DIURVAL VARIATION OF PM_{10} AND CARBON MONOXIDE CONCENTRATIONS IN PENANG

By

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Thesis submitted to

UNIVERSITI SAINS MALAYSIA

To fulfill the requirement of graduation

BACHELOR DEGREE IN CIVIL ENGINEERING

School of Civil Engineering,
Universiti Sains Malaysia

April 2005

ABSTRAK

Pencemaran merupakan suatu masalah yang tidak diberi perhatian yang penuh pada suatu masa dahulu kerana ia tidak terlalu mempengaruhi kehidupan manusia. Sejak kebelakangan ini, isu pencemaran sering menjadi topik perbualan hangat kerana pencemaran telah berlaku di merata-rata tempat..

Walaupun sesetengah pencemaran merupakan kesan daripada punca-punca semula jadi, namun sebilangan besar pencemaran merupakan kesan daripada kegiatan manusia. Punca-punca utamanya ialah pengeluaran dari kenderaan dan kegiatan perindustrian. Kualiti udara di kebanyakan bandar di dunia berada pada tahap yang membimbangkan berikutan daripada penambahan besar dalam bilangan kenderaan di jalan raya.

Oleh sebab itu kajian ini dijalankan bagi membincangkan mengenai sumber-sumber utama yang menyumbang dalam peningkatan pencemaran udara di Prai. Di samping itu, kesan-kesan dan langkah-langkah yang patut diambil turut dibincangkan bagi memperbaiki kualiti udara di Prai.

Laporan yang disediakan ini dapat memberi gambaran yang jelas mengenai pencemaran udara yang berlaku di Prai, Pulau Pinang.

ABSTRACT

Pollution is not a very important matter long time ago since it does not give any big impact to human life. But it becomes to be a big issue now since there are a lot of pollution occurred in many places.

Though some pollution comes from these natural sources, but most pollution is the result of human activity. The main sources are vehicle and industrial emissions. Air quality is deteriorating in most cities in the world due to a huge addition in the number of motor vehicles on the road.

Therefore, this study is done to discuss about the main sources which contribute to the increasing air pollution in Prai. Furthermore, the impacts and mitigation steps that should be taken are also discussed in order to upgrade the air quality in Prai.

This report will give a good overview about air pollution in Prai, Penang.

ACKNOWLEDGEMENT

Alhamdulillah, thanks to Allah, with His permission and guidance, I manage to finish up my final year project on time and successfully.

By doing this project, it helps me in understanding more about air pollution especially in Prai. This project also makes me realize on how important it is to have an unpolluted air surrounding.

I would to thank my project supervisor, Dr. Nor Azam bin Ramli, for letting me to be under his supervision and I really appreciate all the support, guidance and help that he gave me during this project.

My big thank you also go to all my friends who are under the same supervision, Nurulilyana, Nurul Adyani, Dayangku Kamisah and Darol Shafek, for the cooperation given.

Lastly, I would like to give my appreciation to both of my parents, Ab. Manaff bin Ann and Fadzillah bt Selamat, for giving me a full support in completing my final year project report.

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CHAPTER 1 INTRODUCTION

1.0 INTRODUCTION

The air is made up of nitrogen and oxygen, with traces of other gases such as carbon dioxide, plus minute particles like dust. Although clean air should be freely available to all plant and animal life, humans have been gradually polluting it, putting their health at risk and the well-being of the earth itself.

Air pollution is the presence in the atmosphere of a mix of chemicals and particles which is harmful to humans, animals and plants. Apart from affecting the health of those most susceptible it reduces the quality of life of everyone. Air pollutants mainly come from the discharges of gases and particles mainly from industry, motor vehicles and domestic wood burning. There are also natural sources such as wind-blown dust, forest fires, volcanic eruptions, wind erosion, pollen dispersal, evaporation of organic compounds, and natural radioactivity. Usually, natural air pollution does not occur in abundance in particular locations. The pollution is spread around throughout the world, and as a result, poses little threat to the health of people and ecosystems.

Though some pollution comes from these natural sources, most pollution is the result of human activity. The main sources are processing industries and car emissions. The primary pollutants in photochemical smog are produced by combustion of fossil fuels in motor vehicles and are formed both from car emissions and nitrogen in the atmosphere. Air quality is deteriorating in most cities of the world, due to a huge

expansion in the number of motor vehicles plus an increase in the number of kilometers traveled per year in each vehicle.

Every industrial process exhibits its own pattern of air pollution. Petroleum refineries are responsible for extensive hydrocarbon and particulate pollution. Iron and steel mills, metal smelters, pulp and paper mills, chemical plants, cement and asphalt plants discharge vast amounts of various particulates. Insinuated high-voltage power lines ionize the adjacent air, forming ozone and other hazardous pollutants. Airborne pollutants from other sources include insecticides, herbicides, radioactive fallout, and dust from fertilizers, mining operations, and livestock feedlots.

