Assessment of Non-Methane Hydrocarbon Trends in Ambient Air of Tronoh, Perak, Malaysia

by

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CERTIFICATION OF APPROVAL

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Approved by,

(Dr. Wesam AlMadhoun)

UNIVERSITI TEKNOLOGI PETRONAS

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SEPTEMBER 2017

CERTIFICATION OF ORIGINALITY

This is to certify I am responsible for the work submitted in this project, that the original work is my own except as specify in the references and acknowledgement, and the original work contained herein have not been undertaken or done by unspecified sources or person.

(MUHAMMAD ZULHAFIZ BIN ISMAIL)

ABSTRACT

Air pollution are primary and most dangerous pollutions because it was involving all the creature in the world including human and ecosystem. Non-Methane Hydrocarbon was the pollutants that highlighted in this research and was categorized as the precursor for the ozone formation when reacted with radical oxides. The main objective of the researches was to examine the trends of Non-Methane Hydrocarbon (NMHCs) in ambient air of Tronoh and to investigate the effect of meteorological conditions on the trends of NMHCs. The flyover in Tronoh has been chosen as the location of study area due to condition of flyover's column. There are a few researched has been done involving the investigation of NMHCs concentration at the developed area in Malaysia such as Pulau Pinang and Klang Valley. For this project, the sampling time was conducted from 27 October 2017 until 18 November 2017 which are during 3 weekdays and weekends respectively. In the beginning, the sampling was conducted to obtain the peak period of concentration NMHCs. Then, continue to indicate the diverse of concentration between the three-different location at the study area. The intervals that selected for every sampling period is 3 minutes. The equipment that has been utilized to carry out this investigation is Aeroqual AQM-60 that able to measure the concentration of selected pollutant also meteorological condition at specific area. After that, time series was applied to analyzed the data that obtain from the experiments and comparing to the standard guidelines such as New Ambient Air Quality Standard. From the result that has been collected, the average NMHCs was in the range 50-80 ppb and doesn't exceed the limit has been fix by DOE. Then, the result also illustrated the vehicles emission lead the sources of pollutants during weekdays and rural area lead during weekend because of several reasons including huge total volume of vehicles and combination of natural and anthropogenic sources. As a conclusion, monitoring of air pollution are significant to avoid bad quality of air at the developed area.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Earth atmosphere or air can be formed by the invisible mixture of gases mainly are nitrogen and oxygen that surround the earth and it is necessary for all living things to survive in their life (Woodford,2017). The earth atmosphere basically can be classified to 4 main layers which are troposphere, stratosphere, mesosphere and ionosphere that shown in Figure 1.

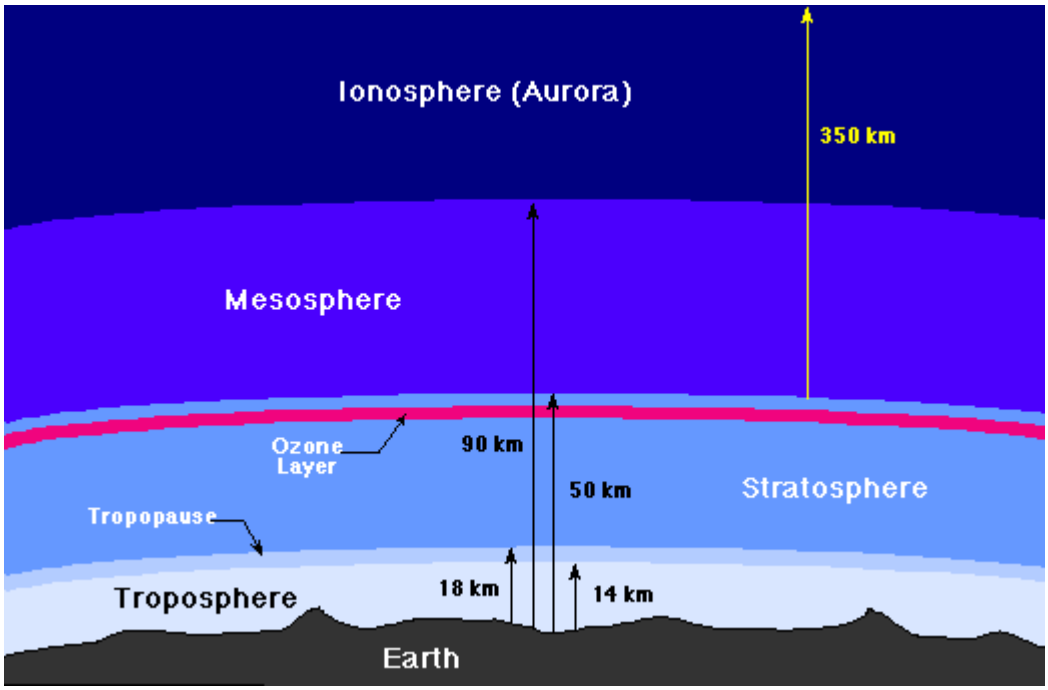

Figure 1:Layer of earth atmosphere

The temperature and density of these layers are varying by the latitude, the density become less dense in troposphere and the gaseous molecules will be far from each other (Haris,2017). The actual composition of air is 78% of nitrogen, 21% of oxygen, and 1% is other gases including inert gases, carbon dioxide, and water vapor and very small of other gases (Woodford,2017). This composition of air is valid if no human activities on the earth and the air not polluted. Our responsibilities as the human who live in the earth

to ensure the natural characteristic of atmosphere not polluted. Subsequently, the study of air contamination is vital to surpass this contamination problem.

Pollution is the way toward making land, water air and other part of the environment messy and hazardous to be utilize. This can be possible through the introduction of a pollutant into a natural environment, but the pollutant does not need to be tangible. According to Bradford (2015), things as basic as light, sound and temperature can be considered pollutants when introduced preciously into an environment. There are many types of pollutions include water, noise, land, light and air pollution and this research was focusing on the air pollution which is the most dangerous hazard to the environment because it related with the respiratory system of human (Bradford, 2015).

Air pollution occur when the pollutant such as sulfur oxides, carbon monoxide, ozone and other photochemical oxidants, nitrogen oxide, toxic compound, lead and other heavy metal and variety of volatile organic compounds (VOCs) suspended in our atmosphere with the huge amount that can be harmful (Haris,2017). Pollutant can penetrate to the earth atmosphere with different ways, it can be done by the emission from the industrial factories, vehicles exhaust and open burning that created by human.

Pollutant can be categorized into two which are primary pollutants and secondary pollutants. For the primary pollutants, the substances are release directly from sources to the environment like restructured combustion process, the harmful gases that will be emitted are carbon dioxide, carbon monoxide, sulfur dioxide and nitric oxide. Then from the industrial process, hydrogen sulfide, ammonia, hydrogen chloride and hydrogen fluoride were released. Secondary pollutant can be defined as the chemical reactions occur among the primary pollutants (Haris,2017). The sources of secondary pollutant from the combustion of local waste such as dioxin, heavy metal element and acid oxide. These pollutants are yields recombined element during oxidation when pollutants are decomposing during combustion (Margarida,2011). One of the examples of the secondary pollutant is ozone which is the reaction between nitrogen oxide and volatile organic compounds (VOCs) with the present of the sunlight and stagnant wind (Puliski et al.,2006). In the air pollution parlance, the primary pollutant that react are termed the precursors of the secondary pollutants.

The amount of these pollutants in air will reflect to the condition of air quality on the environment (Warrington Borough Council Portal,2012). At the certain amount and period of exposure to pollutants will cause implication to health and other hazards (Papakonstantinou, et al.,2003). Air quality standard has been introduced to express the acceptable average amount of pollutant over the period time. The New Ambient Air Quality Standard was establish to replace the oldest Malaysia Ambient Air Quality Guidelines (MAAQS) that has been used since 1989 which are adopting 6 air pollutants criteria that include 5 existing air pollutants which are particulate matter with the size of less than 10 micron (PM10), sulfur dioxide (SO2), carbon monoxide (CO), nitrogen dioxide (NO2), and ground level ozone (O3) as well as 1 additional parameter which is particulate matter with the size of less than 2.5 micron (PM2.5) as shown in Table 1.

Table 1: The New Ambient Air Quality Standard

Pollutants	Average Time	Ambient Air Quality Standard	
		PPM	$\mu g/m^3$
Ozone	1 Hour	0.2	200
	8 Hour	0.12	120
*Carbon Monoxide (CO)	1 Hour	30.0	35
	8 Hour	9.0	10
Sulfur Dioxide (SO_2)	1 Hour	0.3	300
	24 Hour	0.09	90
Nitrogen Dioxide (NO_2)	1 Hour	0.3	300
	24 Hour	0.75	75
Particulate Matter (PM_{10})	1 Year	0.045	45
	24 Hour	0.12	120
Particulate Matter ($PM_{2.5}$)	1 Year	0.025	25
	24 Hour	0.05	50

*mg/m^3

Non-methane volatile organic compounds (NMVOCs) can be classified as variety of chemical compounds like benzene, ethanol, formaldehyde, cyclohexane and acetone. Non-methane hydrocarbon (NMHCs) is the of NMVOCs, methane's are excepted

because the gases are not harmful to the ambient air with the low reactivity. Although, it important as the one precursor for greenhouse gas and have a long-live in the ambient air. NMHCs are the sum of all hydrocarbon particle in the ambient are excluding methane. The other hydrocarbons have short-live in atmosphere comparing to the methane. NMHCs play a vital role in atmosphere due to their high reactivity behavior that can generate tropospheric ozone when through the chemical reaction with the nitrogen oxides (NOx) and radicals at the high concentration of NOx (Matsunaga, 2010). 'Tropospheric ozone is considerably as toxic and strong greenhouse gas which is formed in the lower atmosphere and exists in the ambient air to which people, agricultural crops, forests and ecosystems are exposed and must respond every day' (Haris,2017). The limitation of ozone formation is significant to improve the air quality at the area that have high concentration of NOx (Matsumaga,2010).

Nowadays, all people are on the track in pursuing the glory and wealth without take any consideration to the environment. As the number of populations on earth increases, industrial and human activities have a greater impact on the environment, particularly on the atmosphere due to increasing the number of populations on earth. There are many industrial activities that will affect the environment because this industry will emit the pollutants such as organic solvents, respirable particles, sulfur dioxide and nitrogen oxides (Vallero,2008). These pollutants can be both harm public health and damage the environment by contributing to global phenomena such as climate change, the greenhouse effect, ozone hole and increasing desertification.

1.2 PROBLEM STATEMENT

Motor vehicles which is the most popular transport in Malaysia will emit large quantities of carbon monoxide, hydrocarbons, nitrogen oxides and toxic substances including fine particles and lead. Each of these, along with secondary by product such as ozone, can cause adverse effect on health and environment (Vallero,2008).

Emission of VOCs resulting from fossil fuels combustion has resulted in increased photochemical smog levels in urbanization areas of the world due high demand of coal and petroleum product. These events have produced a situation in which large numbers of people are exposed to high level of ozone with resulting increased risk of both short-term and long-term health effects (Vallero,2008).

For this area of study, the formation of smog has been spotted at the particular areas in Tronoh and it was trapped between the main road and the flyover. It becomes more worst when the column of the flyover change in term of color. There are two possibilities which are comes from industrial activities underway in this area also can be comes from the emission of vehicles exhaust. Firstly, there are many manufacturing factories in this area which operate actively for this time. Secondly, the smog clearly spotted in the morning when the number of vehicles passed that particular areas was increased. So, the significant to study the formation of smog in particular area at Tronoh is essential by knowing the pollutant that emitted by industrial and human activities.

1.3 OBJECTIVES

1. To identify the type of pollutants emitted and the effect of industrial and human activities to the ambient air in Tronoh
2. To investigate the concentration of non-methane hydrocarbon (NMHCs) in ambient air of Tronoh.
3. To examine the effect of meteorological condition on the concentration of non-methane hydrocarbon (NMHCs) in ambient air of Tronoh.

CHAPTER 2

LITERATURE REVIEW

Air pollution is not a recent phenomenon and it is the introduction of particulates, biological molecules and other harmful materials into earth's atmosphere that may contribute to a disease that can cause death and damage to other living organisms such as food crops or natural environment. There are many ways has been invented in order to minimize the effect of air pollution to the human health also an ecosystem.

2.1 SOURCE OF POLLUTANTS

Human and industrial activities have become main contributor to the climate change in Earth's atmosphere in the amounts of greenhouse gases, small particles and cloudiness. Malaysia as the country that undergo a rapid development also not neglected from experienced the pollution. Like other countries, the major problem is air pollution which are may affecting human health, agricultural crops, forest species also an ecosystem (Afroz,2003). The major sources of air pollution in Malaysia can be classified to mobile sources, stationary sources and burning sources. Figure 6 shows the distribution of types of emission load.

