BIO-45D MACHINE (BIO-DIESEL PROCESSING MACHINE FROM WASTE COOKING OIL)

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ABSTRACT

Food enterprise called chips based on materials such as banana, cassava and sweet potatoes are most popular among the Malay community. This material will be processed by slicing in small pieces and then fried with cooking oil. The commencement survey shows that Small Medium Entrepreneurs Industry (SMEI) in Batu Pahat, Johore (Malaysia) tossed away the saturated cooking oil since that it was not use anymore. Researcher concluded that this phenomenon can be beneficial by creating a machine which use to convert the cooking oil to bio-diesel yet can be rused as stove and boiler fuel. The innovation of bio-diesel machine is used to develop understanding for student in the area of Industrial Design such as the basic concept, research methodology, design application and to create a product based on Problem Based Learning (PBL). The design of Bio-45D machine was applying combination on the ADDIE and SDLC Model. The processes involved were pre-heating, mixing of Methanol and caustic soda (Natrium Hidroxyde) at controlled temperature, precipitating of glycerin and the deportation of 6%-8% of glycerin silt which producted the bottom of main reactor. In turn, Bio-45D Machine can produce more than 90% bio-diesel, avoid waste by recycling the used cooking oil to bio-diesel, also it can save the cost even in mass production. The design is a combination of knowledge and skills are also relevant to the other sector, such as agriculture and food industries. Furthermore, this Bio-45D machine has been contested at the international level. The best achievement was a Gold Medal, The Best Award in Malaysia Technology Expo 2009 and The World Exhibition On Innovation Research and New Technologies 2009 (Brussels Innova '09).

Keywords: Bio-diesel, Cooking oil, Industrial Design, Research and Innovation

1.0 INTRODUCTION

Parit Raja is indeed a small town famous for the Small & Medium Enterprises, the company where the focus is crisp and soy-based foods. Through research studies, many companies are using diesel as fuel for boilers and at the same time, the company is also widely used cooking oil, and finally thrown away.

Given the situation in such a way, the idea occurred to researchers to create and develop a machine that can take advantage of the cooking oil used for processing into bio-diesel, which can then be reused as fuel for heating boilers, known as the Automated Bio-diesel Processor Machine (Bio-45D).

Bio-45D was developed with some unique features, which it is different from the machine that was invented in European countries, many of which are still using manual systems. Bio-45-D produced was more cost effective because they only use materials and simple controls such as timers, press the switch, indicator lights and only use a liquid pump motor unit. In addition, this machine is running the five-step production of bio-diesel, compared to 14 steps that are commonly used in Europe (Utah Bio-diesel Supply, 2007). Five simple steps referred to is the pre-heating at 65° C, 20% of the injection of chemicals (methanol and sodium hydroxide), the mixing of chemicals and cooking oils used in the temperature range between 60 - 75° C, the precipitation of glycerin (expected at 6-8% yield), and the outflow of bio-diesel to consumers.

The entire engine system is designed based on the simple production of bio-diesel formula that was introduced by a local chemical consultant, Hexagon Synergy Holding (M) Sdn. Bhd.
This machine is also designed based on the request of the company that has a problem because production is not a machine to process bio-diesel according to the formula introduced by them.

With the generation of bio-45D engine, the researchers hope it will help many people, especially entrepreneurs for SMEs that do not directly utilize used cooking oil they use. This machine is finally expected to open the minds and thoughts of Malaysians that the production of bio-diesel is something that can be done by their own.

2.0 PROBLEM BACKGROUND

According to Malaysian Palm Oil Board (MPOB), The use petro-diesel fuel (fossil fuel) in Malaysia is very broad, and indirectly caused the country to produce the relatively high costs for diesel fuel exported from abroad. Which one of the Government to reduce the export of diesel oil from abroad is to promote the use of bio-diesel. But through the experiences of researchers, the use of bio-diesel in Malaysia is still not widespread because the technology to produce it is still under review and the technology has not really practical for commercialization. Even so, according to Deputy Prime Minister of Malaysia in the press conference, Datuk Seri Najib Tun Razak (2008) states, based on the reputation and capability of local researchers, Malaysia could become the world's leading bio-diesel producer.

Based on random interviews and a pilot study conducted by researchers in the SME entrepreneurs (the industry to make chips and soy-based foods) around the town of Parit Raja, found that over 50% used cooking oil that has been thrown away.

