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A Monitoring of Air Pollutants (CO, SO_2 and NO) in Ambient Air Near an Industrial Area

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Abstract. A monitoring assessment was carried out to measure the concentration of air pollutants in ambient air in the university campus, which is located adjacent to the industrial area. The air pollutants were monitored for CO (Carbon monoxide),SO_2 (Sulfur dioxide) and NO (Nitrous oxide) at the three sampling points, with distance reference based from the industrial area. Air pollutant gases were sampled from the I-Brid Toxic Gases Analyzer with the sampling hour referred to the Recommended Malaysian Air Quality Guidelines (RMAQG) during October 2013 to Jun 2014. Meteorological data was collected from the E-Sampler device for 24 hours. It was found that the CO concentrations were fall within the RMAQG at all stations monitored. The SO_2 concentration was high at Station 3 (Material lab), with 0.66 ppm which was exceeded the RMAQG of 0.13 ppm. All three stations recorded high concentration of NO, which the peak concentration occurred at the afternoon sampling. The nearest Station 3 (Material lab) has recorded the highest level of NO, SO_2 and CO compared to the other stations. The monitoring data has contributed some highlights to the authority and awareness about possible long risk effect of the air pollutants at the case study .

1 Introduction

Air pollution is one of the most serious problems in the world. It occurs when the air contains gases, dust, fumes or odor in harmful amounts, which could be harmful to the health or comfort of humans and animals. For the past 50 years, air pollution was a widely recognized problem that comes with long and short term impact on human health and the environment [1]. With high rate of urbanization, industrialization and increase in motorized transport from the rapid population growth has resulted in increased concentration of various air pollutants sulphur dioxide (SO_2), nitrogen oxide (NOx), carbon monoxide (CO), lead (Pb), ozone (O_3) [2].SO_2 and CO concentrations in industrial areas and housing in Senai, Johor Malaysia were reported high concentration which were 2 ppm and 37 ppm, respectively, and the concentration had exceeded the limit SO_2 (0.13 ppm) and CO (30 ppm) [3].

The Universiti Tun Hussein Onn Malaysia (UTHM) is located in Batu Pahat, Johor, Malaysia (1°51'32"N 103°5'3"E) and has a student population of approximately 14,638 (Jun 18, 2015). Due to its proximity to a nearby industrial park (activities include data centers, electrical appliances manufacturing, wood processing plants, corrugated carton maker and packaging facilities), events of air pollution and its persistence, especially that of air pollutant gases is of particular concern to the

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health and well-being of the student and faculty population. The ambient air across the UTHM campus is polluted by emission from vehicles (motocycles and cars) as the data showing the rise of number 11, 037 (2014) compared to 10, 232 in the year 2012 as recorded by the Safety Department UTHM. Pollution from motor vehicle is the single largest source of air pollution emissions, which composition depends on fuel used, and type and operating condition of the engine. The major constituents of motor vehicle pollutants are carbon monoxide (CO), hydrocarbon (HC), 8.5% nitrogen oxides (NOx), 0.8% particulate matter and 0.6% sulfur oxide (SOx). Cannistraro and Ponterio [4] stated that the pollution from motor vehicles is of great importance in developing countries with problems such as increasing vehicle fleets, infrastructural limitations, absence of emission control technologies of vehicle engines and poor maintenance or vehicle regulation. The wood processing involves the use of various chemicals (adhesives, thinners, paints, preservatives) [5]. These activities emit many gaseous pollutants including CO that may cause irritation of respiratory tracts and lungs and elevate the risk of respiratory tract infections.

Previous study on analysis of NO stated that, the combination of nitrous oxide causes paralysis of the nervous system, and concentrations greater than 100 $\mu g/m^3$ cause death for animals and humans. NO_2 is a deep lung irritant causing bronchial neutrophilic infiltration, pro inflammatory cytokine production, and responses to inhaled allergens in patients with asthma, both alone, and with SO_2 [6].To address the problem of air pollution, it is important to measure the level of air pollutants in the risk ambient air surrounding. The information of the status of air pollutants are essential in preventing the long term effects. Therefore, this monitoring data of the concentration of CO, NO_2 and SO_2 in ambient air was performed. As UTHM campus is located nearby an industrial area, it has raised the concern of air quality towards students and university staff. The concentration of air pollutants acts as an indicator in assessing the level of ambient air in UTHM campus.