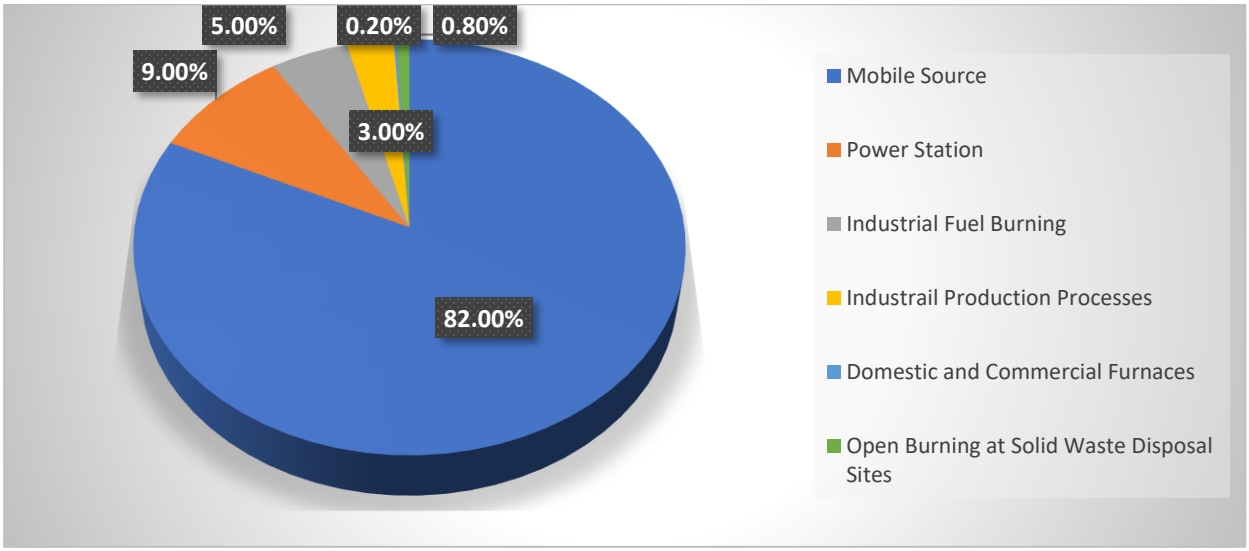

Figure 2:Sources of air pollution in Malaysia

2.1.1 Source of Emission

Emission of the pollutant can be categorized from various sources like shape, motion, urbanization level, elevation and also duration. Variety sources of emission was summarized and showed in the Table 4.

Table 2:Sources of emission

Shape	Point	Single
		Identifiable
		Combustion from furnace
	Line	One-dimensional
		Vehicular traffic
	Area	Two-dimensional
		Forest fire
	Volume	Three Dimensional
		Petrochemical plant
Motion	Stationary	Flue gas stack
	Mobile	Buses
Urbanization Level	Urban	
	Rural	
Elevation	Ground Level	
	Near Surface	
	Elevated	
Duration	Puff	Short-term
	Continuous	Long-term

2.1.2 Open Burning Sources

Burning of the solid wastes become serious issues especially involving urban areas due to increasing of human population, developing of human activities and high demand of essential items (Hairy,2009). Production of solid wastes in Peninsular Malaysia has been increase with average 0.8 kg per day from 2001 to 2005. The main causes of this problem due to immigrant the people from rural area to urban area. Uncontrolled forest fires also may contribute to the air pollution. ‘Over the last several years between July and September significant amounts of particle matter have been transported by south-westerly

winds from a neighboring country due to uncontrolled biomass burning activities. As a consequence, serious haze events were recorded in Peninsular Malaysia, Sabah, and Sarawak in 1994 and recently during September and October of 1997' (Afroz,2003). Serious haze can limit our visibility to less than 500m and its become a problem to vehicles driver to plan their journey.

2.1.3 Mobile Sources

Mobile sources have a highest contribution which is around 75% from the total air pollution with the second is emission from stationary sources cover 20% and last is open burning sources is around 5% (Afroz,2003). Mobile sources include motor vehicles such as private cars, commercial vehicles, and motorcycles. By the end of 2000, there were 10.6 million vehicles registered in Malaysia, compared to 7.7 million in 1996, an increase of almost 2.9 million vehicles or 26% (DOE, 2001). The statistics shown Kuala Lumpur was leading the highest vehicles population followed by Johor, Selangor, Perak and Pulau Pinang. This situation causes traffic congestion in some central business areas that leads to air pollution arising from unburnt hydrocarbon of motor vehicles exhaust (Awang,2000). 'The morning rush hour peak was mainly due to vehicles emission, while the late evening peak was mainly attributed to meteorological conditions, particularly atmospheric stability and wind speed' (Awang,2000).

In Malaysia, private cars are the most important contributor of atmospheric pollutants. They contribute about 75% of the total carbon monoxide (CO) and suspended particulate matter (SPM), as well as about 76–79% of the oxides of sulfur and nitrogen (DOE, 1991). A few regulations have been amended by DOE in order to control the vehicles emission at the manufacturing and assembly stage. There are The Environmental Quality (Control of Emissions from Diesel Engines) Regulations 1996 and the Environmental Quality (Control of Emissions from Petrol Engines) Regulations 1996. Table 5 show the accumulated register motorcar from 2005 until 2009.

Table 3:Total accumulate Registered Motorcars in Malaysia (Road Transport Department,2010)

Accumulated Registered Motorcar	
Year	Total
2005	6473261
2006	6941996
2007	7419643
2008	7966525
2009	8506080

2.1.4 Stationary Sources

Stationary sources defined as any fixed emitter of air pollutant. The sources can be from fossil fuel burning power plant, petroleum refineries, petrochemical plant, food processing plants and heavy industrial. In Malaysia, the main industries affecting air quality are the iron and steel industry, mineral industry, oil and gas industry, petrochemical industry, pulp and paper, power plants, and waste incineration sector. In 2004, the industrial production growth rate was estimated around 10.2% (Goodsite,2012). The increasing of production growth rate has been accompanied by an increased energy utilization also commodities traffic. Figure 7 show distribution of air pollution in Malaysia that categorized by states.

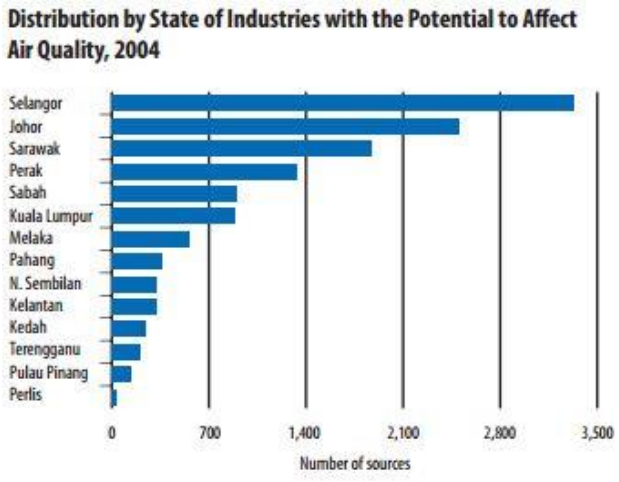

Figure 3:Number of industries contribute Air Pollution in Malaysia based on States

However, most of the small and mid-sized industries does not implemented pollution control equipment which lead to uncontrol emission from stack gas. To overcome this problem, Environmental Quality Act (EQA) run their roles to issuing the standard for stack gas emission that shown in Table 6 (Afroz,2003).

Table 4: Stack gas emission (DOE,1996)

Emission Source	Standard
Dark Smoke • Solid fuel equipment • Other fuel types • Dust	 Ringlemann Chart No. 2 Ringlemann Chart No. 1 0.01 gm/Nm^3
Metal and metallic compound • Mercury • Cadmium • Lead • Antinomy • Arsenic • Zinc	 0.015 gm/Nm^3 0.025 gm/Nm^3 0.025 gm/Nm^3 0.025 gm/Nm^3 0.1 gm/Nm^3 0.1 gm/Nm^3
Gases • Acid gases • Sulfuric acid mist, SO_3 • Chlorine gas • HCl • Florine • Hydrogen sulfide • NOx	 3.5 g of SO_3/Nm^3 0.2 g of SO_3/Nm^3 0.2 g of HCl/Nm^3 0.4 g of HCl/Nm^3 0.3 hydrofluoric acid g/Nm^3 5 ppm (vol. %) 1.7-2.0 g of SO_3/Nm^3 (source dependent)

2.2 NON-METHANE HYDROCARBON

Non-methane hydrocarbon (NMHCs) can be classified as the one of significant compound that must be control to ensure the optimum air quality of atmosphere (Matsunaga,2010). This compound has an important role in the formation of ozone at the urban area (Madhoun,2010). NMHCs are the compound that have high reactivity that able to generate tropospheric ozone via the chemical reactions between the high concentration of nitrogen oxides and radicals (Matsunaga,2010). So, controlling the emission and understanding the behavior of NMHCs are vital to ensure the risk to environment can be minimized (Choi,2011).

2.2.1 Sources of Non-Methane Hydrocarbon

Hydrocarbons are the large group of gases that easily vaporized liquids including various groups of organic chemicals and most of the compounds are odorless and colorless. Methane was excluding in the groups of NMHCs because the gases are not harmful to the environment. The sources of NMHCs can be divided to two which are natural and anthropogenic sources. Natural sources are the pollutant that generate by substances of natural origin such as soil microbes, vegetation, biomass burning and lightning. Meanwhile, anthropogenic sources are the pollutant that caused directly from the human activities such as emission from vehicles exhaust, factories operation and industries energy consumed/produced. Both of sources are created from the natural and anthropogenic sources can lead to the significant change of the composition of air in the atmosphere. On the global scope, natural emission of NMHCs are greater contribution to the air pollution rather than anthropogenic sources, although anthropogenic dominates the urban areas (Guenther,2000).

2.2.2 Types of Non-Methane Hydrocarbon

There are various types of hydrocarbons that may give a dramatic impact on air quality in the global environment. Risk on human health can be postured by the ambient air pollutants such as volatile organic compound that originate from vehicles exhaust, industries processes and domestic activities (Rubin,2006). Isoprene is the one organic

compound that include as non-methane hydrocarbon (NMHCs) and its release through the natural sources. The compounds are produced by many plants which dominantly comes from natural rubber. Meanwhile, benzene is carcinogenic compound that emitted from anthropogenic sources which is mainly from petrol-fueled cars. Table 3 was explained the examples of compound that release by household products.

Table 5: Example of Compounds released by household products

Compounds	Products
BTEX (Benzene, Toluene, Ethylbenzene, Xylene	Gasoline, Kerosene, Fuel oil Paint Thinner Aerosol
Acetone, Isopropyl Alcohol, Methacrylate	Perfumes Nail Polish Hair Spray
Tetrachloroethene	Fabric Cleaners Spot Removers Dry Cleaned Clothes
Formaldehyde	Furniture Carpet
Butane, Pentane, Heptane	Aerosol Spray Cosmetic Automotive product
Naphthalene	Moth balls Deodorizers Air fresheners
Trichlorofluoromethane, Dichlorodifluoromethane	Air-conditioners Refrigerators
Methylene Chloride	Electronic cleanser Spray lubricants
Isoprene	Pine oil cleaners

Cyclohexane, Methyl Ethyl Ketone (MEK)	PVC Cement Various Adhesive Contact Cement

2.2.3 The Effect of Non-Methane Hydrocarbon to Human Health

Benzene is the of non-methane hydrocarbon that easily found in the ambient air and was including in categorized of alkene gas that may affect the environment and human health in the negative way. Benzene was released to the environment from many ways such as emission from burning coal and oil, benzene waste and storage operations, motor vehicles exhaust and evaporation from petrol/gasoline stations. Benzene was reacted with the other chemical when it in atmosphere and take a few days to break down and also can deposited on the ground through the rain or snow (Xiaojiang,2009). The high concentration of benzene in the environment give a disaster to the human health because if they exposed to the benzene that have concentration around 3.7 to 42 μg/m3, may risk to have leukemia disease (Duarte-Davidson,2001).

Formaldehyde is the one subdivision of the aldehydes that can initiate in the ambient air. The sources of formaldehyde are from the industrial activities but also can naturally formed. The main industry that contribute to the formation of formaldehyde is manufacturing such as wood products, mining, agriculture and cosmetics. Formaldehyde also can be found through emission from vehicles exhaust. At the atmosphere, formaldehyde generally break down easily to produce formic acid and carbon monoxide that harmful to environment and living things. When the living things exposed to high concentration of formaldehyde, they may risk their health and lead to have nasopharyngeal cancer and leukemia (Xiaojiang,2009).

Naphthalene is the part of the polycyclic aromatic hydrocarbon that release to the ambient air through the industrial activities mainly from coal tar. According to history, petroleum refineries is the main consumption of the naphthalene, but the technology that invented in present time able to reduce the significant amount of naphthalene. Exposure to the large amount of naphthalene may damage red blood cells in the human bodies. The disease

known as glucose-6-phosphate dehydrogenase (G6PD) deficiency, which can be indicate through the symptoms like lack of appetite, restlessness and pale skin. Besides, naphthalene also may cause a confusion, nausea, vomiting, diarrhea and bloody urine.

All those compound that stated above are most common non-methane hydrocarbon that simply indicated in the ambient air. These compounds are harmful to the environment also to human bodies if exposed in the large amount of quantities. Monitoring the emission of NMHCs are vital to ensure the best air quality.

