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Renewable Energy Fuel Product Innovation

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Abstract— *Diesel oil is one of the fuels that consumes the most in Indonesia, while the amount of its reserves is getting smaller. MDF (Marine Diesel Fuel) or can also be called IDO (Industrial Diesel Oil) to be excellent second diesel products in terms of specifications that are better than MFO (Marine Fuel Oil), so that it can make the engine last longer. However, at the moment the price is still relatively expensive, because production is still dependent on the production of Crude Oil in the Processing Unit which is then transferred to the Stockpile Marketing Unit through the Tanker as well as the pipeline, before finally being distributed to the Customer. DF / IDO is a distillate type fuel which is black, but liquid at low temperatures. MDF consumption is generally used for diesel engines with moderate or slow rotation (300-1000 rpm). MDF can be obtained from the oil distillate which is also a middle fraction which is located between the MFO fraction (Marine Fuel Oil) and the lighter fraction, solar. In this study, an experiment will be made in the manufacture of new products by approving Bio in Diesel Fuel / Oil using the In Line Blending method in the Marketing Unit to obtain new product innovations that are suitable for mass production. This is expected to produce industrial fuel products with better quality than pure MDF and at lower prices with renewable energy sources. For this reason, it is necessary to conduct research to make BioMDF with the In Line Blending method, in order to understand the optimal composition for making the product. These optimal assessment provisions contain several considerations regarding the requirements of the Directorate of Oil and Gas specifications and have low Operating Costs*.

Keywords— *Innovation, fuel, diesel fuel, bio-MDF, in line blending.*

I. INTRODUCTION

Geographically, Indonesia is a country consisting of large and small islands totaling approximately 17,504 islands. Indonesia as an archipelagic country has been recognized internationally through the third United Nations convention on the law of the sea, the United Nation Convention on the Law of the Sea 1982 (UNCLOS 1982), which was later ratified by Indonesia with Law No.17 of 1985. Three-quarters of its territory is sea. covering an area of 5.9 million km2, with a coastline of 95,161 km2 and 2.7 million km2 of sea waters in the Exclusive Economic Zone (EEZ). Therefore, there is great potential for the development of facilities and infrastructure for the maritime sector in Indonesia.

Based on the National Energy General Plan (RUEN) passed in 2013, the national energy demand in 2025 could reach 406.15 MTOE, or an average increase of 6.9% per year. The industrial sector is the largest energy user sector with a share of 59% of national energy consumption, followed by the transportation sector (21%), households (12%), the commercial sector (3%), other sectors (3%) and non-energy use. (2%). [1].

Utilization of alternative renewable energy (renewable energy) can be a new hope for Indonesia in increasing energy security. In line with the Regulation of the Minister of Energy and Mineral Resources Number 25 of 2013 concerning the provision, utilization and trading system of biofuels as biofuels as other fuels with stricter environmentally friendly specifications. For example, the sulfur content in fuel products is required to get lower every year.

Diesel Oil is one of the most used fuels in Indonesia, while its reserves are getting smaller. MDF (Marine Diesel Fuel) or also known as IDO (Industrial Diesel Oil) is the star of the second diesel product in terms of its specifications which are better than MFO (Marine Fuel Oil), so that it can make the engine last longer [2] [3]. However, currently the price is still fairly expensive, because the production still relies on the production of Crude Oil processing in the Processing Unit which is then transferred to the Tanker Marketing Unit via Tanker or pipeline, before finally being distributed to customers.

Marine Fuel Oil (MFO) is a product of petroleum refining, which is produced after residue and before asphalt. Namely fuel oil which is not a product of distillation but is the result of a black residue. This type of oil has a high level of viscosity than diesel oil. The use of this fuel oil is generally for direct combustion in large industries and is used as fuel for steam power stations. In addition, MFO fuel is also used mostly for fuel for ship engines. From an economic point of view, the use of fuel oil is considered cheaper. [4]

