



**NATIONAL TECHNICAL UNIVERSITY COLLEGE OF
MALAYSIA**

**DRY POWDER TURBO VACUUM
REFINERY MACHINE**

SUBJIT (Mengandungi maklumat yang berkaitan keselamatan atau kepentingan Malaysia yang terkandung di dalam AKTA RAJISIA B. 55M1 1972)

Thesis submitted in accordance with the requirements of the National Technical University College of Malaysia for the Degree of Bachelor of Engineering (Honours) Manufacturing (Process)

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ABSTRACT

Fire protection industries are becoming more and more important nowadays in world wide. By having a safe environmental implementation and application in industries or manufacturing plants , the safety of workers are more sustained and ensured. There are quite a number of safety protection system which are available in the market , and one of the safety precaution steps is to have fire extinguishers in our plant. Therefore this PSM project is nothing much , but to concentrate on the design of the dry powder turbo vacuum refinery machine which is used to perform maintenance of the fire extinguisher units.

DEDICATION

For my parents.

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CHAPTER 1

INTRODUCTION

1.1 Overview

In accordance to the industrial training which I have undergone during last semester and its objective is to expose the students so that giving them some ideas to bring back as the PSM projects.

During my industrial training, I was attached to a company that involving in fire protection and safety engineering. Here I was quite curious about the machineries that been used for several years with old and expensive parts. One of them is the Dry Powder Turbo Vacuum Machine.

My point of view is the machine could be able to redesign and to be improved in terms of manufacturing cost, functional and flexibilities. Therefore, I have chosen this machine redesign and improvement as my PSM 1 project title.

Basically, the turbo vacuum machine is used to suck up dry powder chemical from fire extinguisher to a reservoir tank as to be refinery. This is a requirement from the Fire And Rescue Department of Malaysia, at least the pressure stored fire extinguisher to be service and pressurize once a year.

There are two composites of dry powder; ammonium sulphate and ammonium phosphate. These type of chemical in powder foam are actually hazardous to human beings if without proper handling.

1.2 Objectives

- To associate with the Fire Department coming policy that maintenance and servicing of fire extinguishers needed to be carried out at customers' sites. Therefore a portable dry powder refinery machine is a must.
- To study the alternative method / design which remains the functions of the machine.
- To improve size and weight of the machine to be lighter and more flexible to be carried around (easier handling & portable).
- To reduce the cost / price as in the market.

1.3 Project Scope

The scope of project will comprise of the existing machines which available at my previous industrial training company and its main dealer site located at Taman Sungai Besi , Kuala Lumpur.

The scope of studies will cover aspects such as :-

- ❖ Functions of the machine.
- ❖ Alternatives or remain the current designs.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Literature review can be defined as a background study about the knowledge and information needed to develop a project. In order to develop a complete and really functional project in the reality , a literature review is necessary to go through before starting to study and redesign the project.

Literature review for the Dry Powder Turbo Vacuum Refinery Machine project is started on the beginning of the project. Information and knowledge that needed to gather from the industrial training company , internet and discussion with my project supervisor had eased the process of the literature review.

Literature review can be done by refer to the theories and concepts that published and declared by expertise or celebrity that in the related fields. However , this machine actually is custom made locally and literature review or the survey to be carried out mostly based on the reference company and related websites.

The advantages and significant of the literature review are that it helps to determine the project scopes and features that are necessary in the intended develop project. Further more-, case study are helpful to avoid the system weakness that may found in the similar review's projects.

2.1.1 Definition of Vacuum

The Italian physicist Torricelli (1608-1647) , inventor of the barometer, is credited with beginning the study of vacuum techniques by his experiments on the existence of a pressure due to air.

Pascal (1623-1662) continued this research by showing the reduction of air pressure at different altitudes. Boyle (1602-1686) The classical definition of a vacuum is an enclosed space devoid of any gases or vapors. This definition, of course, is impossible to achieve. The best that can be accomplished is an area of low pressure where most of the gases and vapors have been removed.