At the same time, they had to use a lot of the total diesel boiler for heating in their factories, which between 80 to 400 liters per day. This led to them having to bear the costs are too high to buy diesel fuel, where the price is increasing from time to time.

At present, there are many bio-diesel processor engine that has been produced in Europe, such as the creation of Future Fuels Processor FF2000 Distribution, United Kingdom, Bio-Pro190 Processor invention Utah Bio-diesel Supply, the United States and other bio-diesel processors around the world. However, Bio-45D machine is created with its own characteristics, which are not owned by another processor machine, where it is automated, less expensive, has a more simple measures of income, safe and easy to operate.

J. Van Gerpen in the journal entitled “Bio-diesel Production Technology” (2004) states, in the production of bio-diesel, the process of injecting a chemical solution is safe and the separation of glycerine from bio-diesel precipitation is one of the failures are often a problem for individuals to produce bio-diesel.

3.0 PROBLEM STATEMENT

Although the Malaysian Government is actively carrying out research and development relating to the production of bio-diesel, but the research institutes that are more relevant to the use of crude palm oil is not used, and no serious study for the cooking oil used (MPOB, 2008).

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In this regard, studies to produce bio-diesel processing machines automatically using cooking oil as raw materials at lower cost, suitable for use by SMEs is a matter that should be implemented.

4.0 RESEARCH OBJECTIVES

i. Develop automated bio-diesel processing machines (machinery Bio-45D).
ii. Analyzing the engine capacity of bio-diesel production process is automatically.
5.0 RESEARCH QUESTIONS

i. Is the machine that was developed to carry out five bio-diesel production process automatically?
ii. Is the machine that was developed to make the process of precipitation on the density of different cooking oils?

6.0 SCOPE

i. Develop an automated bio-diesel processing machines that are ‘lower scale bio-fuel processor’ for SMEs only.
ii. This machine can only regulate and control the heating process at a maximum temperature of 80°C only.
iii. Automated process machines only operate 20% methanol that was ready to mix with 5% Sodium Hydroxide genuine.
iv. Bio-diesel is produced from this machine is for heating boilers.
v. This machine is only used to control the cooking oil has a density range between 901.77 to 912.57 kg/m³ only.

7.0 METHODOLOGY

In this study, the design is used as a reference in determining the development of rail track machines is the method of Bio-45D model design System Development Life Cycle (SDLC). According to P.J. Avard (1977), SDLC project involves the development of information systems is fundamental to the maintenance of equipment, where the methodology of this model involves the development of some models such as the waterfall model and spiral model.

7.1 Preliminary Study

Refer to the SDLC model, the initial phase of this study is the first pre-design process was developed. In this phase, several criteria have been established, namely:

i. Determine the system’s development objectives
ii. Identify scope
iii. Identifying the source of the information needed

7.2 Determining Objectives

In the process of designing machines Bio-45D, the objective is a fundamental matter of great importance, which will determine the direction and the real objective of development. With the objectives, goals and targets of the design will not be deflected or run away from its original purpose. In addition, the objective is also to be a key reference when designing the development of this machine until the latter stages. For this reason, in determining the design of this machine require that work hard for this machine can be built with quality.

7.3 Identifying the scope

The scope of work should be identified after the specified objectives. The scope is very important to ensure that all work and study done not strayed from the true purpose. In addition, the scope will give a specific limit to the researchers for the work done can be focused and dedicated.
7.4 Identifying the sources of information

The next step after the objectives and scope available, researchers must find out, locate and identify sources of information related to the design of machines and systems are Bio-45D. Resources are available from the readings directly, or through the findings of previous studies that have been done before. Sources of information have been identified for the purposes of this engine design are from journals, previous theses, newspapers, reference books and so forth. In addition, information was obtained indirectly through electronic media such as internet, radio, television, telephone and through the many discussion forums in the field of e-group on the Internet. In addition, information was obtained from a speaker in seminars related.

8.0 ENGINEERING ANALYSIS

Analysis of data in this study made to investigate the ability of Bio-45D machine is doing five bio-diesel production process is automated, the process of pre-heating, chemical mixing process, transferred process, the process of precipitation and the precipitation process of production the resulting glycerin. However, before working our entire machine can automatically analyze, first five processes are using a manual system on the machine, and the results of the analysis was a manual system will be used to set the period of the digital electrical timer (digital electric timer) in the control system automatically. In addition, the researchers also made a detailed analysis of the technical aspects of machine design, size, control systems, safety, cost of design and production cost of one liter of bio-diesel by using Bio-45D machine.