Particulates are another component - a mixture of solid particles and liquid droplets that vary in size and composition. The main source for fine particulates is combustion of fossil fuels in vehicles.

1.1 AIR POLLUTION EFFECTS

The effects of air pollution are a major threat to our health. Every year, the health of countless people is ruined or endangered by air pollution. Older people are highly vulnerable to diseases induced by air pollution. Those with heart or lung disorders are under additional risk. Children and infants are also at serious risk.

This is because people are exposed to so many potentially dangerous pollutants. It is often hard to know exactly which pollutants are responsible for causing sickness. Also, because a mixture of different pollutants can intensify sickness, it is often difficult to isolate those pollutants that are at fault.

Many diseases could be caused by air pollution without their becoming apparent for a long time. Diseases such as bronchitis, lung cancer, and heart disease may all eventually appear in people exposed to air pollution.

Air pollution can also damage the environment and property. Trees, lakes, and animals have been harmed by air pollution. Air pollution has thinned the protective ozone layer above the Earth. Air pollution can damage buildings, monuments, statues, and other structures.

1.2 OBJECTIVES OF RESEARCH

- To study about PM_{10} diurnal variations and one criteria gas in developing town during weekdays and weekends cycle.
- To observe the present of PM_{10} in the air.
- To profile the pollutants which present in the air.
- To monitor the ambient air quality in developing town.
- To analyze PM_{10} data.

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2.5.2 M300 CO ANALYZER:

2.5.2.1 Principle of Operation

The detection and measurement of carbon monoxide in the Model 300 is based on the absorption of Infra Red (IR) radiation by CO molecules at wave lengths near 4.7 microns. In practice, the Model 300 uses a high energy heated element to generate broad-band IR light. This light is passed through a rotating Gas Filter Wheel which causes the beam to alternately pass through a gas cell filled with Nitrogen, (the Measure Cell) and a cell filled with CO/Nitrogen Mixture (the Reference Cell). This alternation occurs at a rate of 30 cycles/second and causes the beam to be modulated into Reference and Measure pulses. During a Reference pulse, the CO in the gas filter wheel effectively strips the beam of all IR energy at wave lengths where CO can absorb. This results in a beam which is unaffected by any CO in the Sample Cell. During the Measure pulse, the Nitrogen in the filter wheel does not effect the beam which can subsequently be alternated by any CO in the sample cell. The Gas Filter wheel also incorporates an optical chopping mark which superimposes a 360 Cycles/Second Light/Dark modulation on the IR Beam. This high frequency modulation is included to maximize detector signal-to-noise performance (DoE, 25th August 2004).

