Analysis Of Technoeconomy Of Bioavtur Production With Hydroprocessed Esters And Fatty Acids (Hefa) Process In Indonesia

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Abstract: Bioavtur plays an important role in the development of world energy security because most of the aviation demand has not been fully met from fossil energy production. The development of Bioavtur itself is still hampered by the fulfillment of the aircraft's very strict fuel technical qualifications. The use of Bioavtur in the CO2 gas recycling cycle, the reduction of exhaust emissions can be generated not only from physical properties and production processes alone using the process of HEFA, ATJ and FT, where Bioavtur does not contain sulfur but CO2 generated from combustion can also be absorbed by Plants that produce raw materials for Bioavtur. Methodology used secondary and primary data collection to obtain economic simulation. To generate and achieve goals in this activity, of course require data. The types of data used in this study are primary and secondary data. Stages of data collection / survey in this study include data collection both qualitative and quantitative to aspects related to economic simulation by calculating NPV, IRR, ROI, B / C ratio and PBP. Calculation of economic simulation with first scenario with BAU scenario (Business as Usual), this scenario contains the calculation condition for raw material price and product selling value adjusted to current market price condition. The second scenario is made so that this study can produce the economic quantity that feasibility. Especially for this second scenario will be adjusted to the price of raw materials in order to provide a decent economic value. The result of analysis with BAU scenario with raw material price of CPO $ 688.5 / Ton and product selling price as shown in table 2. Generating an unfeasible economic quantity, this is indicated by the value of NPV $. -245.108.330, the value of the ratio B / C -13.55, this is because the value of production costs is higher than the value of sales of its products. The value of production costs because the price of CPO is higher than the selling value of products, especially bioavtur as the main product. After analyzing the sensitivity on CPO price of $ 531.29 / Ton with 3% price increase, the price of CPO becomes $ 547.23 / Ton. The results of economic analysis with such conditions indicate that the parameters of NPV, IRR, B / C and PBP have improper values. This means that this investment is very sensitive to rising raw materials.

Index Terms: Bioavtur, HEFA, price, CPO, economic

1 Introduction

Avtur (Aviation Turbine) is a fuel for several types of commercial aircraft with the main components of paraffin hydrocarbon (C10-C14), Avtur obtained from the process of hydrocracking crude oil and then followed by a gradual separation of the hydrocarbon fraction. Some Avtur types are used on commercial aircraft such as Jet A, Jet A-1, Jet B, JP-4, JP-5, JP-7 or JP-8 [1-4]. Bioavtur plays an important role in the development of world energy security because most of the aviation demand has not been fully met from fossil energy production. The development of Bioavtur itself is still hampered by the fulfillment of the aircraft's very strict fuel technical qualifications [5-9]. The global aviation industry has a target to reduce emissions of carbon dioxide (CO2) emissions by 50% compared to the level (CO2) emissions in 2005 at 2050 [10-13]. American Society for Testing Materials (ASTM) specifications established two criteria that became the standard aircraft fuel is Jet A and Jet A-1. Jet A is the specification of fuel used in the United States, while Jet A-1 is an aircraft fuel specifications are set for areas outside of North America. Both specifications have the same criteria for density, dot heating (energy content), but Jet-A1 has a slightly lower freezing point of Jet-A. Aviation fuel is produced must meet the standards refer to ASTM D1655 - 09 of Standard Specification for Aviation Turbine Fuels [17-18].

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The use of Bioavtur in the CO2 gas recycling cycle, the reduction of exhaust emissions can be generated not only from physical properties and production processes alone using the process of HEFA, ATJ and FT, where Bioavtur does not contain sulfur but CO2 generated from combustion can also be absorbed by Plants that produce raw materials for Bioavtur [19-22]. The emissions generated by Bioavtur use are very small, where to produce Bioavtur the resulting emission will be smaller between 16-29 g CO2ekv / MJ compared to aviation production producing 84 g CO2ekv / MJ emissions [23]. The purpose of this research is to simulate the economics of Bioavtur production with HEFA process.

