these are derived from the IEA (International Energy Agency) [23].

2.2.1 Viewpoint of Energy Demand and Supply

IEA reported that in last 25 years 58% increase was observed in world’s primary energy supply. In 1980 energy supply was 7.2 billion TOE (tone of oil equivalent) and it increase to 11.4 billion ton of oil equivalent in 2005, Table 2.1 represents worlds energy demand. The demand of energy was observed to be high for OECD (Organization for Economic Cooperation and Development) countries. Compared with non OECD countries, OECD countries have low economical growth. For OECD
countries’ change in financial industrial structure causes low demand. Approximately
51% consumption in 2006 was noted for non-OECD in energy demand. Growth in
market of the countries like India, China and Middle East may increase energy
demand. It may increase by 48% over 25 years. Primary demand for the petroleum
fuel may decrease from 35% to 30%, however total extent may increase by 27.7%
[24].

Investments in petroleum and natural gas infrastructure will be more important.
Presently oil fields average depletion rate is 6.7 % annually, and may be increase by
about 2% till 2030. To meet the increasing demand it is important to obtained or
discover new oil fields. By the end of year 2030 to meet the faster increasing demands
additional IEA stated that 64 bbl/day will be needed. This is approximately six times
the current production in Saudi Arabia. A sufficient amount of oil deposits in the
world is predicted to exist even after 2030. However large scale investment is
necessary meet the corresponding increase in demand but the reservoirs in the world
are distributed unevenly. That is, the According to Organization of the Petroleum
Exporting Countries (OPEC) 75.7% are proved oil reserves in the world, 82% out of
this is in Russia and OPEC countries [25]. For natural gas the trend is that 55% of the
proved resources are within the three countries, namely Russia, Iran and Qatar [25].
76% of reserves are with National oil companies, 17% are hold by Russian oil
companies and International Oil Companies (IOC) has only 7%. IOC has an access to
advance technology and availability of funds and hence it is an area for improvement.
Hence for the development and to meet the future worldwide demand it is necessary
to concentrate on resource-rich countries [25]. According to IEA World Energy
Outlook, By the end of 2030 OPEC share may increase 7%.

It is estimated that oil sand and oil shale (non-conventional petroleum sources) are
available in abundant by about 2 trillion barrels. For example, about 170 billion barrel
of oil san is minable in Canada. To obtain this mining of several tens meter depth is
required using vapor methods. In these vapor extraction methods; water and natural
gas resources are used. Such methods have environmental cost, such as increase in
CO₂ and recycling of water resources.
Table 2.1 World Energy Demand [24]

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<td>11,429</td>
<td>14,121</td>
<td>17,014</td>
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<td>Oil</td>
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<td>4,000</td>
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<td>1,895</td>
<td>2,450</td>
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<td>82</td>
<td>96</td>
<td>113</td>
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2.2.2 Transportation Sector

For the transportation sectors energy demand may increase by 57%. Petroleum alternatives are very difficult this may be the cause of very large fraction of energy supply for transportation. There are several thermodynamic advantages for petroleum fuels for which they are important to airplane, ships and automobiles. Liquid petroleum fuels can be handled very easily and also they have higher densities. More important is that this is practically not possible for us to change our infrastructures used for storage and engines. Hence it is important that the new alternative petroleum fuel should be compatible with existing fuel. Alternative liquid fuels can be blended with present petroleum fuel which can be advantageous for transportation fuel diversification.

2.3 International Trend of Energy Prices

Crude oil price variations are represented in Fig. 2.3. Oil crises in 1970 and 1990 were the cause of disturbance of supply of crude oil. This faces 4th Middle East war, Iran Revolt and Kuwait attack. This results in to increase in oil prices by about 2 to 4 times. Oil prices then went down to low at $10/bbl in December, 1998. Prices are very high as $147/bbl due to Iraq crises in July, 2008. Sharp decrease was noticed about in 199998 as $34/bbl. Till April 2009 it then fluctuates in the range of $40 to $60/bbl [25].
Fig. 2.3 Variation in Crude Oil Price (USD/bbl) [25]

The price then increases gradually. Factors that involved this time are: (1) Increase consumption by developing countries, (2) Political affairs and reserve patriotism in supply countries, (3) Influences of exploratory investors, (4) Dollar value decrease and so forth.

