Production of Virgin Coconut Oil and CocoVinegar

In Partial Fulfillment of CHFK591D,
SEMI-INTEGRATED COCONUT PRODUCTS
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INTRODUCTION

For many years, the coconut fruit had always been used by Filipinos in many diverse ways. Even if it’s as delicious as food, as simple as decoration or as complicated as fuel, the coconut fruit has proven to be very useful. One of its products that had a great impact on Philippine agriculture until now is the coconut oil. A significant amount of the country’s population depends in the coconut oil industry as a source livelihood especially in locations where the coconut tree is abundant.

Now that other countries are competing with us on being one of the world’s primary producer of coconut oil, we have once again tapped on one of its useful product, the Virgin Coconut Oil (VCNO). This is popular to us Filipinos as “lana”, the name for an age long tradition passed to us by our ancestors of making oil out of coconut milk.

Due to its increasing demand in the export industry, we decided to make this study about virgin coconut oil and further utilize the other parts of the coconut fruit by expanding our study to a plant the would produce multiple products from the coconut fruit.
NAME OF COMPANY

Our company would be named “ARKHE Incorporated”. The company name is derived from the nicknames of the members of our group namely: Alejandro – Raymond – Kheeya – Hera – Emerald.

COMPANY LOGO

Our company logo depicts the vision that we want to achieve. In the middle, we placed a drawing of the coconut fruit. Not only is it our main raw material, but it would also give consumers an idea about the company by just looking at our logo. This way, we would be able to attract potential users of our product.

The coconut fruit is placed within a circle with three colors: brown, blue, and green. The circle represents the earth while the tree colors represents, brown for earth, blue for water, and green for vegetation. All of this represents our intent to be competitive worldwide and in competing with other nations in the coconut product industry.
PLANT LOCATION

Our company will be situated in Mindanao, specifically in Davao City. We chose this plant location because Mindanao is the highest producer of our major raw material, which is the coconut fruit. It would be easier for us to acquire this raw material since it is readily available all over Mindanao.

It would also be ideal for our vision of expansion for the coming years. With this in mind, we are assured that there would be no shortage of our major raw material. The location is also strategic since it is not a typhoon prone location.
MARKET STUDY
VIRGIN COCONUT OIL

PROJECT DESCRIPTION

Name of the Product

Our product is called virgin coconut oil mainly because of the process used for its production. Virgin Coconut oil is naturally processed and free of chemicals.

Properties of the Product

Virgin Coconut oil is the naturally processed, chemically free and additive-free product from fresh coconut meat or its derivative (coconut milk and coconut milk residue) which has not undergone any chemical processing after extraction. Copra derived coconut oil has to undergo chemical refining, bleaching and deodorization processes to make it suitable for human consumption. It is yellow or pale yellow in color and does not contain Vitamin E since this is removed when the oil is subjected to high temperature and the various chemical process. This is not the case in the production of Virgin Coconut oil.

THE IDEAL QUALITY CHARACTERISTICS OF VCNO

Color- Water-White: 1 Yellow, 0.1 Red

*Free Fatty Acid- 0.1% maximum*

Moisture- 0.1 % maximum
Peroxide Value- 0.5 meq/ kg maximum
Lauric Fatty Acid Content- 49-53%
Tocopherol (Vit. E) Content- 40 mg/ kg

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7 VCNO publicity pamphlets – Philippine Coconut Authority
Virgin coconut oil also has a lot of health and medicinal uses. It contains a significant amount of lauric acid which is the same with the main component that makes breastmilk so good for babies. It is very beneficial to attacking viruses, bacteria, and other pathogens in our body system. It also builds the body’s immune system (just as human mother’s milk does).

**Uses of the Product**

In our country we have been using virgin coconut oil as a conditioner, massage oil, and body oil/lotion. However, its potential as a healing oil is now being recognized all over the world.

*Coconut oil is the healthiest oil on earth*. Modern research seems to back up this bold statement. Once wrongly accused of increasing cholesterol levels, coconut oil is now actually being used by doctors in the treatment of a variety of disorders. Clinical studies have shown that coconut oil has anti-microbial and anti-viral properties, and is now even being used in treating AIDS patients. Studies conducted in the Philippines last year showed that coconut oil does indeed reduce the viral load in AIDS patients.\(^8\)

Coconut oil is rich in lauric acid, which is known for being anti-viral, antibacterial and anti-fungal. Studies have been done on its effectiveness in lowering the viral load of HIV/AIDS patients. Coconut oil is also being used by thyroid sufferers to increase body metabolism, and lose weight. Virgin coconut oil is also used for making natural soaps and other health products, as it is one of the healthiest thing one can put on their skin.\(^9\)

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\(^8\) Dr. Bruce Fife – The Healing Miracles of Coconut Oil

\(^9\) www.coconut-connection.com
Production of Virgin Coconut Oil and CocoVinegar

What Coconut Oil DOES NOT Do:

- Does not increase blood cholesterol level.
- Does not promote platelet stickiness or blood clot formation.
- Does not contribute to atherosclerosis or heart disease.
- Does not contribute to weight problems.

What Coconut Oil DOES Do:

- Reduces risk of atherosclerosis and related illnesses.
- Reduces risk of cancer and other degenerative conditions.
- Helps prevent bacterial, viral, and fungal (including yeast) infections.
- Supports immune system function.
- Helps control diabetes.
- Provides an immediate source of energy.
- Supports healthy metabolic function.
- Improves digestion and nutrient absorption.
- Supplies important nutrients necessary for good health.
- Supplies fewer calories than other fats.
- Promotes weight loss.
- Helps prevent osteoporosis.
- Has a mild delicate flavor.
- Is highly resistant to spoilage (long shelf life).
- Is heat resistant (the healthiest oil for cooking).
- Helps keep skin soft and smooth.
- Helps prevent premature aging and wrinkling of the skin.
- Helps protect against skin cancer and other blemishes.
- Functions as a protective antioxidant.¹⁰

Aside from being marketed as raw oil, it is also made into bath and beauty products. They are also used as raw materials in the pharmaceutical industry.

¹⁰ www.coconut-connection.com
Major Users of the Product

Since Filipinos are right now still unaware of the capability of the full potential that the Virgin Coconut Oil can offer, we would be selling all our products to countries that has a significant of demand for this product. As of the present countries such as USA, Japan, and Norway are into importing Virgin Coconut Oil.
DEMAND ANALYSIS

Since our product will be exported, we were supposed to look for the export data of the said product. Because the product is new to our country, Philippine Coconut Authority and National Statistics Office only had export data starting from the year 2001. These three years of data was not sufficient for us to make a demand projection in order to go on with our study. However, we were able to get the value of the rated capacity of the Philippines monthly production of Virgin Coconut Oil.

<table>
<thead>
<tr>
<th>VIRGIN COCONUT OIL INDUSTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAGNITUDE</td>
</tr>
<tr>
<td>1, Production</td>
</tr>
<tr>
<td><strong>Average Monthly VCNO (for 2003)</strong> : 831.84 MT</td>
</tr>
<tr>
<td>Dispersal:</td>
</tr>
<tr>
<td>Luzon</td>
</tr>
<tr>
<td>Visayas</td>
</tr>
<tr>
<td>Mindanao</td>
</tr>
</tbody>
</table>

**Rated capacity of VCNO monthly production as of 2003**

From this data, we assumed producing approximately 10% of the monthly rated capacity for Virgin Coconut Oil production. This served as the basis of all our daily production.

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11 Marketing Department - Philippine Coconut Authority
MARKETING MIX

Product  Virgin Coconut oil is an unrefined coconut oil. It contains about 50% - 53% content of lauric acid. No chemical or high-heat treatment is used, and this oil contains no trans fatty acids. It has the longest shelf life of any plant oil.

Being rich in lauric acid, a proven antiviral and antibacterial agent. It is currently being used in treating AIDS. Lauric acid is also found in human mother's milk.

Place

Our company will be exporting our products to countries that are using Virgin Coconut Oil, using the oil as it is or as a raw material for some industries.

Promotion

There would be not that much local promotion for our product. Since it would all be exported, our only forms of promotion is by giving samples of our product to potential importers and try to sell it lower than that of its conventional price.

Pricing

Export pricing of Virgin Coconut oil ranges from US$4,000-$4575/MT or US$400-925/drum. Our aim is to be able to meet the proposed standard of Virgin Coconut Oil then sell it cheaper in comparison to our competitors.
VINEGAR

INTRODUCTION

Vinegar may be produced in several ways. But the basic principle involves the acetic acid fermentation of dilute alcoholic liquids. In the Philippines, the most abundant raw material available is the coconut water. Conversion to vinegar is an attractive method of coconut water disposal. Other fruit juices may also be used in vinegar production such as pineapple cashew, calamansi, etc.

Vinegar must contain not less than 4 g of acetic acid per 100 mL at 20°C and may not contain more than 0.5 vol% of ethanol. Local vinegars have characteristics of their own. They have a low acetic acid content with an average of 2.9%. The vinegar is considered ready for consumption when it is sour enough to taste.

The schematic outline of vinegar production is shown below:

1. Fermentable Mono & Disaccharides
   Alcoholic Fermentation

   \[ \text{C}_6\text{H}_{12}\text{O}_6 \rightarrow \text{anaerobic} \rightarrow \text{C}_2\text{H}_5\text{OH} + \text{CO}_2 \]
   glucose or fructose
   ethyl alcohol carbon dioxide

2. Acetification

   \[ \text{C}_2\text{H}_5\text{OH} + \text{O}_2 \rightarrow \text{CH}_3\text{COOH} + \text{H}_2\text{O} \]
   alcohol oxygen acetic acid water
Raw Materials Specifications

Coconut Water
- Sucrose: 0.37%
- Invert Sugar: 3.83%
- Water: 95.50%
- Organic Solids: 0.30%

*Specific Gravity: 1.049

Brown Sugar
- Sucrose: 97.00%
- Invert Sugar: 1.60%
- Moisture: 0.67%
- Ash: 0.73%

*Specific Gravity: 1.58

**Yeast:** Saccharomyces cerevisiae or Saccharomyces ellipsoidens

**Bacteria:** Bacterium schuetzenbachii or Bacterium curvuni

**Yeast Nutrients:** (NH₄)₂SO₂ and (NH₄)₂HPO₄
Production of Virgin Coconut Oil and CocoVinegar

PROJECT DESCRIPTION

Name of the Product
Vinegar

Description of the Product
Vinegar is defined as a condiment obtained from the consecutive alcoholic and acetic fermentation of a saccharine solution, the particular type of vinegar being indicated by a prefix, such as coco vinegar, fruit vinegar, etc. Literally, the term means “sour wine”, according to its derivation from the French vinaigre (vin-wine plus aigre-sour or sharp).

According to the standards prescribed by the Food and Drug Act of the Philippines, finished vinegar must contain not less than 3 grms. acetic acid (CH₃COOH) in 100 cubic centimeters. The United States government prescribes a minimum of 4 grms. acetic acid in 100 cubic centimeters at 20°C.

Composition of the Product
Acetic acid ------------------------------- 4.00
Ethanol ----------------------------------- 0.15
Ethyl acetate ----------------------------- 0.27
Glycerol ---------------------------------- 0.23
Fusel oil ------------------------------- 0.05
Organic acids ---------------------------- 0.09
Unreacted sugar -------------------------- 0.23
Ammonium sulfate ------------------------ 0.04
Ammonium biphosphate ------------------- 0.01
Ash and solids --------------------------- 0.04

Specific gravity at 25°C : 1.0027

12 Philippine Coconut Authority
Uses of the Product

Vinegar is consumed mainly for direct use on the table. In addition to this, it is also utilized on a commercial scale in the manufacture of pickles, tomato catsup, mayonnaise, “achara”, chili sauce, and sauces in the canning fish. The manufacture of acetic acid and acetone may also employ vinegar. It is also used as an antiseptic in many instances.
DEMAND ANALYSIS

Historical Demand of Vinegar

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>687916</td>
</tr>
<tr>
<td>1994</td>
<td>740743</td>
</tr>
<tr>
<td>1995</td>
<td>471486</td>
</tr>
<tr>
<td>1996</td>
<td>531379</td>
</tr>
<tr>
<td>1997</td>
<td>374939</td>
</tr>
<tr>
<td>1998</td>
<td>392016</td>
</tr>
<tr>
<td>1999</td>
<td>324826</td>
</tr>
<tr>
<td>2000</td>
<td>521048</td>
</tr>
<tr>
<td>2001</td>
<td>269962</td>
</tr>
<tr>
<td>2002</td>
<td>406225</td>
</tr>
<tr>
<td>2003</td>
<td>37095</td>
</tr>
</tbody>
</table>
## Projected Demand of Vinegar

<table>
<thead>
<tr>
<th>YEAR</th>
<th>VOLUME (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>131,775,187</td>
</tr>
<tr>
<td>2006</td>
<td>134,207,372</td>
</tr>
<tr>
<td>2007</td>
<td>136,639,557</td>
</tr>
<tr>
<td>2008</td>
<td>139,071,742</td>
</tr>
<tr>
<td>2009</td>
<td>141,503,927</td>
</tr>
<tr>
<td>2011</td>
<td>146,368,297</td>
</tr>
<tr>
<td>2012</td>
<td>148,800,482</td>
</tr>
<tr>
<td>2013</td>
<td>151,232,667</td>
</tr>
<tr>
<td>2014</td>
<td>153,664,852</td>
</tr>
</tbody>
</table>
MARKETING MIX

Product

Coco Vinegar contain not less than 4 g of acetic acid per 100 mL at 20°C and may not contain more than 0.5 vol% of ethanol. Coconut Vinegar is packed in a high quality plastic bottle. The packaging material will be printed with some specification and will be marked by our company logo.

