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Preliminary studies on readiness of biojet fuel for commercial aviation: The feasibility and potential in Malaysia

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Abstract. This paper demonstrates the need for a new alternative energy using biojet fuel in commercial aviation. The demand of air travels leads the authority, airlines and government in seeking for new renewable and sustainable energy for aircraft operation in the future. This study looks into the level of readiness in using biofuel. 40 personnel who are working in the aviation industries have participated and completed the survey questionnaires. The preliminary findings suggest that the impact towards this new fuel will lead to a better environment, less cost, better maintenance and energy sustainability. The usage of biojet fuel seems possible to be pursued in Malaysia.

1. Introduction

Many new engines today have much better fuel efficiencies than previous ones, which helps to reduce the fuel consumption. While this facilitates the airlines in dealing with the instability of fuel prices, the problem with carbon dioxide (CO₂) emissions remains. Many research have been focused on finding alternative energy sources to replace the fossil fuel, which will also aid in reducing the maintenance and cost for airlines [1-3]. The current growth in aviation sector has been highlighted by the statistics in the annual report of International Air Transport Association (IATA) [4-9]. It is estimated that about 2.3 billion passengers use air transportation to travel around the world since it is the shortest and also the fastest way of traveling. Based on the future projection, air traffic is expected to increase at 4.8% per year until 2036, with the Asia/Pacific region as the primary contributor to this increment [10]. The rise in air traffic also increases the environmental concerns for the region.

Researchers in the Sustainable Way for Alternative Fuel and Energy in Aviation (SWAFEA) have previously claimed that the use of alternative fuels such as 50% SPK can provide significant reduction in engine soot and sulphur oxides (SO_x) emissions due to reduced content of aromatics and sulphur [11]. In line with a similar notion, more research have been carried out to promote the usage of biojet fuel to reduce emissions [12]. The purpose of this investigation is to carry out a preliminary study in identifying the basic knowledge of biojet fuels among aviation personnel, feasibility of biojet fuel used in aviation and the impact it has on the aviation industry.



2. Research Method

In the big picture, this research will cover several phases as indicated in Figure 1. The four phases are essentially adapted from Ref. [13]. First phase of this research is already completed and the findings reveal the awareness, feasibility and impact of biojet fuel on the aviation industry. Phase 2, which is the focus of this study, the survey questionnaire [14] is applied to understand the readiness of aviation personnel for adaptation of biojet fuel in the aviation industry and aircraft maintenance in particular. A brief guide has been introduced at the beginning of the questionnaire.

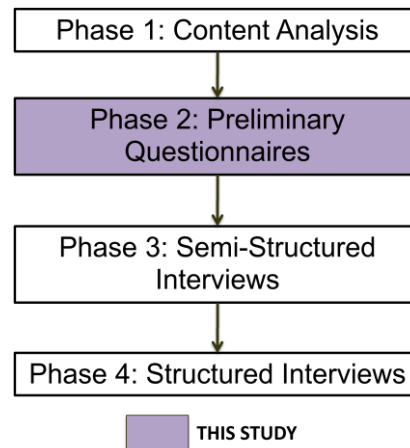


Figure 1: Research phase

According to Ref. [15], “the higher the need for control, the more critical it be that an interviewer is present and possibly that the questionnaire is done on paper”. The collected data in this Phase 2 is the content analysis data, which has been gathered in previous Phase 1 [16]. The respondents are chosen based on convenience sampling. The questionnaire has been divided into four main sections: personal (biographical) data, general knowledge on biojet fuels, feasibility of biojet fuels in aviation and impact of the usage of biojet fuels. All respondents’ response to the questionnaire is obtained through face-to-face manner.

3. Results and Discussion

3.1. Section A: Personal (biographical) Data

The participants are asked to indicate their gender. As tabulated in Table 1, 28 respondents (70%) are female while the remaining 12 participants (30%) are male. Historically, engineering has been a male-dominated profession although more females are joining this profession in current trends. On the other hand, Table 2 shows the frequency for different groups of age for the respondents. Both age groups of 35-40 and 45-50 have the highest frequency with 18% while the lowest is 5% for the age groups of 20-25, 55-60 and 60-65. From the distribution of the age groups, it seems that majority of the respondents have an experience and knowledge about aviation sector with more than five years in this industry. It should be noted that the targeted group in this study is the aviation personnel who have more than four years of experience in handling aircraft, particularly on engine or aircraft systems.

Table 1: Gender of respondents

Gender	Frequency
Female	28
Male	12

Table 2: Age of respondents

Age Group	20-25	26-30	30-35	36-40	40-45	46-50	50-55	56-60	60-65	Total
Frequency	2	4	5	7	5	7	6	2	2	40

Participants are also asked to indicate their position in the industry by writing the relevant answers. As illustrated in Figure 2, 17 (43%) respondents used to be License Aircraft Engineer from various airlines. The other answered positions include apprentice engineer (7%), aircraft technician (12%) and aviation lecturer (30%) and students (8%). Aviation students chosen were those in their final year of study and were currently on-the-job training (OJT). In the meantime, the aviation lecturers are among those closer to the industries and current new technology. Furthermore, the respondents are also asked to put the relevant numbers of experiences. As shown in Figure 3, the majority of the respondents (i.e. 17 respondents or 42%) reported having between 16 to 20 years of experience in the aviation industry and other three respondents (8%) had between 26 to 30 years of industry experience. The experienced participants have tremendous impact on this study for the practicality and accuracy of its contribution.