2.3 METEOROLOGICAL PARAMETERS

Meteorological conditions are environment condition that can influence the prediction of weather. There are various parameters must be considered in studying air pollution including temperature, relative humidity, air pressure, wind direction, wind speed and solar radiation. These parameters are significant because able to manipulate the concentration of pollutants in the ambient air.

2.3.1 Air Temperature

Temperature are necessary to evaluate chemical reaction of pollutants in ambient air. For example, ozone can be formed in tropospheric layer when chemical reactions between NMHCs and NOx occur in high temperature condition (Jallad,2010). The concentration of NMHCs should be high when the air temperature increase. During the temperature transposal, the atmosphere is stable and very little turbulence takes place. The gathering of the smoke and other pollutants averts the sun rays to warm the ground and the adjacent air. Smog usually related with the transposal because the air temperature at ground level falls below the precipitation point of the water vapor in the air.

Turbulence dispersion able to increase the entrainment and mixing of unpolluted air into the plume, at the same time can reduce the concentration of the pollutants. This type of dispersion is scale dependent which is depend on size of mixing motion, if the size of the cloud bigger the mixing motion will be stronger (Narumi,2009). Convective motion due to heating of the earth's surface enhancing atmospheric turbulence greatly. It can be

illustrated by Pasquil quantitative rating scheme that consist of six stability classes which are class A most unstable and class F most stable (Jallad,2010). Table 2 show the classification of atmospheric stability with the presence of turbulence. Figure 2, 3 and 4 show the average Malaysia temperature for the previous three months.

Table 6:Classification of atmospheric stability

Stability Class	Weather Condition	Windspeed (m/s)	Description
A	Sunny day	< 3	Very Unstable
B or C	↓	2-6	Unstable
D	Cloudy or Windy	>3-4	Neutral
E	↓	2-4	Stable
F	Clear Night	< 3	Very Stable

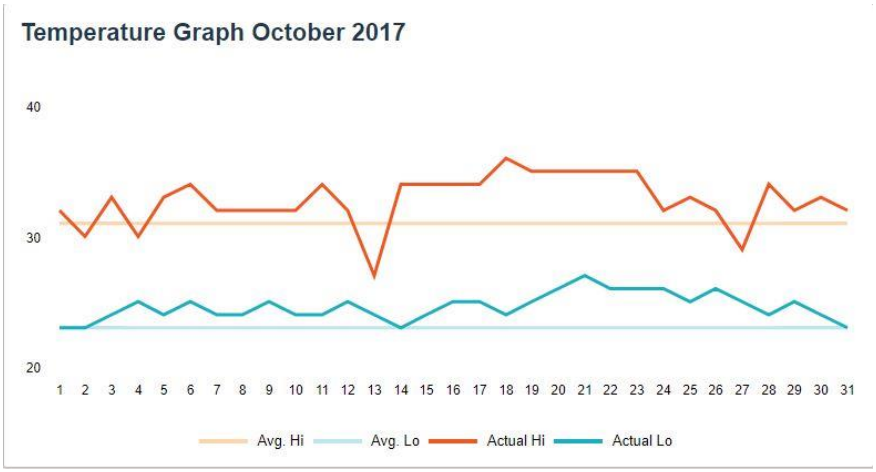

Figure 4:Average Malaysia Temperature for October 2017

2.3.2 Relative Humidity

The moisture content of the atmosphere affected the corrosive action of the air pollutant and indicates the potential for the formation of smog in relation to the degree of air pollution. Malaysia is the country that experienced humid and dry weather at the normal condition. Although, in the recent year the humidity of air in Malaysia quite low due low rainfall intensity that cause the temperature increase and weather become warm and dry.

The concentration of pollutants increases when the relative humidity at the low rate. Air humidity are significant during the reaction of containment in the atmosphere. Average relative humidity in Malaysia for a year was illustrated in the Figure 5.

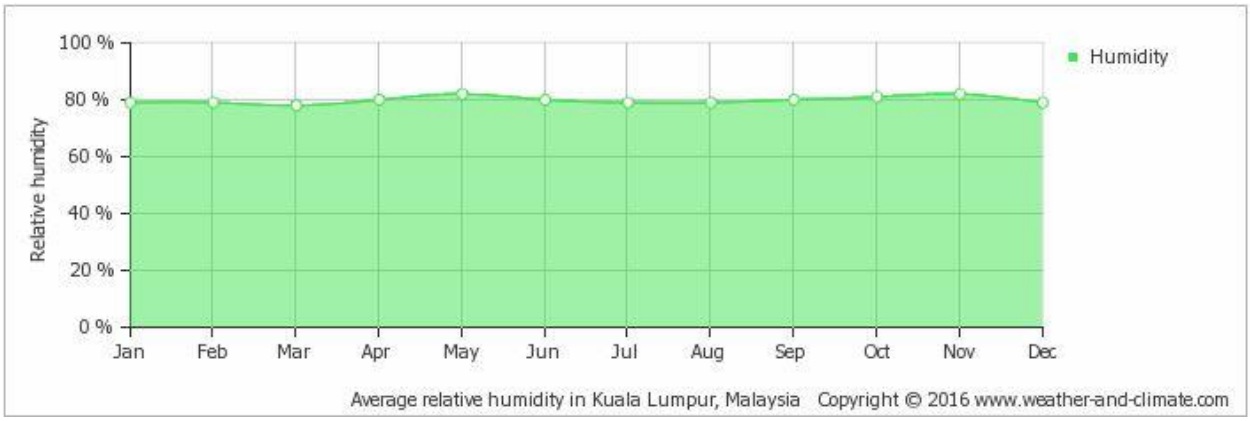

Figure 5: Average Relative Humidity for 2016

2.3.3 Wind Speed and Direction

The direction and the speed of wind govern in the drift and diffusion of the air pollutants discharge near the ground level. The higher the wind speed near the point of the discharge of the pollution, more is the pollutants are rapidly carried away from the source. Then, the pollutants so dispersed will not exist at the same point but will rapidly be diluted with the greater volume of air**.** Average wind speed in Malaysia are below than 2 m/s which is categorized as at moderate level.

CHAPTER 3

METHODOLOGY

3.1 STUDY AREA

This sampling was conducted at fly-over intersection near Batu Gajah, Perak. The exact location was 15.7 KM from Universiti Teknologi Petronas (UTP) with coordinates (4.4695877,100.9960791). Figure 6 shows the location of Batu Gajah in Malaysia map.

Figure 6: Maps Perak in Malaysia

Figure 7 illustrated the street view of the flyover at Batu Gajah and the ‘arrow’ mark show the column that change the color of apperances after exposed to the pollutants.

Figure 7:Street view of the flyover at Batu Gajah,Perak

This was a main road that connected Ipoh to Lumut in Perak. Along this Ipoh-Lumut Highways, there were another district like Batu Gajah, Seri Iskandar, Setiawan and Manjung. All these districts were the focal point of the people to run their business which leads to increasing number of vehicles passes the road.

Three different location was selected to place the Air Monitoring instrument within the radius 2 km from the exact study area. Figure 8 illustrated the location of study area in Google Maps. Table 7 show the sign and description for every location.

Table 7: Location description

Color	Description
Red	Exact location of study area
Orange	Location 3: Rural area
Blue	Location 2: Industrial area
Yellow	Location 3: Roadsides

Figure 8: Distribution of study area in Google Maps

First point was around 300 meters from the exact location that the instrument placed at the restaurant beside the main road. Figure 9 was showed the street view of location 1.

Figure 9: Street view of Location 1

For the second point, the location was at the mosque which near to residential area and industrial area. The distance from the exact study area around 700 meters. Location 2 can be shown in Figure 12.

Figure 10: Street view of Location 2

The last point was 1.2 kilometers away from the exact study area which at the rural area. Nearest to this location there was a factory that manufacture the fine sand that utilized for construction industry. Figure 13 illustrated the third location.

Figure 11: Street view of Location 3

Batu Gajah having a tropical rainforest climate, that experienced dry and humid weather with the lowest average temperature 25°C and the highest average temperature 35°C. Batu gajah also experiences mean rainfall 500mm and 308 days per year.

3.2 SAMPLING DATA

Non-methane hydrocarbon (NMHC) has been chosen as the pollutant that been investigated in this research. Sample was collected for whole day to determine the peak time of NMHCs was released to the ambient air. Through this sampling time, it helps to indicates three peaks of NMHCs readings which are in the morning, afternoon and evening. After the peaks already indicated, the sampling time can be minimized only for each peak. So, the sampling time can reduce to 12 hours sampling time which were consists all the peak hours. Then, three different location were selected to carry out the sampling where it must in the 2 kilometers radius from the exact study area. For each location, there were 2-days sampling time in the weekday and weekend. So, sampling

collection took 7 days to finish up which started from 27 October 2017 until 18 November 2017. The interval to collect the data was three minutes.

3.3 AQM60 ENVIRONMENTAL STATION

3.3.1 Instrument Description

The Aeroqual AQM60 Environmental Station is a custom built ambient air quality instrument. It was designed to record the common air pollutants including nitrogen dioxide (NO_2), carbon dioxide (CO_2), sulfur dioxide (SO_2), ozone (O_3), nitrogen oxide (NO_x), non-methane hydrocarbon (NMHCs) and also particulate matter (PM_{10}, $PM_{2.5}$). The instrument also can be utilized to measure the meteorological parameter like temperature, humidity, wind speed and direction. The following show the vital component inside the AQM60.

i. Control Module - the interface between the RS485 sensor bus and data communication links.

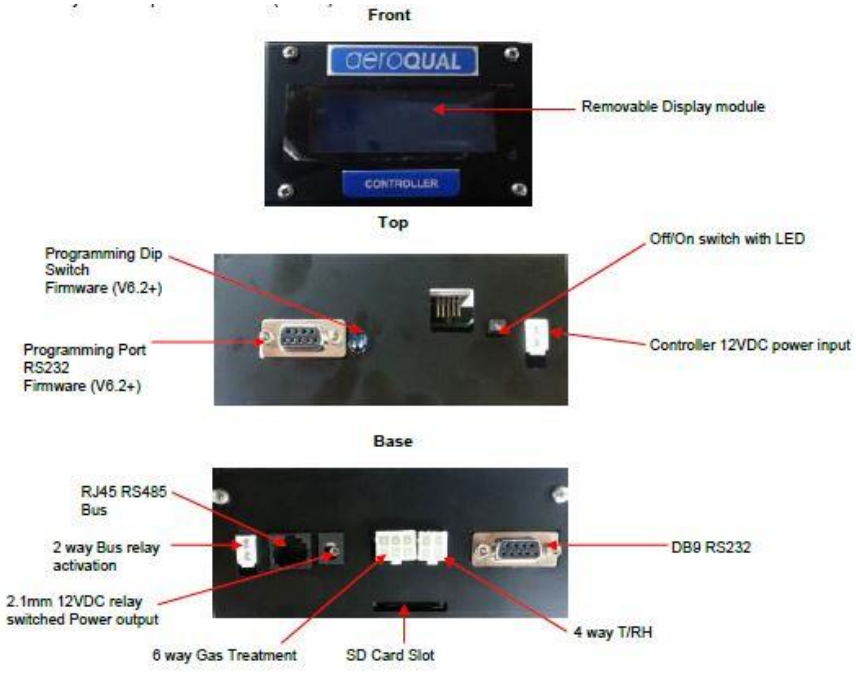

Figure 12:Control Module

ii. Gas Treatment Module – to control the gas sampling.

Figure 13: Gas treatment module

iii. Gas Modules – all modules are mounted onto the base plate using 4 or 2 bolts.

Figure 14: Gas Modules

iv. TMS Modules – to maintain a stable internal temperature of ambient temperature changes.

Figure 15:TMS Module

v. Compressor – provides the cooling system for the AQM60

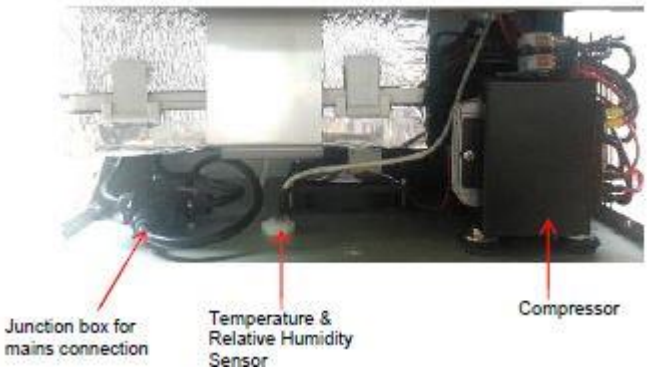

Figure 16: Compressor

vi. Internal Air Duct – improve thermal stability inside the AQM60 system

Figure 17: Internal Air Duct

3.3.2 Instrument Installation and Commissioning

i. Perform a checking on AQM60 to obtain the instrument free from any harm during transportation.
ii. Find the nearest power source to connect with the AQM60 to ensure that can operate for the full day
iii. Insert the SD Card properly into the control module
iv. Switch on the control module
v. Connect the AQM60 with the computer using the USB cable
vi. Install the Aeroqual Software and launch it.
vii. Setup for AQM60

- Go to Setup and select the Communication Port (Usually USB port on AQM60 is RS232 adaptor)
- Go to File and select Monitor. (Computer will connect with AQM60 automatically).