Place

The plant will be located at Davao del Sur where the availability and supply of raw materials required for processing is grown, great accessibility to the market and end-users of the product, the availability of labor, both skilled and unskilled personnel, the availability and relative cost of utilities such as water, electricity, fuel, power, land, and communication and an effective transportation system and transportation facilities.

Promotion

Advertisement is essential in product launching this will be the company’s first step in penetrating the market and will proceed by presenting brochures. At the same time the company will reach out to buyers by means off print ads.

Price

Economy in the Philippines declines dramatically at certain point. With this in mind, the company decided to sell the product at a very reasonable price. It won’t be difficult for the company to set its price overseas since other countries are not suffering from economic crisis.
THE PRODUCTS

Virgin Coconut Oil

This would be our main product. It is the unrefined version of the coconut oil that we traditionally know of. It contains glycerides containing fatty acids and glycerol. The different fatty acids in this coconut oil ranges from C₆-C₁₈ carbon atom chains. It is very rich in lauric acid.

Coco Vinegar

Vinegar may be produced in several ways. But the basic principle involves the acetic acid fermentation of dilute alcoholic liquids. In the Philippines, the most abundant raw material available is the coconut water. Conversion to vinegar is an attractive method of coconut water disposal.
VIRGIN COCONUT OIL
DETAILED MATERIAL AND ENERGY BALANCE
**ENERGY BALANCE AT THE DRYER**

* For Meat, major constituents are **water** and **lauric acid**
  * \( C_{p,\text{meat}} = 0.43 + 0.000027T(\degree C) \) in cal/g\(^\circ\)C
  * Meat is 48% moisture
  * Oil is 35.5% of meat
  * Lauric Acid is 47.10% of oil

### INPUT (30\(^\circ\)C)

<table>
<thead>
<tr>
<th></th>
<th>Mass (kg)</th>
<th>( C_p ) ( \text{(kcal/kg-K)} )</th>
<th>( Q ) (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>26,730</td>
<td>0.5520</td>
<td>73,779</td>
</tr>
<tr>
<td>( H_2O )</td>
<td>535</td>
<td>1</td>
<td>2,673</td>
</tr>
</tbody>
</table>

**Heat Input (kcal)** 76,452

### OUTPUT (80\(^\circ\)C)

<table>
<thead>
<tr>
<th></th>
<th>Mass (kg)</th>
<th>( C_p ) ( \text{(kcal/kg-K)} )</th>
<th>( Q ) (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat</td>
<td>13,900</td>
<td>0.5523</td>
<td>422,190</td>
</tr>
<tr>
<td>( H_2O )</td>
<td>430</td>
<td>1</td>
<td>23,644</td>
</tr>
</tbody>
</table>

**H\(_{\text{vaporization at 80\(^\circ\)C}}\)** 551.8164 7,137,802

**Heat Input (kcal)** 7,583,636

**Heat Requirement in the Dryer (kJ)** 31,410,055
EQUIPMENT SPECIFICATIONS AND MATERIALS OF CONSTRUCTIONS

DESHELLER

Capacity: 200 nuts/hr (skilled operator)
Dimensions:
   - Length – 0.5 m
   - Width – 0.5 m
   - Height – 0.5 m
Material of Construction: Steel
Motor: ½ Hp gear motor
       400 rpm output

SPLITTER/SLICER

Capacity: 400 deshelled nuts/hr (skilled operator)
Dimensions:
   - Length – 0.5 m
   - Width – 0.5 m
   - Height – 0.5 m
Material of Construction: Steel
Motor: ½ Hp gear motor
       400 rpm output
WASHING TANK

*assuming water in the tank is 50% of the amount of the feed*
*taking into consideration all of the meat that would come in per day*

for the water in the tank

\[
\begin{align*}
\Box_{\text{meat}} &= 1 \text{ cm}^3/1000 \text{ kg} \\
V_{\text{H}_2\text{O}} &= m_{\text{H}_2\text{O}} \Box_{\text{H}_2\text{O}} \\
V_{\text{H}_2\text{O}} &= 7.2 \text{ MT (1000 kg/1 MT) (1 cm}^3/1000 \text{ kg)} \\
&= 7.2 \text{ m}^3
\end{align*}
\]

for the meat coming in

\[
\Box_{\text{meat}} = 0.672 \text{ kg/L} \\
V_{\text{meat}} = 14.40 \text{ MT (1000 kg/1 MT) (1 L/0.672 kg/L)} \\
= 21.42 \text{ m}^3
\]

total feed at the tank

\[
\begin{align*}
V_{\text{Total}} &= V_{\text{H}_2\text{O}} + V_{\text{meat}} \\
&= 7.2 \text{ m}^3 + 21.42 \text{ m}^3 \\
&= 28.62 \text{ m}^3 \\
&= 31.48 \text{ m}^3 (\text{with 10% allowance})
\end{align*}
\]

for the optimum diameter of a tank

\[
\begin{align*}
d_{\text{opt}} &= 2 (V/\Box)^{1/3} \\
h &= d \\
d_{\text{opt}} &= 2 (31.48 \text{ m}^3/\Box)^{1/3} \\
&= 4.31 \text{ m}
\end{align*}
\]

Material of Construction: Stainless Steel
GRINDER

High speed grinder

**Capacity:** 1500 nuts/hr

**Dimensions:**
- Length – 1 m
- Width – 0.5 m
- Height – 1 m

**Material of Construction:** Stainless Steel

**Motor:** 20 Hp

DRYER

**Equipment:** Continuous Tunnel Dryer

**Type:** Conveyor Countercurrent Steam Heated Air

**Material of Construction:** Stainless 304*
  - For properties, see T 28-11, Perry

**Dimensions:**
- Length – 5.5 m
- Width – 1.5 m
- Height – 2 m
EXPELLER

Production: 1500 nuts / hr

Dimensions:
- Length – 1 m
- Width – 2 m
- Height – 1.5 m

Material of Construction: Steel
Motor: 5 Hp

SETTLING TANK

for the volume the feed

$\square_{\text{coco oil}} = 0.0919 \text{ g/1 cm}^3$

$V_{\text{oil with foots}} = m_{\text{coco oil}} \times H_2O$

$V_{\text{oil with foots}} = 4.89 \text{ MT} (1000 \text{ kg/1 MT}) (1000 \text{ kg/1 g}) (1 \text{ cm}^3/0.919 \text{ g})$

$= 9,673,258.2 \text{ cm}^3 (1 \text{ m/100 cm})^3$

$= 5.32 \text{ m}^3$

$= 5.85 \text{ m}^3 \text{(with 10% allowance)}$

for the optimum diameter of a tank

$d_{\text{opt}} = 2 (V/\square)^{1/3}$

$h = d$

$d_{\text{opt}} = 2 (9.67 \text{ m}^3/\square)^{1/3} = 2.46 \text{ m}$

Material of Construction: Stainless Steel
FILTER PRESS

**Capacity:** 8 MT /day

**Dimensions:**
- Length – 3.5 m
- Width – 1 m
- Height – 1.5 m

**Material of Construction:** Steel

**Motor:** 2 Hp
VINEGAR
DETAILED MATERIAL AND ENERGY BALANCE
## Energy Balance at the Fermentor

### INPUT (25 deg C)

<table>
<thead>
<tr>
<th>Sugar Mash</th>
<th>Mass (kg)</th>
<th>( C_p ) ( (\text{kcal/kg-K}) )</th>
<th>( Q ) (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>2.51</td>
<td>0.299</td>
<td>18.75</td>
</tr>
<tr>
<td>Invert Sugar</td>
<td>0.78</td>
<td>0.3</td>
<td>5.89</td>
</tr>
<tr>
<td>Water</td>
<td>18.58</td>
<td>1</td>
<td>464.54</td>
</tr>
<tr>
<td>Organic Solids</td>
<td>0.06</td>
<td>1</td>
<td>1.46</td>
</tr>
<tr>
<td>Ash</td>
<td>0.02</td>
<td>1</td>
<td>0.46</td>
</tr>
<tr>
<td>((\text{NH}_4)_2\text{SO}_4)</td>
<td>0.02</td>
<td>0.39</td>
<td>0.16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NH(_4)OH solution</th>
<th>Mass (kg)</th>
<th>( C_p ) ( (\text{kcal/kg-K}) )</th>
<th>( Q ) (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH(_4)OH</td>
<td>0.04</td>
<td>1</td>
<td>0.98</td>
</tr>
<tr>
<td>H(_2)O</td>
<td>0.32</td>
<td>1</td>
<td>7.92</td>
</tr>
</tbody>
</table>

\[ H_{\text{Fermentation}} = 15.6 \text{ kcal/mol CO}_2 \] 536

**Heat Input (kcal)**

<table>
<thead>
<tr>
<th></th>
<th>Mass (kg)</th>
<th>( C_p ) ( (\text{kcal/kg-K}) )</th>
<th>( Q ) (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling ( \text{H}_2\text{O, 12}^\circ\text{C} )</td>
<td>34</td>
<td>1</td>
<td>404</td>
</tr>
</tbody>
</table>

*absorbs heat to maintain product temperature of 30°C

**Net Heat Input (kcal)**

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1,440</td>
</tr>
</tbody>
</table>

---
### Output (30 deg C)

<table>
<thead>
<tr>
<th>Exhaust Gases</th>
<th>Mass (kg)</th>
<th>$C_P$ (kcal/kg-K)</th>
<th>$Q$ (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO$_2$</td>
<td>1.51</td>
<td>0.21</td>
<td>9.52</td>
</tr>
<tr>
<td>C$_2$H$_5$OH</td>
<td>0.01</td>
<td>0.68</td>
<td>0.26</td>
</tr>
<tr>
<td>H$_2$O</td>
<td>0.03</td>
<td>1</td>
<td>0.82</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alcohol Mash</th>
<th>Mass (kg)</th>
<th>$C_P$ (kcal/kg-K)</th>
<th>$Q$ (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C$_2$H$_5$OH</td>
<td>1.60</td>
<td>0.21</td>
<td>10.06</td>
</tr>
<tr>
<td>(NH$_4$)$_2$SO$_4$</td>
<td>0.02</td>
<td>0.39</td>
<td>0.19</td>
</tr>
<tr>
<td>Unreacted Sugar</td>
<td>0.10</td>
<td>0.3</td>
<td>0.93</td>
</tr>
<tr>
<td>Yeast</td>
<td>0.30</td>
<td>1</td>
<td>9.10</td>
</tr>
<tr>
<td>H$_2$O</td>
<td>18.36</td>
<td>1</td>
<td>550.68</td>
</tr>
<tr>
<td>By-Product</td>
<td>0.17</td>
<td>1</td>
<td>5.05</td>
</tr>
<tr>
<td>Ash &amp; Solids</td>
<td>0.23</td>
<td>1</td>
<td>6.79</td>
</tr>
</tbody>
</table>

$\Delta H_{\text{vaporization, } C_2H_5OH}$ = 0.01 kg, $200.75$ kcal, 2.54 kcal

$\Delta H_{\text{vaporization, } H_2O}$ = 0.03 kg, 80 kcal, 2.18 kcal

Heat Output (kcal) = 598 kcal

<table>
<thead>
<tr>
<th>Mass (kg)</th>
<th>$C_P$ (kcal/kg-K)</th>
<th>$Q$ (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot H$_2$O, 25°C</td>
<td>34</td>
<td>1</td>
</tr>
</tbody>
</table>

Net Heat Output (kcal) = 1,440 kcal
### ENERGY AT THE ACETATOR

#### INPUT (25°C)

<table>
<thead>
<tr>
<th>Exhaust Gases</th>
<th>Mass (kg)</th>
<th>( C_P ) (kcal/kg-K)</th>
<th>Q (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{O}_2 )</td>
<td>1.21</td>
<td>0.22</td>
<td>7.98</td>
</tr>
<tr>
<td>( \text{N}_2 )</td>
<td>3.98</td>
<td>0.25</td>
<td>29.85</td>
</tr>
<tr>
<td>( (\text{NH}_4)_2\text{HPO}_4 )</td>
<td>0.00477</td>
<td>1</td>
<td>0.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Centrifuge Alcohol Mash</th>
<th>Mass (kg)</th>
<th>( C_P ) (kcal/kg-K)</th>
<th>Q (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>1.60</td>
<td>0.21</td>
<td>10.06</td>
</tr>
<tr>
<td>( (\text{NH}_4)_2\text{SO}_4 )</td>
<td>0.02</td>
<td>0.39</td>
<td>0.19</td>
</tr>
<tr>
<td>By products</td>
<td>0.17</td>
<td>1</td>
<td>5.05</td>
</tr>
<tr>
<td>Unreacted sugar</td>
<td>0.10</td>
<td>0.3</td>
<td>0.93</td>
</tr>
<tr>
<td>Water</td>
<td>16.97</td>
<td>1</td>
<td>508.99</td>
</tr>
<tr>
<td>Ash &amp; solids</td>
<td>0.23</td>
<td>1</td>
<td>6.79</td>
</tr>
</tbody>
</table>

\[ H_{\text{Acetification}} \] 118.17 kcal/mol \( \text{CH}_3\text{COOH} \) 3,629