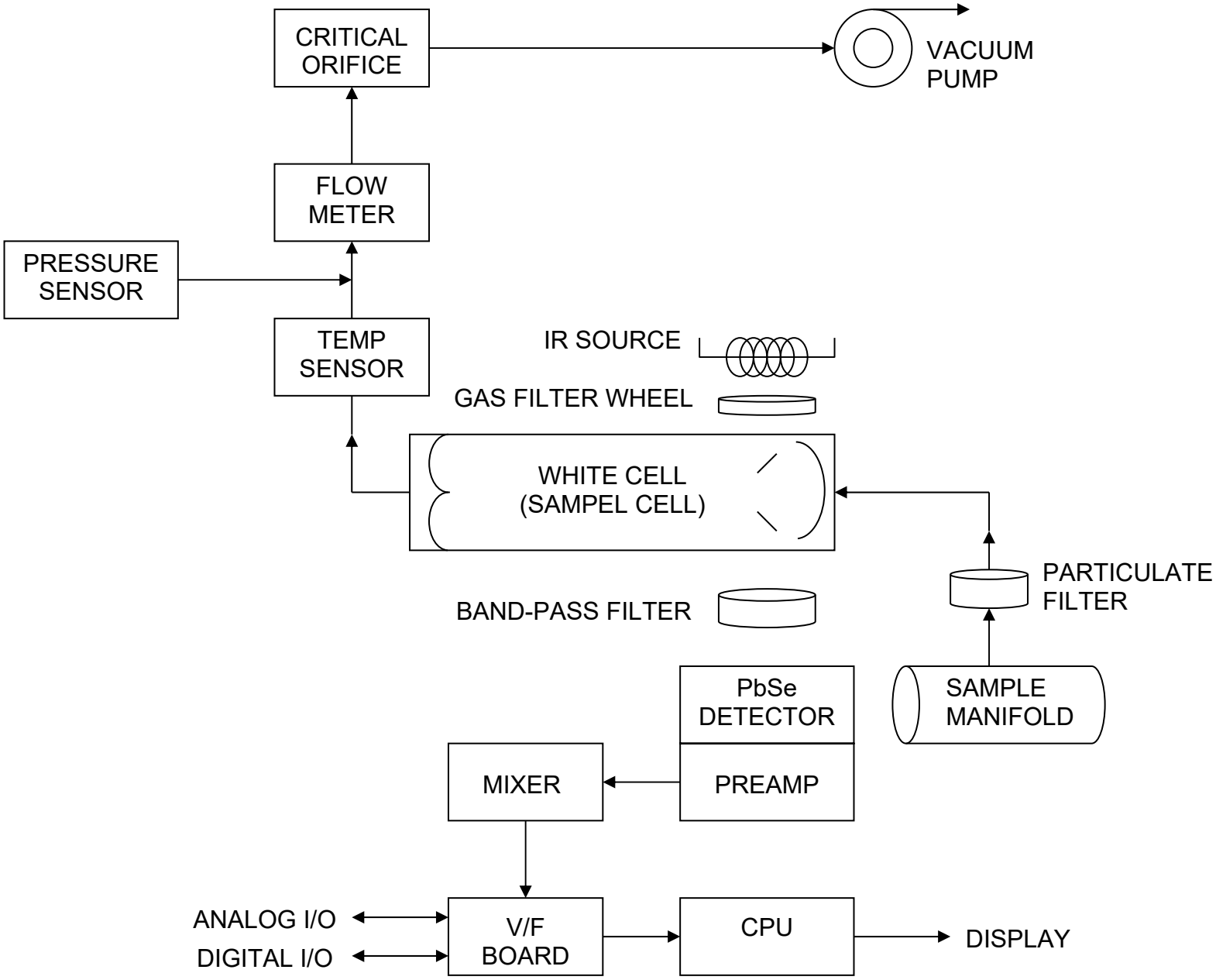
After the gas filter wheel the IR beam enters the multi-pass sample cell. This sample cell uses folding optics to generate a 16 meter absorption path length in order to achieve maximum sensitivity (DoE, 25th August 2004).

Upon exiting the sample cell, the beam passes through a band-pass interference filter to limit the light to wave length of interest (DoE, 25th August 2004).

Finally, the beam strikes the detector which is a thermoelectrically cooled solid-state photo-conductor. This detector, along with its pre-amplifier and bias voltage supply convert the light signal into a modulated voltage signal (DoE, 25th August 2004).

The detector output is electronically demodulated to generate two DC voltages, CO MEAS and CO REF. These voltages are proportional to the light intensity striking the detector during the Measure Pulse and Reference Pulse, respectively
(DoE, 25th August 2004).

2.5.2.2 M300 Carbon Monoxide Analyzer



(DoE, 25th August 2004)

2.5.2.3 M300 General Theory

Theory

Infrared Absorbance

Beer's Law

$$I=I_0 e^{-\alpha c l}$$

Where:

I = intensity of transmitted light (CO Meas Value)

$\mathbf{I_0}$ = intensity of source light (CO Ref Value)

α = absorbance coefficient of CO

l = path length

c = CO concentration

Source Energy Compensation – Gas Filter Correlation

N_2 (CO MEAS) $\quad I=I_0 e^{-\alpha c l}$

40% CO (REF) $\quad I=I_0 e^{-\alpha c l} * e^{-\alpha c} {}^{c}w\, {}^{l}w$

where:

$^{c}\mathbf{w}$ = conc. of CO in wheel

$^{l}\mathbf{w}$ = width of wheel

CO absorbance peak 4680 nM

Chosen for insensitivity to H_2O and CO_2

(DoE, 25th August 2004)

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

The atmosphere is a mixture of gaseous such as nitrogen, oxygen, argon, carbon dioxide, hydrogen and other gaseous. This gaseous mixture becomes polluted when it is changed by the addition (or, theoretically, subtraction) of particles, gaseous, or energy forms (e.g., heat radiation, or noise) so that the altered atmosphere poses some harm because of its impact on weather, climate, human health, animals, vegetation, or materials. The concept of pollution entails a sense of degradation, a loss of quantity, and adverse environmental effects whether it is applied to the air, water, or land (Godish, 1997).

Air pollution is a major environmental health problem affecting the developing countries and the developed countries alike. The effects of air pollution on health are very complex as there are many different sources and their individual effects vary from one to the other. It is not only the ambient air quality in the cities but also the indoor air quality in the rural and the urban areas that are causing concern. In fact in the developing world the highest air pollution exposures occur in the indoor environment
(http://www.ce.udel.edu/~huang/Chapter%2061%20air%20pollution.pdf, 27th July 2004).