- Go to tool and select Update Real Time (The time in AQM60 will synchronized with computer time)

viii. Logging data for AQM60

- To launch real time data table, go to data and select table and real time
- To displayed data in real time table, go to file and select start data logging.

3.3.3 Instrument Software Description

Computer Requirement

- RS323 serial port and USB port
- Minimum 120 MB free storage in HDD
- Minimum 512 MB RAM

File

Menu	Descriptions
Search Monitor	To find an available AQM60 Monitor
Start Data Logging	To start logging data from AQM60 Monitor
Stop Data Logging	To stop logging data from AQM60 Monitor
Export Logged Data	To transfer logging data from AQM60 Monitor
Download Files	To download the files from the AQM60
Update sensor list	To refresh the sensor list on the database
Exit	To close the AQM Software

Setup

Menu	Descriptions
Configuration	To configure the AQM ID, Sensor Module and gas calibration units
Operations	To configures the interval of data logging and Auto Zero Data logging interval and Auto Zero Function
Test Connection	To examine the connection of computer with the AQM monitor
COM Port	To sets the serial COM port for communicating with the AQM Monitor

Data

Menu	Descriptions
Graph Real Time	To obtain the real time data graph
Graph Logged Data	To obtain the logging data graph
Graph Default Graph Style	To changes the graph style
Table Real Time	To tabulate the real time data table
Table Logged data	To tabulate the logging data table

Tools

Menu	Descriptions
View Configuration	To overviews the configuration settings
Update Real Time Clock	To updates the real time clock of AQM60 that must tally with the computer
Reset Controller	To reset the software of the AQM60

RF Modem

Outdoor RF line of sight range	5 km
Transmit power output	50milli W
Receiver sensitivity	-105 dBm
Spread spectrum	Frequency Hopping Spread Spectrum
RF data rate	10000 bps
Frequency range	2.4 to 2.4835 GHz

3.4 TIME SERIES ANALYSIS

The data that has been collected in the AQM60 software was exported to the Microsoft Excel. Time series analysis was the assortment of observations of definite data gained through repetitive measurement over time. The interval for every data was 3 minutes was recorded for the 6 days period for 12-h real time data. The primary objective of time series analysis to explain trend of a particular variable in time. Through this analysis, it can obtain the trend of the concentration of NMHCs in ambient air at the respective time frame. It also can relate with the temperature and humidity that may influence the concentration of NMHCs. Otherwise, the analysis also can use to observe the relationship between number of vehicles and the concentration of NMHCs. Time series analysis was the best method that can be used to give a clear understanding about the relationship of causes and effects to the environment.

3.5 TRAFFIC FLOW

The trend of vehicles that passes the street was observed and recorded. This method is significant to relate with the concentration of NHMC in ambient air. Then, all the vehicles types were converted to passenger car unit (PCU) to be a unified factor (Wesam,2010). Conversion was done based on the standard values where to relate with the trends of NMHCs using this formula.

$$PCU = (Car) + (0.33 \times Motorbike) + (1.75 \times Lorry) + (2.25 \times Truck) + (2.25 \times Bus)$$

3.6 COMPARE CONCENTRATION WITH THE STANDARD GUIDELINES

Compare concentration of NHMC at a few critical areas with the standard guidelines. Maximum concentration of NMHCs for the urban/industrial area is 100 ppb while for the rural area is 80 ppb If the concentration is higher than the limit that has been fix by DOE it shows that particular area was polluted and harmful for the human health.

3.7 GANTT CHART

FYP 1

NO	ACTIVITIES	DURATION													
		MAY			JUNE				JULY				AUGUST		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**Selection Project Title**														
	Survey the relevent topic for FYP														
	Choose FYP topic														
	Meeting with Supervisor														
2	**Preliminary Research Work and Data Gathering**														
	Collect the relevent books, journals and articles														
	Understanding the problem statement														
	Identify the objective of the project														
	Filter and sorting data the critical literature review														
	Choose the suitable methodology														
	Preparation of extended proposal														
3	**Identify the Location for Sampling**														
	Survey the place that can supply power source														
	Learn to sychoronize the instrument with computer														
4	**Submission of Extended Proposal**														
	Submit to supervisor and coordinator														
5	**Proposal Defense**														
	Preparaton of slide for proposal defense														
	Presentation of proposal defense														
6	**Interim Report**														
	Improvement of extended proposal														
	Submission of Pre-Interim Report														
	Submission of Pinterim Report														

FYP 2

NO	ACTIVITIES	DURATION													
		SEPEMBER			OCTOBER				NOVEMBER				DECEMBER		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**Progress Report**														
	Research work continue														
	Sampling period														
	Time series analysis														
2	**Pre SEDEX**														
	Amendment of Progress Report														
	Preparation Poster														
	Poster Presentation														
3	**Submission of Draft Report**														
	Amendment of report based on comment of poster														
	Improving the data analysis														
4	**Submission of Dissertation (Soft Bound)**														
	Amendment of Draft Report														
5	**Submission Technical Paper**														
	Preparaton of technical paper														
6	**Oral Presentation VIVA**														
	Preparation for VIVA														
7	**Submission of Dissertation (Hard Bound)**														
	Submission of Dissertation Report														

CHAPTER 4

RESULTS AND DISCUSSIONS

Concentration of NMHCs was analyzed for 7 days of sampling time that started from 27 October 2017 until 18 November 2017. The data was collected for every 3 minutes interval for 12 hours real time. So, there were 1880 numbers of data collected for the concentration of NMHCs. The sampling session was carried out at three specific areas which are near the roadside, close to industrial area and at the rural area within radius 2 km from the fly over at Batu Gajah. Then, the pattern of NMHCs concentration was analyzed for the respective locations.

Time series analysis was presented by using graph in Microsoft Excel after converting the data into hourly average. The major function of the time series analysis to explain the trend of the particular variables in term of time. The outcomes of sampling data can be classified to two which are during weekdays and weekends. The separation of these time frame because the trend of the vehicles emission and industrial activities which main contributor for air pollution, are slightly different according to the time frame. For the initial conclusion, it can be notified the numbers of vehicles passed the flyover during weekends are less than weekdays. The concentration of NMHCs also higher during the operation hours of the factories at industrial area. Lastly, the concentration of NMHCs at rural area should be less concentrated than industrial area.

4.1 WHOLE DAY PROFILING

4.1.1 Correlation between NMHCs Concentration and Traffic Volume

The sampling was started on 4:15 and finish at 1:45 for whole day, and the main objective to obtain the peak of NMHC's emission to the ambient air during the morning, afternoon and evening. For the traffic flow, PCU formula has been utilized to calculate average volume of vehicles passed through the road for the whole day of sampling time. Both data that collected from traffic volume and the trends of NMHCs concentration was correlated in Figure 18.

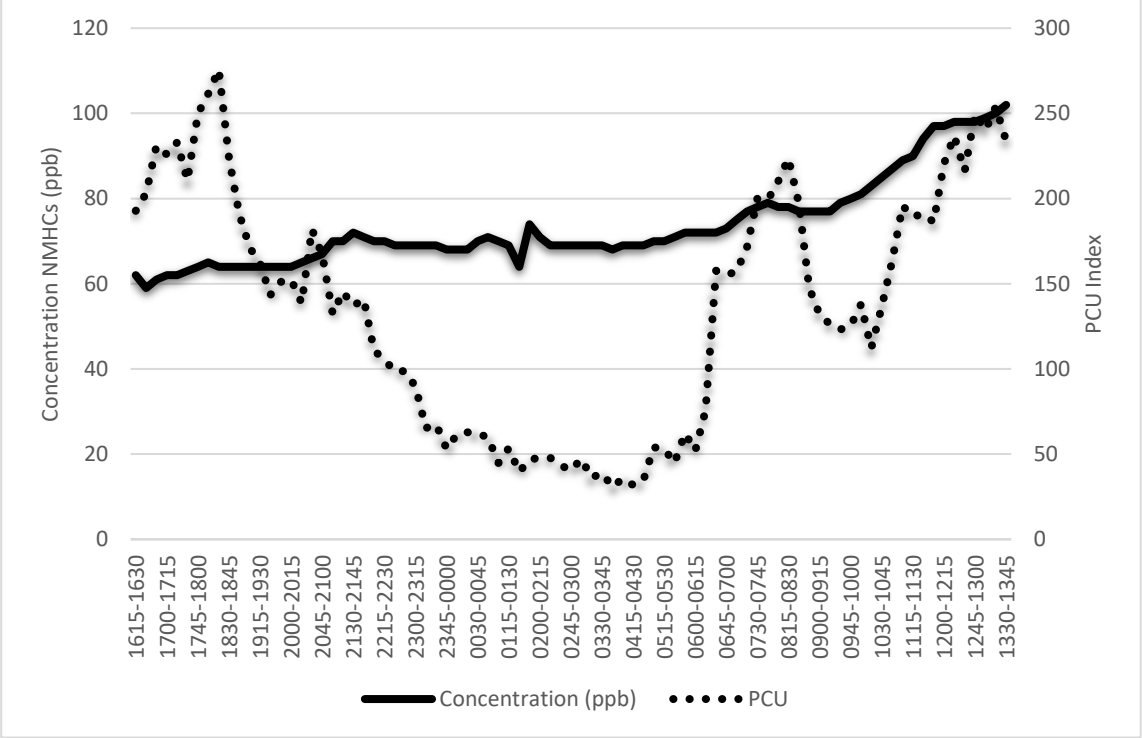

Figure 18:Correlation between concentration of NMHCs and traffic volume

The highest of NMHCs concentration during morning season was between 11:15 until 11:30 with 90 ppb and traffic volume during that period was 189 units. For the afternoon period, the concentration of NMHCs was 102 ppb that occur from 13:30 until 13:45 with the volume of traffic was 234 units. Finally, during the evening season, the peak happens at 18:00 until 18:15 with the concentration around 65 ppb while the traffic volume was 261 units.

From the graph, it can be concluded the peak hour for the morning is between 6:30 to 8:30 and the afternoon period was between 12:00 to 14:00 and during evening, the peak hour at 16:30 to 18:30. Table 8 was summarized the volume of traffic and average concentration during peak hours.

Table 8: Total PCU and average NMHCs concentration for every peak

Time	Total of PCU	Average concentration of NMHCs (ppb)
Morning (6.30 a.m. to 8.30 a.m.)	1475	76
Afternoon (12.00 p.m. to 2.00 p.m.)	1877	99
Evening (4.30 p.m. to 6.30 p.m.)	1891	62

From the Figure 18 and Table 8, it can be resolved the trend of vehicles at the heavy phase during the day comparing to the night. The trends obviously happen because human activities mostly operated during the day. Traffic volume show the significant influence to the trend of NMHCs because during peak hour of traffic volume, concentration of NMHCs was high.

4.1.2 Relationship between Concentration of NMHCs, Temperature and Humidity

Relationship between the concentration of NMHCs with meteorological parameter such as temperature, humidity and wind speed are vital due the effect of these parameter to the reading of concentration. Figure 19 show the comparison between concentration of NMHCs, temperature and humidity with the time.

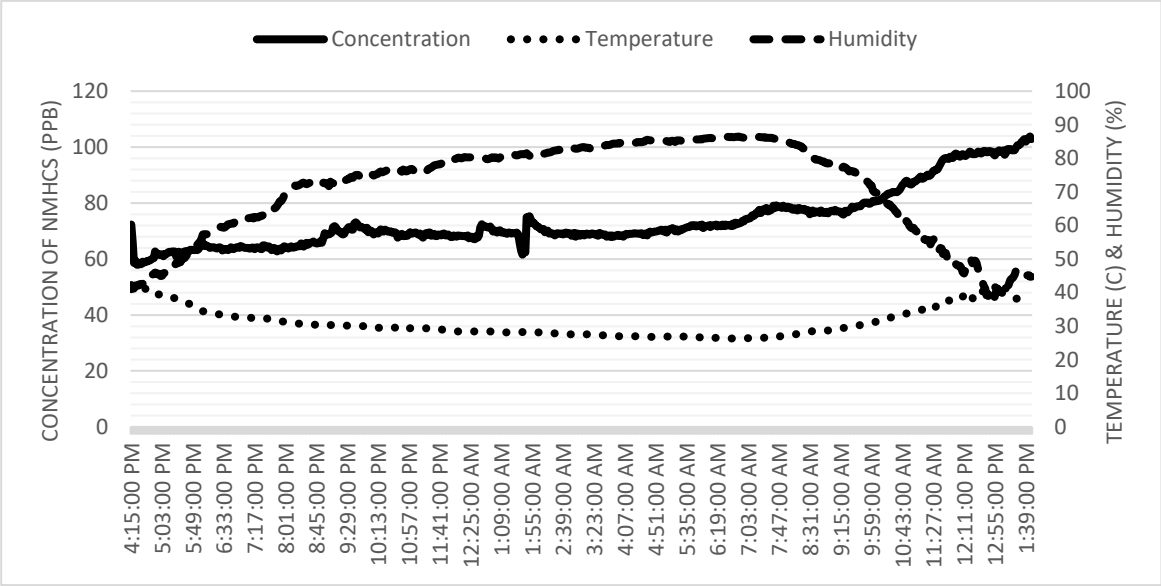

Figure 19: Relationship between concentration NMHCs, Temperature and Humidity

For the initial hypothesis, the concentration of NMHCs was higher at the high temperature and the low relative humidity. At normal condition, the percentage of relative humidity was depending on the temperature that may influenced the concentration.