2 Research Method

Methodology used secondary and primary data collection to obtain economic simulation. To generate and achieve goals in this activity, of course require data. The types of data used in this study are primary and secondary data. Stages of data collection / survey in this study include data collection both qualitative and quantitative to aspects related to economic simulation by calculating NPV, IRR, ROI, B / C ratio and PBP.

3 Results and Discussion

3.1. Aspects of Bioavtur Production Process by the HEFA Process

For pre-feasibility made for Bioavtur production process with HEFA process considering the raw material available in Indonesia that is CPO oil. Production process with HEFA process with flowchart presented in Figure 1.

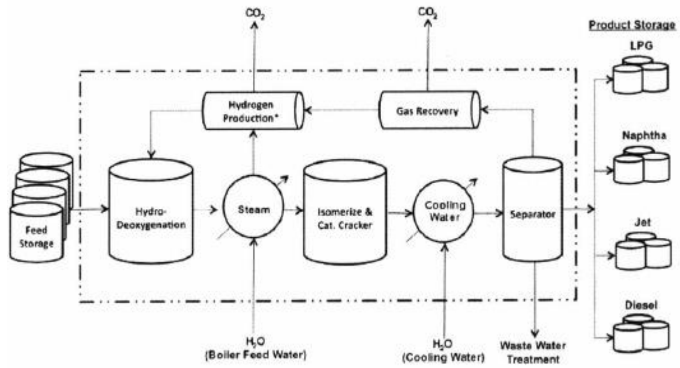

Figure 1. *HEFA Process Flow Chart*

The selected HEFA process includes several process units including:
1. Feed Storage Unit
2. The Hydro-Deoxygenation process unit
3. Isomerization and Cracking Process with Catalyst Unit
4. Unit processes heat and cooling water integration
5. The exhaust gas cleaning process unit and the recycling system
6. Unit of process of separation and purification of product

Unit of product storage process

1. Feed Storage Unit

A raw material storage unit is required to ensure the availability of raw materials in the process unit. The storage time of raw materials depends on the purchase of raw materials. Raw materials are usually stored for 14 days. In addition to shelf the acidity level of raw materials must be considered, because the higher the acidity level of raw materials requires the quality of materials used to store becomes higher. Raw materials in the form of oil are usually stored in tanks equipped with heating (depending on the type of oil stored). Raw material storage tanks with <5% acidity level are usually made from Carbon Steel. Tank used to store raw material with acidity level> 5% recommended using Stainless Steel material.

2. The Hydro-Deoxygenation process unit

Hydro treatment is the process of eliminating oxygen, double bonding and breaking the propane chain from triglycerides by reaction using hydrogen and catalyst. The hydrogen and oil ratio used for this process is between 2.7% - 4%. The results obtained from this reaction are water, CO2, propane and alkane groups of straight chain. Water and CO2 are generated when the hydrogen atom reacts with the oxygen atom. Propane is produced when glycerine from the oil chain is removed. The main result of this reaction is a straight-chain alkane group which includes diesel fuel and jet fuel with carbon chain length from C9 to C 20 depending on the carbon chain of the raw material. An additional process of isomerization is required so that the results obtained meet the fuel requirements set by ASTM.

3. **Isomerization and Cracking Process with Catalyst Unit**

The fog point of the deoxygenation reaction product should be increased by isomerization process and long chain reduction. The results obtained are middle-class distillate fluid on jet fuel and diesel fuel, naphtha and LNG as a by-product.

4. Unit processes heat and cooling water integration

Extremely exothermic hydro treating and isomerization processes produce heat and must be controlled by removing heat during the process. This heat discharging process uses water and must be regulated because it is associated with gas emissions. The integration of heat between the heat dissipating device and the need for heat must also be carried out in order to save the heat supply from fuel.

5. The exhaust gas cleaning process unit and the recycling system

After the product passes through the hydro treating reactor and the isomerization of the reaction gas must be separated from the liquid and purified. Hydrogen is separated by a pressurized swing absorption process and returned to the deoxygenation reactor. Other gases such as methane, ethane and propane are used as fuel for the process. The gas purification process is carried out using a disinfecting process using amines and acid gases.