There are only a limited number of reports which are readily available reporting PM_{10} and criteria gaseous levels for northern region of Peninsular Malaysia, especially Penang. Ramli et al. (2002), and Ibrahim and Ramli (2002) have reported high air pollution levels in developing towns in North Perak. However, these studies concentrate on the traffic derives air pollution. This project intends to study the diurnal variations of PM_{10} and CO concentrations in developing town during weekends and weekdays cycle.

2.2 AIR POLLUTION

Air pollution is woven throughout the fabric of out modern life. A by-product of the manner in which we build cities, air pollution is the waste remaining from the ways we produce our goods, transport ourselves and our goods, and generate the energy to heat and light the places we live, play and work. The earliest pollutants noted in the atmosphere were probably of natural origin such as smokes, ash, fumes, and gaseous from volcanoes, were part of our environment long before human–induced, or anthropogenic, problems came on the scene (Tchobanoglous, et al., 1993).

Indeed, the natural problems would have qualified as "air pollution" under this generally accepted definition of pollution of ambient, or outdoor, air :

"*Air pollution is the presence in the outdoor atmosphere of one or more air contaminants such as dust, fumes, gas or smoke, in sufficient quantities, of such characteristics, and of such duration as to be or to threaten to be injurious to human, plant, or animal life or to property, or which reasonably interferes with the comfortable enjoyment of life and property* (Tchobanoglous et al., 1993)".

Except in such extreme cases as volcanic eruption, pollution from natural sources does not usually, by itself, pose problems severe enough to endanger life and property. Ultimately, human activities are to blame for pollution problems that threaten to make portions of the earth's atmosphere an inhospitable environment (Tchobanoglous et al., 1993).

Air pollution is the presence of undesirable materials in the air, in quantities large enough to produce harmful effects. The undesirable materials may damage human health, vegetation, human property, or global environment as well as create aesthetic insults in the form of brown and hazy air or unpleasant smells. Pollutants are known that may do all of these things. Many of these harmful materials enter the atmosphere from sources currently beyond human control. However, in the most densely inhabited parts of the globe, particularly in the industrialized countries, the principal sources of these pollutants are human activities. These activities are closely associated with human material standard of living (Nevers, 2000).

2.2.1 SOURCES

Air pollutants consist of gaseous pollutants, odours, and particulate matter such as dust, fumes, mist, and smoke. The concentration of these in and near the urban areas causes severe pollution to the surroundings. The largest sources of human-created air pollution are energy generation, transportation and industries that use a great deal of energy sources. Depending on their sources and interactions with other components of the air, they can have different chemical compositions and health impacts. Since these pollutants are generally concentrated in and around urban areas, the outdoor urban pollution levels are far higher than in the rural areas

(http://www.ce.udel.edu/~huang/Chapter%2061%20air%20pollution.pdf,

27th July 2004).

Fires are other major sources of air pollution and lead to severe problems if the smoke is inhaled for a period of time. These fires can either be forest fires, oil well fires, burning of leaves in the backyard or as in the case of rural areas, large-scale burning of agricultural waste. Other sources include industries and power plants located in these areas (http://www.ce.udel.edu/~huang/Chapter%206-1%20air%20pollution.pdf, 27th July 2004).

Air pollution sources may be classified the way they generate emissions such as transportation, stationary combustion sources, industrial processes, solid waste disposal facilities and miscellaneous. The general explanations for these sources are as follows :

- **Transportation**

  This category includes most emissions produced from transportation sources during the combustion process. The internal combustion engines fuelled by gasoline and diesel are the biggest sources in this category. The other sources includes trains, ships, lawnmowers, farm tractors, planes, and construction machinery (http://www.utoledo.edu/~aprg/courses/iap/text/intro/f_intro.html, 25th July 2004).

- **Stationary combustion sources**

  In this category the sources only produce energy and the emission is a result of fuel combustion. The sources include power plants as well as home heating furnaces (http://www.utoledo.edu/~aprg/courses/iap/text/intro/f_intro.html, 25th July 2004).

- **Industrial processes**

  The sources which emit pollutants during manufacturing of products are included in this category. Petrochemical plants, food and agricultural industries, chemical processing, metallurgical and mineral product factories and wood processing industries are the major sources of air emissions. The smaller sources include dry-cleaning, painting and degreasing operations (http://www.utoledo.edu/~aprg/courses/iap/text/intro/f_intro.html, 25th July 2004).

- **Solid waste disposal facilities**

  This category includes facilities that dispose off unwanted thrash. Refuse incineration and open burning are important sources (http://www.utoledo.edu/~aprg/courses/iap/text/intro/f_intro.html, 25th July 2004).