8.1 Analysis Design

In the development of this machine there are four important part of ensuring that it can function properly. The parts are chemical reactors, major reactor, space systems and space clearance between the chemical reactor and main reactor. Overall size of the machine body Bio-45D 960mm x 880mm x 4100mm.

8.2 Analysis of chemical reactor design

This reactor is used to place chemical liquid (liquid chemicals) in which the volume to be accommodated is 20% of the main raw material. Chemicals are mixed in between the two main chemicals, 2 liters of methanol and 5% caustic soda (NaOH flake). The reactor was built with a diameter and height of each of the 150mm and 210mm, and it can accommodate a total maximum volume of 4.9 liters. Reactor was built at the height of 730mm from floor level and 130mm higher than the main reactor. Triumphed height 130mm higher than the main reactor to allow the liquid solution of methanol and caustic soda in it by gravity flow into the main reactor, without using the help of the pump motor.

8.3 Analysis of the main reactor designs

The main reactor is a reactor, the processor, where the reactor is pre-heating process, the mixing process, the process of precipitation, and glycerine production processes carried out. It should be able to accommodate all of the liquid is 10 liters of cooking oil used and the liquid solution 20% (5liter) methanol and 5% sodium hydroxide. The main reactor is also to be able to withstand the heat all the ingredients of the liquid in the temperature range between 60°C - 80°C. The reactor was built with a diameter of over 350mm and 300mm high. This reactor can accommodate a maximum volume of
liquid up to 35.3 liters, where he built up to 300mm from floor level. This is to allow the precipitation of glycerin and bio-diesel fuel that was processed to being swept out into the container using gravity without the aid of any motor stirrer, as well as to reduce the cost of engine development.

### 8.4 Analysis of the preparation of bio-diesel using a manual system

Having completed the machine mechanical system, researchers must conduct an analysis of the machine to know the following:

i. The time required to ensure that the cooking oil to achieve the required average temperature range of 65°C in the pre-heating.

ii. The time required to drain the mixture of methanol and sodium hydroxide from the chemical reactor into the reactor through the main solenoid valve 2 (V2).

iii. The percentage of precipitation glycerin produced at the main reactor and the time required to remove all the glycerin precipitation through the Solenoid Valve 3 (V3).

iv. Analysis of these three things above is done on three samples of different density of cooking oil. This is due to the assumption made earlier, that the different densities of oil will give different results for the three things that should be analyzed as described above.

#### Table 1: Information on the density of the sample

<table>
<thead>
<tr>
<th>No. Sample</th>
<th>Information Samples</th>
<th>Sample density</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>Sample weight : 0.929kg Container Volume : 1.018 × 10⁻³ m³</td>
<td>( \rho = \frac{0.929\text{kg}}{1.018 \times 10^{-3} \text{m}^3} = 912.57\text{kg/m}^3 )</td>
<td>Maximum sample density</td>
</tr>
<tr>
<td>Sample 2</td>
<td>Sample weight : 0.924kg Container Volume : 1.018 × 10⁻³ m³</td>
<td>( \rho = \frac{0.924\text{kg}}{1.018 \times 10^{-3} \text{m}^3} = 907.66\text{kg/m}^3 )</td>
<td>Sample of medium density</td>
</tr>
<tr>
<td>Sample 3</td>
<td>Sample weight : 0.918kg Container Volume : 1.018 × 10⁻³ m³</td>
<td>( \rho = \frac{0.918\text{kg}}{1.018 \times 10^{-3} \text{m}^3} = 901.77\text{kg/m}^3 )</td>
<td>Minimum density of samples</td>
</tr>
</tbody>
</table>

#### 8.5 Analysis of the average for all samples

After the three samples of each density 912.57 kg/m³, 907.66 and 901.77 kg/m³ were tested and analyzed, a summary should be made to determine the following:

i. The time required by the Bio-45D Machinery for pre-heating process.

ii. The time required by the Bio-45D machine to drain all the chemical solution into the main reactor through valve 2 (V2).

iii. The time taken by the Bio-45D Machinery for the manufacture of glycerine produced all of the precipitation.