6. Unit of process of separation and purification of product

The liquid product is separated according to the difference in the boiling point at atmospheric pressure distillation. Jet fuel with a lower boiling point will be separated first and will leave diesel fuel as another liquid fuel product.

7. Product Characteristics

CPO (Crude Palm Oil) will be used as raw material. In the HEFA process will be produced two characteristics of the product are: first production with the product distillate maximum and both products with maximum jet fuel. The composition of products and raw materials are presented in Table 1.

Table 1. *Product Composition and Raw Materials Results of HEFA Process*

Raw Materials (% Weight)	Amount	
	Maximum Bioavture	Maximum Destilate
CPO	100	100
Hidrogen	4	2..7
Total	**104**	**102.7**
Product (%Weight)	**Amount**	
Water	8.7	8.7
CO_2	54	5.5
Propane	4.2	4.2
LPG	6	1.6
Naftha	7	1.8
Jet (Bioavture)	49.4	12.8
Diesel	23.3	68.1
Total	**104**	**102.7**

Because in this study the product that became the main result is bioavtur then the calculation of economic simulation is selected products with product characteristics with maximum jet fuel.

3.2. Aspects of the Economy

Economic model is made to be able to simulate between economic variables to economic feasibility parameters. Economic variables used are years of development, production capacity, raw material prices and product selling prices. Parameters to the economy include NPV (Net Present

Value) at defined bank interest rate, IRR (Interest Rate of Return), B / C (Benefit / Cost) and Payback Period.

a. Assumption

In the calculations performed, in addition to using literature data and actual data are used also some assumptions. Assumption assumptions are: 1-day operational day is 300 days, rupiah exchange rate against $ Rp.13.000, -, raw material, operational cost and sale value every year is assumed 3%, economic life of 15 years factory, Bank deposit 10.5% (source of Bank Mandiri for Corporate loan), first, second and third year of production are 75%, 85% and 100% of production capacity and product in the form of water and CO2 not counted as economic value. Depreciation costs are made for 15 years and in the 15th year the value of the plant is considered 0. The source of funding obtained from the founders of the company does not get help from the bank. The capacity of the plant is designed to meet the needs of bioavtures by 2020 according to GRK Roadmap and RAN GRK Air Transportation 2012-2020 program, equivalent to 156,876 KL.

b. Investment costs

The investment expense or so-called Capital Expenses (CapEx) consists of investment for Inside Battery Limited (ISBL) facility consisting of production process equipment, Outside Battery Limited (OSBL) facility consists of storage facilities for products and raw materials and utility facilities and land acquisition costs Buildings and others. The price of equipment is obtained from the result of making a mathematical equation to the investment of some capacity of process unit ever made. For process units with capacity of 2,000, 4,000 and 6,500 Barrel / day the value of CapEx in cent / Gallon is 27, 19 and 16. With the analysis function in Microsoft excel we can simulate how much CapEx value for the capacity we choose. In this calculation the unit capacity of 350,000 KL per year is equivalent to 7,338 barrels / day of CapEx value of 16 cent / barrel capacity, so its CapEx in 2014 is $ 16,841,171. This CapEx value can be created according to the desired development year, the conversion of CapEx value is done by estimation using Marshall Index from source data in 2010 then made into equipment and facility price in 2014. From the existing Marshall index data made a mathematical equation y = 51,392x - 101795, y is the desired year index of Marshall and X is the year the Marshall index wants to know. The Marshall indexes in 2010 and 2014 are 1,502.92 and 1,708.488.