Indonesia has the potential of alternative energy resources is quite large, both renewable and nonrenewable [5]. Seeing the potential marketing opportunities for MDF / IDO sales, the Marketing Unit of PT. X intends to produce its own MDF / IDO products with other more economical methods, so that it is expected to reduce the purchase price of the processing unit which has been quite expensive (Rp. 7,900 to 8,000, - / liter MDF). Therefore, PT. X will carry out product innovation in this case looking for the best method, where previously the MDF / IDO product manufacturing process was still carried out by the Distillation process in the Processing Unit, diverted to the In - Line Blending method, so that the results of MDF product innovation could produce superior products. This

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product innovation will also utilize renewable energy, namely FAME (Fatty Acid Methyl Ester), which is a biofuel derived from palm oil extract. Indonesia is the largest palm oil-producing country in the world, with total Crude Palm Oil (CPO) production reaching 47 million tons in 2018. According to the Indonesian Palm Oil Association (GAPKI), export volume in 2018 reached 35 million tons or approximately 73% of total palm oil production, and the rest is intended for domestic consumption. Currently, the capacity for biodiesel production in Indonesia is 12 million kiloliters per year [6]. In this research, a trial will be carried out for the manufacture of a new product, namely the addition of Bio to Diesel Fuel / Oil using the In Line Blending method

Based on the research background above, the problem that occurs is how to find the mixing composition of BioMDF / IDO products according to the specifications set by the Directorate of Oil and Gas. The aim of this research is to find the composition of mixing BioMDF products according to the specifications set by the Directorate of Oil and Gas.

II. Literature Review

A. Dilution and Blending

In - Line Blending is a continuous mixing process of two or more different components simultaneously to get the final product, which depends on the agreed composition. This method is considered more efficient than batch blending because the mixing process is faster, requires less labor facilities, and can even reduce storage costs. The In - Line blending system can also be used to deliver products directly to pipelines or to roads, trains or sea tankers, as applied by it self in the fuel supply system using tank cars [7]. The In - Line Blending process work system uses a flow rate setting set by the mix control system to get a composition that matches the setting. This system can be controlled manually or automatically with a constant flow of components according to the mixing ratio. The flow rate used then becomes a means that helps the mixing media to achieve homogeneity. The basic principle of operating a controlled blending rate is that the flow in each component line is measured using a flowmeter, and controlled (regulated) using a control valve, or by varying the output of a positive displacement pump (Positive Displacementi). The signal from this meter will be scaled and totaled by the blender in the computer process [6]. The description of the work process can be seen in Figure 1 below [8] [9]:

B. Statistical Test Method - t

Data analysis is an activity after data is collected from all respondents in quantitative testing using statistics. There are two statistics for analysis, namely descriptive statistics and inferential statistics. Descriptive statistics are statistics used for data analysis by describing or describing the collected data as it is without any purpose to make conclusions for generalizations. Meanwhile, inferential statistics are the statistics used to analyze sample data and the results are applied to the population. In testing the difference between the two parameters, the average analysis technique can be classified into three types, namely the analysis of the difference between the two parameters of the free sample, two independent samples, and two non-homogeneous samples.

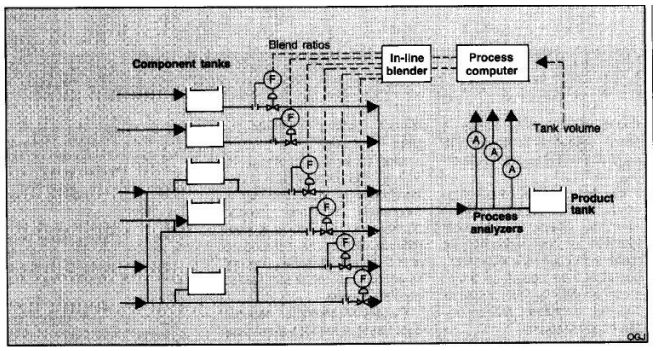

Figure 1. In - Line Blending Work Process System

This aims to study the difference in the average criterion variable of the two groups or those that can be classified into two groups. The requirements that must be met in the t-test are that the data must be normal and homogeneous.