**Heat Input (kcal)** 4,199

<table>
<thead>
<tr>
<th>Cooling ( \text{H}_2\text{O}, 12°C )</th>
<th>Mass (kg)</th>
<th>( C_P ) (kcal/kg-K)</th>
<th>Q (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooling ( \text{H}_2\text{O}, 12°C )</strong></td>
<td>273.04</td>
<td>1</td>
<td>3,276</td>
</tr>
</tbody>
</table>

*absorbs heat to maintain product temperature of 32°C

**Net Heat Input (kcal)** 7,476
### OUTPUT (32°C)

<table>
<thead>
<tr>
<th>Exhaust Gases</th>
<th>Mass (kg)</th>
<th>$C_p$ (kcal/kg-K)</th>
<th>$Q$ (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N_2$</td>
<td>3.75</td>
<td>0.25</td>
<td>30.03</td>
</tr>
<tr>
<td>$O_2$</td>
<td>0.39</td>
<td>0.22</td>
<td>2.75</td>
</tr>
<tr>
<td>Ethanol</td>
<td>0.02</td>
<td>0.68</td>
<td>0.47</td>
</tr>
<tr>
<td>$H_2O$</td>
<td>0.03</td>
<td>1</td>
<td>0.86</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product Raw Vinegar</th>
<th>Mass (kg)</th>
<th>$C_p$ (kcal/kg-K)</th>
<th>$Q$ (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_2O$</td>
<td>17.73</td>
<td>1</td>
<td>567.51</td>
</tr>
<tr>
<td>$CH_3COOH$</td>
<td>1.84</td>
<td>0.522</td>
<td>30.78</td>
</tr>
<tr>
<td>Unreacted Sugar</td>
<td>0.10</td>
<td>0.3</td>
<td>0.99</td>
</tr>
<tr>
<td>Unreacted Ethanol</td>
<td>0.13</td>
<td>0.68</td>
<td>2.75</td>
</tr>
<tr>
<td>By-Product</td>
<td>0.23</td>
<td>1</td>
<td>7.21</td>
</tr>
</tbody>
</table>

| $H_1$, Vaporization, $C_2H_5OH$ | 0.02 | 200.75 | 4.38 |
| $H_1$, Vaporization, $H_2O$   | 0.03 | 80     | 2.14 |

**Heat Output (kcal)**

650

<table>
<thead>
<tr>
<th>Hot $H_2O$, 25°C</th>
<th>Mass (kg)</th>
<th>$C_p$ (kcal/kg-K)</th>
<th>$Q$ (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>273.04</td>
<td>1</td>
<td>6,826</td>
</tr>
</tbody>
</table>

**Net Heat Input (kcal)**

7,476

**ENERGY IN DILUTION AND STERILIZATION**
## Production of Virgin Coconut Oil and CocoVinegar

### INPUT

<table>
<thead>
<tr>
<th>Component</th>
<th>Mass (kg)</th>
<th>(C_p) (kcal/kg·K)</th>
<th>(Q) (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(H_2O)</td>
<td>17.759</td>
<td>1</td>
<td>444</td>
</tr>
<tr>
<td>(CH_3COOH)</td>
<td>1.761</td>
<td>0.522</td>
<td>23</td>
</tr>
<tr>
<td>Unreacted Sugar</td>
<td>0.102</td>
<td>0.68</td>
<td>2</td>
</tr>
<tr>
<td>Unreacted Ethanol</td>
<td>0.064</td>
<td>0.457</td>
<td>1</td>
</tr>
<tr>
<td>By product</td>
<td>0.118</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Sulfates</td>
<td>0.164</td>
<td>0.3</td>
<td>1</td>
</tr>
<tr>
<td>Phosphates</td>
<td>0.016</td>
<td>0.39</td>
<td>0</td>
</tr>
<tr>
<td>Bacteria</td>
<td>0.004</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Ash &amp; solids</td>
<td>0.044</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Distilled Water (97°C)</td>
<td>23.991</td>
<td>1.0102</td>
<td>2,351</td>
</tr>
</tbody>
</table>

### Heat Input (kcal)

2,826 kcal

### OUTPUT

<table>
<thead>
<tr>
<th>Component</th>
<th>Mass (kg)</th>
<th>(C_p) (kcal/kg·K)</th>
<th>(Q) (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(H_2O)</td>
<td>41.714</td>
<td>1</td>
<td>2,744</td>
</tr>
<tr>
<td>(CH_3COOH)</td>
<td>1.759</td>
<td>0.522</td>
<td>60</td>
</tr>
<tr>
<td>Unreacted Sugar</td>
<td>0.101</td>
<td>0.68</td>
<td>5</td>
</tr>
<tr>
<td>Unreacted Ethanol</td>
<td>0.066</td>
<td>0.457</td>
<td>2</td>
</tr>
<tr>
<td>By product</td>
<td>0.119</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Sulfates</td>
<td>0.163</td>
<td>0.3</td>
<td>3</td>
</tr>
<tr>
<td>Phosphates</td>
<td>0.018</td>
<td>0.39</td>
<td>0</td>
</tr>
<tr>
<td>Bacteria</td>
<td>0.004</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Ash &amp; solids</td>
<td>0.044</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

### Heat Input (kcal)

2,826 kcal

### Final Temperature

65.79°C
### Coconut Water Storage Tank

<table>
<thead>
<tr>
<th>Number required</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>To store one week supply of coconut water</td>
</tr>
<tr>
<td>Capacity of each</td>
<td>71 m³</td>
</tr>
<tr>
<td>Diameter</td>
<td>3.5 m</td>
</tr>
<tr>
<td>Height</td>
<td>3.5 m</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Carbon steel</td>
</tr>
</tbody>
</table>

### Brown Sugar Storage Bin

<table>
<thead>
<tr>
<th>Number required</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>To store 1 week supply of brown sugar</td>
</tr>
<tr>
<td>Capacity</td>
<td>6 m³</td>
</tr>
<tr>
<td>Type</td>
<td>Cylindrical with conical hopper bottoms</td>
</tr>
<tr>
<td>Diameter</td>
<td>1.5 m</td>
</tr>
<tr>
<td>Height&lt;sub&gt;cylinder&lt;/sub&gt;</td>
<td>1.5 m</td>
</tr>
<tr>
<td>Height&lt;sub&gt;conical portion&lt;/sub&gt;</td>
<td>1.5 m</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Carbon steel</td>
</tr>
</tbody>
</table>

### (NH₄)₂SO₄ Storage Bin

<table>
<thead>
<tr>
<th>Number required</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>To store 1 month supply of (NH₄)₂SO₄</td>
</tr>
<tr>
<td>Capacity</td>
<td>0.2 m³</td>
</tr>
<tr>
<td>Type</td>
<td>Cylindrical with conical hopper bottoms</td>
</tr>
<tr>
<td>Diameter</td>
<td>0.5 m</td>
</tr>
<tr>
<td>Height&lt;sub&gt;cylinder&lt;/sub&gt;</td>
<td>0.5 m</td>
</tr>
<tr>
<td>Height&lt;sub&gt;conical portion&lt;/sub&gt;</td>
<td>0.3 m</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>
## Production of Virgin Coconut Oil and CocoVinegar

### (NH₄)₂HPO₄ Storage Bin

<table>
<thead>
<tr>
<th>Number required</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>To store 1 month supply of (NH₄)₂HPO₄</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>0.0594 m³</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Cylindrical with conical hopper bottoms</td>
</tr>
<tr>
<td><strong>Diameter</strong></td>
<td>0.5 m</td>
</tr>
<tr>
<td><strong>Height_{cylinder}</strong></td>
<td>0.5 m</td>
</tr>
<tr>
<td><strong>Height_{conical portion}</strong></td>
<td>0.3 m</td>
</tr>
<tr>
<td><strong>Material of Construction</strong></td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>

### Mixing Tank

<table>
<thead>
<tr>
<th>Number required</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>To produce a homogenous mixture of coconut water and brown sugar</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>8.89 m³/day</td>
</tr>
<tr>
<td><strong>Diameter</strong></td>
<td>1.5 m</td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td>1.5 m</td>
</tr>
<tr>
<td><strong>Agitator for mixing</strong></td>
<td>6-bladed turbine</td>
</tr>
<tr>
<td><strong>Material of Construction</strong></td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>

### Sugar Mash Holding Tank

<table>
<thead>
<tr>
<th>Number required</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>Temporary storage of sugar mash for 2 days</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>24 m³/day</td>
</tr>
<tr>
<td><strong>Diameter</strong></td>
<td>2.5 m</td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td>2.5 m</td>
</tr>
<tr>
<td><strong>Material of Construction</strong></td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>

### Fermentor
### Production of Virgin Coconut Oil and CocoVinegar

<table>
<thead>
<tr>
<th>Number required</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>To ferment sugar mash continuously</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>9.30 m³/hr (21.14 m³/hr)</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Enclosed stainless steel tank with internal cooling</td>
</tr>
<tr>
<td><strong>Diameter</strong></td>
<td>1 m</td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td>1 m</td>
</tr>
<tr>
<td><strong>Material of Construction</strong></td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>

### Alcohol Mash Holding Tank

<table>
<thead>
<tr>
<th>Number required</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>Temporary holding of alcohol mash from fermenter</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>12 m³</td>
</tr>
<tr>
<td><strong>Diameter</strong></td>
<td>2 m</td>
</tr>
<tr>
<td><strong>Height</strong></td>
<td>2 m</td>
</tr>
<tr>
<td><strong>Material of Construction</strong></td>
<td>Carbon Steel</td>
</tr>
</tbody>
</table>

### Centrifugal Separator

<table>
<thead>
<tr>
<th>Number required</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td>To centrifuge the suspended solid particles in the alcohol mash</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>10 m³/day</td>
</tr>
<tr>
<td><strong>Bowl Capacity</strong></td>
<td>214 m³/day</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td>16 hp</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>1744 rpm</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Vapor sealed continuous solid bowl centrifuge</td>
</tr>
<tr>
<td><strong>Material of Construction</strong></td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>
### Centrifuge Mash Storage Bin

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number required</td>
<td>1</td>
</tr>
<tr>
<td>Function</td>
<td>To store centrifuged mash</td>
</tr>
<tr>
<td>Capacity</td>
<td>25 m³</td>
</tr>
<tr>
<td>Diameter</td>
<td>2.5 m</td>
</tr>
<tr>
<td>Height</td>
<td>2.5 m</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>

### Aerator

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number required</td>
<td>2</td>
</tr>
<tr>
<td>Function</td>
<td>To convert the alcohol mash into vinegar</td>
</tr>
<tr>
<td>Filling Capacity</td>
<td>20000 Liters</td>
</tr>
<tr>
<td>Type</td>
<td>Type 900 Fring's Acetator with Automatic cooling and water control</td>
</tr>
<tr>
<td>Diameter</td>
<td>2.5 m</td>
</tr>
<tr>
<td>Height</td>
<td>3.5 m</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Motor</td>
<td>20 hp</td>
</tr>
</tbody>
</table>

### Aging Tanks

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number required</td>
<td>2</td>
</tr>
<tr>
<td>Function</td>
<td>To age the raw vinegar until flavor is aromatic</td>
</tr>
<tr>
<td>Capacity</td>
<td>371 m³</td>
</tr>
<tr>
<td>Diameter</td>
<td>2 m</td>
</tr>
<tr>
<td>Height</td>
<td>2 m</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>
### Filter Press

<table>
<thead>
<tr>
<th>Number required</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>To clarify the vinegar of its suspended solids</td>
</tr>
<tr>
<td>Capacity per cycle (42.5 hrs)</td>
<td>14 m³</td>
</tr>
<tr>
<td>Type</td>
<td>Plate and Frame Filter Press</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Stainless steel</td>
</tr>
</tbody>
</table>

### Dilution And Sterilizer

<table>
<thead>
<tr>
<th>Number required</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td>To dilute and sterilize the vinegar at the same time</td>
</tr>
<tr>
<td>Capacity</td>
<td>411 m³</td>
</tr>
<tr>
<td>Type</td>
<td>Jacketed vessel with agitator</td>
</tr>
<tr>
<td>Diameter</td>
<td>5 m</td>
</tr>
<tr>
<td>Height</td>
<td>5 m</td>
</tr>
<tr>
<td>Material of Construction</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Agitator</td>
<td>6 bladed turbine</td>
</tr>
</tbody>
</table>
FINANCIAL STUDY
APPENDIX
ENVIRONMENTAL IMPACT ASSESSMENT
DENTIFICATION OF ACTORS

The proponents of this environmental impact assessment are the owners of the proposed plants, and the consultants. The stakeholders are the residence in the vicinity, the employees, non-government organizations, unions, people’s organization, consumers, suppliers, and producers of raw materials and the suppliers of equipments. Lastly, it also include – SEC, DENR, DTI, and BIR.
PROJECT DESCRIPTION

RATIONALE

For many years, the coconut fruit had been used by Filipinos in many diverse ways. One of its product that had a great impact on Philippine agriculture until now is the coconut oil. A significant amount of the country’s population depends in the coconut oil industry as a source livelihood especially in locations where the coconut tree is abundant.

