

**DEVELOPMENT OF SIEVING MACHINE
FOR PALM OIL MILL INDUSTRY**

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This thesis is submitted to the Faculty of Mechanical Engineering, in partial fulfillment
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(MAY 2009)

DECLARATION

“I hereby declaration that I have read through this thesis and found that it has comply the partial fulfillment for awarding the degree of Bachelor Mechanical Engineering (Thermal Fluid)

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DECLARATION

“I hereby declaration that this thesis is my original work except for questions and citations, which have been duly acknowledgement

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Dedication

This book is especially dedicated to my loving parents and fiancée for the support to lead my successfully to develop a grading size machine.

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ABSTRACT

The growth of palm oil industry in our country generally shows the positive signs on the basis of higher demand for palm oil. Following this scenario that instigate, development of technology should result in a product line for the high quality in terms of processing quality for guarantees product demand continuously. In achieving this objective this report will design a machine that will produce clean loose fruit. The concept that use for this machine is gravity separation method. Gravity separation method is an industrial method of separating two components from a suspension or any other homogeneous mixture where separating the component with gravity is sufficiently practical. All of the gravitational methods are common in the sense that they all use gravity as the dominant force. The outside energy that cause the machine vibrates is a combination of ballast weight and motor. The motor acts as a stimulus ballast and ballast weight will form a resource that imbalance on the machine and cause it to vibrate. This machine is in the know as sieving machine that will sieve the size of raw material that content such as loose fruit, soil, stones, sand and the waste. Finally, this machine will only produce loose fruit as the product that will be in the process. Main things that need to be taken in the matter are to identify the characteristics of raw materials. After that, we will be able to specify types of screen that is used as raw material grading. Solidwork 2005 software is used to design for the entire machine. In this project, actual size grading machine will be produced. The experiment will showed that the suitable vibrating frequency will produce the higher efficiency. On the other hand, from the higher efficiency during running will lead to the selection of suitable or optimum mass flow rate per unit area of the raw material that load into this machine.

ABSTRAK

Perkembangan industri kelapa sawit di negara kita umumnya menunjukkan tanda-tanda positif atas dasar yang permintaan yang tinggi terhadap minyak kelapa sawit. Berdasarkan senario yang memberangsangkan, pengembangan teknologi haruslah selaras bagi menghasilkan produk yang mempunyai tahap kualiti yang terbaik dalam proses menghasilkan minyak sawit bagi menjamin permintaan yang berterusan. Dalam mencapai tujuan ini, laporan ini akan akan menghasilkan satu mesin yang akan menghasilkan produk buah lerai yang bersih. Konsep yang digunakan untuk mesin ini adalah kaedah pengasingan graviti. Kaedah pengasingan graviti adalah kaedah industri bagi memisahkan dua komponen dari sebatian atau campuran homogen dimana memisahkan komponen dengan berat yang cukup praktikal. Seluruh kaedah gravitativ yang umum dalam erti kata kaedah ini menggunakan graviti sebagai kekuatan yang dominan. Tenaga luar yang menyebabkan mesin bergetar adalah kombinasi pemberat dan motor. Motor bertindak sebagai penggerak pemberat, dan keadaan ini akan menyebabkan ketidakseimbangan pada mesin ini. Mesin ini di ketahui sebagai mesin penapis yang akan menapis bahan mentah seperti buah lerai, tanah, batu, pasir dan sampah. Akhirnya, mesin ini hanya akan menghasilkan buah lerai sebagai produk yang akan di proses. Perkara utama yang harus diambil kira dalam proses ini adalah untuk mengenalpasti ciri-ciri bahan mentah. Setelah itu, penentuan jenis skrin yang akan digunakan sebagai penapis bahan mentah ini. Solidwork 2005 adalah perisian yang digunakan untuk melukis secara keseluruhan mesin ini. Dalam projek ini, saiz sebenar 'sieving machine' akan dihasilkan. Daripada eksperimen yang dijalankan akan menunjukkan frekuensi getaran yang sesuai akan menghasilkan kecekapan mesin yang tinggi. Dalam pada itu, daripada kecekapan mesin yang tinggi akan membantu dalam menentukan kesesuaian atau optimum kadar aliran jisim dalam luas kawasan untuk bahan mentah yang digunakan dalam mesin ini.