2 Materials and Method

The air pollutants; carbon monoxide (CO), nitrogen monoxide (NO) and sulphur dioxide (SO_2) were measured during weekend and weekdays in October 2013 to Jun 2014. The sampling points were set up according to the distance from industrial area; Station 1-Stadium (1,000 m), Station 2-Kolej Kediaman Tun Dr. Ismail (500 m) and Station 3- Material Laboratory (300 m) as shown in Figure 1.

Figure 1. Location of air pollutants sampling station in UTHM and their proximity with the industrial area (adopted from Google Map, retrieve on 25th Dec 2014).

Air pollutants wasmonitored by using toxic gas analysis (Toxic Gas Monitor I-Bret Mx6) and E-Sampler Particulate Matter (Met One Instruments, Inc) for meteorological data. Sampling time was performed according to the standard Malaysia Ambient Air Quality as in Table 1. The Statistical Package for Social Sciences (SPSS) Software was used to obtain the significant value or not significant valueto determine whether the influence of meteorology was one of the factors that contribute to the incrementof concentration ofair pollutant. A result was considered 'significant' if the probability of the null hypothesis was equal to or less than 0.05 or ($P \leq 0.05$).

3 Air Pollutants Quality Standard

The air quality standards have been set by the United States Environmental Protection Agency (US EPA) and the Department of Environment Malaysia which is to determine the concentration of polluted air that is considered harmful to public health and environment. In this study, the Recommended Malaysian Air Quality Guidelines (RMAQG) which set up by DOE was used to configure the concentration of contaminants in polluted air. Table 1 shows the guidelines for the concentration of air pollutants in Malaysia**.**

Table 1. Malaysia Ambient Air Quality Guidelines (DOE, 2014).

Air pollutant	**Average time**	**Malaysia guidelines**	
		(ppm)	($\mu g/m^3$)
Carbon Monoxide (CO)	1 Hour	30	35 mg/m^3
	8 Hour	9	10 mg/m^3
Nitrogen Monoxide (NO)	1 Hour	0.17	320
Sulphur Dioxide (SO_2)	10 Minute	0.19	500
	1 Hour	0.13	350
	24 Hour	0.04	105

4 Results and Discussion

Concentration of air pollutants gases carbon monoxide (CO), sulphur dioxide (SO_2) and nitrogen monoxide (NO) were analysed and compared with the Recommended Malaysian Air Quality Guideline (RMAQG). Table 2 shows a summary data concentration of CO, SO_2 and NO between sampling stations during weekdays and weekend. The monitoring result shows that the concentration of CO at three sampling area was not exceeding the standard 30 ppm. The highest concentration of CO was at Station 3 was below than 10 ppm. Meanwhile the concentration of CO on weekend at all station was in range 0-2 ppm.It shows that CO concentration is still within safe levels in weekend. It is seconded by Cannistraro and Ponterio [4] stated that primary pollutants concentrations, benzene, carbon monoxide and particulate, decreased during weekends, this is due to the low vehicular traffic circulating in this period.

The highest concentrationSO_2 was 0.66 ppm at the Station 3 occurred during weekdays from 8.00-10.00 am, which exceeded the RMAQG of 0.13pm. Humidity and wind speed from the meteorological data on the sampling days had identified the factors that influenced the high concentration of SO_2 ($p<0.05$). Nevertheless, there was no SO_2 detected during weekend. Meanwhile, most of the NO concentration at three stations exceeded the standard which was 0.17 ppm occurred during weekdays and weekends especially at 8.00-10.00 am and 12.00-2.00 pm. The highest concentration was clearly recorded as being at afternoon peak between 12.00-2.00pm at Station 2

(KKTDI) which was 3.2 ppm. Besides that, the range for concentration during weekdays was 0.1-3.2 ppm and during weekends was 0.1-1.96 ppm.