From the graph, it can be settled the concentration NMHCs slightly decreased at the night and early in the morning, when the temperature was low and humidity was high. The highest temperature and lowest humidity at 12:37 with 42 °C and 38.1 % respectively with the concentration of NMHCs at 98 ppb. The lowest temperature and highest humidity at 6:37 with 26°C and 86.3% separately with the concentration of NMHCs at 72 ppb. So, the meteorological condition also can influence the concentration of NMHCs in ambient air.

4.2 TRENDS FOR LOCATION 1 (ROADSIDE)

4.2.1 Correlation between Traffic Flow and Concentration of NMHCs during Weekday

Location 1 was located near to roadside which are to investigate the correlation between vehicles emission and NMHCs concentration. The initial conclusion was stated the higher the volume of vehicles passed the road, the higher the concentration of NMHCs. Figure 20 illustrated the traffic flow and the concentration against time.

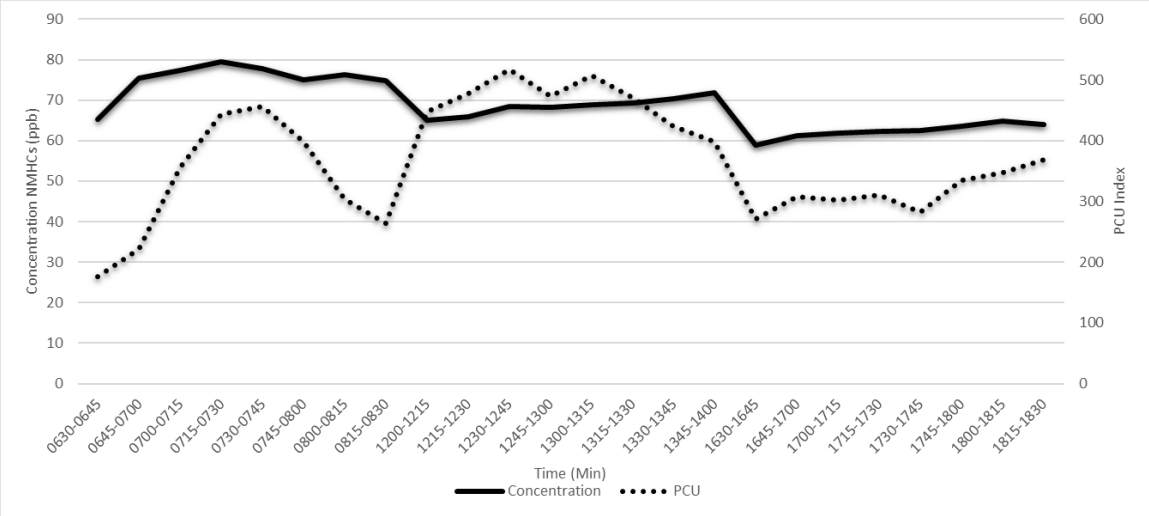

Figure 20: Correlation between concentration NMHCs and Traffic Flow

The total volume of vehicles passed through the road were 8859 units. Table 9 shows the summarized of PCU index that consist average and total volume of vehicles.

Table 9: Average and Total PCU Index

Time	Total of PCU	Average of PCU Index
Morning (6.30 a.m. to 8.30 a.m.)	2620	328
Afternoon (12.00 p.m. to 2.00 p.m.)	3716	464
Evening (4.30 p.m. to 6.30 p.m.)	2523	315

From the graph, it can be concluded at the morning, the volume of vehicles emission influenced the concentration of NMHCs, but during the afternoon period, the concentration of NMHCs doesn't follow the trends of PCU index that causes by industrial activities that not operate during that period. Lastly, at the evening the concentration of NMHCs follow back the trends of PCU index. Subsequently, the vehicles emission can be the main causes of the higher concentration of NMHCs.

4.2.2 Relationship between Concentration of NMHCs, Temperature and Humidity during Weekday

Figure 21 show the relationship between concentration of NMHCs, temperature and humidity against time during the weekdays at the roadside. This location was selected to study the effect of vehicles emission to concentration of NMHCs in ambient air. This sampling was conducted for 12 hours that consist of all the peaks during morning, afternoon and evening.

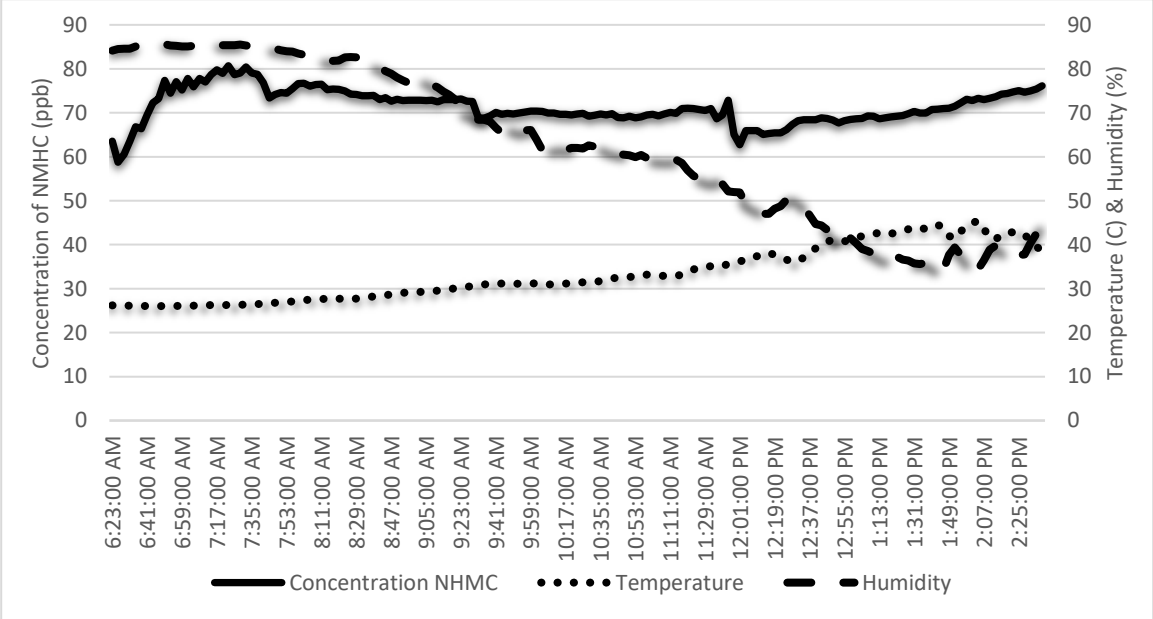

Figure 21: Relationship between Concentration NMHCs, Temperature and Humidity at Location 1

The average concentration of NMHCs during morning is 75 ppb and the highest is 81 ppb that occur at 7:23 (in the range) of peak at the morning. The lowest concentration of NMHCs at 6:26 with 59 ppb that out of the peak's range. For the afternoon period, the average, highest and lowest of NMHCs concentration is 69 ppb, 73 ppb, 63 ppb respectively. The highest and lowest concentration of NMHCs happen at 13:58 (in the range) and 11:58 (out of range) in separately. The highest temperature during the sampling time is 46°C with the concentration of NMHCs was 73 ppb that consider high for a day and the lowest relative humidity was 34.1% with high concentration which is 70 ppb.

4.2.3 Correlation between Traffic Flow and Concentration of NMHCs during Weekend

The instrument was placed at the same point to constant the variable with the weekdays. The initial conclusion was stated the higher the volume of vehicles passed the road, the higher the concentration of NMHCs. Figure 22 illustrated the correlation between traffic flow and the NMHCs concentration against time.

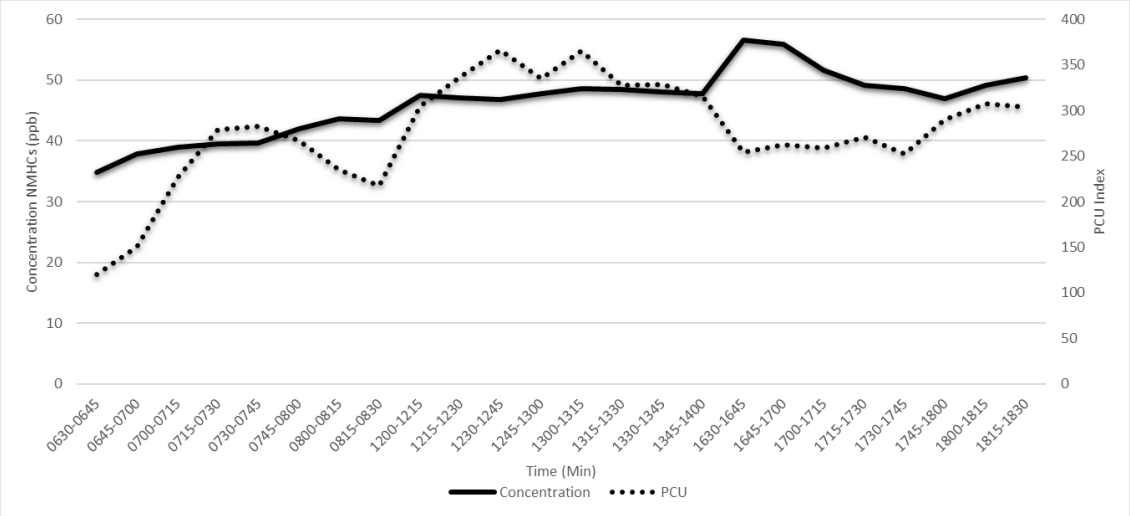

Figure 22: Correlation between Concentration of NMHCs and traffic flow

From the graph, it can be concluded at the morning, the volume of vehicles emission doesn't give a significant influenced to the concentration of NMHCs, but during the afternoon period, the concentration of NMHCs follow the trends of PCU index that causes by high volume of vehicles passed the road during that period. Lastly, at the evening the concentration of NMHCs show the slightly inverse to the trends of PCU index due to open burning has been done by the resident at that area.

As conclusion, the influences of vehicles emission to the concentration of NMHCs during weekends are lower comparing weekdays due to low volume of vehicles passed the road.

4.2.4 Relationship between Concentration of NMHCs, Temperature and Humidity during Weekend

Figure 23 display the relationship between concentration of NMHCs, temperature and humidity against time during the weekends at the location 1.

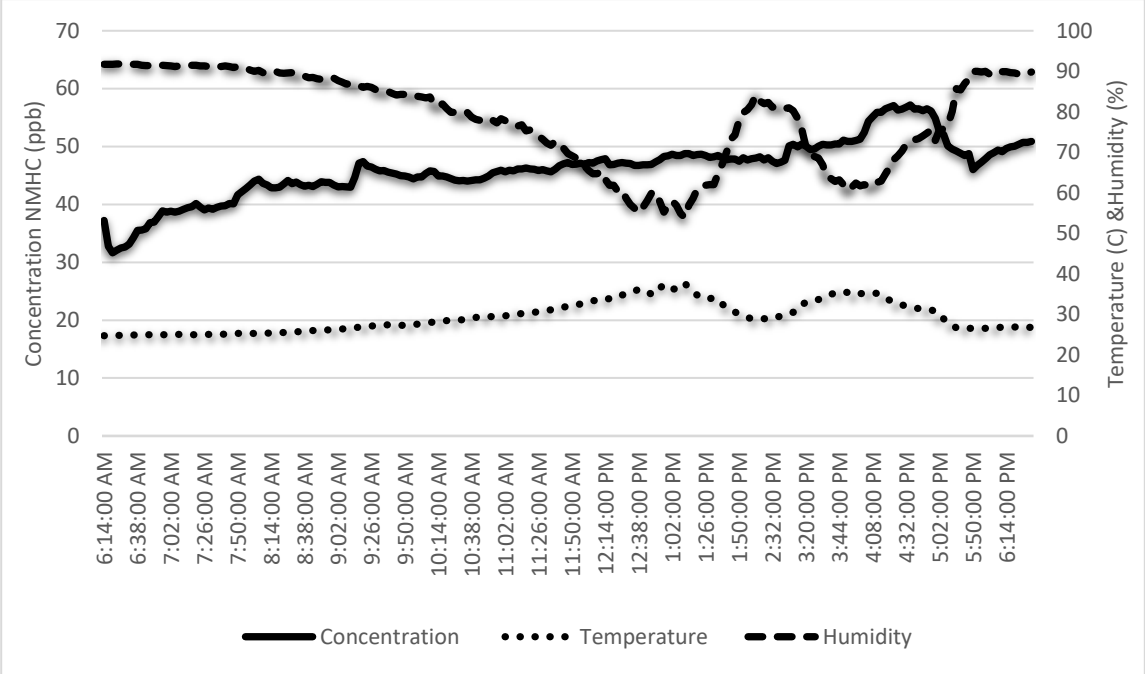

Figure 23: Relationship between Concentration NMHCs, Temperature and Humidity at Location 1

The average concentration of NMHCs during morning was 40 ppb and the highest was 48 ppb that occur at 9:20 which is out the range of peak at the morning. The lowest concentration of NMHCs at 6:20 with 32 ppb that out of the peak's range.