Trend in natural gas price is represented on Fig. 2.4 (a) while Figure 2.4 (b) explains coal prices trend. In future the demand for oil will be lower than that of natural gas and coal. These are the prices which are different from oil prices. Presently there is such basic methods of indexing, but it is observed that the prices are increasing similar to 2000’s prices. Due to certain factors there are indirect influences on oil price. Coal price does not have any direct influence on oil prices. However, demand increases due to increase in fuel demand for steel and iron plants as well as power plants. China, India and Middle East due to higher energy requirements and strong economic growth coal demand may increase. For natural gas steady demand is expected [25].
Fig 2.4 (a) Natural Gas Price Annual Variation (USD/Million BTU) [25]

Fig 2.4 (b) Coal Price Annual Variation (USD/Tone) [25]
World business situation was significantly declined in the mid of 2008 therefore the crude oil prices decreased considerably. For a continuous supply of energy demand, stability and diversification studies on alternative fuels and their application becomes important [25].

2.4 Global Environmental Problems

Now a day’s global warming is the most discussing issue. Development of energy policies and environmental laws are becoming important continually. Before the 19th century there were no any arrangements for scientific temperature observations. It begun in 19th century only. Thereafter faster increase in rate is observed in the latter half of the 20th century. Increase in energy demands means increase in fuel consumptions. Most of the fossil fuels are hydrocarbon fuel that has carbon as a major compound. Increase fuel consumption means large will be the emission of CO$_2$. This is major cause of global warming. With the environmental concern the United Nations conducted a meet on Climate Change issues in 1994, and this results in to release of Kyoto Protocol in February of 2005. This protocol aims towards the reduction of green house gases. It has been stated that the advance countries should aim towards the level of 1990’s green house gas emission. Growth of the plant needs CO$_2$; these plants absorb the CO$_2$ from atmosphere. For biomass and bio-fuels, the same amount of CO$_2$ is generated when the fuel is burned. Therefore the biomass and biofuels are considered as carbon-neutral for CO$_2$ exhaust emissions. Thus biomass and biofuels are important for diversification of energy supply and CO$_2$ reduction.

Intergovernmental Panel on Climate Change (IPCC) in their 4th Assessment Report: 2007 predicted that the average temperature may change from 1.1 to 6.4°C higher till the end of this century. This indicates that the time is now important to make efforts for reduction in CO$_2$ emissions. Energy efficiency is therefore an important task for all engineers to control the CO$_2$ emissions and to explore the new and renewable resources. The Copenhagen Accord explains that in order to avoid the worst effects of climate change temperature should be below 2 degrees is required. Biofuels are considered as a renewable energy form and carbon-neutral therefore the efforts are required for their promotion, use and research [25].
2.5 Bio Fuels

2.5.1 Preface

It is clear from the history of an automotive engine that biofuels are not a new as these are already investigated in 19th century. Fuel oil crises after the 1973 brought the attentions of number of researchers in this area. United States and Brazil these are the two countries has about 90% of contribution to world’s ethanol production. For their energy independence and energy security these countries are promoting the use of blends of ethanol with gasoline called as “gasohol”. Favorable tax treatment was given by US. European countries are now promoting the use of biodiesel for their CO₂ reduction plans. All over the Europe passenger cars and buses are now using biodiesel or the blends [25].

Improvement in automotive emission performance, reduction in CO₂ greenhouse gas and use of renewable energy resource are the basic requirements in promotion of biofuels in US and Europe. Concentrations were made for introduction of domestic sources of bio-fuels for excess of corn and sugar. However their effects on agricultural prices would not be ignored. But increase in the price of oil in last 5 years has renewed the interest of the countries that results into overlooking of the food problem [25].

2.5.2 Direction of Future Biofuels

For the promotion on the use of biodiesel most of the countries are using various supports like tax benefits and tax exemptions. This leads to very large extensions and use. If this expansion is continued the price of major food grain which are the sources of biodiesel may be increased continually. Figure 2.5 shows that the significant rise in grain prices is observed from 2007 to 2008. However there are the factors which cannot be overlooked these are: (1) Increase in grain consumption as developing countries become wealthy, (2) Unfavorable weather conditions in Australia reduces storage of wheat, (3) Speculation, (4) Rise in prices for US dollar [25].
Fig 2.5 Grain Price Variation
However, discussions on food vs. fuel is going on claiming that increase in food price is due to the bio-fuel policy, even there are the different reasons for the increase in food price.

