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Aviation biofuel from renewable resources: Routes, opportunities and challenges



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ABSTRACT

Air transport describes an inevitable part in the day to day life of the modern world. It is highly responsible for the worldwide social contacts and business developments. The use of petroleum fuels as energy source for air transport is not sustainable. Aviation is one of the leading contributors to the total greenhouse gas emissions. Also, the fossil fuel prices are becoming more volatile day by day. So it is very essential to introduce and industrialize alternative aviation fuels generated from renewable resources, especially biomass. A number of industrial commitments and collaborations have emerged to find alternative ways to reach bio aviation fuels. Research on the conversion of biomass based sources to bio jet fuels is of current interest. The main concern is the production of biojet fuel, from renewable resources, with relatively low greenhouse gas life cycle and sustainability with affordable price. The present paper overviews the opportunities and challenges in the development of alternative fuels for aviation. The production process, feedstock used and the most promising global projects are also reviewed.

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1. Introduction

Combustion of fossil fuels and human activities disturb the environment by the emission of greenhouse gases like nitrous oxide, carbon dioxide, methane etc. [1]. The requirement of oils for transport is growing day by day and it is expected to be increased by 1.3% per year up to 2030 [2]. There is no unique solution available for these complications and so alternative ways are to be found out such as modification in vehicle designs, development in public transport and replacement of conventional fuels with alternative advanced fuels and fuel technologies [3]. It is expected that by 2030, the carbon emission from the transport sector and the energy requirement will increase up to 80% [4]. Air transport acquired a significant role in the everyday life of modern world. The influence of air travel increased worldwide social contact, especially in improving business and marketing. The total diesel fuel and jet fuel consumption was in the range of 5 to 6 million barrels per day in between 2005 and 2010 [5]. The average cost of jet fuels was \$320/t in 2004 which is increased to an average of \$1005/t in 2011 [2]. Fig. 1 represents worldwide commercial jet fuel prize and usage, world market: 2011–2021 [6]. According to the report from U.S. Energy Information Administration (IEA), for the next thirty years, the jet fuel cost will increase gradually and the average price in the year of 2013 was (\$2.82/gal) [7].

The production of alternative fuel for aviation is mainly inspired by increased petroleum costs and environmental concern [5]. Not only the increased cost and environmental effects, some other factors such as secured working of the aircraft engine, consistency etc. should also be considered [8]. Use of biofuels are

attracted by the low greenhouse gas emissions while combustion, decrease in the dependence on fossil fuel sources and availability of renewable resources [9]. The aviation transport sector requires fuels with high energy density and so it depends mainly on liquid hydrocarbon fuels. Alternative aviation fuels must possess some specific qualities such as good cold flow properties, thermal stability and low freezing point [10]. The fuel must be well suited for the present design of the aircraft engine [11]. Sustainable aviation fuels must offer low carbon emission over their lifecycles. The energy crops used as the production source should not challenge the food production and ecosystem and also do not harm the environment and do not cause deforestation [12].

The feedstock used for the production of alternative aviation fuels are biological in origin and thus are renewable. Non edible oil crops such as camelina, jatropha, algae, halophytes, municipal and sewage wastes, forest residues etc are the major available resources for the energy production process [13]. Many technologies have emerged for the production of aviation bio fuel from the biomass resources. The conversion routes include thermochemical and biochemical approaches [14]. The bright future of alternative aviation fuel can be influenced by the co-operation between national and international organizations, states and countries [15]. International Air Transport Association (IATA) expects 30% contribution of Bio jet fuel for the jet fuel use by 2030 [16]. The annual universal production of biomass is about 100 trillion kilograms. So obviously, biomass is a potential feedstock having the ability to substitute fossil fuel resource [17,18].

In addition to the reduction in the emission of greenhouse gases, alternative aviation biofuels experiences several advantages

Commercial Jet Fuel Consumption and Cost, World Markets: 2011–2021

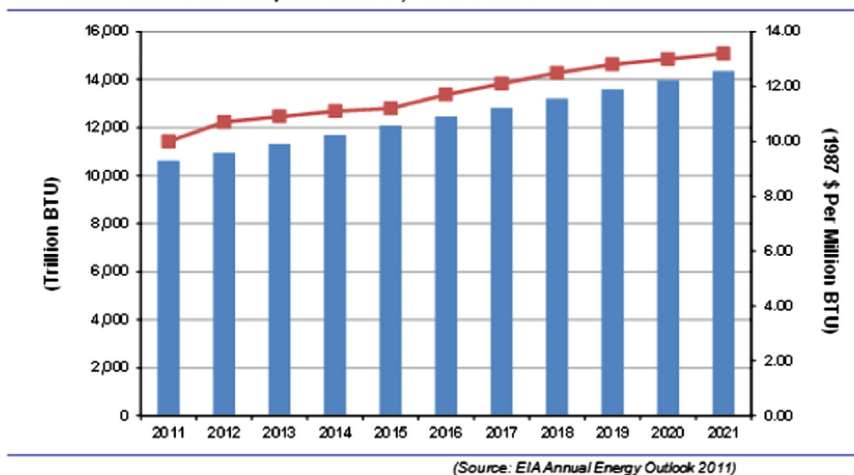


Fig. 1. Worldwide commercial jet fuel prize and usage, world market: 2011–2021 [6].

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