Table 2. The concentration of CO, SO_2 and NO at three sampling stations during weekdays and weekend.

Station	Time	Toxic Gases (ppm)								
		CO			SO_2			NO		
		Weekday	Weekend	Standard (1hr)	Weekday	Weekend	Standard (1hr)	Weekday	Weekend	Standard (1hr)
Stadium (Stn 1)	8.00-10.00 am	0	0	30	0	0	0.13	0.66	0.66	0.17
	12.00-2.00 pm	0	0		0	0		0.46	0.23	
	4.00-6.00 pm	0	0		0.1	0		0	0.06	
	8.00-10.00 pm	0	0		0	0		0	0	
KKTDI (Stn 2)	8.00-10.00 am	0	0		0	0		0.26	0.26	
	12.00-2.00 pm	0	0		0	0		0.66	1.2	
	4.00-6.00 pm	0	0		0	0		0.43	0.33	
	8.00-10.00 pm	0	0		0	0		0	0	
Material laboratory (Stn 3)	8.00-10.00 am	0	2		0.66	0		0.16	1.96	
	12.00-2.00 pm	7	0		0	0		3.2	1.06	
	4.00-6.00 pm	0.66	0		0.1	0		0.16	0.1	
	8.00-10.00 pm	0	0		0.03	0		0.1	0	

5 Influence of Sampling Stations Distance to the Level of Air Pollutants

The levels of NO, CO and SO_2 were compared according to the distance from the industrial area as in Figures 2 to 4. It is shown that the distance has given a different level of air pollutants. Figure 2 shows the concentration of CO on weekday was recorded at three stations. For station 1 (Stadium) and Station 2 (KKTDI), the average reading recorded was 0 ppm. Comparatively at Station 3 (Material Laboratory) can be seen that there was obvious differences at 12:00 to 2:00 pm which the average reading was sharply increased from 0 ppm to 7 ppm and a sudden drop to 0.66 ppm at 4:00 to 600 pm.

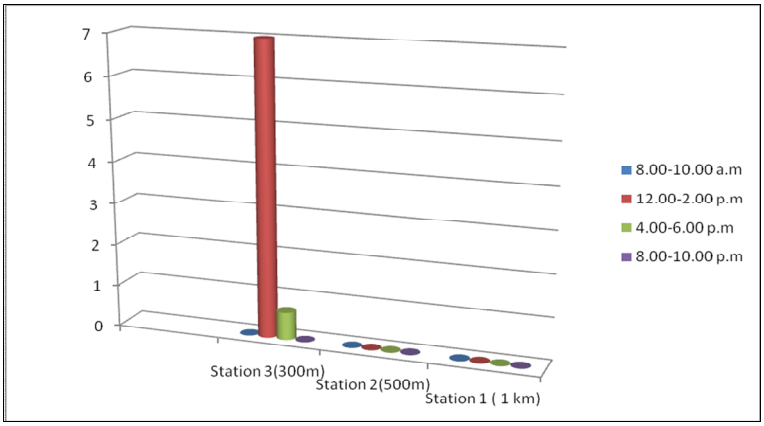

Figure 2. CO concentration in sampling stationsbased on the distance from industrial area.

Figure 3 refers to the average concentration of SO_2 readings at three sampling point which is have a different distance with the industrial plant. At 8:00 to 10:00 am, the highest reading was recorded at station 3 (Material Laboratory) which is 0.66 ppm. This indicates that the SO_2 concentration at that time has exceeded the standards and unsafe. While, the concentrations readings at the other stations was not change from 0 ppm. In the afternoon, starting from 4.00-6.00 pm only 0.1 ppm readings were

recorded at station 1 (Stadium) and Station 2 (KKTDI), while in station 3 does not record any reading. At night, the air quality was safe where the reading of SO_2 concentrations was 0.03 ppm at station 3 only and it were below the standard of 0.13 ppm.