For the afternoon period, the average, highest and lowest of NMHCs concentration is 48 ppb, 49 ppb, 46 ppb respectively. The highest and lowest concentration of NMHCs happen at 13:14(in the range) and 11.32(out of range) in separately. Finally, at the evening, average concentration of NMHCs that measured was 51 ppb with the highest concentration occur at 16:35(in the range) with 57 ppb and the lowest concentration happen at 17:50(in the range) with 46 ppb. The lowest temperature during the sampling time is 28 °C with the concentration of NMHCs was 37 ppb that consider low for a day and the highest relative humidity is 91.8 % with low concentration that was 32 ppb.

4.2.5 The Comparison of NMHCs Concentration during Weekend and Weekday

The traffic volume during the weekdays was higher than weekends which means the concentration of NMHCs during weekends should be lower than weekdays. Figure 24 show the comparison of NMHCs concentration between the weekdays and weekends.

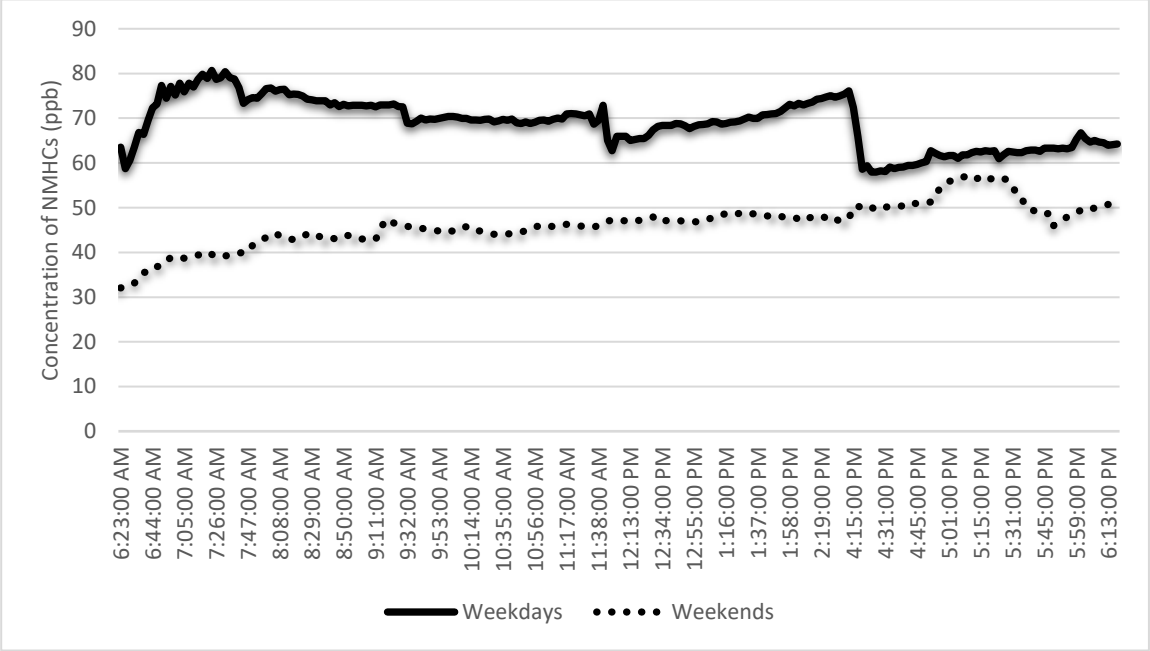

Figure 24: Concentration NMHCs during weekend and weekday

From the graph, it able to resolved that initial hypothesis was acceptable, the concentration of NMHCs during weekdays higher than weekends. The highest concentration was recorded at the morning for the weekdays due human activities started to operate mostly during morning while for the weekends, the highest concentration at the evening because usually family spending their times together to do outdoor activities during this time.

4.3 TRENDS OF LOCATION 2 (INDUSTRIAL AREA)

4.3.1 Relationship between Concentration of NMHCs, Temperature and Humidity during Weekday

The relationship between concentration of NMHCs, temperature and humidity against time during the weekday at the location 2 was shown in Figure 25.

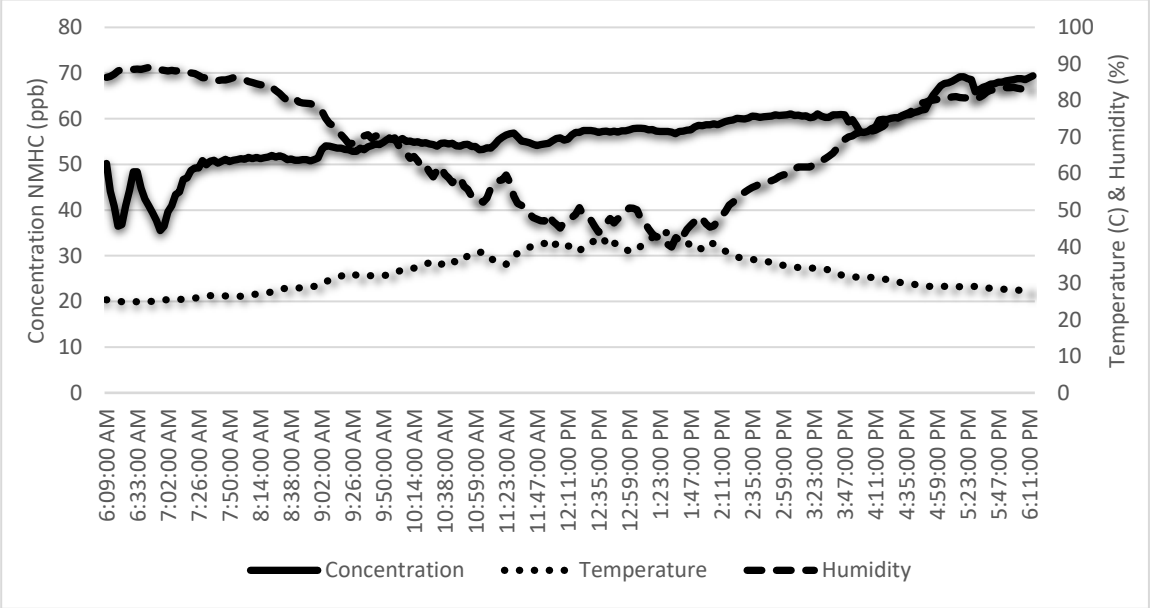

Figure 25:Correlation between Concentration NMHCs, Temperature and Humidity at Location 2

The average concentration of NMHCs during morning was 55 ppb and the highest was 57 ppb that occur at 11:29 that in the range of morning peak for industrial activities operation. The lowest concentration of NMHCs at 6:56 with 36 ppb that out of the morning peak's range. For the evening period, the average, highest and lowest of NMHCs concentration were 60 ppb, 69 ppb, 57 ppb respectively. The highest and lowest concentration of NMHCs happen at 18:14 (in the range) and 13:35 (out of range) in separately. The lowest temperature during the sampling time was 25 °C with the concentration of NMHCs was 44 ppb that consider low for a day and the highest relative humidity was 89.1 % with low concentration that around 39 ppb.

4.3.2 Industrial Activities at Location 2

Location 2 was selected near industrial area to investigate the relationship between industrial activities with the concentration of NMHCs. Most of factories at the areas started their operation from the morning around 8:00 until evening at 17:00, so it can decide to choose two peaks during the sampling time that in the morning (9:30 to 11:30) and evening (14:30 to 4:30). Industrial activities that carried out at the areas was summarized in Table 14.

Table 10: Industrial Activities at Location 2

Name of Organization	Manufactured
Industry 1	Manufacturing of electrical and electronic components
Industry 2	Manufacturing of pre-cast concrete
Industry 3	Manufacturing of can and bottle for beverages
Industry 4	Manufacturing of latex based products for dental and health applications
Industry 5	Manufacturing of stainless steel
Industry 6	Manufacturing of ceramics for home decoration

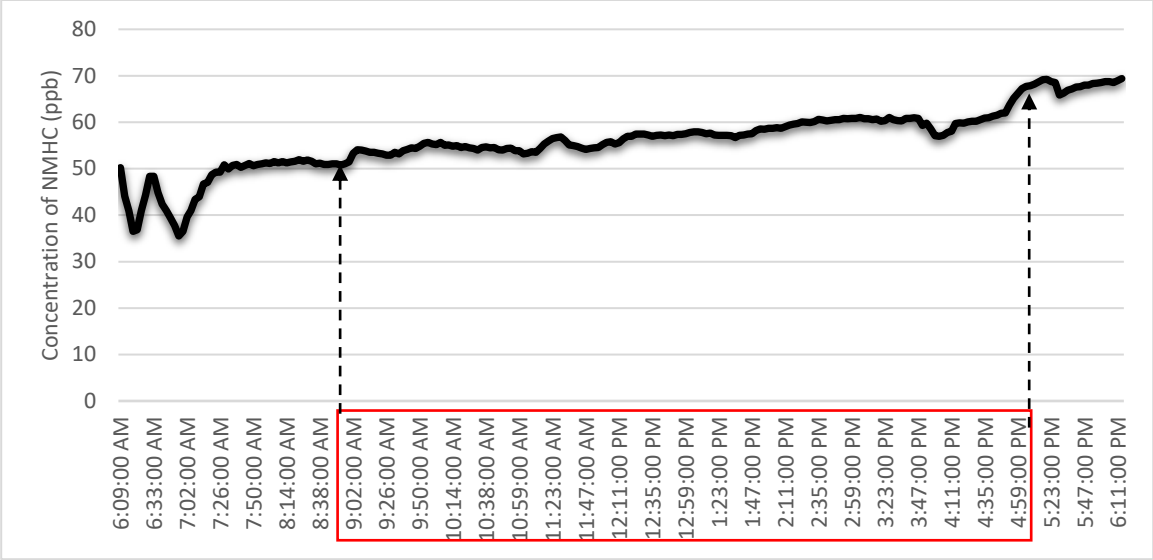

Figure 26:Concentration of NMHCs during weekday

Figure 26 show the concentration of NMHCs during the weekday. The time that been highlighted to show the operation hours for the most of factories at the industrial area. From the graph, it shows an increasing of concentration NMHCs during the operating hours. The peak of the whole day also happens during that period specifically at the evening, during this period the factories has released their residues or pollutants to the ambient air after finished their operation for the whole day.

4.3.3 Relationship between Concentration of NMHCs, Temperature and Humidity during Weekend

The relationship between concentration of NMHCs, temperature and humidity against time during the weekend at the location 2 are shown in Figure 26. Same location was selected like the weekday to avoid the variable was vary. The period of sampling was conducted for 12-hours real time that consist of all the peaks during morning and evening.

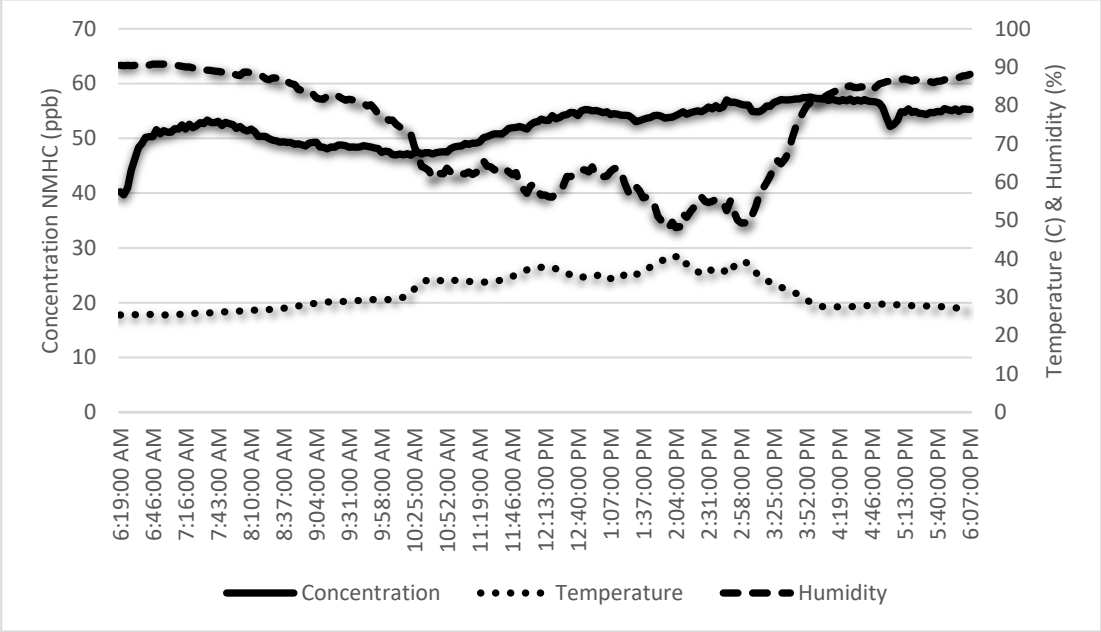

Figure 27:Correlation between Concentration NMHCs, Temperature and Humidity at Location 2

The average concentration of NMHCs during morning was 48 ppb and the highest was 53 ppb that occur at 7:35 that out the range of morning peak for industrial activities operation. The lowest concentration of NMHCs at 6:22 with 40 ppb that out of the morning peak's range. For the evening period, the average, highest and lowest of NMHCs concentration were 57 ppb, 58 ppb, 52 ppb respectively. The highest and lowest concentration of NMHCs happen at 15:55 (in the range) and 17.00 (out of range) in separately. The highest temperature during the sampling time was 41°C with the concentration of NMHCs was 55 ppb that consider high for a day and the lowest relative humidity was 48.1 % with high concentration that 54 ppb.

