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Assessment of Usage of Biofuel in Aviation Industry in Malaysia

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The current scenario of greenhouse gasses emissions is witnessing major impetus as a result of the ever expanding transportation sector across the globe, of which the aviation sector has played a major role. The Malaysian transportation sector, specifically the aviation sector, has a poor record of high carbon emissions, inspite of its history of biofuel and sustainable fuel policy. However, researchers around the globe are now diverting their attention from the conventional fossil fuels to biofuels, because it is cheaper to produce, increases the efficiency of the aircrafts and also reduces the environmental threat fossil fuel emissions pose to the planet. Alternative fuels like bioethanol and biodiesels are increasingly used in aviation industry, as a direct consequence of the global targets set by the International Air Transport Association.
In the present study, the possibility of increased biofuel by the aviation industry of Malaysia is analyzed with specific focus on the global initiatives taken for the same, as well as the past and current trends of Malaysia's general biofuel production and consumption. It has been estimated that the use of alternative fuels in aviation industry could reduce the flight related greenhouse gas emission by approximately 60 to 80 %. The recent trials that have been conducted on the importance of biofuels in aviation industry have indicated that these fuels are technically feasible. In this respect, the European community in conjunction with private airline companies and major biofuels producers in their area have played a very prominent role in commercializing the use of biofuels in air transport. But in Malaysia to see biofuels as anything other than their consumption in the food and healthcare industry is still a debatable topic. By addressing these research gaps, this paper focuses on the possibility of manufacturing biofuel products at a commercial scale in Malaysia to be used in the aviation industry to power jet engines in commercial aviation and for reduced carbon emission for increased sustainability of the environment.

1. Introduction

Air transport is the most growing transportation sector, and it is expected to increase steadily by the year 2030. In fact, international air transport association approximates that the industry will grow by over 5 % annually by the year 2030. It is also estimated that the demand for aviation fuels are to grow at 2 to 3 % every year (Solaymani and Kari, 2014). Various studies have proved that the aviation fuel used in the past has several negative effects on the environment and with the increasing usage, the situation is said to be affected the most, which has led to various research to establish other sources of energy that will have little effect on the environment. Researchers have settled on biofuels since they contain more energy, are cheaper, leave less impact on the environment and has less damage on the engine (Wise and Dooley, 2014).
In Malaysia, the aviation industry is also growing at a high rate and studies show that the industry is growing at an average of 7.5 % every year. In terms of fuel consumption, the aviation industry is one of the highest energy intensive industry taking up 15 % of the total fuel consumption of the transportation industry of the country, suggesting that the industry is the main contributor to air pollution in the country (Indati and Bekhet, 2014). The growth in the airline industry means an increase in the air pollution rate in the country which has seen different agencies raise concerns (Lim and Lee, 2012). Various organizations have carried out studies to

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establish other sources of energy that have less effect on the environment and do not affect the craft. The studies have pointed that the jet fuel has other implication on the environment other than the carbon dioxide emitted. They have proved that jet fuel also produces nitrogen dioxide, sulphate and hydrogen dioxide that has called for a need to research for other sources of fuel for the aviation industry (Solaymani and Kari, 2014). In the year 2009, the global level aviation industry, International Air Transport Association, adopted a climate change target of achieving 1.5 % fuel efficiency by 2020, ensuring carbon neutral growth from 2020 onwards and halving total carbon emissions by 2050 (International Air Transport Association, 2015). However, the Malaysian aviation sector adopted a similar approach much before this, with the inception of the National Biofuel policy in the year 2006, primarily aiming to decrease carbon emissions in the transportation sector (Abdullah et al., 2009). According to this policy, the government encouraged utilization of renewable fuels in the sector, that is, biofuels. However, as a result of several obstacles like lack of infrastructure, high costs of manufacturing and low public demand, the implementation of this policy was delayed for several years (Lim and Lee, 2012). In the present review, the current trends and future policies of biofuel consumption within the aviation sector of Malaysia are discussed, with specific focus on the existing initiatives around the world and biofuel technology. Subsequently, the possibilities and challenges of implementing highly efficient biofuel consumption in the aviation industry of Malaysia is studied, to predict the growing usage of biofuels in future.

2. Biofuel Initiatives around the Globe

Although biofuel was developed in the 1970s, it was not adopted by most countries as they lacked information with respect to production and technology, as well as since the raw materials was not available easily Today biofuels have gained popularity as most research labs and Non-Governmental Organizations (NGO) have conducted research and determined strong advantages of adoption of biofuels and have hence have recommended biofuels (Ong et al., 2012). Different technologies have been used to develop different qualities of biofuels, and they can now be applied for various machines and engines. The development of the biofuel, in combination with the existing fossil fuels, has led to a reduction of the negative effects they have on the environment.