James Dewar (1848-1923) was the first to use vacuum insulation. His invention , the double-walled glass vessel with a high vacuum in the space between the walls , is now a common article in research laboratories. Any vessel that utilizes vacuum insulation to prevent heat flow is called a Dewar. Dewar designed his vessel after studying the 1820s research of Dulong and Petit who discovered the following two properties of insulation:

1. There is no convective transfer of heat between walls confining gas at sufficiently low pressure.

2. The emission or absorption of thermal radiation by the surface of a material grows weaker as the reflectivity increases. (Scurlock 155)

Vacuum insulation alone can nearly eliminate two of the principal modes of heat transfer, that of **conduction** and **convection**. When appropriate measures are taken also to minimize heat transfer by **radiation** , and conduction by solid structural members , then vacuum insulation is by far the most effective known (Scott 143).

2.1.2 General Definition

vacuum = empty space

from vacuus = [Latin] empty

2.1.3 Scientific Definition

- A pressure lower than atmospheric, in an enclosed area.

- A space in which the pressure is significantly lower than atmospheric pressure.

- A condition in which the quantity of atmospheric gas present is reduced to the degree that, for the process involved its effect can be considered negligible.

2.1.4 Ideal Gas Law

- Experimentally found by Robert Boyle and published 1662.

$$pV = nRT$$

p = pressure
 V = volume
 n = number of gas molecules
 R = universal gas constant
 T = temperature

- Works well for sub atmosphere pressure and normal temperature.
- For better accuracy use a correction factor $q(p,T)$ (gas specific)

2.1.5 Kinetic Gas Theory

- A theory that could explain Robert Boyle's experimental results.
- The gas molecules...
 - ✓ are treated as hard spheres.
 - ✓ are many, small, and far apart compared to their size.
 - ✓ collide elastically with walls and each other.
 - ✓ moves randomly with constants speed between collisions.
 - ✓ obey Newton's laws of motion.

2.1.6 Gas Molecule Speed Distribution

Derived from kinetic gas theory ,

$$P(v) = 4\pi \left[\frac{m}{2\pi kT} \right]^{3/2} v^2 e^{-mv^2/2kT}$$

v = gas molecule speed
 m = gas molecule mass
 k = Boltzmann's constant

$$v_{rms} = \sqrt{\frac{3kT}{m}}$$

$$\lambda = \frac{kT}{\sqrt{2}\pi d^2 p}$$

λ = mean free path
 d = gas molecule diameter
 v_{rms} = root mean square velocity