Figure 4 shows the NO concentration between the three stations based on distance from industrial area. The concentration at Station 3 (Material Laboratory) recorded the highest concentration at 12.00 to 2.00 pm, which the concentration rose dramatically from 0.16 ppm to 3.2 ppm. From the graph, it clearly seen the station 3 was the nearest to the industrial area.The concentration also was exceeded the standard RMAQG which was 0.17 ppm. This result shows that the industrial activities were contribute to the increased concentration of NO could jeopardize human health if exposed to concentrations of NO continuously.

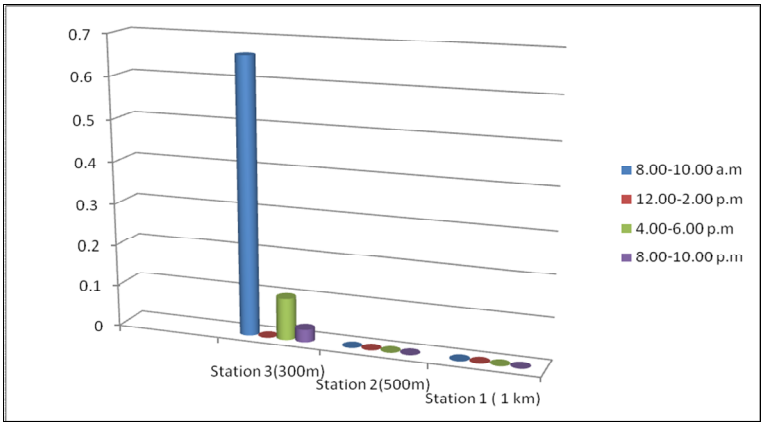

Figure 3. SO_2 concentration in sampling stations based on the distance from industrial area.

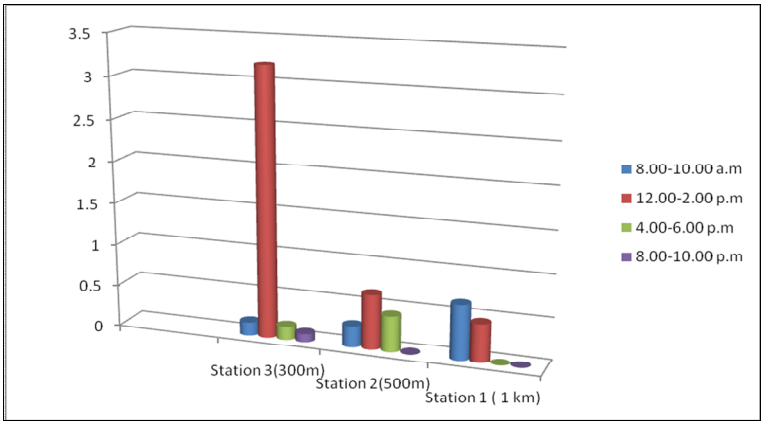

Figure 4. NO concentration in sampling stations based on the distance from industrial area.

6 Conclusion

The air pollutants concentrations were found high in the Station 3 (Material Lab) and Station 2 (KKTDI), with the concentration of SO_2 and NO were 0.66 ppm and 3.2 ppm, respectively and did not comply with the RMAQG of 0.13 ppm and 0.17 ppm. The results obtained from the distance between stations with industrial plant also play a role where near the station increased potential for exposure to toxic gas. The highest concentration was identified have occurred at Station 3 (Materials Laboratory) where that sampling station was closest station to the industrial area.

This monitoring work has suggested the links between certain meteorological factors and air pollutants concentration. This was derived through observations of air quality and postulation of wind speed and humidity. A more detailed analysis, correlating air quality with measured factors (such as human activities, an expanded set of meteorological factors) is necessary. Hence, the extensive monitoring of ambient air quality is currently conducted to provide a clear dispersion of air pollutants in ambient air of UTHM campus.
when preparing them.

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