Production of biofuels has been encouraged by individual governments with provisions of incentives and biofuel-production friendly policies. Globally, biofuel (bioethanol and biodiesel) production has increased between 2000 and 2009 from 17.7 x 10^9 L to 86.7 x 10^9 L (Sorda et al., 2010). As of 2013, USA, Brazil and European Union are the highest producers of biofuels in the world, recording a record average increase of 426 % production from 2001 to 2013 (Beckman, 2015). While USA is the world's largest bioethanol producer as a direct result of financial incentives offered by the government for production, the EU is the world's largest biodiesel producer owing to the high consumption policies of France and Germany (Sorda et al., 2010). Policy wise, USA, the largest biofuel manufacturing nation, has passed and implemented the Renewable Fuel Standard in 2010, which provided targets for the increasing production of conventional biofuels, cellulosic biofuels and advanced biofuels by 2022 up to 13.6 x 10^6 L (Sorda et al., 2010).

In comparison to Malaysia, the government has also passed the Biofuel Industry Act (2007), which made available provisions for the Ministry of Plantation Industries and Commodities, for updating and implementing a biodiesel mandate within the country. As such, Malaysia has currently implemented the B7 mandate, which is 7 % mixture of biodiesel, and has delayed the implementation of B10 mandate till end of 2016, owing to resistance from diesel vehicle manufacturers (Wahab, 2013).

With respect to the aviation sector, the IATA's policy of global emissions reduction was followed by adoption of alternative fuels/biofuel specific policies. According to the IATA, a 10 % usage target by 2017 by all major airlines globally was expected, with a 6 % mix of second-generation biofuels by 2020 (Kar et al., 2010). However, the targets by 2050, would remain the same at 10 % fuel consumption, as a result of sustainability issues and land availability problems, as predicted by UK Committee on Climate Change (Kar et al., 2010). International Civil Aviation Organization's Alternative Fuels Task Force (AFTF) is at present undertaking a projection of future sustainability aviation fuel (SAF) creation and use. In the short term, this projection depends on existing declarations and focuses by legislative and industry partners, as displayed previously. In the long haul, overall SAF accessibility will be driven for the most part by specialized and financial constraints in regards to the accessibility of feedstock (biomass and in addition different squanders and buildups), joined with a consistent change of elements, for example, rural yield and compound preparing proficiency.

The industry needs to look for a sustainable source of energy for the sector. Different studies have proved that biofuels can be used effectively and efficiently in place of fossil fuels, which will help the sustainability of the industry source of energy (Sgouridis, 2012). Adoption of the biofuel will bring added advantages to the sector and the country as large. It is expected that it will reduce environmental pollution, reduce water requirements, reduce deforestation and reduce food competition with food production (Bekhet and Abdullah, 2013).

There are different reasons why Malaysia needs to adopt the biofuel for reduction of carbon dioxide, other pollutants into the air and sustenance of the aircraft. The fossil oils will take different durations, they are in small quantities in the country (Mahadevan, 2011). With the increase in consumption, it is estimated that the available petroleum can only take the country for another twenty years. This throws light on the urgent need for alternative sources of energy, in the form of renewable energy, which the country needs to pursue. The country's population is also growing at a very high rate, so they also require more sources of energy (Sgouridis, 2012). It is also estimated that with the growth in population all the oil deposits available can only take the country up to 2052, which has made it necessary for the country to invent and use other sources of energy. The aviation industry plays a critical role in the country as there are so many people leaving or coming to the country for greener pastures. The industry is the leading consumer of the energy in the country take up to 70 % of the energy used in the country (Mahadevan, 2011). Thus if the state can find other sources of energy for the aviation industry, it can prolong the duration of the fossil fuels. The country needs to adopt renewable sources of energy so as to save power and reduce pollution to the environment (Solaymani and Kari, 2014).

3. Conversion Pathways

There are currently three certified technology conversion pathways which can produce drop-in SAF, Fischer-Tropsch (F-T), Hydro-treated Vegetable Oils (HVO) or more generally called Hydro-processed Esters and Fatty Acids (HEFA), and Renewable Synthesized Iso-Paraffinic (SIP) aviation fuel. The Fischer Tropsch (FT) procedure changes over strong biomass (counting lingering waste) into a manufactured gas and subsequently converts the gas into a blend of hydrocarbons including aviation fuels (regularly alluded to as Biomass-to-Liquid - BtL) (Demirbas 2007). BtL fuel can be mixed to a most extreme of half with fossil lamp oil.

