Correlated Factors of the Concentration of the Am bient Total Volatile Organic Compounds (TVOCs) at Suvarnabhumi Airport

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Abstract

The objective of this research was to identify the correlated factors of the concentration of the ambient total volatile organic compounds (TVOCs) at Suvarnabhumi Airport. Measurements of TVOCs, air velocity and dry bul b temperature on the western runway and at the taxi terminal on ground floor were conducted for three consecutive days (March11-13, 2011). Number of flights and taxi services during study were taken from record of the responsible authorities. The results showed that the average ambient TVOCs on the west runway was 0.05 ppm (part per million) and that at the taxi terminal on ground floor was 2.56 ppm. The peaks of the ambient TVOCs of both detection points were in the afternoon. Assumption testing found that only three correlated factors of the ambient TVOCs could be identified. They were number of flights, number of taxi services and detection time.

Keywords: TVOCs, Suvarnabhumi Airport

1. Introduction

Suvarnabhumi Airport is an international and domestic airport of Thailand located on Bangna-Trad Road Km. 15, Samutprakarn Province and is 25 Km. far from Bangkok. It has an area of 8,000 acres and can accommodate 45 million passengers per year, support 76 flights per hour and 3 million tons of cargo per year. There are 2 runways in the first phase, the east runway is 4,000 m. long and the west runway is 3,700 m. long. Each runway is 60 m. wide. The airport has 52 taxiways, 51 contact gates and 69 remote parking bays. (SuvarnabhumiAirport,2011)
Airport is among the greatest sources of local air and noise pollutions, Idling and taxiing planes can emit hundreds of tons of volatile organic compounds (VOCs). On the runway and taxiway, VOCs such as benzene and acrolein are emitted in vehicle exhausts and from fuel tanks. At the taxi terminal on ground floor, many taxi services are the important sources of VOCs emission. Living downwind from the airport may take higher risks of health adverse effects than people not subject to pollution from the airport. (Miller,Jr.,2007)

VOCs are frequently indoor pollutants. Levels of VOCs in indoor environment are often higher than in ambient environment due to a wide range of VOC-emitting sources in building. (Air Quality Consultants,2010) The TVOCs level in air is an indicator of whether or not there are elevated levels. TVOCs can be easily measured in the ambient air. Human responses can include perception of poor air quality, discomfort and headache. Low concentration may cause no irritation and discomfort expected. (Aerias Indoor Air Quality Resource Center, 2011)Environmental Department of AOT is responsible for pollution in the airport. A researcher as of authority of such department was interested in investigation of TVOCs in two areas where he was in charge, the west runway and at the taxi terminal on ground floor. Also, he was interested in searching for the Correlated factors of the ambient TVOCs, number of flights, tax services, air velocity, dry bulb temperature, and detection time. The objectives of this research were to study the level of TVOCs on the west runway and at the taxi terminal on ground floor and to identify the correlated factors of TVOCs in the Suvarnarbhumi Airport with the assumptions as follows;

1) There was a relationship between TVOCs concentration on the west runway and number of flights on such runway.

2) There was a relationship between TVOCs concentration at the taxi terminal on ground floor and a number of taxi services in such area.
3) There was a relationship between TVOCs concentration and time period of TVOCs detection.
4) There was a relationship between TVOCs concentration and air velocities of both detection areas.
5) There was a relationship between TVOCs concentration and the ambient temperatures of both detection areas.

2. Methodology

2.1 Data Collection

There were some activities in data collection as follows:
1) Collecting data on number of flights on the west runway and number of taxi services at the taxi terminal on ground floor from the record of responsible authorities.
2) Measuring air velocity and temperature on the west runway by a mobile air monitoring system. Air velocity and temperature measurements at the taxi terminal on ground floor were completed by portable dry bulb temperature and wind vane anemometer.
3) Detecting the concentrations of TVOCs by Photovac portable ready reading gas chromatography certified by the U.S. EPA and calibration of the instrument was accomplished at laboratory of AOT by ISO 17025. The ambient TVOCs at detection points were conducted for 3 periods a day (morning, afternoon, and night) during three consecutive days (March 11-13, 2011).
4) Correlation analysis and assumption testing from all collected data were accomplished by using sociological statistical computer, Mean, F-test, and Pearson's Correlation test

