TEMPORAL PROFILE OF BTEX AT THE AREA OF PETROL STATION

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นางสาวปัฐมาภรณ์ รัตนจงจิตรกร

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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ปัฐมาภรณ์ รัตนจงจิตรกร : การเปลี่ยนแปลงตามเวลาของสารระเหยบีเทคในสถานีบริการน้ำมันเชื้อเพลิง (TEMPORAL PROFILE OF BTEX AT THE AREA OF PETROL STATION) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร. ทรรศนีย์ พฤกษาสิทธิ์, 108 หน้า.

การศึกษานี้มีจุดประสงค์เพื่อศึกษาการเปลี่ยนแปลงของสารระเหยบีเทค (เบนซีน โทลูอีน เอทิลเบนซีน และไซลีน) ในช่วงวัน และตรวจวัดความเข้มข้นของสารระเหยบีเทคในสถานีบริการน้ำมันเชื้อเพลิงบริเวณหัวจ่ายน้ำมัน หน้าสถานีบริการซึ่งอยู่บริเวณริมถนน และด้านหลังสถานีบริการ ทำการศึกษาเปรียบเทียบระหว่างสถานีบริการในเขตกรุงเทพมหานครและปริมณฑลในปี 2555 และทำการศึกษาเปรียบเทียบระหว่างฤดูฝน (กรกฎาคม-สิงหาคม 2556) และฤดูแล้งฝน (พฤศจิกายน 2556) ที่สถานีบริการในเขตปริมณฑล เก็บตัวอย่างสารบีเทคโดยใช้หลอด charcoal glass tube ต่อเข้ากับเครื่องปั๊มดูดอากาศชนิดพกพาที่อัตราการไหลของอากาศเท่ากับ 100 มิลลิลิตรต่อนาที ระหว่างเวลา 6:00-22:00 น. โดยเก็บตัวอย่างทุกๆ 4 ชั่วโมง ในปี 2555 และทุกๆ 2 ชั่วโมงในปี 2556 หลังจากนั้นนำหลอดตัวอย่างที่เก็บได้มาสกัดด้วยสารละลายคาร์บอนไดซัลไฟด์ และนำไปวิเคราะห์ด้วยเครื่อง GC/FID จากการศึกษาพบว่า สารบีเทคในช่วงวันมีปริมาณมากที่สุดในชั่วโมงเร่งด่วน ได้แก่ 6:00-10:00 น. และ 16:00-20:00 น. ซึ่งเป็นผลจากการจราจรหนาแน่นและลูกค้ามาใช้บริการในสถานีมากกว่าช่วงอื่นๆ นอกจากนี้ยังพบว่า สารบีเทคบริเวณหัวจ่ายน้ำมันมีปริมาณมากที่สุด และมากกว่าจุดริมถนนประมาณ 6 เท่า โดยค่าเฉลี่ยสารบีเทคที่พบบริเวณนั้น คือ 15,866.65±7,248.41 และ 2,536.31±2,018.34 ไมโครกรัมต่อลูกบาศก์เมตร ตามลำดับ จากผลการวิเคราะห์สัดส่วนของสารระหว่างจุดเก็บตัวอย่างพบว่า ปริมาณของเบนซีนไม่ได้ลดลงตามระยะทางที่ห่างไปจากจุดกำเนิดมากเท่ากับโทลูอีน เอทิลเบนซีน และไซลีน สารบีเทคในสถานีบริการที่มีขนาดเล็กและมีสิ่งปลูกสร้างรวมถึงต้นไม้ล้อมรอบมีการแพร่กระจายในสถานีมากกว่าสถานีบริการขนาดใหญ่กว่าและลมพัดผ่านได้มากกว่า ปริมาณสารบีเทคที่พบที่สถานีบริการในเขตกรุงเทพมหานครมีค่าสูงกว่าสถานีบริการในเขตปริมณฑลและปริมาณสารบีเทคในฤดูฝนมีน้อยกว่าในฤดูแล้งฝนอย่างมีนัยสำคัญ (p<0.005) จากการวิเคราะห์ทางสถิติความเร็วลมเป็นปัจจัยที่ส่งผลต่อการเปลี่ยนแปลงในรอบวันของสารบีเทค โดยเฉพาะเบนซีนและเอธิลเบนซินบริเวณหัวจ่ายน้ำมันมากที่สุด

สาขาวิชา การจัดการสิ่งแวดล้อม ลายมือชื่อนิสิต .....