Sources of biofuels, sources of foods, green house gas reduction capability of biofuels, deforestation problems, increasing competitions are the issues which are significantly raised in the Europe. Bio-fuels are becoming more comprehensive discussions on the long-term stability. As a result, a new plan to support a variety of source materials and production methods of biofuels, CO$_2$ reduction effect has been investigated in mind. However, discussions of various bio-fuel life cycle assessments (LCA) are turned on limitations. In certain parts of the bio-fuel standard for sustainability in the developing world is likely to be a factor as a barrier to free trade. Therefore, in addition to biofuels Quality Specifications of harmony, stability, harmonization of standards required to become one. Thus the expectations are from second-generation bio-fuels which then cannot be compared with food. Therefore Europe and the United States made a mandatory quantity of second generation biofuels 2010.

Introduction of second generation biofuels was the important aspects in 2010; particularly in developing countries. The first-generation biofuels, are consistent to increase in many countries. Such as vegetable oils, including mandatory blending of biofuels, more familiar in the promotion and maintenance of agricultural employment as a raw feedstock and oil import growth and thereby to mitigate. As a measure of progress in many Asian countries, consistent with the introduction of Cellulosic Ethanol, a possible source of the increase in volumes not only influence but actually reduce greenhouse gases will increase significantly as well. This process has been in commercial production of research expenses.

Other sources such as micro-algae are in the spotlight as the second-generation bio-fuels. This yields a large amount of organisms per unit area, the arable land is not required, and can flourish land that has high salt content. The third generation biofuels are considered as an ingredient. Overall, 40% lipids to biodiesel production, consists of research, bio-fuel from algae - have been made to the source. In order to reach to the current status reduction in production cost and commercialization of second-generation bio-fuels must have to be advanced.
International Energy Agency using market-based source material prices, "Energy Technology Perspective 2008," The commercialization of plant scales, and tends to reduce the value of second-generation bio-fuel source (shown in Fig. 2.6) increase in the level of production with a cost analysis. Cost of cellulosic ethanol and biomass to liquid decreased after 2010, and the final value will reach around 2030. Is much higher, compared to the optimistic case. As shown in Fig. 2.6 and 2.7 low carbon dioxide emissions are expected in 2050 due to third generation biofuels.

![Figure 2.6 Second Generation Biofuels Expected Cost](image)

*Note: Bil = Biomass-to-liquids; LC = ligno-cellulose.*

**Fig 2.6 Second Generation Biofuels Expected Cost [25].**

![Figure 2.7 Biofuel Introduction](image)

**Fig 2.7 Biofuel Introduction [25]**
Summary

In chapter 2 we have discuss that the energy demand has continually increased from last 30 years. On July 11, 2008 world’s market oil price was the highest. This was the highest value which the world had never seen before. Very high number of vehicles is anticipated for Asian countries, especially China and India. It is observed that about 150 million vehicles are reported in 2000 and may increase by 200 million in next 20 and till the year it 2020 may reach to 350 million. This clearly indicates that automotive fuel requirement may be double. Increase energy consumption and higher fuel prices forcing the Asian countries for promotion of biofuels. Not only this it is important for energy security and alternative fuels. Due to availability of larger feed stocks like Jatropha and Karanja, Asian countries are promoting the use of biodiesel fuel as Fatty Acid Methyl Ester

According to the IEA in last 25 years primary energy supply increases by 58% in 1980 it was 7.2 ton of oil equivalent and it increases to 11.4 billion tone of oil equivalent in 2005. Continuous financial growth was observed for the countries like Middle East, China, and India. This economic growth was the major cause of increase in energy demand. Petroleum as a fuel demand of world’s primary energy is estimated to decrease from 34% to 30%. But in absolute value it is estimated that the demand may increase to 28%. In 2005 demand was about 4 billion ton of oil equivalent. It is expected that by 2030 it may increase to about 52 ton of oil equivalent.

In view of global warming issues Kyoto protocol was issued by United Nations in 2005. This protocol forces that the advanced countries should reach to the level of gas emission which is equal to 1990 levels. This has to be achieved in the period of 2008 to 2012. In the growth process of the plants, plants absorbs the CO$_2$. These plants are the sources of the biomass or biofuels. These fuel on their use emits the carbon dioxide which is then again absorb by these plants only. Hence these fuel. This is considered carbon-neutral when we consider CO$_2$ exhaust emissions. This is the reason which clearly explains that biomass and biofuels are very much important in view of sources of energy and reduction in CO$_2$ emission.
Previous chapter we had a discussion on the use of biodiesel and its necessity. We will have a closer look on sources and production of biodiesel in next chapter. This will set the background for use biodiesel as a fuel in engine.