However, the Hydrotreated Esters and Fatty Acids (HEFA) procedure changes over oils into fuel correspondingly that unrefined fossil oil is refined (Starck et al., 2014). The procedure is financially accessible however worry over the supportability of crude materials and high cost of waste oils has limited uptake for aviation industry (Starck et al., 2014). Although typically, plants and seeds are used as sources for biofuels, algae and algal oils as sources are in the early phases of advancement (Robota et al., 2013). HEFA fuel can be mixed to a most extreme of half with fossil lamp oil. Lastly, Renewable Synthesized Iso-Paraffinic (SIP) is created from hydro handled aged sugars.

The procedure changes over sugar particles to the hydrocarbon farnesane which can be mixed to a most extreme of 10 % with fossil lamp fuel. Notwithstanding these three innovations, Pyrolysis is likewise an in fact achievable pathway; be that as it may, similar to the guaranteed pathways, it requires further work to diminish the unit expense of generation. This argument has been put forward by Mettler et al. (2012), while analyzing the main challenges of using pyrolysis for biofuel production, asserting that even though pyrolysis is a widely used technique and can be used for a large range of feedstock, the major challenge in its application as a commercial technique is the lack of basic details of the process. Other generation pathways additionally yield fluid energizes and their monetary potential keeps on developing. It is expected that up to 6 additional conversion pathways will be certified for use in commercial aircraft over the next 24 months through the ASTM process.

4. Biomass for Aviation Biofuel in Malaysia

There are six main sources of biomass in Malaysia which produce substantial quantities of residues that are only partly used, rubberwood, sugarcane, coconut, paddy / rice, forest / wood, and palm oil (Abdullah and Sulaiman, 2013). All the sources of biomasses are subjected to considerable uncertainty. Firstly, contradiction in the biomass sources differing from one another. Secondly, most commodities are already in the market and only valorisation of residues or co-products make the net value of raw material economical. Residues and co-products are used extremely less today. Valorisation depends on factors such as competition, transport, preconditioning of residues and potential locations of bio-refineries. Last, buildups of palm oil are the greatest deposits in Malaysia. These deposits are as of now valorised for some part and late innovative advances as the reusing of oil palm trunk for composite wood and other higher worth items may radically change the genuine accessibility of these buildups. Palm oil biomass is likewise always under assault by natural gatherings and examiners, as a result of the connection between oil palm manor expansion and deforestation. Taking palm oil biomass into consideration for bio – jet fuel generation can be a question for some end-users, such as airlines, due to the sensitivities of their respective markets. Whether to take into consideration oil palm biomass or not.

With oil palm biomass, the total potential biomass availability would sum up around 100 $x10^6$ t of fresh matter in all Malaysia, or only 50 x 10^6 t in Peninsular Malaysia. Conversely, without oil palm biomass, all Malaysia would offer 20 x 10^6 t of fresh matter, among which 7 - 8 from the peninsula. These indicative numbers are subject to uncertainties of more than plus or minus 50 % (Abdullah and Sulaiman, 2013). Note also that in Peninsular Malaysia, the potential of available paddy residues might be significant and of the same order as that of the available forest products residues, given the lack of precision of the data. Note likewise that in Peninsular Malaysia, the capability of accessible paddy buildups may be huge and of the same request as that of the accessible woodland items deposits, given the absence of exactness of the information.

5. Theoretical Maximum Bio-Jet fuel Production in Malaysia

Published bio-jetfuel conversion efficiency vary around 8.6 kg of dry lignocellulosic biomass per kg of Jet A-1, according to existing aviation- certified processes (Matas Güell et al., 2012). In view of the most recent, Malaysia would have the capacity to create a hypothetical greatest of 8.5 x 10^6 L of jet fuel every year. However the genuine feasible jetfuel creation would positively be less. Firstly, oil palm residues speak to the staggering amount of the hypothetical most extreme feedstock. Be that as it may, just 20 % of the region of profitable oil palm in Malaysia today, is guaranteed under the Roundtable under Sustainable Palm Oil (RSPO), the main globally perceived plan of supportable oil palm manors.

The feasible feedstock from oil palm is 5 times littler than the hypothetical greatest. Taking in record just 20 % of feasible oil palm deposits, Malaysia can create a most extreme of 3.8 x 10^6 L of maintainable jetfuel every year.