ปีการศึกษา 2557 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

5487551620 : MAJOR ENVIRONMENTAL MANAGEMENT
KEYWORDS: TEMPORAL / BTEX / SEASONAL / VARIATION / PETROL / GAS / STATION

PATTAMAPORN RATTANAJONGJITRAKORN: TEMPORAL PROFILE OF BTEX AT THE AREA OF PETROL STATION. ADVISOR: ASST. PROF. TASSANEE PRUEKSASIT, Ph.D., 108 pp.

This study aims to investigate temporal variation of BTEX during a day at petrol station, by collecting BTEX in ambient air at back of the station, near filling nozzle, and roadside. The study of comparison between BTEX variation at the petrol station in urban and suburban area was conducted in 2012, and the study between their variation in wet (July – August 2013) and dry (November 2013) season at suburban station. BTEX was collected by a charcoal glass tube connected to a personal air pump with flow rate 100 ml/min during 6 a.m. to 10 p.m. In 2012, each sample was collected for every 4-hr, while 2-hr interval sampling was done in 2013. After finish the sampling, a charcoal tube was extracted by carbon disulfide and BTEX was analyzed by GC/FID. The study found that BTEX had high concentration in rush hour because of traffic congestion and lot of customers. Moreover, BTEX concentration nearby refueling nozzles had the highest concentration among 3 sampling points, about 6 times of roadside. The averaged tBTEX obtained from the refueling nozzles and roadside were 15,866.65±7,248.41 and 2,536.31±2,018.34 μg/m^3, respectively. The ratio of benzene concentration between 3 sampling points was the lowest among BTEX, because the amount of benzene is not diminished by distance from the main point source as much as toluene, ethylbenzene and xylene. BTEX in a station which was smaller and surrounding with trees and buildings tended to have well dispersion inside station more than the bigger one. BTEX concentration at urban station was extremely higher than at suburban station and BTEX in wet season was significantly lower than in dry season (p<0.005). From statistical analysis, wind speed was a strongest affecting factor on diurnal variation of BTEX especially benzene and ethylbenzene nearby refueling nozzles.

Field of Study: Environmental Management Student's Signature .....
Advisor's Signature .....

Academic Year: 2014

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Introduction

1.1 Rationale background and problem addressed

Presently, energy has become one of necessary things. It effects economic growth of each country. Not only for the economy, but energy also has an important role in human's routine life. With convenience, people use gasoline as fuel without concerning. However, the more energy is used, the more pollution has released. Each petrol station emits some pollutants from the product, gasoline.

Nowadays, transportation becomes the essential part of human life especially in urban area. In terms of public transportation and personal transportation, Thailand has many petrol stations to provide gasoline for people, especially in Bangkok and other town areas. Bangkok and perimeters confront unsolvable issue in traffic congestion and this problem begins to spread to scenery town such as Chiang Mai and Phuket. Private vehicles are increasing every year; although, public transportation has been improving continuously. One of the important reasons is the 'Refunds First Car' policy which has been released by Thai government since September 2012; as a result, vehicle circulation is increasing continuously from the first quarter to the third quarter of 2012 and tends to be increased in the fourth quarter. Bangkokbiz (2012), Thai newspaper, claimed that new 4-wheeled cars has been registered about 1,536 cars/day in first ten months of 2012 which is 39.6% increased from 2011. At the same time, a number of new registered motorcycles has been increase 18.8%. Moreover, the Office of Transport and Traffic Policy Planning (2011, 2012) reported that the number of cumulative registered vehicle in Bangkok has been increasing from 2006 to 2011, both of 4-wheeled car and motorcycle. During 2007-2012, a number of cumulative registered vehicles had increased 27.96%. There are 7.3 million cumulative registered vehicles during January, 2012 and September 2012 which is 7.8% increased from 2011.

Due to increasing of vehicles, fuel demand and supply are also increasing. Many petrol stations have been opened in Bangkok and perimeter for demand support,

resulting in increase of air pollutants emission, BTEX particularly. Gasoline is one of the product from petroleum which consists of vary hydrocarbons. The main hydrocarbons in gasoline are alkanes, monocycloalkanes, dicycloalkanes, aklybenzene, indanes, tetralins, napthalenes, and some oxygenated alcohol additive (Kitwattanavong, 2010). In addition, it emits some volatile organic compounds or VOCs. The prominent VOCs from gasoline are BTEX which are the major compounds which affect to human health.