Now that other countries are competing with us on being one of the worlds primary producer of coconut oil, we have once again tapped on one of its useful product, the Virgin Coconut Oil (VCNO). This is popular to us Filipinos as “lana”, the name for an age long tradition passed to us by our ancestors of making oil out of coconut milk.

Due to its increasing demand in the export industry, an industrial plant would be built that would use the whole coconut fruit as the raw material and further process the remaining parts into other useful products.

This proposed manufacturing plant will use dehusked nuts and process the coconut meat into Virgin Coconut Oil by extraction. The waste from the process called the coconut meal/flakes (sapal) would then be processed into Coconut Flour.

The coconut shell and coconut water acquired from the process would further be processed to produce zero waste.

The coconut shell would be made into Granulated Charcoal and the waste from this process would then be made into Charcoal Briquettes.

On the other hand, all the coconut water would be processed into Vinegar.
SITING

The plant will be located at Davao City, Mindanao for reasons mainly for accessibility to the main raw material which is the whole coconut fruit. The place is equipped with electricity, telecommunication and has enough supply of water. In addition, the accessibility to our target buyers for each products was also considered.

Plant Size

The plant will comprise of the administration building, manufacturing plant, warehouse for the raw materials and finish goods, parking area and maintenance.

The operation will be on a twenty-four hour per days basis, continuous and batch, operating 7 days a week and 360 days per year, which allows five days per year to cover unexpected losses in capacity.
BASELINE INFORMATION

Davao del Sur is located in the southern part of the Philippines. It lies between 125° 5' and 42° longitude and 5°22' and 6°58'39" latitude.

Situated in the southern tip of Mindanao, Davao del Sur is bounded by Davao City on the north, the provinces of Cotabato, Sultan Kudarat and South Cotabato on the west, Celebes Sea on the south and Davao Gulf on the east.

Davao del Sur has a total land area of 393,401 hectares representing 14.49 percent of the total area of Region XI. The largest municipality in terms of land area is Jose Abad Santos with a total land area of 73,443 hectares while the municipality of Padada is the smallest with only 4,503 hectares or 1.4 percent of the total provincial land area.

Of its total land area, about 65 percent is rolling and mountainous with ranges running southward. The general topography of the province is flat with scattered hills and isolated mountains. The level portions of the province are mostly located in the municipalities of Digos, Matanao, Bansalan, Magsaysay, Kiblawan, Hagonoy, Padada and Sulop, which comprise Padada Valley. Irrigated areas are found in these places.

1 Inland Waters

The province is constantly supplied with water by its three major rivers. The Mal River from Cotabato drains the towns of Matanao and Hagonoy; the Bulatukan River from the foot of Mt. Apo flows through the municipalities of Bansalan, Hagonoy and Magsaysay and the Sibulan River which originates from the foot of Mt. Apo roars down to Todaya and consequently forms the famous Todaya Falls which flows through the town of Sta. Cruz.

2 Soil

The soil of Davao del Sur are classified into types based on different characteristics such as color, texture, depth, drainage, relief, permeability, fertility and others which have bearing on the productivity of the soil, the ease of cultivation and their adaptability.
3 Mineral Resources

3.1 Copper

This type of metallic deposit is located in the western peak of Lais River, one of the major drainages discharging toward the Davao Gulf.

3.2 Gold

Two (2) types of gold mineralization such as epithermal gold and porphery-related copper and gold mineralization were identified. The gold mineralization is found in the municipality of Magsaysay, Don Marcelino and Cayaponga of Jose Abad Santos while the porphery-related copper and gold mineralization are located in Lagumit and Little Baguio of Malita.

3.3 Limestone

This is located in Colonasbang, Asbang and Admol of Matanao. It is a creamy to flesh color composed dominantly of coral fingers.

3.4 Clay

This is located in Sitio San Agustin, Barangay Matti, Digos City. There are three varieties of clay noted: the brown to dark brown; the gray to dark gray with some shades of brown and the brick-red colored clay. The calculated volume of the clay deposit is approximately 833,955.7 metric tons.

3.5 Non-Metallic Deposits

It is found in Santa Cruz, Digos, Magsaysay, Padada, Sulop and Kiblawan. The non-metallic deposits include clay, limestone, guano and phosphate rocks and aggregates.
3.6 Coarse Alluvial

Large concentration of beach gravels has accumulated within the mouth of Lais River and the adjacent beach line as well as along the beach of Barangay Tingolo, Malita.

4 Climate

The province is blessed with a favorable climate characterized by a wet dry season. The coldest time of the year usually takes place during the months of December and January and the hottest during the months of April and May.

5 Rainfall Pattern

The rainfall pattern generally conforms to Type IV, which is characterized by more or less evenly distributed rainfall with no mark seasonality. The province falls south of the typhoon belt and is therefore not normally affected by the incidents of tropical depressions.

In the later part of 1997 up to the first quarter of 1998, the province of Davao del Sur experienced drought or what is called El Niño Phenomenon as shown in the average rainfall distribution, Table 1.5 exhibiting a double digit figure. During the months of August and December of 1998 again it exhibited a low rainfall of 94.1 mm and 86.8 mm, respectively. Starting early months of CY 1999 up to September, the province also experienced a heavy downpour of rain or the La Niña Phenomenon. In 2000, the months of April, May and September showed a low rainfall gauge.

6 Land Classification and Existing Land Use

As of 1996, based on the data provided by the National Mapping and Resource Information Authority, DENR, approximately 2,558.74 square kilometers or 65 percent of the total land area of the province are classified as forestland while a total of 1,375.27 square kilometers is alienable and disposable (A&D) land. Of the total forestland about 13 percent are considered as forest reserve, 71 percent as timberland and the remaining 16 percent are national parks.
Based on the data provided by the Bureau of Soil and Water Management, Region XI, the total 2,473.03 square kilometers of Davao del Sur are used as agricultural areas of which 2,220.02 sq. kilometers are devoted to crops such as paddy rice both irrigated and non-irrigated, upland rice, corn, mango, fruit trees, coconut, coffee, banana and other agricultural products, while 171 sq. kilometers are utilized for livestock purposes and 82.01 sq. kilometers for fishery.

A reduction of about 44 percent (43.95\%) of the classified forest area and an increase of 79.82\% of the certified alienable and disposable are noted since part of the classified forest area is developed to agricultural land.

The PANAMIN civil reservation area is presently cultivated to annual crops.

Around 27\% of the Network of Protected Areas for Agriculture (NPAA) highly restricted agricultural land is currently devoted to cultivated annual crops, perennial trees and vines.

The remaining virgin forest in the Mt. Apo National Park is about 32 square kilometers or 8\% of the total area of Mt. Apo National Park and second growth forest occupies 72 square kilometers, for the Non-NIPAS areas around 476 square kilometers are cultivated with annual crops, perennial trees and vines. The remaining virgin forest in this non-NIPAS area is about 248 square kilometers while the second growth forest is placed at around 12 square kilometers. The province’ identified areas of around 16 square kilometers are to be rehabilitated. As a whole, the total virgin forest of Davao del Sur totals 280 square kilometers or about 12\% of the total forestland of the province.

6.1 Environmentally Constrained Areas

The environmentally constrained areas of Davao del Sur include the Network of Protected Areas for Agriculture (NPAA) highly restricted agricultural land, areas with salt-water intrusion, those along the fault lines and areas in volcanic eruption fall out.

The NPAA highly restricted agricultural land covers the most efficient agricultural lands that are traditional sources of food and cash crops. These are the most stable croplands and they can be cultivated to a wide range of crops with minimum to moderate levels of farm management requirement. These lands are supported by large investments in infrastructure.
The province’ NPAA highly restricted agricultural land occupies a total of 165 square kilometers or 4 percent of the provincial area. The municipality of Magsaysay has the biggest restricted agricultural area which shares around 26 percent of the total NPAA highly restricted agricultural areas. Volcanic eruption fall out due to the presence of the Mt. Apo shall affect the municipalities of Sta. Cruz, Digos and Bansalan. This incident has been recorded once in Bansalan and in Sta. Cruz. On the other hand, salt water intruded areas are in Don Marcelino, Malita, Padada, Sulop and Malalag.

7 Slope

Area with a slope range of 0-8 or with level to nearly level and gently sloping to undulating consists of 1,036.14 square kilometers or 26.34 percent of the total land area of Davao del Sur. Around 20.52 percent have a slope range of 50 and above and 22.02 percent have a slope range of 30-50 or considered as steep.

8 Drainage Area and Water Supply of Major and Minor River Basins

The three river basins in Davao del Sur are Digos River Basin, Padada-Mainit River Basin and the Tagulaya-Sibulan River Basin. The Padada-Mainit River Basin has the biggest drainage area with 1,303 square kilometers. This river basin has an estimated annual run-off of 2,606 mcm.

9 Soil Erosion Susceptability

Of the 3,934.01 hectares of Davao del Sur, 2,170.41 hectares or about 55 percent (55.17%) are susceptible to severe erosion.

10 Religion

The predominant religion in the province is Roman Catholic based on the 1990 Census on Population conducted by NSO totaling 473,400. Around 51 percent are males and 49 percent are females. The other leading religions although very far behind are United Church of Christ in the Philippines which ranked 2nd (19,269), Iglesia Ni Cristo (14,994); Islam (15,256) and Jehovah’s Witness (8,161).
11 Language

Most of the population in Davao del Sur is of Cebuano origin comprising of about 65 percent of the total population of the province. Very far behind are those coming from other provinces in the Visayas like Leyte, Iloilo, Bohol, others coming from Ilocos and some are natives in other portions in Mindanao like the Manobos, Bagobos, Tagakaolo, Kalagan, Sangil, Maranao and Badjao.

12 Indigenous People

Based on the data provided by the National Commission on Indigenous People (NCIP) as of CY 2000, Davao del Sur is inhabited by different cultural minorities or the Lumads like the B’laans, Bagobos, Tagakaolo Kalagan And the Manobos. These lumads are mostly found in the municipality of Malita with 89,968 people.

12 HUMAN RESOURCES

A. POPULATION, SIZE, DISTRIBUTION and GROWTH

The population of Davao del Sur as of May 1, 2000 is 758,801 with an increase of 81,732 over the 1995 figure (with September 1, 1995 as reference period). Of the provinces/city in Region XI, the province ranks No. 1 in terms of population. Of the fourteen (14) municipalities, Malita has the largest population of 100,000 while Sarangani has the smallest with only 18,391 persons. On the other hand, Digos City, the newly converted city has a total population of 125,171.

The population of Davao del Sur grew at the rate of 2.47 percent annually in the second half of the nineties. This is almost double the growth rate recorded in the first half of the decade. If the average annual growth rate of the population continues at 2.47 percent, it is expected that the province’ population will double in about 28 years. During this period of time, population would increase by over 27,000 every year or about 3 persons every hour. Among the 14 municipalities in the province, Malita has the fastest growing population with an annual growth rate of 3.95 percent. Magsaysay, on the other hand, is the slowest growing town with an annual growth rate of 0.60 percent. Digos City is second to Malita with 3.51 percent annual growth rate.
B. DENSITY

Davao del Sur has a population density of 193 persons per sq. km. in 2000 with 12.21 percent increase compared to the 1995 figure. Padada is still No.1 in terms of densely populated municipality with 535 persons per sq. km. while Jose Abad Santos has the lowest population density of 78 persons per sq. kilometer.

C. AGE COMPOSITION

Of the total 758,801 persons residing in the province, about 14 percent (14.37%) are those persons aging 5-9 years old and the least number are those belonging to 70-74 years old with only 6,526 or 0.86 percent of the total.

D. CIVIL STATUS

Based on the 1995 Census on Population, about 49 percent (48.91%) of the people residing in the province are legally married while 44.97 percent are single. About 3 percent (3.40%) are widowed and only 0.48 percent are either divorced or separated while 2.16 percent are live-in partners.

On the other hand, more women are married than men with 24.52 percent compared to male percentage of 24.39 percent.

More persons under 30-34 years of age are legally married with 7.63 percent of the total married persons and only 0.07 percent who are legally married are found in ages 85 and over.

Total population who are legally married are mostly found in ages belonging to 25-39 years old with an average 7.50 percent of the total married persons.