- **Miscellaneous**

  The sources which do not fit in the above four categories are listed under this title. These sources include forest fires, house fires, agriculture burning, asphalt road paving and coal mining (http://www.utoledo.edu/~aprg/courses/iap/text/intro/f_intro.html, 25th July 2004).

2.2.2 MAJOR AIR POLLUTANTS

- **Carbon monoxide**

  Carbon monoxide is an odourless, colourless gas produced by incomplete oxidation (burning). As well as wildfires, carbon monoxide is produced naturally by oxidation in the oceans and air of methane produced from organic decomposition. In cities, the motor vehicle is by far the largest human source, although any combustion process may produce it (http://www.epa.nsw.gov.au/envirom/princairpol.htm, 25th July 2004).

  Carbon monoxide usually remains in the atmosphere for a month or two. It is removed by oxidation to form carbon dioxide, absorption by some plants and micro-organisms, and rain (http://www.epa.nsw.gov.au/envirom/princairpol.htm, 25th July 2004).

- **Carbon dioxide**

  Carbon dioxide is the principle greenhouse gas emitted as a result of human activities such as burning of coal, oil and natural gaseous (http://www.ce.udel.edu/~huang/Chapter%2061%20air%20pollution.pdf, 27th July 2004).

- **Lead (Pb)**

  In contrast to the other major air pollutants, lead is a cumulative poison. A further difference is that it is ingested in food and water, as well as being inhaled. Of that portion taken by ingestion, approximately 5-10% is absorbed in the body (Davis and Masten, 2004).

  The major source of lead in the air is leaded fuel used in motor vehicles. It is also presents in lead batteries, paints, hair dye products and so on. Lead is a heavy metal and, when present in the body, can impair brain function, especially in children (http://www.epa.nsw.gov.au/envirom/princairpol.htm, 25th July 2004).

- **Ozone**

  Near the ground, ozone is a colourless, gaseous secondary pollutant. It is formed by chemical reactions between reactive organic gases and oxides of nitrogen in the presence of sunlight. Ozone is one of the irritant

secondary pollutants in photochemical smog and is often used as a measure of it

(http://www.epa.nsw.gov.au/envirom/princairpol.htm, 25th July 2004).

Ozone is strongly oxidising and can irritate the eyes and the respiratory tract. It also damages plants. The formation of ozone in the upper levels of the atmosphere or stratosphere is by a different process. Ozone there is not regarded as a pollutant because it is produced naturally. It is important in absorbing harmful ultraviolet radiation and preventing it from reaching the earth

(http://www.epa.nsw.gov.au/envirom/princairpol.htm, 25th July 2004).

- **Nitrogen dioxide (NO_x)**

  NO_x causes smog and acid rain. It is produced from burning fuels including petrol, diesel and coal

  (http://www.ce.udel.edu/~huang/Chapter%206-1%20air%20pollution.pdf, 27th July 2004). The gas is reddish brown in concentrated form and gives a brownish yellow tint at lower concentrations. Exposure to nitrogen dioxide concentrations results in cough and irritation to respiratory tract (Davis and Conwell, 1998).

- **Particulate Matter**

  Not only there are gaseous pollutants, there are also solid or liquid particles that may be suspended in the air. Referred to as ‘particulate

matter', these particles range in size up to 50 micrometers (μm) in diameter (there are 1,000,000 μm in a meter) and may reduce visual amenity and adversely impact health. Examples of particles in the air include dust, smoke, plant spores, bacteria and salt. Particulate matter may be a primary pollutant, such as smoke particles, or a secondary pollutant formed from the chemical reaction of gaseous pollutants (http://www.epa.nsw.gov.au/envirom/princairpol.htm, 25th July 2004).

- **Sulfur dioxide (SO_2)**

  The sources of SO_2 are natural sources such as volcanoes and manmade sources such as power plants and industrial sources that burn coal or fuel. It can harm human and animal lungs, as well as plants and trees. Sulfur dioxide is the main contributor to acid rain. It reacts with the oxygen in the air to become sulfur trioxide, which then reacts with water in the air to form sulfuric acid. Acid rain can slowly kill both animal population in lakes and rivers and trees and other plants by damaging leaves and root systems. It can deteriorate metal and stone on buildings and statues. The effects of acid rain are not only local, but they can occur hundreds of miles from the sources of sulfur dioxide (http://www.utoledo.edu/~aprg/courses/iap/text/intro/f_intro.html, 25th July 2004).

2.3 PARTICULATE MATTER (PM_{10})

Particulate matter air pollution is among the most harmful of all air pollutants. Particulate matter pollution consists of very small liquid and solid particles floating in the air. PM_{10} is the mass of particulate air pollution collected by a convention that has 50% efficiency for particles with an aerodynamic diameter of 10 μm (Davis and Cornwell, 1998). Of greatest concern to public health are the particles small enough to be inhaled into the deepest parts of the lungs (http://www.arb.ca.gov/html/brpchure/pm10.htm, 27th July 2004).