Furthermore, given far reaching worldwide natural worries on any sort of oil palm, it could even be conceivable that some universal aircrafts traveling to and from Malaysia would lean toward evading any mix from oil palm buildups. Rubberwood, sugarcane, coconut and paddy developments are not connected to deforestation, and their lignocellulosic buildups most likely wouldn't make any major natural worry among the universal group. These harvests are critical for the employments of Malaysian smallholders. The whole woods creation of Peninsular Malaysia is eco-confirmed under Program for the Endorsement of Forest Certification (PEFC), the world's biggest timberland affirmation plan. Hence, barring palm oil and sourcing just on other feasible feedstocks, Malaysia would have the capacity to deliver up to 2.5 x 10^6 L of practical jetfuel every year.

The country of Malaysia consumes more than 3 billion liters of jetfuel every year. Of all traveler activity, around 5 % goes to Europe. Thus, it is conceivable to accomplish up to 6 % of biofuel mix on all flights to Europe, leaving from Malaysia. Correspondingly, it is conceivable to accomplish up to 3 % of economical biofuel mix on all flights to Europe, or up to 2 % of maintainable biofuel mix if barring oil palm feed stocks.

6. Challenges of Biofuel Usage in Malaysian Aviation Industry

Challenges that Malaysia faces in the manufacture of the biofuels arethe high cost of production, lack of proper production technology and lack of regulations that govern the production of biofuel. Most of the South East Asian Countries including Malaysia are mainly focused on exporting the production of biofuel rather than utilization in their own country (Ong et al., 2012). Many investors have shown interest in the sector. According to researchers in the country, most of the interested parties are in the aviation industry followed by the government and also notable and well-established businessmen in the industry.

That shows that if the government put the right measures in the right place to secure these investments, more parties will have interest to invest in biofuel and that can strengthen the sector (Mahadevan, 2011). Government as the critical stakeholder in the implementation of biofuel blends for transportation sector will be responsible to stage a suitable platform or medium for other stakeholders such as industry players, non-govermental organisations (NGO), research institutes and private investors to contribute towards the development of biofuel blends (Lim and Lee, 2012).

The use of biofuel will have a great impact on the industry. In the short-run, the industry is expected to get higher returns, reduction in air pollutions and also reduced travel prices. Adopting energy efficient pathways for the transportation sector in Malaysia will have a critical role in achieving a greener environment (Indati et al., 2013).

The biofuel costs four times the cost of fossil fuels but if different parties invest in biofuel, after a few years the cost of the two sources of the energy will be equal. Most of the advantages of the biofuel will be felt in the aviation industry if there are massive investments (Bekhet and Abdullah, 2013).

According to the potential volumes that can be made available, Wood and forestry residues (FT), Agricultural residues, especially straw (FT), Municipal solid waste (FT), Jatropha oil (HEFA), Camelina oil (HEFA), Used cooking oil and animal fat (HEFA), Alcohols from sugars, like ethanol from sugarcane or from maize (ATJ/SIP), Direct Sugar to Hydro Carbon (DSHC) and Algae (HVO/HEFA) appear to be the most relevant for the different technologies selected . The use of biofuel will reduce the reliance that Malaysia has had in other countries, for they rely on other nations for imported oil. Currently, the production of the biofuel is done by small-scale producers thus limiting the use to a few industries (Altman, 2015). If the production of biofuel is increased, various airlines can adopt the utilization of the biofuel as they have been tested by different aircraft and have worked successfully for all travels (Ahring, 2008).

7. Conclusion

In conclusion, although there is the low usage of biofuel in Malaysia it has gained popularity in the recent years. Moreover, different aviation companies have tested the use of biofuel and have commented positively on the utilization of the fuels. Malaysia stands a good chance of investing in biofuels as they have the required farms. The investment will have various advantages to the industry and the country at large.

The cost of traveling is expected to reduce, pollution of the environment is expected to reduce and the efficiency of the crafts is expected to increase. In the political, economic and social feasibility of biofuels indicated that the fuels could be used in any aircraft without any significant changes to the plane. Malaysia needs to invest in biofuel to reduce dependence on other countries that produces fossil fuel.

The available fossil fuels in the country can only be used for a very short period, which has brought the need for the state to establish other sources of energy. Different researchers have proved that the best sustainable alternative that he country has are the biofuels as they have the required farms to produce the biofuels. Moreover, biofuels have been tested by different airlines and they have been recommended for all travels. Government and other investors have shown the interest to invest the industry giving the sector hope for sustainability.

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