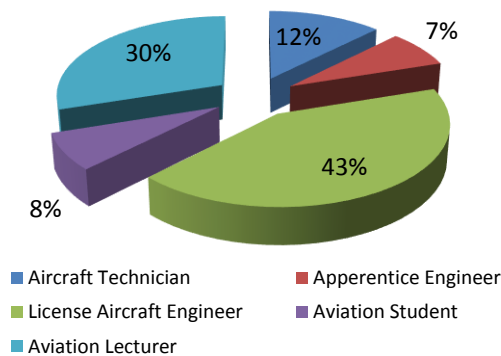


Figure 2: Respondents' position in the industries

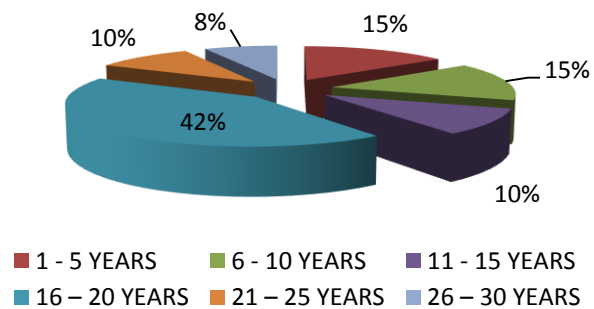


Figure 3: Respondents' length of experience in the industries

3.2. Section B: Personal Knowledge about Biojet Fuels in Aviation

The participants' responses on questions B1 to B5 reflect their personal knowledge about biojet fuels in aviation, and its usage and impact to aviation industries. The responses are tabulated in Table 3. The answers for question B1 shows that majority of the respondents are moderately knowledgeable about biojet fuels usage in aviation. The knowledge about biojet fuels to the environment, to aircraft engines, and reducing fuel cost by using biojet fuels needs to be educated to all personals in aviation industries through training. In addition, based on average response to question B2, the participants' knowledge on the environment is very high. It shows that the respondents highly agree that biojet fuels are good for the environment. Furthermore, Question B3 shows that the respondents are only moderately agreed that biojet fuel is good for aircraft engine. This indicates that the knowledge on what biojet can do to the aircraft engine has not been properly relayed. Moreover, question B4 shows that the respondents are also moderately agreed that biojet fuel is good for reducing the fuel cost. The financial aspect is not being shared to the respondents but they understood that the cost of biojet fuels as alternative fuels is much cheaper than currently used fuels once it is adequately established. Last but not least, answers for question B5 show that the respondents are moderately knowledgeable on potential profits in using biojet fuels in aviation industries as alternative fuels. This due to the knowledge of cheaper alternative fuels that can be applied on most engines, especially those in the automotive vehicles.

All in all, the questions in this Section B are focused on how good biojet fuels to the environment, to aircraft engines, and to reduce fuel cost. Figure 4 highlights the summary of responses for Section B. Questions B1, B3 and B5 have the highest number of respondents (i.e. 50%) answering "moderate" knowledge. This shows that the average respondents know about biojet fuel usage in aviation industry. However, it seems that the respondents have a poor knowledge in biojet fuel.

Table 3: Responses for Section B of the questionnaire

Question	Responses					
	Very High	High	Moderate	Low	Very Low	Unsure
B1: Do you know about biojet fuels usage in aviation?	1	5	20	8	5	1
B2: Do you think biojet fuel is good to the environment?	30	0	10	0	0	0
B3: Do you think biojet fuel is good to aircraft engine?	2	8	20	2	3	5
B4: Do you think biojet fuel is good for reduced fuel cost?	5	15	10	1	0	9
B5: Rate your thought on how profitable biojet fuel to airlines/ aviation company?	4	6	20	0	0	10

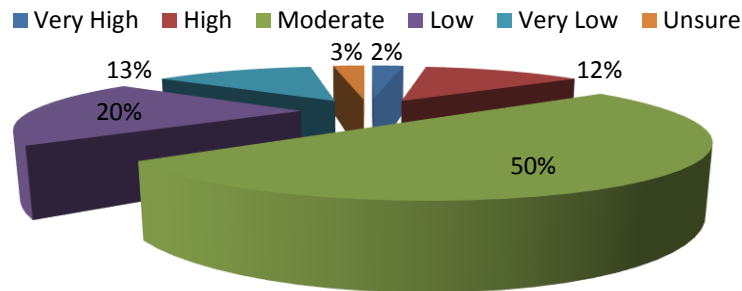


Figure 4: Respondents' knowledge

3.3. Section C: The Feasibility of Biojet Fuels in Aviation

Question C1 is designed to probe whether the biojet fuel is considered safe for aviation industry. Most of the respondents (77%) have agreed with that statement while only nine respondents (23%) are not sure on that matter. For the second until fourth questions (i.e. C2, C3 and C4), the respondents have averagely answered "moderate". These questions are more on the technical side when the biojet fuels are used in aircraft engines. The questions are asking whether any modification will be required to the engines if biojet fuel is used, whether the adaptation level to biojet fuel will be easier when that takes place, and whether the required changes from normal fuel (Jet A/Jet A-1) to biojet fuel will be of low technical feasibility. In the last question C5 however, nine respondents' (23%) agree that biojet fuels will be widely used in future. Figure 5 summarizes the responses for Section C of the questionnaire.