#### 8.6 Analysis of the overall temperature of the Machines Bio-45D

From the graph, to determine the ideal time for pre-heating process is over 13 minutes. At that time, the three samples exceeded the minimum temperature of the pre-heating (65°C) is defined as the individual has reached 68.35°C, 68.45°C and 69.4°C. Therefore, the Digital Relay Timer 1 (T1) which controls the pre-heating the Bio-45D machine should be set for 13 minutes.
8.7 Analysis of control systems

In the design of the Bio-45D engine, the main aspects that must be addressed is the control system. This is because the system was guarantees the quality of bio-diesel. The machine is equipped with two automatic control systems that control and manual control. In the development of both systems, there are some electrical control components used. These components are:

i. Digital or Relay Timer 'timer relay digital'
ii. Relay Timer Analog or ‘analogue relay timer’
iii. Relay or ‘relay’
iv. Contactor
v. Thermostat
8.8 Overall Analysis

All results of the analysis in this chapter can be summarized as Table 2 below:

<table>
<thead>
<tr>
<th>No. Samples</th>
<th>Time for the flow of chemicals into the main reactor</th>
<th>Density of the sample</th>
<th>Time required for pre-heating process</th>
<th>Percentage of glycerine resulting precipitate</th>
<th>Time to remove the precipitate glycerine</th>
<th>Percentage of biodiesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>1 minute 48 seconds</td>
<td>912.57 kg/m³</td>
<td>11 minutes</td>
<td>6.5%</td>
<td>1 minute 58 seconds</td>
<td>93.5%</td>
</tr>
<tr>
<td>Sample 2</td>
<td>1 minute 46 seconds</td>
<td>907.66 kg/m³</td>
<td>10 minute 36 seconds</td>
<td>6.08%</td>
<td>1 minute 56 seconds</td>
<td>93.92%</td>
</tr>
<tr>
<td>Sample 3</td>
<td>1 minute 45 seconds</td>
<td>901.77 kg/m³</td>
<td>10 minutes 28 seconds</td>
<td>5.33%</td>
<td>1 minute 52 seconds</td>
<td>94.67%</td>
</tr>
<tr>
<td>Conclusion</td>
<td>The time taken was 2 minutes</td>
<td>The time taken was 13 minutes</td>
<td>The time taken was 2 minutes</td>
<td>Average production of biodiesel is at 94.18%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes
- Period of two minutes is set at T2
- The 13 minute set at T1
- Period of two minute is set at T5

FIGURE 3: Actual machine Bio-45D

9.0 SUGGESTIONS

During the period of development and analysis of Bio-45D engine, the researchers have identified several problems and weaknesses that can be addressed from time to time for use in the future. The researcher suggested some recommendations to upgrade the machine using the Bio-45D. The proposed study is:

i. Studies conducted on the automatic machines in addition to Bio-45D of the washing bio-diesel, where the results are the "flush" by mixing it with water at high temperatures, and adulterated, and finally the separated water and oil. This process allows the resulting bio-diesel can also be used in diesel engines and to comply with the standards set by SIRIM and international standards EN14214.
ii. Since the wiring in the engine electrical control system is quite complex, researchers suggest in the future, this machine uses programmable logic control (PLC). Use the PLC will be able to simplify the wiring on the engine, thereby reducing the risk of damage to the machine.

iii. Size for the design of this machine can be expanded further, to ensure they are relevant to industry needs.

iv. In order to use digital control panel, in which digital systems are more attractive and has a higher commercial value.

10.0 CONCLUSIONS

Machine control system development is Bio-45D was designed specifically according to the formula proposed by Hexagon Synergy Holding Company. The formula has been used and the production process is performed manually, and the bio-diesel from the formula used by the owners of Al-Falah Farm Sdn. Bhd. (771942-V) in their four-wheel drive.

The design of this machine is dedicated to SMEs, especially the chips companies and soy-based foods, where they use diesel as fuel for the kitchen and at the same time, they have used cooking oil is eventually thrown away or sold to a businessman with a detergent the price is too cheap. However, due to its relatively low cost, Bio-45D machine also may be targeted for individual consumption.

Although there are some weaknesses that can be fixed from time to time as specified in item 5.3 above, but researchers still consider the design of the production of Bio-45D machine is successful because it can be used in a realistic and achieved all its development objectives.

REFERENCES