PM_{10} is made up of fine solid or liquid such as dust, fly ash, soot, aerosols, fumes, mists, and condensing vapours. When they become airborne, the particles can be suspended in the air for long period of time (http://www.valleyair.org/General_info/faq_answers.htm, 25th August 2004). Some particles are large or dark enough to be seen. Others are so small that individually they can only be detected with an electron microscope (http://www.epa.gov/urbanair/pm/what1.html, 27th September 2004).

In Malaysia, standards for air quality are not available. PM_{10} concentrations in ambient air in Malaysia are monitored based on Recommended Malaysian Guidelines (RMG) at a threshold of 150 ugm^{-3} for 24 hours average and a annual means of 50 ugm^{-3} (DoE, 2000).

2.3.1 SOURCES

PM_{10} sources generally fall into two categories : human (anthropogenic) activity and natural sources (nonanthropogenic). Anthropogenic sources include agricultural operations, industrial processes, combustion of wood or fossil fuels,

earthmoving activities, and entrainment of road dust into the air. Nonanthropogenic include windblown dust and wildfires (http://www.valleyair.org/General_info/faq_answers.htm, 25th August 2004).

Particulate matter can be described as being primary or secondary, based on its origin and processes of formation. Primary particles are emitted directly into the atmosphere from a variety of natural and anthropogenic sources. In the former case, these include volcanoes, forest fires, biologic sources (mold, pollen, bacteria, plant parts) and meteoric debris ; the latter includes transportation, fuel combustion in stationary sources, a variety of industrial sources, solid waste disposal and miscellaneous sources such as agricultural activities and fugitive emissions from roadways. Secondary particles are formed in the atmosphere as a result of chemical processes involving gaseous, aerosol particles and moisture (Godish, 1997).

At any given time and place, the composition of PM_{10} in the ambient air depends upon nearby source types, geographical location and meteorological conditions. The PM_{10} present in the air usually contains a mixture of primary and secondary particles from a variety of sources (http://www.valleyair.org/General_info/faq_answers.htm, 25th August 2004).

2.3.2 HEALTH EFFECTS

PM_{10} have been highlighted since the last decade for causing adverse health effects (Schwartz, 1994 ; Dockery and Pope, 1994 ; Pope et al., 1995). Dockery and Pope (1994), reported that for each 10 ugm^{-3} increase in PM_{10} concentration, there is an estimated increase of 0.6 – 1.6% mortality.

Particulate matter alone or in combination of other pollutants constitutes a very serious health hazard. The pollutants enter human body mainly via the respiratory system. When inhaled, these particles evade the respiratory system's natural defences and lodge deep in the lungs. Particulate matter is especially harmful to people with lung disease such as asthma and chronic obstructive pulmonary disease (COPD), as well as people with heart disease. Exposure to particulate matter air pollution can trigger asthma attacks and cause wheezing, coughing and respiratory irritation in individuals with sensitive airways (http://www.arb.ca.gov/html/brpchure/pm10.htm, 27th July 2004).

2.4 CARBON MONOXIDE

Colourless, tasteless and odourless gas, carbon monoxide or CO, is formed when carbon in fuel is not burnt completely. It is chemically inert under normal conditions and has on estimated atmospheric mean life of about 2 ½ months (Tchobanoglous et al., 1993). In the atmosphere at large, the concentrations are negligible. Under the restricted ventilation conditions sometimes found in towns, concentrations can be a significant health hazard (Colls, 2002). Carbon monoxide at present ambient level has little if any effect on property, vegetation, materials and even on human aerobic metabolism, when the concentrations is higher.

2.4.1 SOURCES

Carbon monoxide is a product of the incomplete combustion of carbon-containing compounds. In oxygen-rich air, carbon monoxide burns to form carbon dioxide. When there is insufficient oxygen, however, carbon monoxide does not burn completely and becomes one of the many by-products of combustion. Combustible carbon-containing materials include wood, charcoal, coal, natural gas, gasoline, diesel, fuel, kerosene, oil, organic waste and tobacco products (Hess-Kosa, 2002).

Carbon monoxide sources are both natural and anthropogenic. Carbon monoxide is produced in large quantities as a result of incomplete combustion of fossil fuels and biomass (Godish, 1997). Anthropogenic sources (those associated with the activities of human beings) include motor vehicles, fossil fuel burning for electricity and heat, industrial processes, solid waste disposal and miscellaneous

burning of such things as leaves and brush (Davis and Masten, 2004). The natural source includes forest fires.