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LIST OF SYMBOL

v = velocity of sinking / floatation (cm/s)

ρ' = density of the solid particle (g/cm³)

ρ = density of the liquid (g/cm³)

g = acceleration of earth's gravitational pull (9.81 m/s²)

x = diameter of the solid particle (cm)

μ = viscosity of the liquid (g/cms)

f = vibrating frequency (Hz/rpm)

\dot{m} = Mass flow (kgm⁻²s⁻¹)

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CHAPTER 1

INTRODUCTION

1.1 Overview

The Sieving machine design is to produce and give the benefit for the Palm Oil Mill (P.O.M) industry in Malaysia by purpose on the processing of loose fruit. Main concept of this machine is separation method to separate raw material that content loose fruit, sand, soil, stone and leaf with the loose fruit as the product. On the other hand, application of gravity separation method is ideal way to separate this raw material using suitable screen type. In screening (or sieving), each individual in a particulate material is presented to apertures which using circular motion and which act as two-dimensional gauges. Ability to pass through depends on size but is also affected particles shapes that will study by doing some research on the raw material characteristic. Gravity separation method is an industrial method of separating two components from a suspension or any other homogeneous mixture where separating the components with gravity is sufficiently practical. All of the gravitational methods are common in the sense that they all use gravity as the dominant force. Often other methods are applied to make the separation faster and more efficient, jig, centrifugal jig, and shaking table. The most notable advantages of the gravitational methods are their cost effectiveness and in some cases excellent reduction. A review of the palm oil milling technology (Sieving Machine), looking at some of the improvements made in machine designs and mill layouts practices applied by the industry. [1]

1.2 Problem Statement:

A sieving machine is an essential system for the producing of palm oil. Some problem if the raw material that provide appear dirty such as stone, soil and leaf (impurities). Furthermore, the impurities that no need for the process will cause low quality of oil production and quality of process work in addition, it will because machine will quick to damage and automatically the cost of maintenance will increase. Besides of that, oil extraction rate will low since during the process come together with impurities or debris that cannot give the oil for this process. To encounter that problem, by design a sieving machine for loose fruit and others impurities will fix this problem to produce the high quality loose fruit process.

1.3 Objective of Project:

The primary goal of this project is to design a sieving machine for palm oil industry. This project will conduct to develop a machine that separate loose fruit with other impurities or debris.

1.4 Scope of Project:

1. To develop a sieving machine using gravity separation method.
2. To analyze characteristic of raw material such as loose fruit, stone, sand and leaf that sent from estate.
3. To test sample via the experiment that will conduct the graphical view of the performance for this machine.

1.5 Thesis Structure

In chapter one, this thesis detailing about the overview of the project which is the objective and the scope of study that might be involved in the project development process are started well as project guideline and goal. In this chapter also has been defined clearly about some of the problem statement that occurred in constructing this project.

In chapter two, there are literature studies of the project. In this chapter, the appropriate data and information is gain from all the sources including from the internet website surfing, from people, journal, textbook, and so on. In this chapter there have a product review as a project references and to make sure this project made by self.

The chapter three is the explanations of the project methodology. It is about the design development and rough sketching of the product in design configuration stage, design parametric and the detail of the project.

Chapter four is about the experimental analysis that explained the performance of the grading size machine after experiment. In this chapter also, explained about the maintenance programmed to maintain performance of grading size machine. Besides that, the explanation will extend to safety aspect for the operation of this machine so that no accidents during to handle this machine.

Conclusion and recommendation is a summarize part of the entire process of report that from the beginning to the end last of process development grading size machine. Since this project is still need some improvement, the recommendation is about some features or concept must to comply for this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

A Literature review is a body of text that aims to review the critical points of current knowledge on a particular topic. Its ultimate goal is to bring the reader up to date with current literature on a topic and forms the basis for another goal, such as the justification for future research in the area. In this chapter will talk about concept and mechanism of sieving machine and the suitable mechanism will select for the process to complete the idea of the real sieving machine that function as need.

2.2 Separation Process

Separation process is to filter or transform a mixture with differ in chemical properties or some physical property, such as size, or density of the mineral. The mineral that using not in separation process will come with impure state such as mixture of two or more substances. Many times the need to separate it into its individual components arises. [1]

Separation processes can essentially call as mass transfer processes. The classification based on the mechanical or chemical separation processes. On the other

hand, the choice of separation depends on application and the practical used for the machine with other criteria due to the size of particles and condition on machine used. Mechanical separation is usually favored if possible due to the lower cost of the operation as compare to chemical separation. For the chemical separation process actually more expensive and need to the closed system because of its will cause pollution.

Depending on the raw mixture, various processes can be separate the mixtures. Many times two or more of these processes have to be used in combination to obtain the desired separation. In addition to chemical processes, mechanical processes also can apply where possible. In the example of crude palm oil mill, one upstream distillation operation will feed its two or more product streams into multiple downstream distillation operations to further separate the crude palm oil, and so on until final products are purified.