III. Research Methodology

The procedures carried out in this research development include the following stages:

1. Data collection. Collecting fuel specification data information from the Director General of Oil and Gas of each MFO, HSD, FAME, and MDF products and their economic purchase prices.
2. Blending Trial Simulation. Perform simulation of composition calculations for the manufacture of BioMDF using a dilution formula.
3. Determination of the percentage of the mixing composition for the manufacture of BioMDF products. The determination is made by considering the aspect of conformity with the specifications of the Director General of Oil and Gas and the most efficient Production Costs.
4. Product Sample Testing. The implementation of BBM product testing is carried out in 3 stages:
   a. Initial product testing. This was done to determine the initial characteristics of the HSD, MFO, and FAME products from the Storage Tank which will be used to manufacture BioMDF.
   b. Testing Laboratory Scale BioMDF Products. In this step the laboratory scale BioMDF product is manufactured according to the mixing procedure, using the mixing composition specified in step 4
   c. BioMDF Product Testing uses the In Line Blending method. This step is carried out if the results of testing the Laboratory scale BioMDF product show the conformity of the results to the Director General of Oil and Gas specifications. Then the making of BioMDF using the In Line Blending method, and continued with the testing of products produced from the In Line Blending method.
5. Homogeneity test. Parametric statistics in this case the analysis of Hypothesis Testing (t-Test) Non-Free Samples using Ms. Excel between the results of product testing. The statistical testing process is to determine the effectiveness

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of the test results between the manufacture of Laboratory scale BioMDF products and the manufacture of BioMDF In Line Blending products with the following hypotheses:

a. H0 = Effectiveness of the test results between the manufacture of BioMDF products in the Laboratory with the results of testing the manufacture of BioMDF products using the In Line Blending method.
b. H1 = The effectiveness of the test results between the manufacture of BioMDF products in the Laboratory is not the same as the results of testing the manufacture of BioMDF products using the In Line Blending method.

This developmental research procedurally goes through several steps or stages as described above, but due to the limitations of the research, the development of this research is carried out in accordance with research needs.

IV. Result And Discussion

In this study, the volume percentage of MFO product mixing to the manufacture of MDF products will be limited to a maximum of 10% of the total mixing referring to the Best Practice of the R&D Function of PT. Pertamina (Persero). The percentage of the FAME product volume in this case will be varied into 10%, 20% and 30%. Meanwhile, the volume percentage of solar products will adjust from the lack of the percentage of mixing volume to reach 100%. Trial calculations are carried out using the dilution formula:

$$\sum VxMx = V1M1 + V2M2 + V3M3$$

This calculation is the result of the calculation of the dilution formula using Ms Excel which is calculated by the researcher with the percentage variation of the FAME mixing. Based on the table, it is found that the variation in the percentage of mixing FAME 10%, 20%, and 30% can all meet the requirements of the Director General of Oil and Gas.

The results of the calculation of the simulation of making BioMDF can be seen in Table 1 below:

TABLE 1. Calculation Results of BioMDF Manufacturing Simulation

Parameter	Metode	Batasan Produk MDF		Hasil Trial Pencampuran FAME		
		Min	*Max*	P-01	P-02	P-03
Density 15 °C (Kg/m³)	ASTM D-1298		900	876	879	882
Visc. Kinematic at 40 °C (mm²/secs)	ASTM D-445	2.5	11.0	6,0	6,2	6,3
Flash Point PM CC(°C)	ASTM D-93	60	-	>60	>65	>71
Water Content (%v/v)	ASTM D-95	-	0,25	0,12	0,12	0,12
Sediment Content (%wt)	ASTM D-473	-	0.02	0,018	0,017	0,016
Sulfur Content (%m/m)	ASTM D-1552	-	1,5	0,6	0,5	0,5
Pour Point (°C)	ASTM D-97		18	17	16	14

Before conducting experiments on mixing BioMDF products on a laboratory scale, it is important for researchers to know in advance the results of the analysis of the petroleum products that form them, in this case, they are sure MFO, FAME, and Solar. Following are the results of MFO product testing can be seen in Table 2 below:

TABLE 2. Manufacture of Laboratory Scale BioMDF Products

Parameter	Metode	Batasan		Sampel BioMDF A			Sampel BioMDF B			Sampel BioMDF C		
		MIN	*MAX*	Uji A.1	Uji A.2	Uji A.3	Uji B.1	Uji B.2	Uji B.3	Uji C.1	Uji C.2	Uji C.3
Density 15 °C (Kg/m³)	ASTM D-1298	-	900	864	864	865	865	866	866	867	867	868
Visc. Kinematic at 40 °C (mm²/secs)	ASTM D-445	2.5	11.0	4,3	4,3	4,2	4,3	4,3	4,3	4,2	4,3	4,3
Flash Point PM CC(°C)	ASTM D-93	60	-	77	79	79	80	81	78	79	78	79
Water Content (%v/v)	ASTM D-95	-	0,25	0,07	0,08	0,07	0,07	0,07	0,06	0,08	0,07	0,07
Sediment Content (%wt)	ASTM D-473	-	0.02	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Sulfur Content (%m/m)	ASTM D-1552	-	1,5	0,4	0,4	0,4	0,3	0,4	0,4	0,4	0,4	0,4
Pour Point (°C)	ASTM D-97	-	18	6	6	6	6	6	6	6	6	6

Remarks :
- Hasil Pengujian ini hanya berlaku untuk sampel yang diujikan
- Dirjen MIGAS No.14499 K/14/DJM/2008 tgl.21 Agustus 2008 tentang standar dan mutu (Spesifikasi) BBM Jenis Minyak Diesel
- Dilarang memperbanyak/copy secara terpisah tanpa ijin dari Lab Tg. Gerem

In this study, a variation of the mixing of FAME as a component of the production of BioMDF products was carried out. Mixing variations carried out for the manufacture of BioMDF are divided into three, namely Mixing-01 (80% HSD, 10% MFO, and 10% FAME), Mixing-02 (70% HSD, 10% MFO, and 20% FAME), and Mixing- 03 (60% HSD, 10% MFO, and 30% FAME). In fact, the greater the composition of the FAME mixing, the better the quality of fuel produced, according to the theory expressed by Brown [10]. However, the higher the FAME content used, the more expensive the production costs. According to the regulation Permen ESDM No. 12 of 2015, that for the period between 2016 and 2020, the minimum obligation to use Bio is set at 20%. In addition, the application of Bio to Fossil Fuel will certainly increase sales from FAME Suppliers, so researchers feel the need for further studies regarding the security of supply from FAME. This is related to the continuity of BioMDF supplies going forward. Meanwhile, according to [11] "there is still a gap between production capacity and the achievement of Biodiesel production in Indonesia of around 25% or 1.11 million kilo liters." Therefore, until the problem can be resolved, in this research, the Mixing-01 composition was selected with the addition of 10% FAME for further development. After obtaining the On Spec recommendation from the laboratory, the researchers then continued the In Line Blending experiment using a modified tank car filling facility. This serves as a Pilot Plan prior to greater implementation of the means of filling fuel to ships for sales. To get the right mixing composition, the variable that is controlled in this In Line Blending application is the Flowrate of each product. The total distribution flowrate used is 2,000 liters per minute

To study the degradation or differences in the test results of making BioMDF products between the In Line Blending method and the Laboratory scale, a statistical hypothesis test was carried out, assuming a value of $\alpha = 5\%$ because it is considered that this process has a fairly high accuracy value, with the hypothesis that there is no difference between the test results of making BioMDF products between the In Line Blending (Y2) method and the Laboratory scale (Y1). The value range limit "t table" for the value $\alpha = 5\%$ and the total population N = 9 is $\alpha / 2 = 0.25\% = 2.306$. Calculation This hypothesis test uses the method of testing the difference

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between two means for the dependent sample. This is because the two data that want to be tested for differences come from the same sample group, namely the FAME, HSD, and MFO fuel products, which then produce two data distributions, namely the results of making Lab-scale BioMDF with the results of making BioMDF in Line Blendin. Data from laboratory scale production of BioMDF products is data from the initial mixing before treatment using the In Line Blending method.