2.4.2 HEALTH EFFECTS

The effect of carbon monoxide inhalation of human health is directly proportional to the quantity of carbon monoxide bound to haemoglobin. Oxygen is transported in the blood as oxyhaemoglobin (HbO_2), a semi-stable compound in which oxygen is weakly bound to the ferrum in haemoglobin in red blood cells. The oxygen is removed for cell respiration, and the regenerated haemoglobin is available for more oxygen transport. Carbon monoxide reduces the oxygen-carrying of the blood by combining with haemoglobin and forming carboxyhaemoglobin (HbCO), that is stable. Haemoglobin that is tied up as HbCO cannot be regenerated and is not available for oxygen transport for the life of that particular red blood cell (Vesilind et al., 1993).

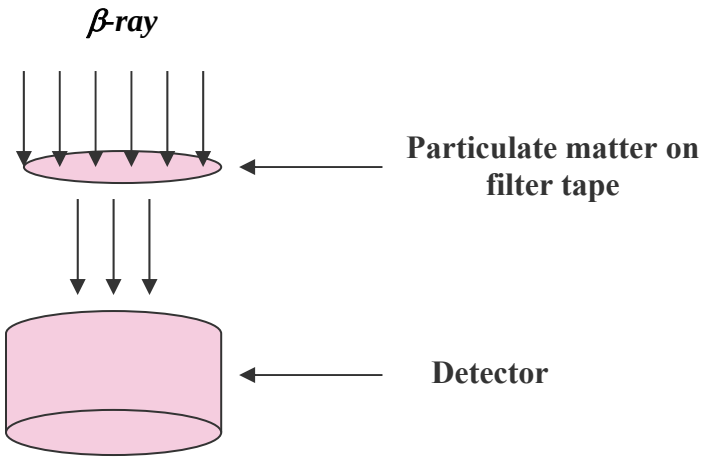
Haemoglobin has a greater affinity for carbon monoxide than it does for oxygen. Thus, the formation of HbCO effectively deprives the body of oxygen. The sensitive populations are those with heart and circulatory ailments, chronic pulmonary disease, developing foetuses, and those with conditions that cause increase oxygen demand, such as fever from infectious disease (Davis and Masten, 2004).

2.5 EQUIPMENT

2.5.1 BAM1020 – PARTICULATE MATTER (PM_{10}) ANALYZER

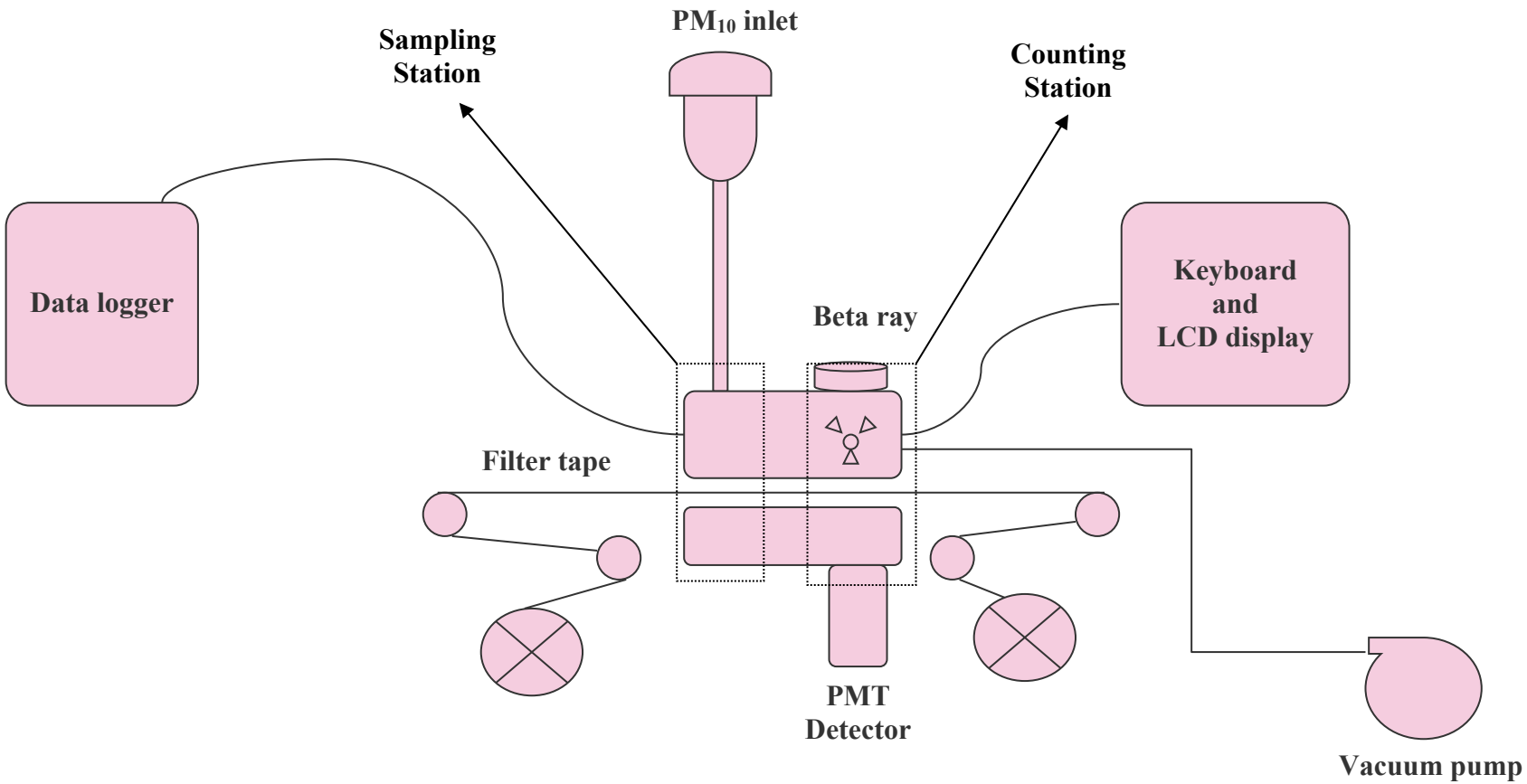
BAM1020 automatically measures and records dust concentration. It uses the principle of beta (β) adsorption to provide a simple determination of mass concentration. A known amount of electron scattering and attenuation through a clean filter is compared with that of a dust-sampled filter. To calculate mass concentration, a ratio of the number of detected beta particles passing through the filter and the sample volume is used (DoE, 25th August 2004).

