

CHAPTER 12

Advanced fuel formulations containing biodiesel: real-world applications

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12.1 Introduction

According to the International Energy Agency, primary global energy demand has grown from 4243 million tons of crude oil equivalent in 1971 to about 9938 million tons in 2018. The International Energy Agency predicts that from 2018 to 2030, the primary global energy demand will increase by 10% [1]. Although the forecasts indicate that there are sufficient oil reserves even after 2030, an increase in the investment required to extract oil and gas resources, on the one hand, and an increase in the need for these resources, on the other hand, will be two major obstacles to rely on these resources as only energy resources. Furthermore, oil resources are unevenly distributed around the world. Organization of the Petroleum Exporting Countries (OPEC) member states hold more than 75% of known oil reserves, which adds up to more than 82% with the addition of Russia [2]. There are similar conditions for natural gas, with Russia, Iran, and Qatar having 55% of the world's known reserves. At the corporate level, national oil companies hold more than 76% of the reserves, of which 17% belong only to Russian oil companies. International oil companies (IOCs), which can mainly develop technology, have 7% of the resources. In short, developing the oil and gas industry in line with increasing global demand requires large investments in this field, especially in a handful of resource-owning countries.

On the other hand, unconventional oil reserves such as Shale Oil are estimated at 2 trillion barrels [2]. Although they are major and potential reserves, they require tens of meters of drilling and steam extraction. Moreover, during the extraction process, significant amounts of water and gas are consumed, and hence, the extraction of oil from these sources is associated with environmental risks, such as problems in recycling water resources and increased carbon dioxide (CO₂) emissions.

The fluctuating oil prices are another challenge. The 1970s and 1990s crises caused by the Middle East war, the Iranian revolution, and the invasion of Kuwait disrupted crude oil supplies. Historically, prices rose two to four times, then after the crisis of the 1990s, the world price of crude oil remained at around USD 20 per barrel. In 1998, prices plummeted to about USD 10 a barrel. The Iraq crisis began in 2003 with a hacking of prices that reached USD 147 a barrel in July 2008 and dropped sharply to USD 34 a few months later [1].

These challenges have pushed governments to find an appropriate substitution for liquid fuels used in the transportation sector. Biodiesel has been introduced and utilized by many countries as one of these solutions and as a substitution for diesel fuel.

12.2 Global biodiesel production and consumption

In the last decade, the global biodiesel market has been growing worldwide, and three main factors influence this market growth:

1. The pressure to reduce dependence on oil resources
2. Compulsory mandates requiring mixing biodiesel with diesel
3. Financial incentives

The global average growth rate from 2008 to 2018 was about 11.6% yearly. In 2019, global biodiesel production reached 699 thousand barrels of oil equivalent daily, 34.3% of which came from Europe, 31.3% from Asia-Pacific, and 13.8% and 12.4% from the United States and Brazil, respectively. This was due to the policies supporting biofuel production, as well as the increasing use of diesel vehicles in Europe, Asia, Brazil, and the United States. On the other hand, Europe is the largest consumer of biodiesel in the world (39.9%), while the United States has developed its biodiesel consumption at a remarkable pace (15.4%). More details on biodiesel production and consumption in the European Union (EU), the United States, Asia, and Brazil are given in [Tables 12.1 and 12.2](#).