Based on the results of the calculation of the hypothesis test using the two-mean difference test method for the dependent sample [12], it was found that all the "t_0" values of the test parameter results of the BioMDF product were in the acceptance area of the t table value using the $\alpha = 5\%$ value, the total population was N = 9, and the value of degrees of freedom = 8. As summarized in Table 3 below:

TABLE 3. Summary of the Table of Results of Non-Free Sample Hypothesis Testing

Parameter	Batasan "t_{tabel} "		t_0	H0
	t_{tabel} min	t_{tabel} max		
Density 15 ^oC (Kg/m^3)	-2,306	+2,306	0,503	Diterima
Visc. Kinematic at 40 ^oC (mm^2/secs)	-2,306	+2,306	1,757	Diterima
Flash Point PM CC(^oC)	-2,306	+2,306	(2,133)	Diterima
Water Content (%v/v)	-2,306	+2,306	1,873	Diterima
Sediment Content (%wt)	-2,306	+2,306	0	Diterima
Sulfur Content (%m/m)	-2,306	+2,306	0,240	Diterima
Pour Point (^oC)	-2,306	+2,306	0	Diterima

V. CONCLUSION

Based on the research results, the composition of the BioMDF product blending in accordance with the specifications set by the Directorate of Oil and Gas are as follows: mixing-01 with a composition of 80% HSD, 10% MFO, and 10% FAME ; mixing-02 with a composition of 70% HSD, 10% MFO, and 20% FAME ; mixing -03 with a composition of 60% HSD, 10% MFO, and 30% FAME. Mixture-01 at point "a" is selected for product development

REFERENCES

[1] M. Murtiningrum and A. Firdaus, "Perkembangan Biodiesel di Indonesia Tinjauan Atas Kondisi Saat ini, Teknologi Produksi & Analisis Prospektif," *Penelit. dan Apl. Sist. dan Tek. Ind.*, vol. 9, no. 1, p. 182836, 2016.

[2] N. Padilah, Subaer, and Muris, "Analisis Penggunaan Bahan Bakar High Speed Diesel (HSD) Dan Marine Fuel Oil (MFO) Terhadap Parameter Titik Utama Siklus Kerja Dan Performa Mesin Diesel Mitsubishi Man Type 18V52/55A," *J. Sains dan Pendidik. Fis.*, 2019.

[3] S. Kesic, J. Sadadinovic, and F. Zilic, "Optimal possibilities of use of biodiesel in diesel engine passenger cars older than 10 years," *Ann. Fac. Eng. Hunedoara*, vol. 11, no. 2, p. 97, 2013.

[4] G. H. H. Salsabila, "Proses Treatment Marine Fuel Oil (Mfo) Sebagai Bahan Bakar Pada Mesin Diesel," *J. Kompetensi Tek.*, 2019, doi: 10.15294/jkomtek.v11i1.19749.

[5] H. Thaheer, S. Hasibuan, and A. Ma'ruf, "Kajian Strategi Pengembangan Investasi Energi Alternatif Di Indonesia."

[6] A. Firdaus, M. Machfud, A. Suryani, and N. A. Achsani, "Impact Of Biodiesel Agroindustry On The Achievement Of National Energy Security," *SINERGI*, 2020, doi: 10.22441/sinergi.2020.2.009.

[7] B. T. Ince, "In-Line Blending (Control Systems)," *Tech. Pap. TB006-0512-2*, 2005.

[8] Y. Serpemen, F. W. Wenzel, and A. Hubel, "Blending technology key to making new gasolines," *Oil Gas J.*, 1991.

[9] Y. Serpemen and F. W. Wenzel, "Diesel blending system cuts quality give-aways at Ruhr refinery," *Oil Gas J.*, 1991.

[10] A. S. Brown, "Blending fuels to boost efficiency," *Mech. Eng.*, vol. 131, no. 11, pp. 18–19, 2009.

[11] A. Firdaus and U. Amrina, "Energy Audit Analysis By Business Intelligence Application," *SINERGI*, 2015, doi: 10.22441/sinergi.2015.3.002.

[12] Sugiyono, "Metode Penelitian Kuantitatif, Kualitatif dan R & D.Bandung:Alfabeta.," *Metod. Penelit. Kuantitatif, Kualitatif dan R D.BandungAlfabeta.*, 2012, doi: 10.1017/CBO9781107415324.004.