2.2 Research Framework

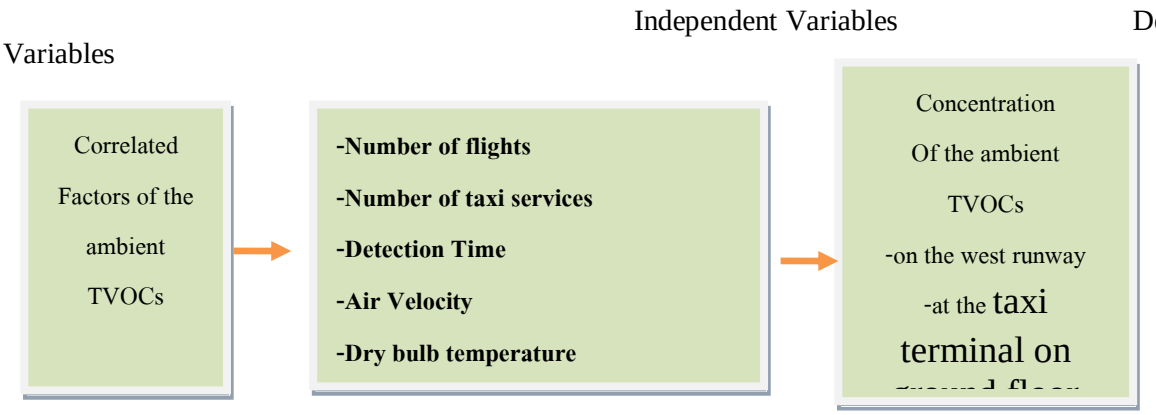

Figure I The research Framework

From the figure I, the independent variables were number of flights, number of taxi services, detection time, air velocity, and dry bulb temperature. The dependent variables were concentrations of the ambient TVOCs on the west runway and at the taxi terminal on ground floor.

3. Result and Discussion

3.1 The ambient TVOCs concentration

The average concentrations of the ambient TVOCs on the west runway were 0.05,0.05,and 0.04 ppm, respectively. Those at the taxi terminal on ground floor were 2.56,2.40,and 2.56 ppm, respectively. The peaks of the ambient TVOCs of both detection points were in the afternoon as shown in table I.

Table I. Average concentrations (ppm) of the ambient TVOCs at both detection points

Detection Time	At the taxi terminal on ground floor				On the west runway			
	Morning	afternoon	Night	Average	Morning	afternoon	Night	Average
Day I	1.69	3.02	2.53	2.41	0.02	0.08	0.03	0.04
	1.98	3.56	2.44	2.66	0.01	0.10	0.05	0.05
	2.08	3.22	2.67	2.66	0.02	0.10	0.04	0.05
	1.88	3.75	2.38	2.67	0.01	0.08	0.05	0.05
	1.76	2.98	2.46	2.40	0.01	0.09	0.03	0.04
Average	1.88	3.31	2.50	2.56	0.01	0.09	0.04	0.05
Day2	2.08	3.02	2.02	2.37	0.01	0.09	0.03	0.04
	2.34	3.24	1.98	2.52	0.02	0.10	0.05	0.06
	2.18	2.88	2.32	2.46	0.02	0.10	0.04	0.05
	1.99	3.12	1.78	2.30	0.02	0.09	0.05	0.05
	2.17	2.96	1.99	2.37	0.01	0.09	0.03	0.04
Average	2.15	3.04	2.02	2.40	0.02	0.09	0.04	0.05
Day3	2.13	2.92	2.25	2.43	0.01	0.05	0.05	0.04
	1.78	2.73	2.56	2.36	0.02	0.06	0.03	0.04
	2.26	4.18	2.75	3.06	0.02	0.08	0.04	0.05
	2.07	2.98	2.40	2.48	0.02	0.08	0.04	0.05
	2.28	2.85	2.22	2.45	0.01	0.07	0.05	0.04
Average	2.10	3.13	2.44	2.56	0.02	0.07	0.04	0.04

3.2 Meteorological conditions

Air velocity and dry bulb temperature at both detection points were recorded as shown in table 2. The averages of air velocities and dry bulb temperature on the runway within three consecutive days were 3.55 m/sec and 30.84 degrees Celcius, 3.69 m/sec and 30.19 degrees Celcius and 4.29m/sec and 30.76 degrees Celcius, respectively. Those at the taxi terminal on ground floor also within three consecutive days were 0.67m/sec and 31.20 degrees Celcius, 0.48m/sec and 30.65 degrees Celcius and 0.76 m/sec and 30.90 degrees Celcius, respectively. The peaks of air velocity and dry bulb temperature at both detection points varied upon detection time.