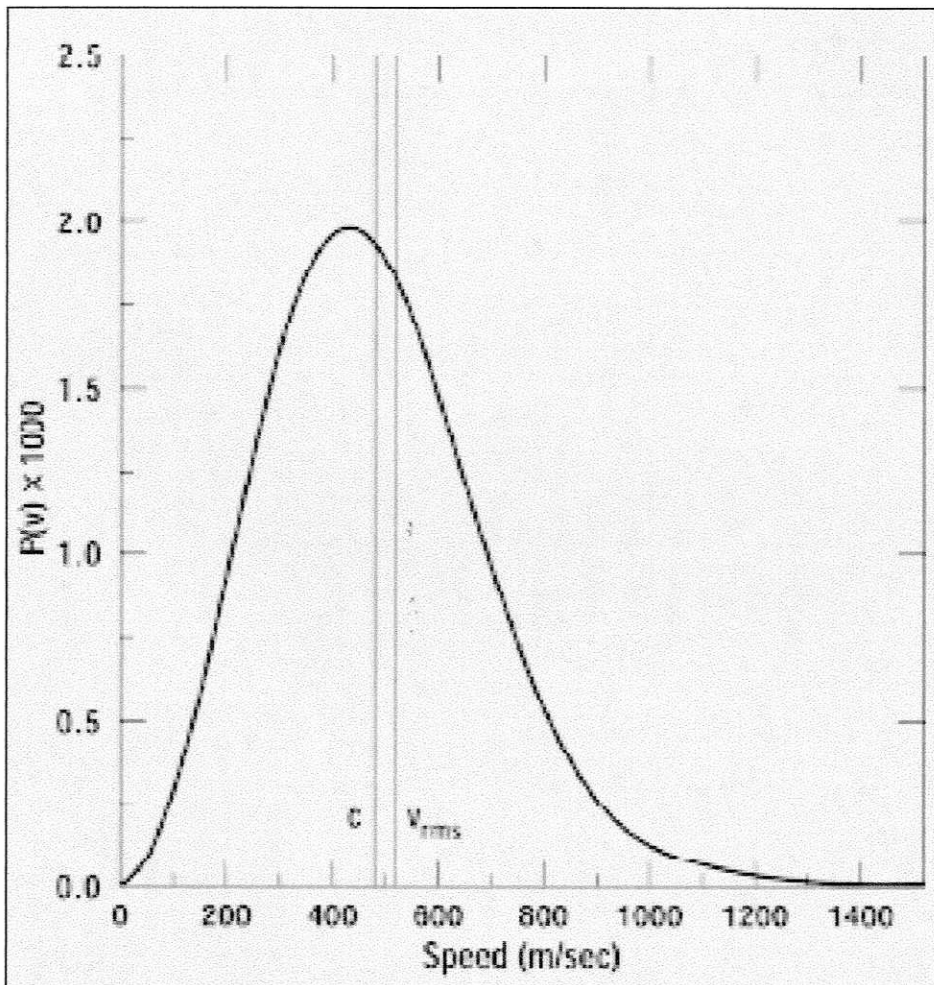


Figure 2.1 A Maxwellian speed distribution of particles. $P(y)$ is the probability that a particular particle will have the magnitude of velocity.

