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Title of Paper : FEASIBILITY STUDY OF FUEL STATION WITH WASTE COOKING OIL PROCESSING TO BIODIESEL

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FEASIBILITY STUDY OF FUEL STATION WITH WASTE COOKING OIL PROCESSING TO BIODIESEL ADDITIONAL FACILITY IN PADANG, INDONESIA

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Abstract – This fuel station will serve fuel supply for campus buses of University of Andalas (Unand) and general transportation in Padang, West Sumatera, Indonesia. Biodiesel is only for campus buses and other kinds of fuel i.e. petrodiesel and gasoline are for general transportation. All this time, to supply the requirement of petrodiesel, campus buses must go to the nearest fuel station in Bypass Street, Padang, Indonesia which is located more than 5.4 kms from Pasar Baru, Padang, Indonesia. It can cause high petrodiesel consumption. So, it should be built a fuel station in Pasar Baru, Padang because there are many area which are not optimally used. It means this fuel station can give two advantages, i.e. saving the petrodiesel consumption and increasing biodiesel utilization as renewable energy.

Keywords – Fuel Station, Petro diesel, Biodiesel, Waste Cooking Oil.

I. INTRODUCTION

Energy crisis on Indonesia is caused by the increasing of oil consumption. The increasing of oil consumption is caused by the increasing of vehicle amount. On the other hand, the amount of oil is more and more decreasingly. Other alternative energy sources must be found to solve this problem.

One kind of oil product is petrodiesel. It is important product from oil because used by many sectors. The shortage of petrodiesel amount causes Indonesia must import petrodiesel from other countries. The consumption of petrodiesel can be decreased by using biodiesel. The production and consumption of oil in Indonesia is shown in Table I.

TABLE I. OIL PRODUCTION AND CONSUMPTION IN INDONESIA (2003-2009) [15]

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (barrel)</th>
<th>Consumption (barrel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>337,260,837.00</td>
<td>297,602,721.00</td>
</tr>
<tr>
<td>2008</td>
<td>356,436,786.00</td>
<td>273,505,549.00</td>
</tr>
<tr>
<td>2007</td>
<td>348,314,945.00</td>
<td>321,302,814.00</td>
</tr>
<tr>
<td>2006</td>
<td>359,289,337.00</td>
<td>349,845,435.00</td>
</tr>
<tr>
<td>2005</td>
<td>385,708,779.00</td>
<td>357,493,997.00</td>
</tr>
</tbody>
</table>

Based on regulations from Pertamina (Indonesian Mining and Petroleum Corporation), the private corporation is permitted to manage fuel station and the additional facilities are minimarket, restaurant and washing of vehicles.[12] On the other hand, Indonesian Government has made regulation to decrease petro diesel consumption.[6] The consumption of petro diesel can be decreased by using biodiesel which is produced from waste cooking oil. To synchronize these regulations, it should be done feasibility study which analyze fuel station with facility waste cooking oil processing to biodiesel. The evaluation aspects on this feasibility study consist of marketing, technical, management and finances.

II. BIODIESEL

Biodiesel comes from coconut oil, crude palm oil, waste cooking oil and Jatropha curcas.[2] Biodiesel is a type of bio energy which is included as a new and renewable source of energy. Burn characteristic of biodiesel is near with petro diesel. It means biodiesel can be considered as the substitute of petro diesel. Waste cooking oil can be produced from food entrepreneur, restaurant and house hold.
In food cooking, waste cooking oil should not be used repeatedly because it will generate the free radical which can cause cancer. A sample of waste cooking oil is shown in Figure 1. A sample of biodiesel is shown in Figure 2.

![Figure 1. Waste Cooking Oil (WCO) [4]](image1)

![Figure 2. Biodiesel [4]](image2)

Waste cooking oil is the residue of CPO consumption. Crude palm oil (CPO) is often used for cooking oil. Crude Palm Oil Production and Consumption on Indonesia on 2001 – 2005 is shown in table III.

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (ton)</th>
<th>Production Increasing (%)</th>
<th>Consumption per Capita (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>3.89</td>
<td>-</td>
<td>14.90</td>
</tr>
<tr>
<td>2002</td>
<td>4.20</td>
<td>7.38</td>
<td>15.00</td>
</tr>
<tr>
<td>2003</td>
<td>4.22</td>
<td>0.47</td>
<td>15.40</td>
</tr>
<tr>
<td>2004</td>
<td>4.77</td>
<td>11.53</td>
<td>16.00</td>
</tr>
<tr>
<td>2005</td>
<td>5.39</td>
<td>11.50</td>
<td>16.50</td>
</tr>
</tbody>
</table>

On Indonesian President Regulation number 5 year 2006, the oil consumption should be decreased 20% from national energy consumption [6]. One of the actions which can be done is making conversion of petro diesel to biodiesel. Biodiesel which will be developed consists of 5% biodiesel and 95% petro diesel. It is usually called Biodiesel B5.

It means the waste cooking oil utilization as biodiesel can give more function for it. Beside that, the using of waste cooking oil to make biodiesel can decrease the consumption of petro diesel. It can support the target of Indonesian President Regulation number 5 year 2006. The consumption of Crude Palm Oil (CPO) on food entrepreneur, restaurant and house hold is shown in Figure 3, Figure 4 and Figure 5.

![Figure 3. The Consumption of CPO on Food Entrepreneur [18]](image3)

![Figure 4. The Consumption of CPO on Restaurant [16]](image4)

![Figure 5. The Consumption of CPO on House Hold [17]](image5)
Esterification and transesterification methods are used to process WCO to biodiesel. Esterification process uses acid catalyst, like sulfuric acid (H$_2$SO$_4$) or chloride acid (HCl). Esterification and transesterification process is shown in Figure 6.