The total registered marriages as of CY 2000 was 3,902. About 58 percent are married in the church while others were solemnized either in civil ceremony and other types of ceremony. By month of registration, most marriages occurred during the month of September and May with 16.25 percent and 15.61 percent of the total marriages.
With regards to the ages of the groom and bride, for the second quarter of CY 2000, about 34 percent (34.06%) of the total groom are those belonging to ages 20-24 years old and about 33 percent (32.82%) belong to 25-29 years of age, while almost 41 percent (40.90%) of the total brides belong to ages 20-24 and 22 percent are brides with 25-29 years of age.

E. GENDER

Based on the 1995 result on population count, the projected population by sex of Davao del Sur are dominated with male persons with 51 percent and about 49 percent (48.82%) are female population.

The province has a male to female ratio of 105:100. This means that in every 105 male population there are corresponding 100 females.

F. NUMBER of HOUSEHOLDS and HOUSEHOLD SIZE

Based on the 2000 Census on Population, the province has a total of 157,054 households higher than the 1995 data (133,591) by 23,463 or by 18 percent. Digos City tops the list in the number of households with 26,306 followed by the municipality of Malita with 20,526 households. The municipality of Padada has the least number of households with only 5,202.

Moreover, the average household size of Davao del Sur is 4.83 which is 5.29 percent lower compared to the average household size in 1995 (5.1).
G. DEPENDENCY RATIO

Dependency Ratio of Davao del Sur for CY 2000 is 78.25. This means that 78 persons belonging to 0-14 years old and 65 and above are dependent for their basic needs such as food, clothing and shelter to 100 working age population. With regards to Young Dependency Ratio or ratio of persons ages 0-14 years old who are considered uneconomically active or do not engage in any economic activities and depend their basic existence to those whose ages range 15-64 is around 73. This means that 73 young persons are dependent to the 100 working age population.

While the Old Dependency Ratio of the province is 6. This also means that 6 persons belonging to ages 65 and over are dependent to the 100 working age population.

By municipality, Jose Abad Santos has the highest young dependency ratio of 87.58 while Padada has the lowest young dependency ratio with 62.14. On the other hand, Sulop has the highest Old Dependency ratio of 8.18 and the municipality of Don Marcelino has the lowest Old Dependency Ratio of 3.17

H. CHILD-WOMAN RATIO

There are 628 children with ages ranging 0 - 4 years old per 1,000 women of childbearing age in CY 2000. The farthest municipalities in Davao del Sur exhibit the three highest Child-Woman Ratio. These are the municipalities of Sarangani (678); Don Marcelino (673) and the municipality of Jose Abad Santos (668). This indicates that the fertility rate of these municipalities are also high.

I. LITERACY OF HOUSEHOLD POPULATION

The province has a high literacy rate of about 86 percent (86.15%) out of the total population 10 years old and over. There are more literates found in rural areas comprising 72.88 percent and only 27.12 percent are found in the urban areas. On the other hand, illiterates are also found in the rural areas mostly in 10-14 years old population.
By sex, more literates are male than female with 51.52 percent male while the female population have 48.48 percent.

More literates are found in age categories 10-14 years old (87,008).

Under the highest grade completed of population 5 years old and over, about 28 percent (27.59%) of males finished their elementary education while 24 percent of females also finished their elementary education. About 10 percent of the population 5 years old and over of both sexes were able to reach the secondary level of education and only 2 percent are degree holder. Very few of the population continued their education up to Post-Baccalaureate which is only 0.05 percent.

**J. LABOR FORCE**

The employment situation in Davao del Sur took a backward route in CY 2000 resulting from the current political, socio-economic and insurgency problems in the country. Employment rate in the province went down by 1.7 percentage points to 92.2 in CY 2000 from 93.9 percent in last year period.

Unemployment rate on the other hand is gloomy as it increased the rate from 6.1 percent in 1999 to 7.8 percent in 2000 although it is not worst compared to other places in Mindanao where unemployment rate posted a double digit figure.

The visible underemployment rate of the province for CY 2000 is 14.8 percent. There are still segment of employed population who have expressed their desire to put more hours of works to augment their income and others to achieve a higher level of self fulfillment.
PROJECT DESCRIPTION

The figure below shows the entire plant operation. Process 1 involves deshelling the nuts, grinding the meat acquired and then extracting the oil. The wastes would go to Process 2, 3, and 4, where it would be processed into Coconut Flour, Granulated Charcoal and Charcoal Briquettes, and Vinegar.

OVERALL PROCESS FLOWCHART

DEHUSKED NUTS
Production of Virgin Coconut Oil and CocoVinegar

PROCESS 1

- VIRGIN COCONUT OIL
- COCO WATER

PROCESS 3

- COCO WATER
- COCO SHELL

PROCESS 4

- VINEGAR
- GRANULATED CHARCOAL AND CHARCOAL BRIQUETTES

PROCESS 2

- COCONUT FLAKES
- COCONUT SHELL

- COCONUT FLOUR
ENVIRONMENTAL IMPACT AND MITIGATING MEASURES

The first part of this section would tackle on defining the impacts from the process involved. After that, mitigating measures would be suggested. The presentation is arranged in three parts. First would be the impacts on pre-operation, second on the actual operation, and third is the abandonment plan.

The second part would be on the impacts on specific parts of the environment.

Pre-Operating Period

This period refers to the time of construction of the manufacturing plant including constructions of buildings and of the actual plant.

Land – Wastes from the construction period (such as excess timber, blocks, metal sheets, etc.) should be properly disposed upon completion of the plant.

Water – There would not be that much impact on the water during this period. However, wastes from the daily consumption of the workers must be properly disposed to prevent contaminating the nearest water source.

Air - Possible sources of pollutants is the cement. During the construction period, some of the particles might get the air. However, the amount would not be that much to cause significant damage. Occasional rainshower would be a natural way of resolving this impact.

Social - A positive impact because it will provide new jobs for the local people.
Operating Period

Virgin Coconut Oil and Coconut Flour Processing

This process would mainly involve acquiring the meat for extraction. During the process, coconut shell and coconut water would be gathered as wastes. This two material would be further processed later on into another products.
Production of Virgin Coconut Oil and CocoVinegar

Washing with water

Grinding & wet milling

Expelling

Drying

coconut meat with testa

granulated fresh meat

Waste (losses during grinding)

H₂O

Dried

115°C

60°C

H₂O
Production of Virgin Coconut Oil and CocoVinegar

Granulated meat

Coconut flakes

Coconut flour (final product)
Production of Virgin Coconut Oil and CocoVinegar

- **FILTRATION**
  - Filter cake
  - Coconut oil

- **SETTLING**
  - Coconut oil with fine foots
  - Coconut oil with big foots

- **PACKAGING (VCNO)**
  - Cont.
Virgin Coconut Oil

The wastes in the production of Virgin Coconut Oil would mainly be coming from the losses on the expeller and the grinder. All the other wastes would be later on processed.

The wastes from the expeller and the grinder would be composed mainly of grinded meat. This could be sold as animal feed or as a natural fertilizer.

The wastes from the settling tank and filter press can be added to the wastes from the expeller and grinder. Its composition would mainly be coconut oil and some fibers from the coconut meat.

Vinegar

This involves the natural fermentation of Vinegar. There would be no significant pollutant that might come from the process.

ABANDONMENT PLAN

Upon abandonment, the plant would have very little traces of wastes in the vicinity that could not be taken care of. Since almost all the wastes from the process are biodegradable, a compost pit would not only be a good way to dispose the wastes.

In the case of the building and equipments, it would be disposed off properly by the owners or sold to interested buyers.

There would be a total clean-up to make sure no waste would be left. Air, land, and water conditions would be tested. If problems arise, corrective measures would immediately be applied.
GENERAL IMPACT DEFINITION

1. WATER

Surface Water

Underground drainage pipes will replace the creeks which will be reclaimed in the process of building the industrial estate. Adequate drainage system will be provided to leveled ground. Civil works of the Project may cause some soil erosion and may increase the turbidity levels of water sources. Given the present level of turbidity in the project area which is fair high, the increase will be negligible.

Groundwater

It is estimated that demand of water is at full operation. In order to supply this amount of water some wells will be dug in the project site. Pumping points are located along the east and west boundaries. Impact of the planned deep wells to existing spring and deep wells in Barangay Lumipa is negligible.

In addition, pumping tests shall be continued to observe long-term behaviour of groundwater even during the construction phase in order to make the final plan of water supply considering the problem of interference.

Since residents in the area depend on drinking water from groundwater, it is crucial to prevent its contamination. Major suspected sources of ground water contamination are organic solvents. Some reports indicate that groundwater pollution by these sources has occurred in Japan and the United States and that residents who obtained drinking water from the contaminated wells have suffered injurious effects to the health.

Oftentimes, pollution has been caused by inappropriate way of treating the waste. For example, the tanks to stock wastes were not sturdy enough and waste was drained into the ground or was spilled over during delivery. Each factory therefore is expected to establish reliable system to stock and treat the wastes. EMB will be responsible in the evaluation and approval of the systems that these factories will put in place. In addition, regular monitoring from NPCC is expected.

2. Atmosphere

The project might create possible sources of air pollution from the kilns and acetators if CO$_2$ and CO$_3$ emissions are not treated as suggested.
3. Solid Waste Disposal System

Solid wastes will be divided into biodegradable and non-biodegradable wastes. Trashcans will be provided so as to ensure that the waste is properly disposed. The non-biodegradable wastes will be properly sealed in container, labeled and collected on a daily basis through the help of the municipal waste system and local government. The biodegradable wastes, which are the resulting cake of the filtration process, are planned to minimize by selling these entire solid wastes to other companies which make use and collect such wastes to run their plant as a source of raw material for their process. Right after the operation, it is then collected and sent to other plant or companies for further process of fertilizer.

The following are affected and mitigating measures done:

Sorting Area

One of the major requirements for materials recovery process, the sorting area is the place where refuse of a factory will be segregated into reusable or for direct landfill.

Storage Area

This area is where reusable materials will be kept temporarily in while awaiting transport.

Sanitary Landfill

Non-combustible refuse left after sorting will be collected, transported and dumped to the proposed sanitary landfill.

PROCESS

Solid waste storage, collection, transport and final disposal are the major aspects to be considered in formulating an effective and efficient solid waste sytem.

Storage

On-site storage of refuse will be provided and will be located at strategic places. These receptacles will be properly enclosed and protected. The required number of receptacles will be based on the per capita refuse generation and population projection. In factories that have no individual wastes chutes, they will provide their own receptacles. These waste chutes will be large enough to facilitate collection.
The collected wastes will then be sorted out in the sorting area/room of the factory. Recovered materials at the sorting yard will be stored at the storage area/room and will be recycled or marketed by the factory concerned. Non-reusable wastes will be collected and dumped at the landfill site.

Collection

Collection will be done once a day or if the need arises on an on-call basis. Routing of the collection route will be useless because the discharge amount of industrial wastes vary widely in accordance with the production activities of factories. The on-call collection basis will also affect the collection system. Since the collected industrial waste will be directly transported to the landfill site and sorting has already been done in the factory for material recovery, it is no longer necessary to combine collected wastes of the same characteristics in one trip.

Transport

A standard dump truck will be used in transporting all types of refuse. The number of required dump trucks will be based on refuse generation and factory material recovery studies.

Final Disposal

From the site, the collected wastes will be directly transported to the proposed sanitary landfill disposal site that can very well accommodate the projected daily volume of generated wastes of the estate.

3. CONSTRUCTION PHASE

All noise and vibration-producing machinery shall be enclosed in a building and shall be provided with effective noise-absorbing materials, noise silencers and mufflers, if necessary. To minimize vibration, a machine will be mounted on shock-absorbing mountings such as cork set on reinforced concrete foundations or a floating isolated foundation set on piles, as needed by the machinery concerned to reduce vibration to a reasonable level.

4. ECOLOGICAL EFFECTS

Development of the proposed project will remove existing vegetation in most of the site except the planned greenbelt area. Trees, especially mango, which
significantly contribute in the prevention of erosion will be preserved. Since there is no rare species of flora to preserve in the site, effects of the Project on vegetation is limited.

Removal of most of the existing vegetation will result in the loss of habitat of birds and small animals. These species may be established themselves in the adjacent/neighboring areas where natural environment is preserved.

5. AESTHETIC EFFECTS

Land

No outstanding geographical nor scenic features are found in the project area. Earth movement activities such as excavation and land filling are so limited that aesthetic effects on land is minimal. Site clearance will create an open view of the project site.

Atmosphere

During the construction period, dust is generated due to site preparation and land formation works. Dust will be reduced by sprinkling water. With this measure, aesthetic effects on the atmosphere is minimal.

Water

Civil works of the Project will result in siltation of Malibik-libik River. Thus turbidity levels of these surface waters will increase during the construction period. Suspended solids in the present water bodies, however, is fairly high. Increase in turbidity levels is therefore difficult to project.

Vegetation in the project site will be totally changed except in areas reserved for greenbelt. Although there will be less vegetation, there will be trees and grasses around factories and communal facilities.

Most of the birds and small mammals presently inhabiting the project site is expected to establish in the adjacent areas.

Man-made Objects

The project site is surrounded by agricultural land and watercourses. There is no man-made object affected by the Project in the vicinity of the project site.
Production of Virgin Coconut Oil and CocoVinegar

Composition

Modification of the project site from agricultural land to industrial land will result in a change of physical make-up of the site. The group of factories will form part of the landscape of Barangay Lumipa Municipality and will create an urban outlook.