2.5.1.1 Principle of Operation



The BAM1020 measures and records hourly particulate mass concentrations in ambient air. It uses beta ray attenuation to calculate collected particle mass concentrations in units of $\mu g/m^3$. A ^{14}C element emits a constant source of high-energy electrons, also known as beta particles. The beta rays are attenuated as they collide with particles collected on a filter tape. The decrease in signal detected by the BAM1020 scintillation counter is inversely proportional to the mass loading on the filter tape (DoE, 25th August 2004).

2.5.1.2 BAM1020 Schematic Diagram



(DoE, 25th August 2004)

2.5.1.3 BAM1020 Theory of Operation

12:00	1. Move tape to new spot under the counting system.
	2. Initial count – I0 – 4 minutes
2:04:45	3. Move tape from counting station to sampling station. Closed nozzle, pump turns on.
	4. Initial count – I1 (membrane)
	5. Moves membrane out.
12:13:00	6. Final count – I2 (calculate the mass of the membrane)
	7. Re-tracks membrane.
12:54:45	8. Waits for end sampling period (40 minutes).
	9. Pump stops – lifts nozzle – move tape from sampling station to counting station (particulate filter)
	10. Final count– I3 (concentration) – calculate concentration (I0/I3)
	11. Wait till 1:00 to begin again.

(DoE, Malaysia, 25th August 2004)

CHAPTER 3 METHODOLOGY

ANALYSIS OF MONTHLY DATA

The monthly data that had been provided were particulate matter (PM_{10}) concentrations and carbon monoxide (CO) concentrations in Prai for the year 2001. The PM_{10} data consists of concentrations readings from January to September, while the CO data provides the concentrations readings from January to December. Both data are arranged according to hourly and daily for each month. The average concentrations for daily and hourly data for each month also had been provided.

As the first step to analyze the monthly data is identifying the NA and CAL values which are normally assumed as zero. These values then had to be removed and replaced it with a new value which obtained from some calculations. After removing all the NA and CAL value, the daily and hourly average concentrations have to be calculated once again. The calculations and all the data analysis were done in Microsoft Excel 2002. When the average concentrations had been calculated, standard deviation, mean, maximum and minimum values for each data can be determined. By referring to all the provided and obtained values, the data then can be plotted into graphical form.

The simplest graphical forms that can be extracted from both PM_{10} and CO concentrations data is the hourly and daily concentrations graphs for every month. Some other graphs that also can be plotted by using the same data are monthly average concentrations graph, diurnal variations graph and daily average concentrations graph. These graphs are plotted for

both PM_{10} and CO. Then lastly the graph that showed the relationship between and CO is plotted.

Finally, the plotted graphs being analyzed by observing the trends from time to time in order to recognize which month that had been badly polluted by PM_{10} or CO or vice versa. Then figure out the reason and sources that caused the pollution. The comparison between and CO also had been done to find the relationship between these pollutants.