c. Operating Costs

Operational expenses, also called Operational Expenses (OpEx) consist of direct operating expenses (DOE) and Variable operating expenses (VOE). DOE consists of purchasing catalysts, insurance, taxes, maintenance fees, labour and the supply of goods for production. DOE values with capacities of 2,000, 4,000 and 6,500 Barrel / day are used as reference in determining the value of DOE in cent / Gallon are 27, 20 and 15. With the analysis function in Microsoft excel we can simulate how much DOE value for the capacity we choose. In this calculation the capacity of the 350,000 KL process unit per year is equivalent to 7,338 barrel / day of DOE value of 15 cent / barrel capacity. VOE consists of water production costs, electricity costs, fuel purchase costs and procurement of hydrogen. Unlike DOE that has a function to capacity, the VOE value will be linear in accordance with the capacity of the plant. VOE value is equivalent to 44 cent / gallon, this VOE cost does not include raw material price. The price of raw materials used is the CPO according to world market prices.

d. Production and Reception Projection

Receipts are obtained from the proceeds of the sale of products with the assumption of a predetermined price level based on the assumptions that have been submitted. Products that have value to the economy and sales price assumptions and projected production will be presented in Table 2.

Table 2. *Assumption of Product Selling Price and Production Capacity*

Produk Name	Selling Price, $/Gallon	Production, KL
Propane	2,05	18.620
LPG	3	30.855
Naftha	1,02	26.199
Avtur	2,92	157.987
Biodiesel	3,44	79.457

e. Projected Profit Loss

The profit and loss projection is a summary of the receipt and financing of the company each accounting period and gives the company progress from time to time. Net income represents the value derived from a reduction in total revenue with operating costs and income taxes.

f. Cash Flow Projection

Cash Flow is a report of cash receipts and disbursements showing cash transactions that take place during certain accounting periods. Cash in question includes net income and depreciation. While categorized as cash out is the cost of investment, working capital costs, facility fees and loan repayment costs.

g. Investment Feasibility Analysis

The feasibility criteria used include NPV, PBP, Net B / C and IRR which can illustrate whether the project is still attractive to be realized. The full calculation results of all components of the eligibility criteria are presented in the financial attachment. The NPV calculation results are based on net cash flow on the cash flow projection with discount factor (DF) of 10.5%. The IRR value for the bioavetic industry is considered feasible if the resulting IRR is greater than the set rate of 10.5%. The bank's current lending rate is 10.5%. The bioavetic industry's payback period (PBP) is expected to be faster than half the lifetime of the plant. The Net B / C value obtained from the establishment of the bioavetic industry is expected to be greater than 1.

h. Analysis Results

The calculation of this economic simulation will be made in several scenarios, firstly with BAU scenario (Business as Usual), this scenario contains the calculation condition for raw material price and product selling value adjusted to current market price condition. The second scenario is made so that this study can produce the economic quantity that feasibility. Especially for this second scenario will be adjusted to the price of raw materials in order to provide a decent economic value. The result of analysis with BAU scenario with raw material price of CPO $ 688.5 / Ton and product selling price as shown in table 2. Generating an unfeasible economic quantity, this is indicated by the value of NPV $. -245.108.330, the value of the ratio B / C -13.55, this is because the value of production costs is higher than the value of sales of its products. The value of production costs because the price of CPO is higher than the selling value of products, especially bioavtur as the main product. Comparison of the value of production costs with the sale of product value is reflected in the projected income and will be presented in Table 3.

Table 3. *Projection of Profit Loss BAU Scenario*

Description	Year of 1	Year of 2	Year of 3	Year of 4	Year of 5
Selling	177.006.918	200.607.841	236.009.225	243.089.501	250.382.186
Amount of Selling	177.006.918	200.607.841	236.009.225	243.089.501	250.382.186
Production cost	210.264.658	238.299.946	280.352.877	288.763.463	297.426.367
Gross Profit	-33.257.739	-37.692.105	-44.343.652	-45.673.962	-47.044.181
Tax (30%)	0	0			
Net Profit/year	-33.257.739	-37.692.105	-44.343.652	-45.673.962	-47.044.181

The results of the analysis using the second scenario is to adjust the price of raw materials is done to find out how the price of raw materials that can provide decent value with IRR 15% on parameters to the economy. Simulation results on the CPO price of $ 531.29 / Ton can give value to the economical parameters that feasibility, as shown in Table 4.