2.1.7 General Vacuum Chart

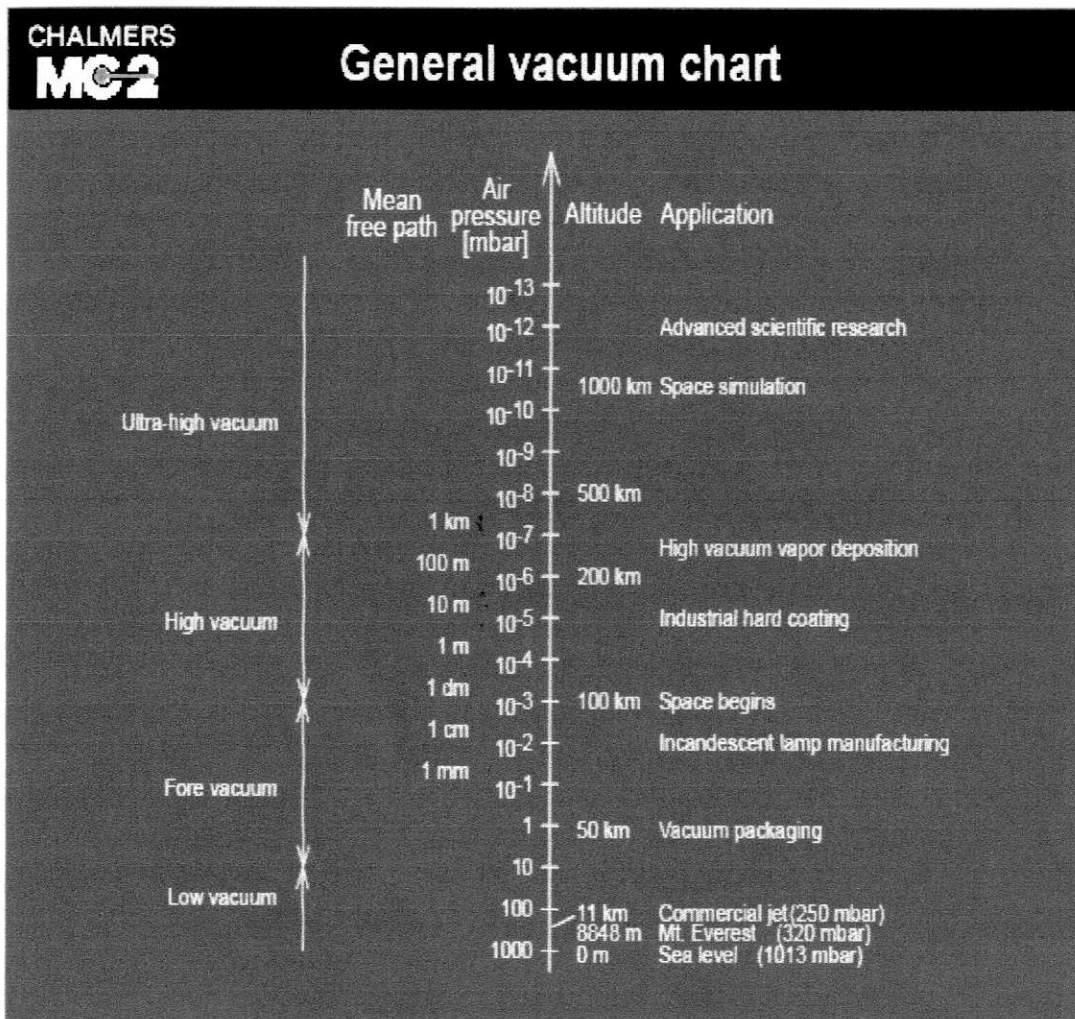


Figure 2.2 General Vacuum Chart

Based on the above vacuum chart, there are few classifications of vacuum level which can be used for this PSM application. Here the most suitable level is low vacuum level which applied for industrial and commercial fields.

2.1.8 Gas Flow Rate

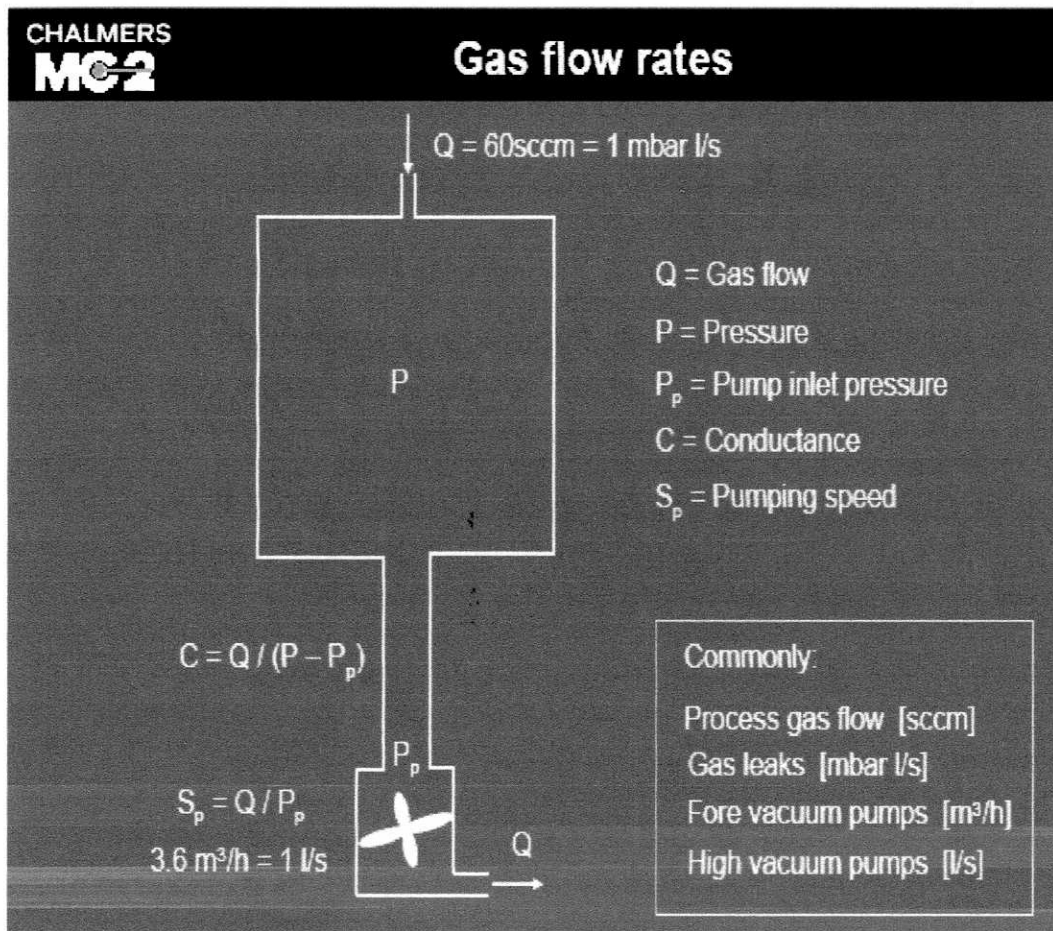


Figure 2.3 Gas Flow Rate

2.2.1 Definition Of Vacuum System

A high - vacuum system usually consists of several items working together:

1. A mechanical pump called the fore pump , which exhausts to the atmosphere and maintains an inlet pressure in the range of 1 to about 100 microns of mercury.
2. A pipe connecting this pump to the outlet of a diffusion pump capable of reducing the pressure several orders of magnitude more.
3. A pipe of a larger diameter connecting the diffusion pump to the volume being evacuated.
4. Sometimes a second pump , called a booster pump , is used between the high - vacuum diffusion pump and the mechanical pump.
5. It is also customary to provide a cold trap to remove condensable vapors (Scott 155).

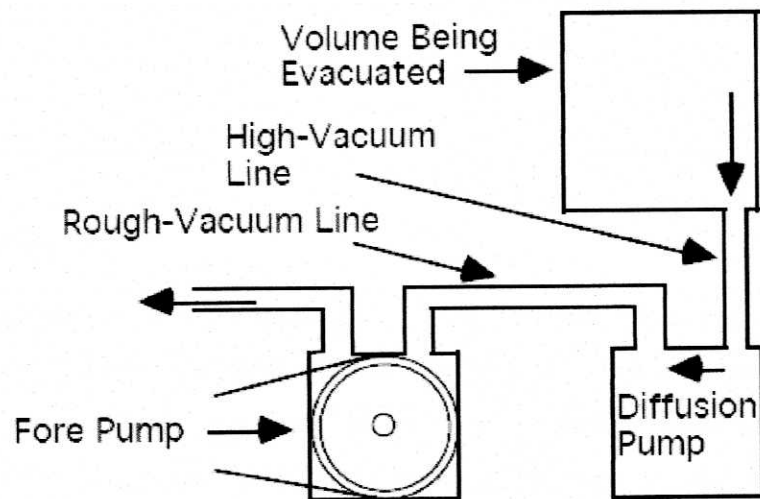


Figure 2.4. shows a Simple Vacuum System

Some of the different types of vacuum pumps are diffusion pumps, ion pumps, cryogenic pumps, and turbo-molecular drag pumps.

CRYOPUMPING

Gas will condense on a cryogenically cooled surface. If this surface is in an evacuated enclosure, such as a vacuum shield for liquid helium, it will produce a better vacuum. This phenomenon involves not only phase change from gas to solid at the cold surface but also adsorption of the gas molecules. (Adsorb: to collect a gas, liquid, or dissolved substance, in condensed form on a surface.) The attractive feature of cryo pumping is the extremely large pumping speeds that can be attained. The effect of this "pump" is that it occurs wherever there's liquid helium (or gas if the temperature is below 20°K) across a surface in

conjunction with a vacuum line (all transfer lines). The surface of the pipe becomes the pump's collection point.

VACUUM VALVES

Of the many valves designed for high-vacuum use, the most reliable are those that do not depend on packing to separate the vacuum region from the atmosphere. Some valves use metal bellows and others have an elastic diaphragm of synthetic rubber pressed onto a seat by a metal member that is on the atmospheric side of the diaphragm. These are not very suitable due to air diffusion through the diaphragm.

HIGH-VACUUM VALVES

The Richards seal-off valve, developed by NBS Cryogenic Engineering Laboratory, has proved very useful. After pumping is completed, the valve is closed and then the valve handle and bonnet can be removed, leaving only the closed valve seat on the evacuated apparatus.

VACUUM GAUGES

Since pressures measured by vacuum gauges are several orders of magnitude smaller than atmospheric pressure, most of the ordinary pressure gauges cannot be easily used in vacuum work. In fact, most vacuum gauges are secondary gauges - the pressure is not measured directly, but is inferred from measurement of other properties. So, if pressure can't be measured directly, how is it measured? In the free molecular flow range of low pressure, the thermal conductivity of a gas decreases as the pressure of the gas is reduced.