4.3.4 The Comparison of NMHCs Concentration during Weekend and Weekday

The industrial activities mainly operate during the weekdays and stopped during the weekends. That means the concentration of NMHCs during weekdays should be higher than weekdays. Figure 27 show the comparison of NMHCs concentration between the weekdays and weekends.

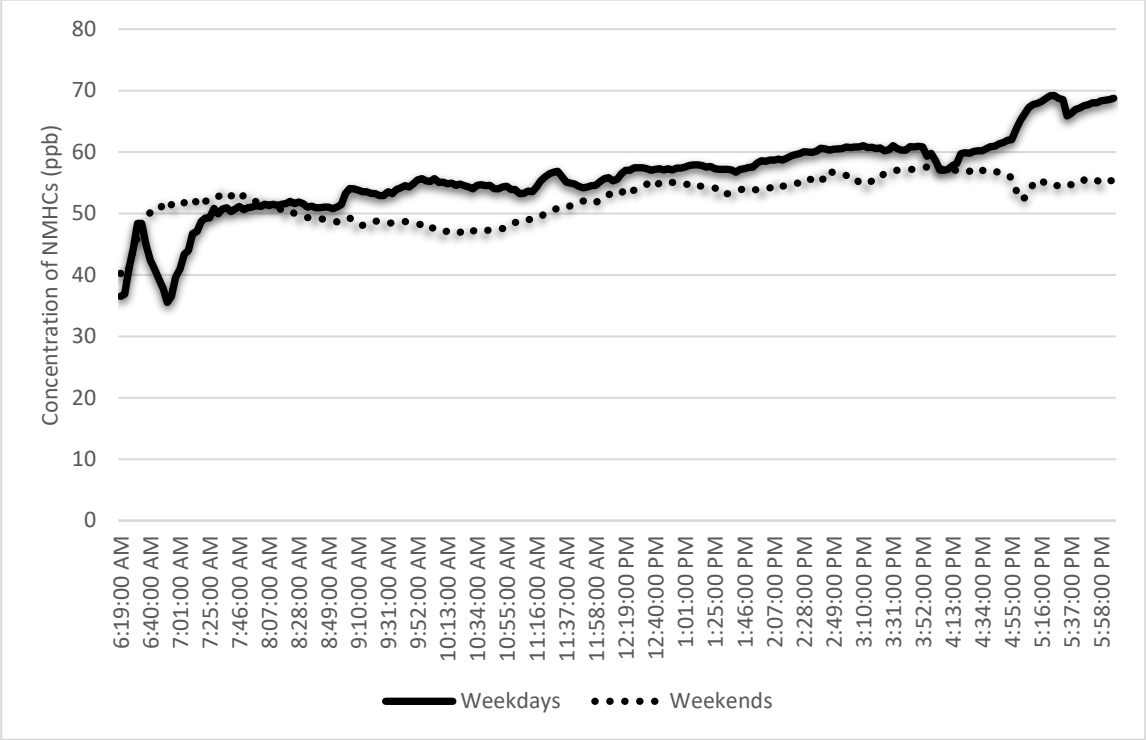

Figure 28: Concentration NMHCs during weekend and weekday

From the graph, it able to resolved that initial hypothesis was accepted that concentration of NMHCs during weekday higher than weekend. But the variation was not too big around 5 ppb for every time interval. During the morning, the concentration of NMHCs during weekend was higher that contra to the initial conclusion. The reason was due to meteorological condition like the weather was cloudy during weekday and steady during weekend. After that, for the whole day, the concentration during weekday was higher than weekend. As a conclusion, the industrial activities can be secondary source to the increasing of the concentration NMHCs in ambient air after vehicles emission.

4.4 TRENDS FOR LOCATION 3 (RURAL AREA)

4.4.1 Relationship between Concentration of NMHCs, Temperature and Humidity during Weekday

The relationship between concentration of NMHCs, temperature and humidity against time during the weekday at the location 3 are shown in Figure 28. Location 3 was selected to study the concentration of NMHCs at the rural area. Papan Village that located 1.2 km from the fly-over was chosen because this place only the rural area within radius 2 km from exact study area. The period of sampling remains the same that conducted for 12-hours real time consist of all the peaks during morning, afternoon and evening.

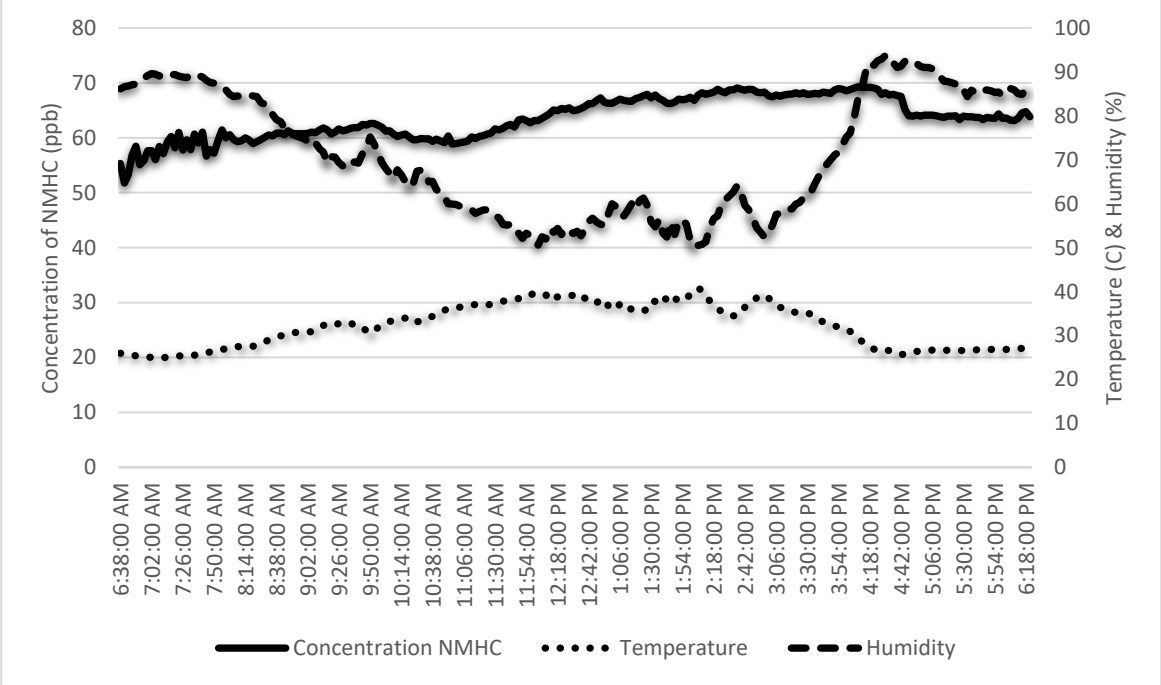

Figure 29:Correlation between Concentration NMHCs, Temperature and Humidity at Location 3

The average concentration of NMHCs during morning was 60 ppb and the maximum concentration was 63 ppb that occur at 9:50 and the minimum concentration was 52 ppb that happen at 6:41. At the afternoon, average concentration of NMHCs was recorded around 66 ppb with the highest concentration occur at 14:21 with the reading around 69 ppb and the lowest concentration happen at 11:33 (in the range) with 61 ppb. Finally, for the evening period, the average, highest and lowest of NMHCs concentration were 66

ppb, 69 ppb, 63 ppb respectively. The highest and lowest concentration of NMHCs happen at 16:10 and 18:10 in separately. The lowest temperature during the sampling time was 25°C with the concentration of NMHCs was 58 ppb that consider low for a day and the highest relative humidity was 93.7 % with high concentration that 68 ppb.

4.4.2 Relationship between Concentration of NMHCs, Temperature and Humidity during Weekend

The relationship between concentration of NMHCs, temperature and humidity against time during the weekend at the location 3 was shown in Figure 29. The instrument was placed at the same location as weekday to avoid the reading were manipulated due differ location. The period of sampling remains the same that was conducted for 12-hours real time consist of all the peaks during morning, afternoon and evening.

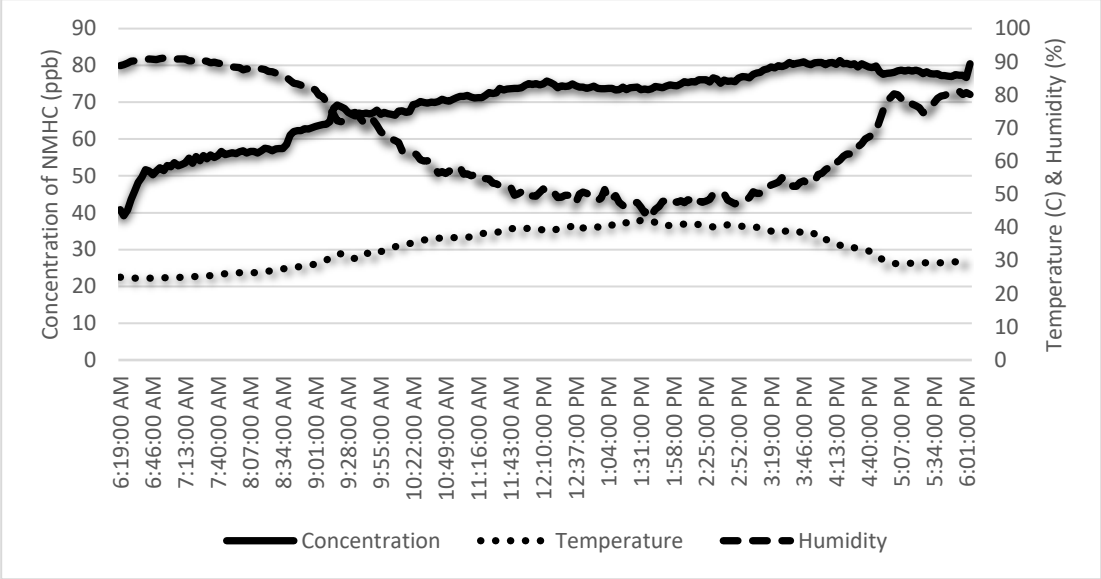

Figure 30:Correlation between Concentration NMHCs, Temperature and Humidity at Location 3

The average concentration of NMHCs during morning was 61 ppb and the maximum concentration was 73 ppb that occur at 11:25 and the minimum concentration was 39 ppb that happen at 6:22. At the afternoon, average concentration of NMHCs that been measured was 74 ppb with the highest concentration occur at 14:25 with the reading around 76 ppb and the lowest concentration happen at 11:31 with 72 ppb. Finally, for the evening period, the average, highest and lowest of NMHCs concentration were 79 ppb, 81 ppb, 75 ppb respectively. The highest and lowest concentration of NMHCs happen at 16:16 and 14.37 in separately. The highest temperature during the sampling time was 42°C with the concentration of NMHCs was 73.37 ppb that consider high for a day and the lowest relative humidity was 43.9 % with high concentration that 73 ppb.

4.3.3 The Comparison of NMHCs Concentration during Weekend and Weekday

Location 3 (rural areas) mainly not disturbed by the industrial activities and volume of vehicles, so concentration of NMHCs should be lesser than location 1 (roadside) and location 2 (industrial area). So, the most influenced variable for this area were meteorological parameters. Location 3 was faced a rainy weather on both day during sampling was conducted that also affected the concentration of NMHCs. The other factor that can be spotted for this location was open burning that has been done by villagers. The concentration of NMHCs for this area should be only have a small gap for both day. Figure 30 show the comparison of NMHCs concentration between the weekday and weekend.