Now we have several of separation process with several of mineral want to separate for industrial used. It is include for the mechanical and chemical separation process such as:

- a) Gravity
- b) Centrifugation / Cyclone
- c) Decantation
- d) Flocculation
- e) Stripping
- f) Winnowing

2.3 Gravity Separation Method



Figure 2.3: Gravity Separation Machine

Source: Physical separation in science and engineering

Gravity separation, one of the oldest separation techniques, has become increasingly popular with new equipment enhancing the range of separations possible, which when coupled with generally low capital and operating costs and lack of chemicals to cause environmental concerns, often provides an attractive process. [2]

Gravity separation relies upon the differences in density of minerals to provide efficient separation. Easy and efficiency of separation is dependent on a number of factors including relative density, particle size and shape, friction level, all of which affect the selection of type of separation method or in easy word we can say type of separation method machine that want to use.

The duration it takes for the solid particles to set to the bottom can be illustrated with Stokes' Law [3] [4]:

$$v = \left(\frac{(\rho' - \rho)g^2}{18\mu} \right)$$

Where:

v = velocity of sinking / floatation (cm/s)

ρ' = density of the solid particle (g/cm³)

ρ = density of the liquid (g/cm³)

g = acceleration of earth's gravitational pull (9.81 m/s²)

x = diameter of the solid particle (cm)

μ = viscosity of the liquid (g/cms)

2.3.1 Why Use Gravity Separation Method



Figure 2.3.1: Gravity separation machine.
(Source: Dovemining – Explorer IV)

Gravity separation is the best-proven and accepted technique of concentrating minerals and has been used as a primary form of mineral concentration for centuries. Due to its high efficiency and low cost, gravity separation is always the first consideration in any work to separate the mineral differences of the specific gravity of the valuable [3].

Palm Oil Mill is place that processes the Fresh Fruit Bunch (FFB) and the loose fruit that suitable using this separation process with high efficiency and low costs. The raw material that come from estate actually not in clean condition with leaf, sand, stone and other impurities that useless for the process will become problem to the machines when it's also enter to the systems. For that purpose, we must separate the impurities using gravity separation process. Have some reason to choose gravity separation process:

1. To reject barren waste as an initial pre-concentration step.
2. To remove sand, stone, and leaves that comes from the estate.
3. To pre-concentrate heavy minerals to minimize downstream processing costs.
4. To get the clean of loose fruit.

2.3.2 Various of Gravity Separation

a) Jigs



Figure 2.3.2.1: Deltapro (Jigs type)

Source: Advanced separation of shredded plastic mixture (January 2004)

Conventional jigs have been use for well over a century. New developments include the In Line Pressure jig and the Kelsey jig, the latter of which incorporates centrifugal motion. In principle, separation of particles of differing specific gravity is

effected in a bed resting on a ragging screen. The bed is fluidized by a vertical pulsating motion created by a diaphragm and incoming flow of hutch water, coupled with a bed of intermediate specific gravity particles of ‘ragging’. The pulsating and dilating action of this motion on the bed causes the heavier particles (high specific gravity and size) to sink into and through the ragging to form a concentrate underflow, and lighter and smaller particles to form a tailing overflow. [5]

1. Conventional Jigs

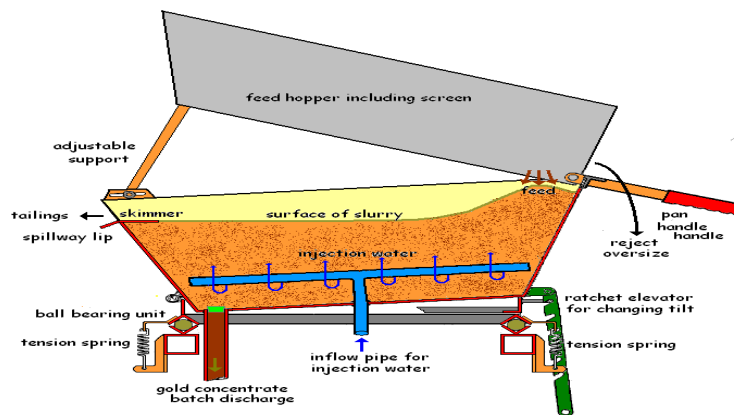


Figure 2.3.2.2: Graeffe E-Tanks (Conventional Jig)

Source: Keene Hydromatic (1985)

There are many variations of a conventional jig. One of the example is ‘*Russell*’. This consists of two parallel feed boxes each of which discharges into two sets of cells arranged in series. The feed slurry flows over the two hutches where it is subjected to the forces described above. The high specific gravity (SG)/coarse grains pass through the ragging and screens into the hutches where they are removed as an underflow concentrate, while the remainders of slurry discharges into an overflow launder as tailings. [5]