Esterification consists of four steps, i.e.:
1. Mixing of strong acid (H$_2$SO$_4$/HCl) and alcohol (methanol/ethanol),
2. Warming of oil with high FFA (> 5%) like waste cooking oil,
3. Mixing of strong acid (H$_2$SO$_4$/HCl), alcohol and oil to decrease the amount of FFA less than 5%,
4. Separation of oil with methanol.

After the FFA less than 5%, the process is continued with transesterification process, i.e.:
1. Mixing of alkaline catalyst (NaOH or KOH) with alcohol (Methanol or Ethanol), Catalyst concentration is 0.5 – 1 wt% to oil mass. Alcohol concentration is 10 – 20wt% to oil mass,
2. Mixing of alcohol, catalyst and oil on temperature 55°C with constant mixing velocity. This reaction is done about 30 – 45 minutes,
3. Separating of the mixture until methyl ester is separated with glycerol. Methyl ester which is produced on this step is called crude biodiesel because consists of polluter substance like methanol residue, catalyst alkaline residue and soap,
4. Washing of methyl ester with use warm water to separate polluter substance and then be continued with drying to evaporate water on biodiesel.

IV. CAMPUS BUSES IN UNAND
University of Andalas (Unand) is one of university on Padang which is located on Limau Manis, Pauh. Unand campus buses serve students and people from Pasar Baru, Pauh to Unand campus. Unand has 27 micro buses and 7 buses which serves alternately on working day. These buses is called white buses. On the holiday, white buses can be leased to general people. Based on interview to the bus driver, the average of petrodiesel requirement is 45 L per day for a small white bus and 90 L per day for a big white bus. Small and big white buses is shown in Figure 7 and 8.

To supply the requirement of petrodiesel, campus bus must go to the nearest fuel station on Bypass Street which is located more than 5 kms from Pasar Baru. It can cause high petrodiesel consumption. So, it should be built a fuel station on Pasar Baru because there are many area which are not optimally used. This fuel station can serve biodiesel requirement for campus buses and other kinds of fuel for general transportation.

Beside that, Unand has campus buses which serve lecturer, administration staff and university
guest. Campus buses which serve lecturer and administration staff are called green bus. There are 4 green buses. Petrodiesel requirement for one green bus is 20 L per day. Campus bus which serves university guest is called exclusive bus. There is one exclusive bus. Green and exclusive bus are shown in Figure 9 and 10.

![Figure 9. Green Bus on Unand](image)

![Figure 10. Exclusive Bus on Unand](image)

V. RATING ASPECTS

Rating aspects on this research consists of technical, marketing, management and financial aspects. On technical aspects, the requirement of fuel for campus buses is 1,925 L per day which consists of 1,215 L for 27 white micro buses, 630 L for 7 white buses and 80 L for 4 green buses. So, it needs 9,625L petro diesel for a week (5 working days). Type of biodiesel which will be developed is B5 (5% biodiesel and 95% petro diesel). 1 L waste cooking oil can be used to produce 930 mL biodiesel. If the amount of waste cooking oil per week was 414 L, B5 could be used for campus buses. Waste cooking oil will be collected from food entrepreneur, restaurant and house hold.

On marketing aspects, it will be done the survey to know opinion from the people around the fuel station location planning. On management and financial aspects, it will be done economic analysis in fuel station reconstruction planning and management.

VI. SURVEY

This research is started by searching data about respondents location in Padang, West Sumatera. This data can be obtained on Statistics Center of West Sumatera. There are two kinds of survey, i.e. survey the people opinion about fuel station planning and survey the minimum amount of waste cooking oil (WCO) which can be gotten from respondents every month. Based on first survey, if the people around the location of fuel station planning agree with this planning, it means fuel station can be built on there.

On second survey, it will be done WCO collection from three categories respondents i.e. food entrepreneur, restaurant and household. The estimation of respondents number in Padang (based on data from Statistics Center on 2009) is shown in table IV.

<table>
<thead>
<tr>
<th>Location</th>
<th>Respondent Category</th>
<th>Estimation number</th>
</tr>
</thead>
<tbody>
<tr>
<td>School</td>
<td>Food entrepreneur</td>
<td>953</td>
</tr>
<tr>
<td>Universities</td>
<td>Food entrepreneur</td>
<td>51</td>
</tr>
<tr>
<td>Market</td>
<td>Food entrepreneur and Restaurant</td>
<td>17</td>
</tr>
<tr>
<td>Hospital</td>
<td>Food entrepreneur and Restaurant</td>
<td>23</td>
</tr>
<tr>
<td>Hotel</td>
<td>Food entrepreneur and Restaurant</td>
<td>17</td>
</tr>
<tr>
<td>Restaurant</td>
<td>Restaurant</td>
<td>54</td>
</tr>
<tr>
<td>Household</td>
<td>Household</td>
<td>210,840</td>
</tr>
</tbody>
</table>

The most priority respondents is restaurant because the highest consumption of cooking oil is on there. So, the sequence priority respondents location is restaurant, market, hospital, school, universities and household. Based on second survey, the amount of WCO is collected to make database.

After that, this data is analyzed to know the amount of biodiesel B5 which can be produced per month. If the minimum amount of biodiesel B5 is same or more than the petrodiesel requirement of campus buses, it means biodiesel B5 is suitable to be used as the fuel for campus buses on Unand.

If the minimum amount of biodiesel B5 is less than petrodiesel requirement, it means respondents must be added to get more WCO. The algorithm of this research is shown in Figure 11.
Figure 11. Flowchart for Research

REFERENCES

[12] www.pertamina.com