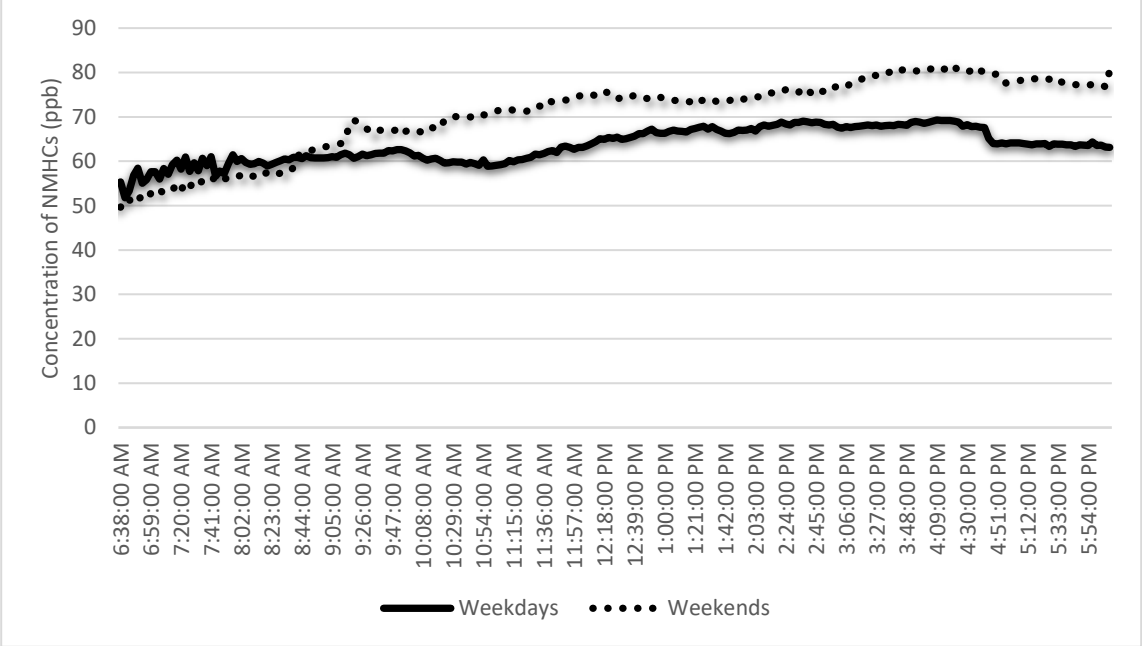

Figure 31:Concentration NMHCs during weekend and weekday

From the graph, it able to resolved that initial hypothesis was accepted that the chasm between the weekday and weekend was small. The largest chasm around 10 ppb that was acceptable. For these location, the concentration of NMHCs at weekend was dominate the concentration NMHCs during weekday. But at the morning, weekday higher than weekend that the reason was open burning has been done by the villagers at that area.

4.5 THE COMPARISON OF DIFFERENT LOCATION

4.5.1 The Comparison of NMHCs Concentration at Different Location during Weekday

The comparison was conducted to observe the most influenced factor that can cause a high concentration of NMHCs between three different locations that display in Figure 31 during the weekdays**.**

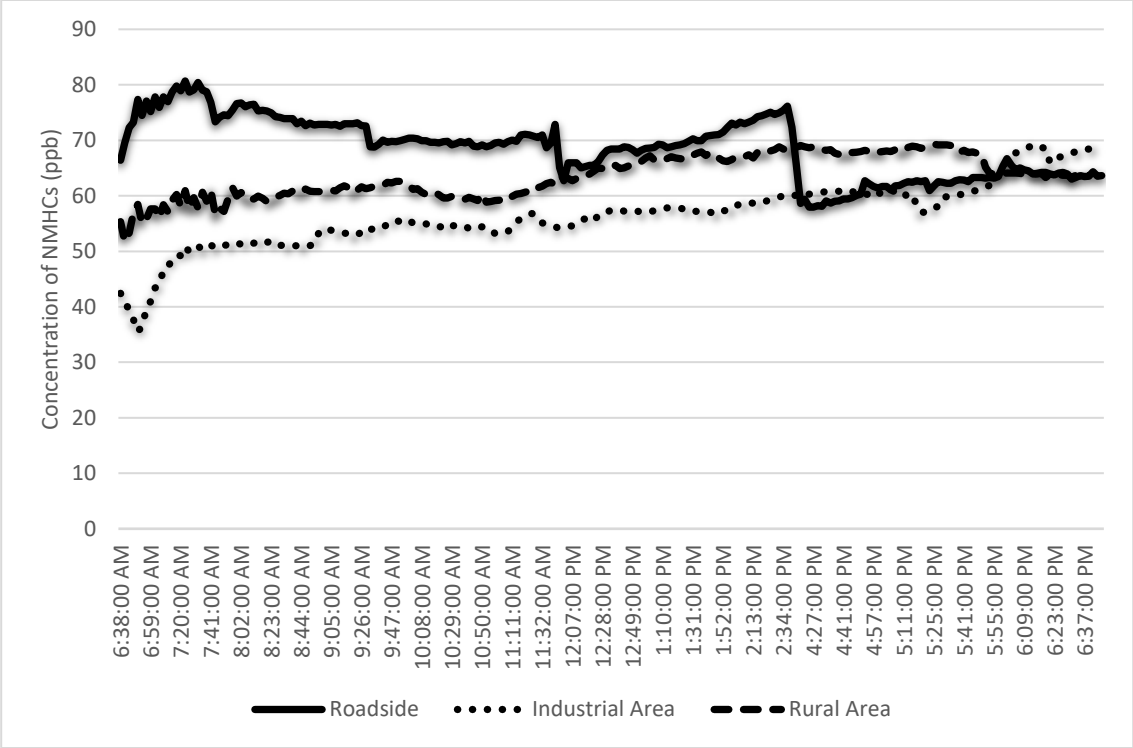

Figure 32:Comparison of NMHCs Concentration at Different Location

From the graph, roadside was dominating the concentration of NMHCs from 6:30 until 12:00. When the day comes to afternoon, the concentration NMHCs experienced the decreasing from 70 ppb to 60 ppb but still dominating the other factors. From 15:00 to 18:00, the rural area takes a first position followed by roadside and rural area. Lastly, for 18:00 onwards the industrial activities at the highest concentration for the first time in whole day.

The largest gap for the morning session was around 40 ppb between roadside and industrial area and the smallest gap around 16 ppb also between roadside and industrial

area. During afternoon session, the biggest and smallest gap are 20 ppb and 8 ppb respectively and both between roadside and industrial area. Finally, at the evening period, the major gap was around 11 ppb between industrial and rural area and the minor gap around 0.5 ppb also between industrial area and rural area.

As a deduction, the roadside was contributing the highest concentration during the morning and afternoon session because the volume of vehicles at the most during that periods that cause emission from vehicles exhaust at the high rate. From the early until end of evening, the humidity decrease that cause the concentration of NMHCs increase. Lastly, started from late of evening until twilight, the industrial area subsidizes the highest concentration of NMHCs due to many factories release the residue after operating for whole day during that time.

4.5.2 The Comparison of NMHCs Concentration at Different Location during Weekend

Figure 32 illustrated the comparison of concentration of NMHCs at different location that has been done to spot the most influenced factor that can cause high concentration of NMHCs in ambient air.

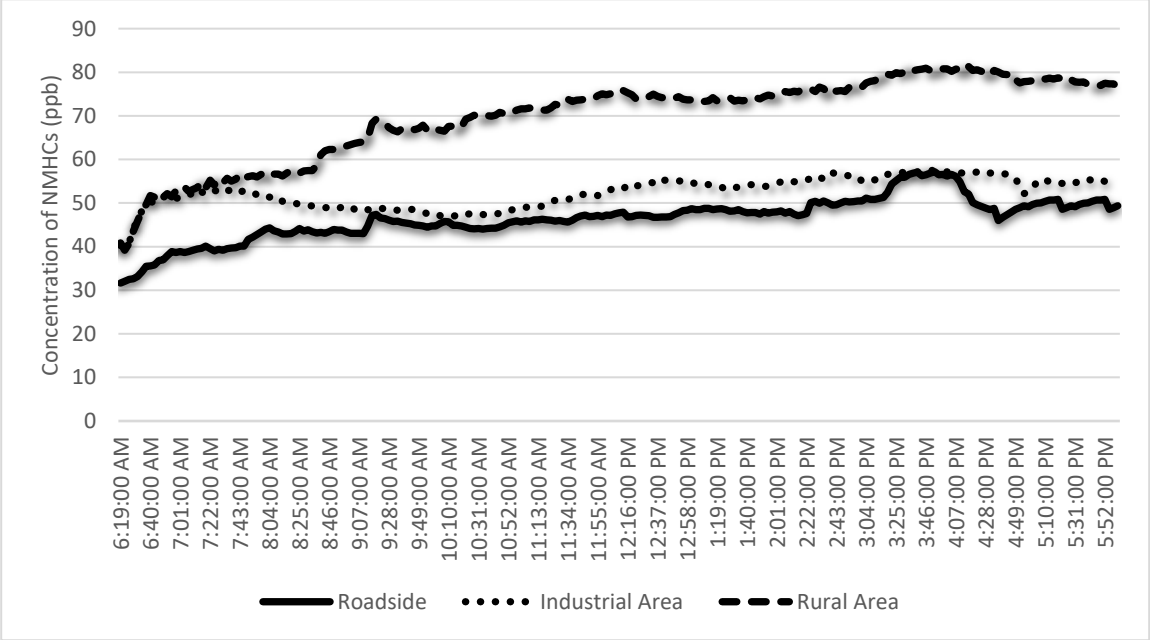

Figure 33:Comparison of NMHCs Concentration at Different Location

From the graph, industrial and rural area show slightly same concentration of NMHCs between 6:20 until 7:30 that higher than roadside. Starting from 7:30 until 18:00 which means the whole day, the concentration NMHCs was dominating by rural area follow by industrial area and roadside.

The largest gap for the morning session around 21 ppb between rural area and roadside and the smallest gap around 0.6 ppb also between industrial area and roadside. During afternoon session, the largest and smallest gap were 27 ppb and 5 ppb respectively and that happen between rural area and roadside, and between industrial area and roadside. Finally, at the evening period, the major gap around 34 ppb between rural area and roadside, the minor gap around 0.4 ppb between industrial area and roadside.

In the nutshell, the rural area was contributing the highest concentration for the whole day although the concentration at same value during the morning between rural and industrial area. These results because humidity at the rural area remains low due the rain for most of the whole day. Besides, the volume of vehicles passed by the main road was low and most of factories at industrial area was not operated

CHAPTER 5

CONCLUSION

The effect of air pollution cannot be taken by granted. The hazardous effects provided very dangerous to human health especially to the respiratory system. This study also significant because it can identify the types of pollutant that emitted by industrial and human activities in Tronoh. There are two main sources has been indicated through these researches that from vehicles exhaust and factories chimney. The compounds that release by vehicles exhaust were particulate matter (PM_{10}), various types of hydrocarbon except methane (NMHCs), nitrogen oxides (NOx), carbon monoxide (CO), sulfur dioxide (SO_2) and toxic including benzene, acetaldehyde and 1,3-butadiene. There were various factories that manufacturing different products like steel, electronic, beverages containers, concrete, latex and ceramic industry. These factories were released various pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), particulate matter (PM_{10}) and various organic solvent including isopropanol, acetone, xylene and substance can cause ozone depletion.

From these researches, the concentration of NMHCs in ambient air of Tronoh can be classified in the healthy or safe zone because doesn't exceed limit that has been standardized by Department of Environment (DOE). The traffic volume at the Tronoh can be allocated in moderate zone and the industrial activities also can be controlled. Through this, it's can conclude the consequent of harmful pollutant that may deteriorated the natural environment. Lastly, there are various meteorological parameters that can influenced the concentration of NMHCs including temperature, humidity and wind speed. These factors give more impact to the concentration during the weekends comparing to the weekdays. Tronoh can be categorized the place that have stable temperature because never exceed 45°C and the peak was happen during the afternoon. The weather at Tronoh can be classified as humid during morning and late of evening and dry at the afternoon which means the common weather in Malaysia.

5.1 RECOMMENDATIONS

There were several matters that can be improved in the further investigation about the coordination of pollutants in ambient air. First, it recommended to add number of sampling days at each location. This method was effective to study the trends concentration of NMHCs though comparing the average concentration. Secondly, extend the sampling time to 24-hours real time so that able to observe the concentration of NMHCs for the whole day. The data analysis become more accurate to find the maximum and minimum concentration. Besides, the selection of location that was safer to carry out the investigation. For these researches, the location a bit danger that why the investigation cannot be conducted for 24-hours. Then, expand the scope of study rather than one pollutant to the various pollutants for each student. The benefits of implementation were able to gain more knowledge and data analysis will be more complex. If this method was utilized, supervisors must provide the equipment that more lighter than existing instrument. During the research, the students have a difficulty to carry the equipment which need at least 3 members to set up the equipment.

From the researched, it was recommended to control the emission of carcinogenic compound to the ambient air from the various sources including vehicles and industrial area. When, the emission was controlled the quality of ambient air can be improved and the human disease due to air pollution also can be reduced. Besides, it's also vital to build a specific barrier between the industrial and rural area. When the distance of this area was far, the rural area was not being affected by pollutants that has been emitted by the industrial activities. So that, the combination of two sources of pollution can be dealt by apply this method to ensure a good air quality.

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