Table 4. *Economic Feasibility Parameters*

NPV DF 10,5 %, $	4.778.760	$
IRR	15	%
B/C ratio	1,28	
Pay Back Period	6,22	Year
ROI	20	%

The analysis for both scenarios is that when the bio-gas industry will be established in Indonesia with the HEFA process the policy maker must be able to position that the industry must obtain a CPO price of $ 531.29 / Ton, this price has a difference of $ 157.21 / Ton with The current market price is $ 688.5 / Ton. In other words when mandatory construction of this plant is issued then the government should be able to provide incentives to the bioavetic industry to be able to repeat the difference in the price of raw materials that are feasible to use in industry at current market prices. In addition to the CPO price difference worthy of investment compared to current market prices there is another factor that should be of concern in the investment plan of this industry is the increase in raw material prices. To see this, a sensitivity analysis will be conducted on the pre-feasibility study calculation. The increase in raw materials is chosen to be variable because CPO prices have a proven price hike history and occur with predictable cycles. When vegetable oils in the form of soybean oil and canola oil stocks in the world fell then the price of CPO will creep up. This price increase will be able to continue in the event of failure in the production of soy and canola in America and Europe, not only increases in price but also lasts for a long time. Therefore an analysis of the increase in this raw material should be done. This sensitivity analysis is carried out on the feasible price for investment i.e. at the price of CPO $ 531.29 / Ton. The level of sensitivity we tested with CPO price increase of 3%. After that if the result of economic analysis shows the investment parameter becomes improper, and then we will decrease the investment worthy price until the new feasibility is obtained which, when added with the 3% raw material price increase, the result of the analysis shows the proper result.

i. Sensitivity Analysis

After analysis the price of CPO $ 531.29 / Ton with 3% price increase, the price of CPO becomes $ 547.23 / Ton. The results of economic analysis with such conditions indicate that the parameters of NPV, IRR, B / C and PBP have improper values. This means that this investment is very sensitive to rising raw materials. Even with a 1% increase this investment is not feasible. Therefore we must do the second step is to lower the price of CPO is feasible for investment. From the simulation result of proper CPO price plus 3% raw material increase is $ 515.35 / Ton called scenario 3, can be seen in Table 5.

Table 5. *Sensitivity Analysis*

Eligibility Parameters	Scenarios				Unit
	Scenario 2	CPO Price Increase (3%)	CPO Price Increase (1%)	Scenario 3	
CPO Price, $/Ton	531.29	547.23	536.6	515.35	$
NPV DF 10,5 %, $	4.778.760	-20.556.287	-3.666.255	30.118.099	$
IRR	15	#DIV/0!	6,60%	34,64	%
ROI	20	-5%	11%	44	%
B/C ratio	1.28	-0.22	0.78	2.79	
Pay Back Period	6.22	-20.95	10.73	2.84	Year

Considering a 3% price increase, the price difference is feasible at the current market price is $ 173.15 / Ton.

4 Conclusion

The conclusions of the economic simulation are as follows:

1. Calculation of economic simulation with first scenario with BAU scenario (Business as Usual), this scenario contains the calculation condition for raw material price and product selling value adjusted to current market price condition. The second scenario is made so that this study can produce the economic quantity that feasibility. Especially for this second scenario will be adjusted to the price of raw materials in order to provide a decent economic value. The result of analysis with BAU scenario with raw material price of CPO $ 688.5 / Ton and product selling price as shown in table 2. Generating an unfeasible economic quantity, this is indicated by the value of NPV $. -245.108.330, the value of the ratio B / C -13.55, this is because the value of production costs is higher than the value of sales of its products. The value of production costs because the price of CPO is higher than the selling value of products, especially bioavtur as the main product.
2. After the sensitivity analysis at CPO price of $ 531,29 / Ton with 3% price increase, then the price of CPO becomes $ 547,23 / Ton. The results of economic analysis with such conditions indicate that the parameters of NPV,

IRR, B / C and PBP have improper values. This means that this investment is very sensitive to rising raw materials.

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