Demography

The establishment of the industrial estate will result in a higher population growth rate due to the migrants.

The increase in population growth may result in the rise of various social problems related to rapid urbanization. The municipal government in close coordination with the national line agencies involved in the provision of basic social services will work towards providing adequate educational, health and housing facilities to answer to the needs of the growing population. This is to avoid the so-called “urban problems”

Housing and Community Infrastructure

The private sector is expected to respond to the need/demand of housing/community facilities by the industrial workers. New housing areas can be developed in the neighboring areas of the estate.

Perception of residents on the Proposed Development

During public hearing consultant’s proponents, local and national government official, people in the locality will be there to discuss and share information about the project problem that may arise. Mitigating measure is to be done if problem arise and reaction, feedback and evaluation will also be done.

Among the reasons given for favoring the projects are:

a. inability to keep their farm because of old age;
b. low income due to poor condition of land, e.g., non-irrigated, poor location;
c. lack of capital and high costs of farm inputs;
d. interest in the disturbance compensation package and
e. provision of employment opportunities
MONITORING

Although carbon dioxide exists naturally in nature, accumulation would greatly contribute to global warming. Since the plant has carbon monoxide emissions, a division in the testing laboratory would be assigned to regularly test the amount of carbon dioxide in the perimeter to ensure that it does not exceed the required standard.
WASTEWATER TREATMENT PLAN
Production of Virgin Coconut Oil and CocoVinegar

PROCESS FLOW CHART

influent → Bar screens → Grit chamber → Aeration Tank 1 → Aeration Tank 2 → Aeration Tank 3 → Sedimentation Tank → effluent

Screenings → Grits

Sludge digester

Belt press Filter

Filter cake (Sludge cake)
Production of Virgin Coconut Oil and CocoVinegar

PLANT LAYOUT

Sludge digester

Sludge digester

Sludge digester

Sludge digester

Sludge digester

Belt Press filter

Sludge cake

Aeration Tank 1

Aeration Tank 2

Aeration Tank 3

Sedimentation Tank

Grit Chamber

Grit Chamber

Grits

Bar Screens

Screenings

Influent

Effluent
PROCESS DESCRIPTION

The plant is designed to treat the waste water of a semi-integrated coconut products in a quarterly basis. The waste water will be composed of the water from washer, water from dryer, water from washing the equipments and the oil with coarse foots from the expeller and settler. It shall flow by gravity to the wastewater treatment plant. The wastewater first enters the lift station passing through the bar screens for rag removal. In this section, two automatic bar screen cleaners remove large solids from the raw sewage. The collected material is placed in dumpsters to be taken later to the landfill after passing through screens, grit removal channels, these tanks reduce the velocity of the sewage so that heavy particles may fall to the bottom. The solids are pumped to an auger pump which separates the water from the grit while the water moves onward. The wastewater will then go to the biological treatment processes.

Wastewater is thoroughly mixed with the microorganisms in an activated sludge process, organics of wastewater will be the food of microorganisms for them to grow. As the microorganisms grow and are mixed by agitation of air supplied, the individual organisms stick together to form an active mass of microbes called mixed liquor suspended solids.

The mixed liquor flows from aeration tanks to the clarifiers, where the sludge is settled. The settled out sludge is returned to the aeration tanks to maintain a high population of microbes to permit rapid breakdown of the organics.

The effluent leaves the clarifier and is directed to the chlorination tank for disinfection by means of chlorination, before being discharged.
BIOLOGICAL TREATMENT

An activated sludge system is a complete-mix activated sludge process providing for the total decomposition of organic matter in wastewater by bacteria and microorganisms in the presence of air. It is one of the most efficient types of wastewater treatment since it provides for a high degree of organic oxidation and low production of solids.

Screening

The raw wastewater is normally delivered by gravity to the treatment plant. The wastewater is first passed through a screening device to remove and reduce in size large objects found in the wastewater.

Wastewater will contain a certain amount of grit which causes abnormal wear to moving mechanical equipment due to abrasion, causes conduit clogging and reduces the effective volume of the treatment units. Grit removal devices are normally provided after screening equipment for separation and collection of grit.

Aeration

Wastewater flows into the aeration tank where, in the presence of air supplied from the aeration equipment, it comes into intimate contact with the activated sludge produced by the growth of organisms in the presence of dissolved oxygen. The bacteria will reproduce and grow in population so long as there is oxygen and food present. The oxygen provided by the air and the food in the form of organic matter in the wastewater. As the organic material in the wastewater is decomposed and absorbed by the bacteria, it breaks down into stable, inorganic material. This
combination of bacteria and inorganic material form a dark brown mass known as bacteria floc or activated sludge.

Air is introduced into the tank through air diffusers or surface aerators to provide mixing within the tank, to prevent solids from settling out to maintain an adequate oxygen supply to the living organisms for their life support.

**Sedimentation**

From the aeration tank, the mixed liquor with activated sludge enters the settling tank (clarifier) through a submerged transfer pipe. The sludge settles to the bottom and the clear treated liquid flows over a vertical metal plate or weir into the outlet flume, which carries the effluent to the chlorination tank and other post-treatment steps.

The settled sludge containing bacteria is returned to the aeration tank by an air lift for treatment of the incoming raw wastewater. Sometimes sludge transfer pumps are used in lieu of an air lift.
WASTE WATER CHARACTERISTICS
Water used for washing = 454,176.57 gal
Coconut oil with coarse foots = 136,079.82 gal

DENSITIES
H2O = 1 kg/L
Coconut oil = 0.8666 kg/L
### EQUIPMENT DIMENSIONS

#### Bar Screen

- **No. of screens:** 2
- **Bar size**
  - Width, in
  - Depth, in
- **Clear spacing between bars, in**
- **Slope for vertical, degree**
- **Approach velocity, ft/s**
- **Allowable headless, in**

#### Grit Chamber

- **No. of chambers:** 2
- **Volume:** 20 ft³
- **Depth:** 5 ft
- **Length:** 8 ft
- **Width:** 6 ft

#### Aeration Tank 1

- **No. of tanks:** 1
- **Volume:** 1875 m³
- **Depth:** 5 m
- **Width:** 25 m
- **Length:** 15 m
Aeration Tank 2

No. of tanks: 1
Volume = 1000 m³
Depth = 5 m
Width = 25 m
Length = 8 m

Aeration Tank 3

No. of tanks: 1
Volume = 525 m³
Depth = 5 m
Width = 15 m
Length = 7 m

Sedimentation Tank

No. of tanks: 1
Volume = 525 m³
Depth = 7 m
Width = 5 m
Length = 15 m
Aerobic Sludge Digester

No. of tanks: 5
Volume = 3750 m³
Depth = 10 m
Width = 25 m
Length = 15 m

Belt Press Filter

Belt size = 2.1 m
CALCULATIONS

Grit Chamber

average flow rate = 590,256.39 gal/day - 2 chambers
peaking factor = 2.75 - detention time is 3 min

Peak flow rate
= 590,256.39 gal/day (2.75)
= 1,623,205.073 gal/day

Volume
= \( \frac{1}{2} \) \( 1.62 \text{ Mgal/d} \) \( \times 10^6 \text{ x } 3 \text{ min} \)
\( \times (7.48 \text{ ft3/gal})(24 \text{ hr/d})(60 \text{ min/hr}) \)
= 225.60 ft3
= 6.39 m3

Dimensions
1.2:1 (width to depth ratio)
assume depth is 5 ft (1.524 m)

Width
= 1.2 (5 ft)
= 6 ft
= 1.83 m

Length
= \( \frac{\text{volume}}{\text{width x depth}} \)
= 225.60 ft3
Production of Virgin Coconut Oil and CocoVinegar

6 ft x 5 ft
= 7.52 ft
= 2.29 m

Air supply requirement
= 5 ft³/min – ft of length will be adequate (assumption)

Air required (length basis)
= 7.52 ft³/min (5 ft³/min-ft)
= 37.6 ft³/ft-min

Average quantity of grit handled
= 7 ft³/Mgal (assumption)

Volume grit
= 0.59 Mgal/day (7ft³/Mgal)
= 4.13 ft³/day
Aeration Tank 1:

Average flow rate = 0.59 Mgal/day
BOD influent = 90000 mg/L
BOD effluent = 4500 mg/L
Ratio of mixed liquor volatile suspended solids (MLVSS) to mixed liquor suspended solids (MLSS) = 0.8
Return sludge concentration = 10000 mg/L of suspended solids
MLVSS = 350000 mg/L
Design mean cell residence time $\theta_c = 10$ d
Effluent contains 4950 mg/L of biological solids, of which 65 percent is biodegradable
$\text{BOD}_5 = 0.68 \times \text{BODL}$

BOD of the effluent SS
Biodegradable portion of effluent biological solids
= 0.65 (4950 mg/L)
= 3217.5 mg/L

Ultimate $\text{BOD}_L$ of the biodegradable effluent solids
= (0.6) (4950 mg/L) (1.42 mgO2 consumed/mg cell oxidized)
= 4568.85 mg/L

BOD effluent of SS
= 4568.85 mg/L (0.68)
= 3106.818 mg/L

Influent soluble BOD escaping treatment
$4500 \text{ mg/L} = S + 3106.818 \text{ mg/L}$
$S = 1393.182 \text{ mg/L}$
Treatment efficiency
E = (So – S) / So x 100%

Based on soluble BOD
E = (90000 – 1393.82)mg/L / 90000 mg/L x 100%
= 98.45%

Overall plant efficiency
E = (90000 – 4500) mg/L / 90000 mg/L x 100%
= 95%

Reactor volume
θc = 10 d
Q = 0.59 Mgal/d
Y = 0.50 lb/lb (Table 8-7, Tchobanoglous)
So = 90000 mg/L
S = 1393.182 mg/L
X = 350000 mg/L
kd = 0.06d^-1 (Table 8-7, Tchobanoglous)

Vr = [θcQY (So – S)] / [X (1+kdθc)]
= [(10 d) (0.59 Mgal/d) (0.5) (90000-1393.182) mg/L] / 350000 mg/L [ 1 + {(0.06 d^-1)(10 d)}]
= 0.47 Mgal/d
= 1766.90 m3/d
Assume depth = 5 m
Length to width ratio = 5:1

Width
= 5 (5m)
= 25m

Length
= volume/ (width x depth)
= 1766.9 m³ / (25m x 5 m)
= 14.13 m

Quantity of sludge wasted each day
\[ Y_{obs} = \frac{Y}{1 + kd\theta c} \]
\[ = 0.5 / [1 + (0.06)(10)] \]
\[ = 0.3125 \]

Mass of MLVSS
\[ P_x = Y_{obs} Q (S_o - S) (8.34) \]
\[ = 0.3125 (0.59 Mgal/d) (90000 – 1393.182) mg/L (8.34 lb/Mgal - mg/L) \]
\[ = 136,249.6 lb/d \]
\[ = 61,931.6 kg/d \]

Increase in the total mass of MLSS
\[ P_x(SS) = \frac{136,249.6}{0.8} \]
\[ = 170,312 lb/d \]
\[ = 77,414.55 kg/d \]
Mass of sludge to be wasted
= increase in MLSS – SS lost in effluent
= 170,312 lb/d – 0.59 Mgal/d (4950 mg/L) (8.34 lb/Mgal - mg/l)
= 145,955.03 lb/d
= 66,343.2 kg/d

Sludge wasting rate
Assumptions:
Qe = Q and VSS in the effluent is equal to 80% of the SS

θc = Vr X / (Qw X + Qe Xe)
10 d = 0.8 d

Retention time at the reactor
θc
= Vr / Q
= 0.47 Mgal / (0.59 Mgal/d)
= 0.8 d
= 19.1 hrs

Oxygen requirement based on the ultimate carbonaceous demand, BODL
Mass of BODL, utilized
= (Q (S-So) / 0.68) x 8.34
=((0.59 Mgal/d)(90,000–1,393.182) mg/L /0.68) x (8.34 lb/Mgal – mg/L)
= 641,174.57 lb/d
= 291,442.85 kg/d
Production of Virgin Coconut Oil and CocoVinegar

lb, O₂/d
= [Q (So − S) x 8.34 / f] − [1.42 (Px)]
= 641,174.57 lb/d − 1.42 (136,249.6 lb/d0
= 447,700 lb/d
= 203,500 kg/d

F/M ratio
F/M
= So / 0X
= 90,000 mg/L / (0.8 d) (350000 mg/L)
= 0.32 d⁻¹

Volumetric loading
= SoQ / Vr x 8.34 (1000/10³)
=(90 g/L)(0.59 mgal/d)(8.34 lb/Mgal - mg/l) (1000 ft³)(7.48 gal/ft³)
= 7048 lb BOD₅ / 10³ ft³-d

Volume of air required
Assumptions:
  8% (oxygen transfer efficiency for the aeration equipment)
  Safety factor of 2 will be used to determine the actual size design volume for sizing the blowers