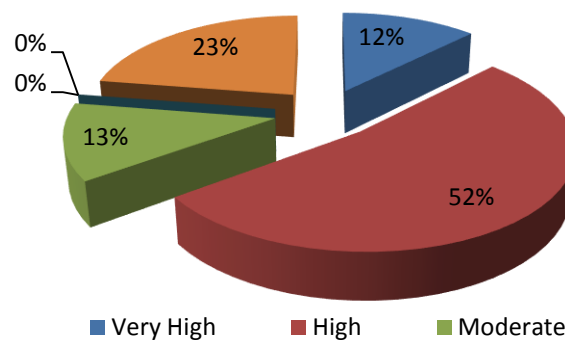


Figure 5: The feasibility of biojet fuels in aviation

3.4. Section D: Impact from the Usage of Biojet Fuels

Figure 6 highlights the responses obtained for Section D of the questionnaire. The first question D1 is asking the respondents whether they think that biojet fuels lead to a better environment, with 13 of the respondents has rated it as very high (32%). The second question D2, on the other hand, is asking if the biojet fuels provide better fuel cost and the highest answer is "moderate" by 13 respondents (32%). For questions D3 and D4, the respondents averagely answered as "moderate", with 55% and 37%, respectively. The questions are about the increase of engine performance and the saving in airlines fuel cost if biojet fuel is used. Finally, the last question D5 is asking whether sustainable biojet fuels can be achieved. Most of the respondents have rated this question as moderate (42%).

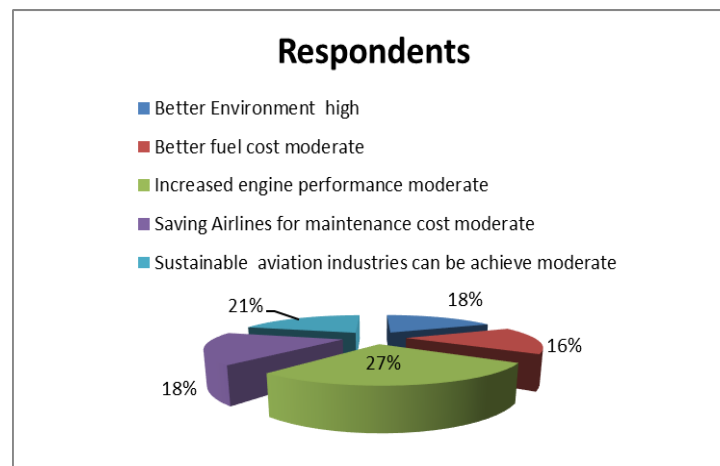


Figure 6: The impact of using biojet fuel based on 40 respondents

Overall, in measuring the readiness level, the respondents are aware that biojet fuels are safe to be used in aviation. This is supported by the results of more than 25 airlines already tested or conducted biojet fuel flights [17, 18]. However, the level of knowledge on the new green technology, especially biojet fuels, is still at moderate level as shown in Figure 4 where 36% of the respondents are unsure of biojet fuel. Overall, majority of the respondents have acknowledged the good impact of using biojet fuels to the environment, aircraft safety and fuel. The minimal harmful emissions of gas release from biofuels as compared to the existing fossil fuels will help in producing a greener environment. On top of that, the safety and high specification of fuel quality are important in the aviation sector and biojet fuels are offering them. The technical requirements for aviation biojet fuels are high-performance fuel (that can withstand a range of operational conditions), does not compromise safety, directly substitute traditional jet fuel aviation, and meets the required performance target [19]. The feasibility of biojet fuel adaptation in aviation industries is also given by the responses of 52% at the high rate as shown in Figure 5.

4. Conclusion

Challenges remains in adapting the biojet fuel in aviation industry as it requires high-quality standard requirements in measuring the impact on the environment as well as the fuel cost. The cost has a high impact for new alternative fuel as increase in cost will create a huge hurdle to the aviation industries. Aviation industries will be reluctant to adopt this new energy if there is an increase in fuel operation. The investigation done in this study has shown that the basic knowledge of biojet fuels among aviation personnel is still at a moderate level. The potential feasibility of biojet fuel used in aviation industries in Malaysia can be further explored and its impact towards environment, better fuel cost, increase in engine performance and maintenance can be better assessed for more sustainable aviation industries. The readiness situation in Malaysia for this purpose can be projected through the research's feasibility studies, which is expected to create more local opportunities in the perspective of social, economic and operation.

Acknowledgement

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