BTEX are commonly used in industry such as chemical industry and textile industry. They are also essential part of petroleum. Thus, BTEX can disperse both of industrial estates and traffic area. International Agency of Research on Cancer and World Health Organization (2013) found that benzene is a Group 1 carcinogens which can lead to leukemia and ethylbenzene is a group 2B carcinogens.

Although, some researchers determined the concentration of BTEX at petrol stations in inner and outer of Bangkok, but their period of observed time usually was 8 hours per day to evaluate risk of workers in petrol stations comparing with air quality standard. This study, then, aims to investigate the concentration of BTEX in different season and their temporal profile in ambient air at the petrol station and the roadside along with observation of meteorological data which would affect BTEX concentration and its dispersion.

1.2 Objectives of study

1. To investigate BTEX concentrations and their temporal profile in ambient air at the petrol station and roadside

2. To find relationship between BTEX concentration and meteorological data at the petrol station

1.3 Hypothesis

1. BTEX concentrations would be increased by a number of vehicles in petrol station especially in busy hour

2. Wind direction would affect on BTEX dispersion and BTEX concentrations would be decreased with high relative humidity

1.4 Scope of Study

1.4.1 Study area

The study was divided into two parts, Part I and Part II. Two petrol stations were chosen in Part I to compare between different stations environment. One is in the urban area which located on Rama IV road near wireless intersection in Bangkok (BKK station). The other one is the represent of suburban area which located on Cheangwattana road in Nonthaburi (NBI station). The differences of these two stations are surrounding area, location in the city and brand of station. BKK station is on the main road, 300 meters far from a major intersection and 400 meters far from a junction to express way. NBI station is also on the main road but far from major section 700 meters. The study in Part II focused on only one station in Nonthaburi to study temporal profile of BTEX at petrol station.

1.4.2 Sampling technique for ambient air

The active sampling was applied to collect benzene, toluene, ethylbenzene, and xylenes. Charcoal glass tubes connected to personal air pumps were set inside the petrol stations at the height about 2 meters for 16 hours a day, by divided into time period in each part.

1.4.3 Sampling duration

The sampling in Part I was operated only in wet season, 2012, while sampling in Part II was performed in wet season and dry season, 2013. For Part I, samples in each season were collected 3 days in a week in each station; Tuesday, Friday, and Sunday. They were collected in 4 periods per day, 4 hours per period. Besides, sampling in Part II was gathered in 2 days per week; Tuesday and Sunday, 2 weeks in each

season at only NBI station. Samples were collected in 8 periods per day, 2 hours per period.

1.4.4 Analytical technique

Carbondisulfide (CS_2) was used to extract BTEX which absorbed on activated charcoal in a charcoal glass tube and analyzed by GC/FID.

1.5 Expected outcomes

1) Temporal profile of BTEX at petrol station in urban area and suburban area would be obtained.

2) Temporal profile of BTEX from specific source: filling nozzle and roadside would be observed.

3) From this study result, a guideline to manage workers shift in petrol station and recommendation to reduce BTEX exposure to workers in petrol station would be introduced.

4) The knowledge would be able to be applied in further study in BTEX and other VOCs in vicinity area of petrol station.

Chapter 2

Literature Review

2.1 Property and toxicity of BTEX

BTEX is an acronym which stands for benzene, toluene, ethylbenzene, and three isomers of xylenes; meta-xylene, para-xylene, and ortho-xylene. They are some of VOCs or volatile organic compounds. Benzene is the compound with the greatest environmental impact among the hydrocarbons. Besides, BTEX can be found in gasoline and easy to disperse in the air which leads to human health effect. The Structure, physical, and chemical properties of BTEX are shown in Table 2.1 and Figure 2.1. Besides, the characteristics of BTEX and their toxicity to human are following;