Table2 Air velocities and dry bulb temperatures at both detection points

Detection time	Detection period	Air velocity (m/sec)		Temperature in degree Celcius	
		On the west runway	At the taxi terminal on ground floor	On the west runway	At the taxi terminal on ground floor
Day I	Morning	4.08	0.55	31.39	31.20
	Afternoon	3.83	0.97	32.95	32.50
	Night	2.75	0.50	28.19	29.90
	Average	3.55	0.67	30.84	31.20
Day 2	Morning	3.03	0.50	31.44	31.00
	Afternoon	5.06	0.35	31.23	31.28
	Night	2.98	0.60	27.91	29.67
	Average	3.69	0.48	30.19	30.65
Day3	Morning	2.34	0.92	32.06	31.30
	Afternoon	5.70	0.40	32.01	31.60
	Night	4.84	0.97	28.20	29.80
	Average	4.29	0.76	30.76	30.90

3.3 Traffic records

During three consecutive detection days, the average number of flights and taxi services per day were 449 flights on the west runway and 7327 taxi services at the taxi terminal on ground floor. The peaks of number of flights and taxi services per day in the afternoon during the detection time are shown in table3.

Table3 Traffic in the Suvarnabhumi Airport during detection time

Time	Number of taxi services				Number of flights			
	Morning	Afternoon	Night	Total	Morning	Afternoon	Night	Total
Day 1	2110	3478	1986	7574	0	320	115	435
Day 2	2228	3113	1758	7099	55	343	58	456
Day 3	2158	3227	1923	7308	56	338	61	455
Average	2165	3273	1889	7327	37	334	78	449

Source: Traffic Control Center and Flight Service Division of the Suvarnabhumi Airport, 2011

3.4 Assumption Testing

From the results of statistical analysis by F-test and Pearson's Correlation Coefficient, there were only three factors correlated with the ambient TVOCs in air on both detection points, number of flights, number of taxi services and detection time as shown in table 4.

Table 4 Results of assumption testing

Assumption N0.	Correlation	Correlation coefficient (r)	F-test sig.(2-tailed) when p=0.01
1	TVOCs V.S Number of flights	0.975	sig.(0.000)
2	TVOCs V.S Number of taxi services	0.897	sig.(0.001)
3	TVOCs V.S Detection periods	0.816	sig.(0.000)
4	TVOCs V.S Air velocities on the west runway	0.633	not sig.(0.067)
5	TVOCs V.S Air velocities at the taxi terminal	-0.046	not sig.(0.906)
6	TVOCs V.S Temperatures on the runway	0.296	not sig.(0.0439)
7	TVOCs V.S Temperatures at the taxi terminal	0.552	not sig.(0.123)

There were two points from the results of assumption testing should be discussed 1) there was no standard of the ambient TVOCs in air and 2) air velocity and dry bulb temperature had no correlation with the ambient TVOCs in air.The average TVOCs concentration at the taxi terminal on ground floor is much higher than that on the west runway. However, TVOCs are not regulated as criteria pollutants (Buchholz, 1998). Generally, TVOCs level in air is an indicator of whether or not there are elevated levels (Aerias. Org. 2011).

Air velocity and dry bulb temperature are important factors in air pollutant dilution and reduction. The ambient TVOCs peaks of both detection points were found in the afternoon when the dry bulb temperatures of both detection points were peaks, especially in day with no rain. Temperature inversion may effect to reduce the ambient TVOCs. At night with low traffics, the ambient TVOCs might probably be lower than in the afternoon. However, this research found that neither air velocity nor dry bulb temperature had no correlation with the ambient TVOCS. This was meaningful because it seems abnormal.

4. Conclusion and Recommendation

4.1 Conclusion

Investigations of TVOCs at the Suvarnabhumi Airport found the average ambient TVOCs on the west runway was 0.05 ppm. and at the taxi terminal was 2.56 ppm. The peaks of the ambient TVOCs of both detection points were in the afternoon. Refer to the results of assumption testing, there were only three factors correlated with the ambient TVOCs. They were number of flights, number of taxi services and detection time. In the opposite, air velocity and dry bulb temperature were not significant factors.

4.2Recommendation

Periodical monitoring of TVOCs and specific VOCs such as benzene, acrolein and other suspected human carcinogens in the Suvarnabhumi Airport are highly recommended for the public safety. The additional detection points such as contact gates, remote parking bays and the airport emergency center are also recommended. The ambient TVOCs at the taxi terminal was much higher than on the runway and air velocity was quite low. It is better to have more exhaustion installed there especially.

Also, taxi should come in to pick customers up and depart immediately instead of waiting customers there which causes accumulative air pollution. If there is any compliant about air pollution in Suvarnabhumi Airport which effects health, the authority must pay high attention in order to improve. Otherwise, image of the airport may be wors

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