Theoretical air requirement (air contains 23.2% oxygen by weight)
= 447,700 lb/d / [(0.075lb/ft³) (0.232)]
= 25,729,885 ft³/d
= 728,615 m³/d
Actual air requirement
= (25,729,885 ft³/d) / (0.08)
= 321,623,563 ft³/d
= 910,769.7 m³/d

= (321,623,563 ft³/d) / (1440 min/d)
= 223,349.7 ft³/min
= 6,324.79 m³/min

Design air requirement
= 2 (223,349.7)
= 446,699.4 ft³/min
= 12,649.6 m³/min

Air requirement per unit volume
= (321,623,563 ft³/d) / (590,000 gal/d)
= 545.12 ft³/gal

Air requirement per pound of BOD released
= (321,623,563 ft³/d) / [(90,000 – 1939.182) mg/L (0.59 Mgal/d) (8.34 lb/Mgal-mg/L)]
= 742.24 ft³/lb of BOD₅ removed
= 46 m³/kg
Aeration Tank 2

Average flow rate = 0.59 Mgal/d
BOD influent = 4500 mg/L
BOD effluent = 250 mg/L
Ratio of MLVSS to MLSS = 0.8
Return sludge concentration = 10000 mg/l of SS
MLVSS = 35000 mg/L

Design mean cell residence time $\theta_c = 10$ d
Effluent contains 275 mg/L of biological solids, of which 65% is biodegradable
$\text{BOD}_5 = 0.68 \times \text{BOD}_L$

$\text{BOD}_5$ of the effluent SS
Biodegradable portion of effluent biological solids
= 0.65 (275 mg/L)
= 178.75 mg/L

Ultimate $\text{BOD}_L$ of the biodegradable effluent solids
= (0.6) (275 mg/L) (1.42 mgO$_2$ consumed/mg cell oxidized)
= 253.83 mg/L

$\text{BOD effluent of SS}$
= 253.83 mg/L (0.68)
= 172.601 mg/L

Influent soluble BOD escaping treatment
250 mg/L = $S + 172.601$ mg/L
$S = 77.40$ mg/L
Treatment Efficiency
E = (So – S) / So x 100%

Based on soluble BOD
E = (4500 – 77.40)mg/L / 4500 mg/L x 100%
= 98.28%

Overall plant efficiency
E = (4500 – 250) mg/L / 4500 mg/L x 100%
= 94.94%

Reactor Volume
θc = 10 d
Q = 0.59 Mgal/d
Y = 0.50 lb/lb (Table 8-7, Tchobanoglous)
So = 4500 mg/L
S = 77.40 mg/L
X = 35000 mg/L
kd = 0.06d⁻¹ (Table 8-7, Tchobanoglous)

Vr = [θcQY (So – S)] / [X (1+kdθc)]
= [(10 d) (0.59 Mgal/d) (0.5) (4500 – 77.40) mg/L]
35000 mg/L [ 1 + {(0.06 d⁻¹)(10 d)}]
= 0.23 Mgal/d
= 881.9 m³/d

Assume depth = 5 m
Length to width ratio = 5:1
Width
= 5 (5m)
= 25m

Length
= volume/ (width x depth)
= 881.9 m$^3$ / (25m x 5 m)
= 7.06 m

Quantity of sludge wasted each day
$Y_{obs}$
= $Y / (1 + kd\theta c)$
= $0.5 / [1 + (0.06)(10)]$
= 0.3125

Mass of MLVSS
$P_x$
= $Y_{obs} Q (S_o - S) (8.34)$
= 0.3125 (0.59 Mgal/d) (4500 – 77.40) mg/L (8.34 lb/Mgal - mg/L)
= 6801 lb/d
= 3091 kg/d

Increase in the total mass of MLSS
$P_x(SS)$
= 6801 / 0.8
= 8501 lb/d
= 3864 kg/d
Mass of sludge to be wasted
= increase in MLSS – SS lost in effluent
= 8501 lb/d – 0.59 Mgal/d (77.40 mg/L) (8.34 lb/Mgal - mg/l)
= 8120 lb/d
= 3690 kg/d

Sludge wasting rate
Assumptions:
Qe = Q and VSS in ythe effluent is equal to 80% of the SS

\[ \theta_c = \frac{V_r X}{Q_w (X + Q_e X_e)} \]
\[ 10 \text{ d} = \frac{0.23 \text{ Mgal/d} (35000 \text{ mg/L})}{(0.59 \text{ Mgal/d}) (35000 \text{ mg/L}) + (0.59 \text{ Mgal/d}) (77.40 \text{ mg/L} \times 0.8)} \]

Qw
= 0.022 Mgal/d
= 83 m³/d

Retention time at the reactor
\[ \theta_c \]
= \[ \frac{V_r}{Q} \]
= \[ \frac{0.23 \text{ Mgal}}{(0.59 \text{ Mgal/d})} \]
= 0.39 d
= 9.36 hrs

Oxygen requirement
Mass of BODL, utilized
= \[ \frac{Q (S-S_o)}{0.68 \times 8.34} \]
= \[ (0.59 \text{ Mgal/d}) (4500 – 77.40) \text{ mg/L} / 0.68 \times (8.34 \text{ lb/Mgal – mg/L}) \]
= 32003 lb/d
= 14546.7 kg/d
Production of Virgin Coconut Oil and CocoVinegar

lb, O2/d

= [Q (So – S) x 8.34 / f] – [1.42 (Px)]

= 32003 lb/d – 1.42 (6801 lb/d)

= 22346 lb/d

= 10157 kg/d

F/M ratio

F/M

= So / θX

= 4500 mg/L / (0.79 d) (35000 mg/L)

= 0.33 d⁻¹

Volumetric loading

= SoQ / Vr x 8.34 (1000/10³)

= (4500 mg/L) (0.59 Mgal/d)(8.34 lb/Mgal - mg/l)(1000 ft³)(7.48 gal/ft³)

= (240000 gal) (10³ ft³)

= 720.12 lb BOD₅ / 10³ ft³-d

Volume of the air required

Assumptions:

8% (oxygen transfer efficiency for the aeration equipment)

Safety factor of 2 will be used to determine the actual size design volume for sizing the blowers
Theoretical air requirement
= 22346 lb/d / [(0.075 lb/ft³) (0.232)]
= 1284253 ft³/d
= 36367 m³/d

Actual air requirement
= (1284253 ft³/d) / (0.08)
= 16053161 ft³/d
= 454591 m³/d

= (16053161 ft³/d) / (1440 min/d)
= 11148 ft³/min
= 316 m³/min

Design air requirement
= 2 (11148)
= 22296 ft³/min
= 631 m³/min

Air requirement per unit volume
= (16053161 ft³/d) / (590000 gal/d)
= 27.21 ft³/gal

Air requirement per pound of BOD removed
= (16053161 ft³/d) / [(4500 – 77.40) mg/L (0.59 Mgal/d) (8.34 lb/Mgal-mg/L)]
= 738 ft³/lb of BOD₅ removed
= 46 m³/kg
Aeration Tank 3

Average flow rate = 0.59 Mgal/d
BOD influent = 250 mg/L
BOD effluent = 20 mg/L
Ratio of MLVSS to MLSS = 0.8
Return sludge concentration = 10000 mg/l of SS
MLVSS = 3500 mg/L
Design mean cell residence time $\theta_c = 10$ d
Effluent contains 22 mg/L of biological solids, of which 65% is biodegradable
$\text{BOD}_5 = 0.68 \times \text{BODL}$

BOD5 of the effluent SS
Biodegradable portion of effluent biological solids
$= 0.65 \times (22 \text{ mg/L})$
$= 14.3 \text{ mg/L}$

Ultimate BODL of the biodegradable effluent solids
$= (0.6) \times (22 \text{ mg/L}) \times (1.42 \text{ mgO}_2 \text{ consumed/mg cell oxidized})$
$= 20.30 \text{ mg/L}$

BOD effluent of SS
$= 20.30 \text{ mg/L} \times (0.68)$
$= 13.8 \text{ mg/L}$

Influent soluble BOD escaping treatment
$20 \text{ mg/L} = S + 13.8 \text{ mg/L}$
$S = 6.2 \text{ mg/L}$
Treatment Efficiency
E = (So – S) / So x 100%

Based on soluble BOD
E = (250 – 6.2)mg/L / 250 mg/L x 100%
= 97.52%

Overall plant efficiency
E = (250 – 20) mg/L / 250 mg/L x 100%
= 92%

Reactor Volume
θc = 10 d
Q = 0.61 Mgal/d
Y = 0.50 lb/lb (Table 8-7, Tchobanoglous)
So = 250 mg/L
S = 6.2 mg/L
X = 3500 mg/L
kd = 0.06d-1 (Table 8-7, Tchobanoglous)

\[ V_r = \frac{\theta c Q Y (S_o - S)}{X (1 + kd\theta c)} \]
\[ = \frac{[(10 d) (0.59 \text{ Mgal/d}) (0.5) (250 - 6.2) \text{ mg/L}]}{3500 \text{ mg/L} [1 + \{(0.06 \text{ d}^{-1})(10 \text{ d})\}]} \]
\[ = 0.12 \text{ Mgal/d} \]
\[ = 446.28 \text{ m}^3/\text{d} \]

Assume depth = 5 m
Length to width ratio = 3:1
Width
= 3 (5m)
= 15m

Length
= \frac{\text{volume}}{\text{width} \times \text{depth}}
= \frac{446.28 \text{ m}^3}{(15 \text{ m} \times 5 \text{ m})}
= 5.95 \text{ m}

Quantity of sludge wasted each day
\(Y_{obs}\)
= \frac{Y}{1 + kd\theta_c}
= \frac{0.5}{1 + (0.06)(10)}
= 0.3125

Mass of MLVSS
\(P_x\)
= \frac{Y_{obs} Q (S_0 - S)}{8.34}
= 0.3125 (0.61 \text{ Mgal/d}) \times (250 - 6.2) \text{ mg/L} \times (8.34 \text{ lb/Mgal - mg/L})
= 374.89 \text{ lb/d}
= 170.41 \text{ kg/d}

Increase in the total mass of MLSS
\(P_x(SS)\)
= \frac{374.89}{0.8}
= 468.61 \text{ lb/d}
= 213 \text{ kg/d}
Mass of sludge to be wasted = increase in MLSS – SS lost in effluent
= 468.61 lb/d – 0.59 Mgal/d (22 mg/L) (8.34 lb/Mgal - mg/l)
= 360.3593 lb/d
= 163.8 kg/d

Sludge wasting rate
Assumptions:
Qe = Q and VSS in ythe effluent is equal to 80% of the SS

θc = Vr X / (Qw X + Qe Xe)
10 d = ______________ (0.12 Mgal/d) (35000 mg/L) _____________
Qw Mgal/d) (35000 mg/L) + (0.59 Mgal/d) (22 mg/L x 0.8)
Qw
= 0.012 Mgal/d
= 44.3 m³/d

Retention time at the reactor
θc
= Vr / Q
= 0.12 Mgal / (0.59 Mgal/d)
= 0.20 d
= 4.88 hrs

Oxygen requirement
Mass of BOD₅, utilized
= Q (S-So) / 0.68 x 8.34
= (0.59 Mgal/d) (250 – 6.2) mg/L / 0.68 x (8.34 lb/Mgal – mg/L)
= 1764.18 lb/d
= 801.9 kg/d
lb, O2/d
= \lbrack Q (S_o - S) \times 8.34 / f \rbrack - [1.42 (P_x)]
= 1764.18 lb/d - 1.42 (387.60 lb/d)
= 1231.82 lb/d
= 559.92 kg/d

F/M ratio
F/M
= \frac{S_o}{\theta X}
= \frac{250 \text{ mg/L}}{0.79 \text{ d}} (3500 \text{ mg/L})
= 0.34 \text{ d}^{-1}

Volumetric loading
= \frac{S_o Q}{V_r} \times 8.34 \left(1000/10^3\right)
= \frac{(250 \text{ mg/L})(0.59 \text{ mgal/d}) (8.34 \text{ lb/Mgal} - \text{mg/L}) (1000 \text{ ft}^3)}{(7.48 \text{ gal/ft}^3) (120000 \text{ gal}) 10^3 \text{ ft}^3}
= 76.68 \text{ lb BOD}_5/10^3 \text{ ft}^3 \cdot \text{d}

Volume of the air required
Assumptions:
8\% (oxygen transfer efficiency for the aeration equipment)
Safety factor of 2 will be used to determine the actual size design volume for sizing the blowers
Theoretical air requirement

\[ \text{Theoretical air requirement} = 1231.82 \text{ lb/d} \times [(0.075 \text{ lb/ft}^3) \times (0.232)] \]

\[ = 70794.25 \text{ ft}^3/\text{d} \]

\[ = 2004.74 \text{ m}^3/\text{d} \]

Actual air requirement

\[ \text{Actual air requirement} = \frac{(70794 \text{ ft}^3/\text{d})}{(0.08)} \]

\[ = 884928.13 \text{ ft}^3/\text{d} \]

\[ = 25059.29 \text{ m}^3/\text{d} \]

\[ = \frac{(884928 \text{ ft}^3/\text{d})}{(1440 \text{ min/d})} \]

\[ = 614.53 \text{ ft}^3/\text{min} \]

\[ = 17.4 \text{ m}^3/\text{min} \]

Design air requirement

\[ \text{Design air requirement} = 2 \times (614.53) \]

\[ = 1229.06 \text{ ft}^3/\text{min} \]

\[ = 34.8 \text{ m}^3/\text{min} \]

Air requirement per unit volume

\[ \text{Air requirement per unit volume} = \frac{(884928 \text{ ft}^3/\text{d})}{(590000 \text{ gal/d})} \]

\[ = 1.50 \text{ ft}^3/\text{gal} \]

Air requirement per pound of BOD removed

\[ \text{Air requirement per pound of BOD removed} = \frac{(884928 \text{ ft}^3/\text{d})}{[(250 - 6.2) \text{ mg/L} \times (0.59 \text{ Mgal/d}) \times (8.34 \text{ lb/Mgal-mg/L})]} \]

\[ = 737.66 \text{ ft}^3/\text{lb of BOD}_5 \text{ removed} \]

\[ = 46 \text{ m}^3/\text{kg} \]
Sedimentation Tank

Length to width ratio = 3:1
Detention time = 5 hrs
Flow rate = 2380.85 m$^3$/d
Depth = 7 m
No. of tanks = 2

\[ H = \frac{Q}{tA} \]

\[ 7 \text{ m} = \frac{(2308.85 \text{ m}^3/\text{d}) \text{ (1 day/25hrs)}}{5 \text{ hrs} \ A} \]

A = 68.72 m$^2 = 3w^2$
W = 4.79 m
L = 14.36 m

\[ U_0 = \frac{Q}{A} \]

\[ = \frac{(2308.85 \text{ m}^3/\text{d})}{(68.72 \text{ m}^2)} \]

\[ = 33.60 \text{ m}^3/\text{m}^2\cdot\text{d} \]
Aerobic Sludge Digester

Total mass = 57840.7 lb/d
Assumptions:
Liquid temperature is 25°C
44% reduction of volatile solids
Waste sludge is concentrated to 3%
Specific gravity of the waste sludge is 1.03
Sludge concentration in the digester is 70%
Reaction rate coefficient, $kd = 0.06$ d$^{-1}$
Volatile fraction of digester suspended solids is 0.80
Diffused air mixing used

Volume of sludge to disposed

Q

\[ Q = \frac{(57840.7 \text{ lb/d})}{[(62.4 \text{ lb/ft}^3)(1.03)(0.03)]} \]

\[ = 29997.87 \text{ ft}^3/\text{d} \]

\[ = 849.45 \text{ m}^3/\text{d} \]

Total mass of VSS

\[ = 0.8 (57840.7 \text{ lb/d}) \]

\[ = 46272.56 \text{ lb/d} \]

VSS reduction

\[ = 46272.56 (0.44) \]

\[ = 20359.93 \text{ lb VSS reduced/d} \]
Oxygen requirement
= 20359.93 (2.3) 
= 46827.83 lb O2/d

Volume of air required
= (46827.83 lb/d) / [(0.075ld/ft$^3$) (0.232)] 
= 2691254.64 ft$^3$/d 
= 76207.84 m$^3$/d

Air requirement
Assuming an oxygen transfer efficiency of 10%
= (2691254.64 ft$^3$/d) / [(0.10) (1440 min/d)] 
= 18689.27 ft$^3$/min 
=529.22 m$^3$/min

Volume of aerobic digester (Solid concentration = 30000 mg/L)
V 
= [(29997.87 ft$^3$/d)(30000 mg/L)] / [(30000 mg/L) (0.07){(0.06 /d) (0.80) + (1/31.7 d)}] 
= 538735.31 ft$^3$ 
= 15255.29 m$^3$

Air requirement per 1000ft$^3$ of digester volume
= (18689.27 ft$^3$) / (32.29 ft$^3$/10$^3$ ft$^3$) 
= 578.79 ft$^3$/10$^3$ ft$^3$-min
Digester dimensions
No of tanks = 5
Volume = 3750 m³
Depth = 10 m
Width = 25 m
Length = 15 m

Belt Filter Press

Volume of the thickened sludge = 224414.07 gal/d
3% solids
Normal operation
= 8 h/d
= 5 d/wk
Loading rate = 3000 lbm/m-h
Total solid in dewatered sludge = 25%
SS concentration in filtrate = 900 mg/L = 0.09%
Waste water flow rate = 24 gal/min per m of belt width
Specific gravities:
   Sludge feed = 1.02
   Dewatered cake = 1.07
   Filtrate = 1.01

Average weekly sludge production rate
Wet sludge
= (224414.07 gal/day) (7 d/wk) (8.34 lb/gal) (1.02)
= 13363319 lb/wk
Dry solids
= 13363319 lb/wk (0.03)
= 400899.57 lb/wk

Daily and hourly dry solids processing requirements
Daily rate
= (400399.57 lb/wk) (5 d/wk)
= 80079.91 lb/d

Hourly rate
= 80079.91 / 8
= 10010 lb/h

Belt filter press size
Belt width
= (10010 lb/h) / (5000 lbm/m-h)
= 2.002 m
= 2.1 m

Filter flow rate
Solids in sludge feed = solids in sludge cake + solids in filtrate
80080 = (S gal/d) (8.34 lb/gal) (1.07) (0.25) + (F gal/d) (8.34 lb/gal) (1.01) (0.0009)
80080 = 2.231 S + 0.0075 F

NOTE:
S = sludge cake flow rate, gal/d
F = filtrate flow rate, gal/d
Daily sludge flow rate
= 224414.07 gal/d (7/5)
= 314179.70 gal/d

Wash water flow rate
= (24 gal/min-m) (2.1 m) (60 min/h) (8 h/d)
= 24192 gal/d

Sludge flow rate + wash water flow rate = filtrate flow rate + cake flow rate
F + S = 314179.70 + 24192
F + S = 338371.7 gal/d

F = 303497.76 gal/d

Solids capture
= solids in feed – solids in filtrate x 100%
     solids in feed
=(80080 lb/d) –[(303497.76 gal/d) (8.34 lb/gal) (1.01) (0.009)] x 100%
      80080 lb/d
= 71.27%

Operating requirement for the sustained peak sludge load
Ratio of peak to average mass loading for 3 consecutive days is 2
Peak sludge load
= 224414 (2)
= 448828 gal/d
Daily operating time requirement
(Neglecting sludge in strange)

Dry solids/d
= 448828 gal/d (8.34 lb/gal) (1.02) (0.03)
= 114543 lb/d

Operating time
= (114543 lb/d) / (5000 lb/m-h) (2.1 m)
= 10.9 hrs
MATERIAL SAFETY
AND
DATA SHEET
Product Name: **Virgin Coconut Oil**

1 - CHEMICAL PRODUCT/ COMPANY IDENTIFICATION

- Product name: Virgin Coconut Oil
- Trade name: Unrefined Coconut Oil
- Producer: Agbanga Karite BP 548 Sokode, Togo or PO Box 74405, Davis, CA 95617 Tel: 001-530-756-4009 Fax: 001-530-504-8092

2 - COMPOSITION/INFORMATION ON INGREDIENTS

- INCI Name: Coconut Oil (Cocos nucifera)
- CAS Number: 8001-31-8
- EINECS/ ELINCS: 232-282-8
- Chemical description: Fatty acid triglyceride
- Substance presenting health Hazard: None

3 - HAZARD IDENTIFICATION

- Environmental Hazards: None expected if handled and used properly.
- Human Health Hazards: None expected if handled and used properly.

4 - FIRST AID MEASURES Effects and symptoms:

- Ingestion: Not considered dangerous
- Inhalation: Not considered dangerous
- Skin contact: Non-irritating
- Eye contact: May cause irritation

First Aid Measures:

- Ingestion: Not a direct hazard.
- Inhalation: No vapors appear at normal working temperature.
- Skin contact: Not a direct hazard.
- Eye contact: Flush with water for about 15 minutes. If irritation continues see a doctor.
5 - FIRE FIGHTING MEASURES
-Suitable Extinguishing Media: Dry powder, foam, carbon dioxide.
- Unsuitable Extinguishing Media: Water jet, but use water to cool fire exposed containers, disperse vapors, and flush spills away from fires.
- Protection of Firefighters: Wear NIOSH approved self-contained breathing apparatus and other protective clothing to prevent contact with skin and eyes.
- Unusual Fire And Explosions Hazards: Emits toxic fumes under fire conditions.

6 - ACCIDENTAL RELEASE MEASURES
-Personal Precautions: Watch out for slippery conditions when spillage. Wear protective equipment. Avoid contact with eyes.
- Environmental Precautions: Keep away from drains and ground water.
- Methods of Cleaning Up: Absorb with non-combustible absorbant and place in closed containers for disposal. Ventilate area and wash spill site after material pickup is complete.

7 - HANDLING AND STORAGE
- Handling: Handle with care and avoid spillage on the floor (slippage).
- Measures for safety handling: Consider normal working hygiene. Keep away from sources of ignition.
- Storage: Store in a cool dry place. Keep away from heat.
- Suitable packing materials: Coated steel drums, dark plastic containers, dark glass.
- Non-suitable packaging materials: Direct contact with iron, bronze or copper.

8 - EXPOSURE CONTROL / PERSONAL PROTECTION
- Ventilation: Efficient mechanical exhaust system is recommended
- Respiratory protection: No special measures at normal room temperature.
- Hand protection: Impervious gloves
- Eye protection: Usage of safety glasses/ goggles is recommended.
- Skin protection: Impervious apron is recommended
9 - PHYSICAL AND CHEMICAL PROPERTIES

- Appearance
  * Form: Oily, yellow liquid or semisolid at room temperature. * Smell: Characteristic
- Information related to safety

10 - STABILITY AND REACTIVITY

- Conditions to avoid: Oxidation promoting conditions ( Heat, Sunlight and Air).
- Materials to avoid: Strong Oxidizing Agents
- Hazardous decomposition products: Only through Thermal decomposition products: H2O and CO2

11 - TOXICOLOGICAL INFORMATION The product is considered non-toxic

- Acute Toxicity:
  * Oral ( LD 50): Not tested on animals * Inhalation ( LC 50): Not to be expected * Skin irritation: No skin irritation. * Eye irritation: Slightly irritant.
  * Sensitisation: NA * Chronic Toxicity: Not to be expected

12 - ECOLOGICAL INFORMATION

- Elimination ( persistency and degradability): Readily biodegradable
- Bioaccumulative potential: NA
- Ecotoxicity: NA
- According to the chemical composition, does not contain heavy metals and substances classified as dangerous for the environment

13 - DISPOSITORIAL CONSIDERATIONS

- Product: Dispose of in accordance with local regulations. This material is not considered Hazardous Waste.
- Contaminated packaging: Suitable waste-disposal site approved by local authorities.
14 - TRANSPORT INFORMATION  This product is not a hazardous material.

15 - REGULATORY INFORMATION
- According to our information this product is not dangerous material.
- Symbols and phrases according to health hazards: None.
- Dangerous substances to label: None.

16 - OTHER INFORMATION - This information is given in good faith and based on our current knowledge of the product. The above information does not claim characteristics of the product in term of legal claims of performance / guarantee. This information only describes safety measures and no liability may arise from the use or application of the product described herein.
Product Name: **Vinegar**

**Chemical Name:** Acetic Acid  
**Chemical Formula:** CH₃COOH  
**Exposure Limits:** (TWA unless noted otherwise)  
- NIOSH: 10 ppm (25 mg/m³)  
- ST: 15 ppm (37 mg/m³)  
- OSHA: 10 ppm (25 mg/m³)  

**IDLH:** 50 ppm

**Physical Description**  
Colorless liquid or crystal with a sour, vinegar-like odor. (Note: Pure compound is a solid below 62˚F. Often used in an aqueous solution).

**Chemical and Physical Properties**  
- **MW:** 60.1  
- **BP:** 244˚F  
- **Sol:** Miscible  
- **FI P:** 103˚F  
- **IP:** 10.66 eV  
- **Sp Gr:** 1.05  
- **Class II Combustible Liquid**  
- **VP:** 11 mm  
- **FRZ:** 62˚F  
- **UEL:** (200˚F) 19.9%  
- **LEL:** 4.0%
incompatibilities and Reactivities

Strong oxidizers (especially chromic acid, sodium peroxide and nitric acid), strong caustics. (Note: Corrosive to metals).

Personal Protection and Sanitation

Skin: Prevent skin contact (>10%)
Eyes: Prevent eye contact
Wash Skin: When contam (>10%)
Remove: When wet or contam (>10%)
Change: N.R.
Provide: Eye wash (>5%)
         Quick Drench (>50%)

Health Hazards:

Route     Symptoms
Inh        Irrit eyes, skin, nose.
Con        throat, eye, skin burns; skin sens, dental erosion, black skin, hyperkeratosis: conj lac; phar aderma, chronic boron

First Aid

Target Organs

Eyes, skin, resp sys, teeth

Eye:      Irr immed
Skin:     Water flushed immed
Breath:   Resp support
Swallow:  Medical attention immed