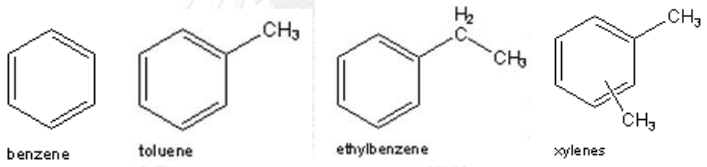


Figure 2.1 Structures of BTEX (Kongpaung, 2012)

1) Benzene or cyclohexatriene is liquid with non-color. The effects if exposed by inhalation and ingestion are similar; respiratory tract irritation, drowsiness, unconsciousness, and central nervous system depression. Benzene can be absorbed through human skin and causes dry skin, skin irritation. Its chronic effects are bone marrow abnormalities with damage to blood forming tissues, and anemia and other blood cell abnormalities. Benzene can break apart into CO, CO_2, aldehyde and ketone.

2) Toluene or methyl-benzene is liquid with no color like benzene. Inhalation and ingestion exposure may irritate respiratory tract and cause CNS encephalopathy, headache, depression, lassitude (weakness, exhaustion), impaired coordination, transient memory loss, and impaired reaction time. It may be absorbed through skin

and cause skin irritation. Moreover, this substance may affect to liver, kidney, bladder and brain.

3) Ethylbenzene is colorless liquid. If exposed through inhalation, it may cause respiratory tract and central nervous system depression. Ingestion exposure may cause nausea, vomit and headache and irritate skin and eye. In addition, ethylbenzene may harm fetus. After disintegration, ethylbenzene can be turn into CO and CO_2.

4) Xylenes is colorless liquid. With eye and skin exposure, it may cause irritation and burning pain. Respiratory tract can be irritated by xylenes and ingestion exposure may cause nausea, diarrhea and loss of appetite. Besides, it can destroy nerves, eyes, ears, liver, kidney and fetus. Xylenes can volatile and disintegrate to be CO and CO_2.

Table 2.1 The physical and chemical properties of BTEX

Compound	Formula	Molecule weight (g/gmole)	Solubility (mg/l)	Vapor Pressure (mmHg)	Henry's coefficient (m^3-atm/mol)	Melting point (°C)	Boiling point (°C)
Benzene	C_6H_6	78.11	$1.75x10^3$	80.85	$4.84x10^{-3}$	5.5	80.1
Toluene	$C_6H_5CH_3$	92.14	535	21.86	$5.72x10^{-3}$	-93	110.6
Ethylbenzene	$C_6H_5C_2H_5$	106.18	152	7.08	$7.04x10^{-3}$	-95	136
Xylene	$C_6H_4(CH_3)_2$	106.18	198	4.89	$6.38x10^{-3}$	-25	144

Source: Verschueren (1983)

2.2 Sources of BTEX

BTEX compounds are in crude oil physically and usually found in sea water where natural gas and petroleum deposit. The man-made sources of BTEX compounds are emitted from motor vehicles and aircraft, also cigarette smoke. BTEX are created and commonly used during processing of petroleum products and production of consumer goods such as paints and lacquers, thinners, and rubber products. However, unburned benzene can be directly released from incomplete combustion of gasoline in old vehicles and vaporization of gasoline from fuel tanks and filling stations.

One of the main BTEX source are industrial estates. There are several studies of BTEX concentrations from industry including following study. Pimpisut et al. (2006) investigated concentration of BTEX in Map Ta Phud, one of industrial estates in Thailand. They claimed that residence in Map Ta Phud area which located downwind of industrial estate is affected by industrial activities, especially petrochemical industry and oil refinery. The other one was held in Hanoi, Vietnam by Quynh Truc and Kim Oanh in 2007. They collected roadside sample from different road conditions; high traffic volume, low traffic volume and high traffic volume running through an industrial estate and found that the road with industrial estates has the highest BTEX concentration among three roads.

Besides industrial estates, roadsides are also main source of BTEX. Study in Vietnam by Quynh Truc and Kim Oanh in 2007 gave another interesting result, relation of BTEX concentrations and number of vehicle. As mentioned above, three roads with different conditions are investigated. The road with high traffic volume had higher BTEX concentrations than the one with low traffic congestion. In addition, the study also reported that BTEX levels are mainly peak at busy hour, which has more traffic congestion than another hour of the day, as same as study in Greece by Karakitsios et al. (2007) Which revealed temporal variation of benzene comparing to traffic flow as seen in figure 2.2.

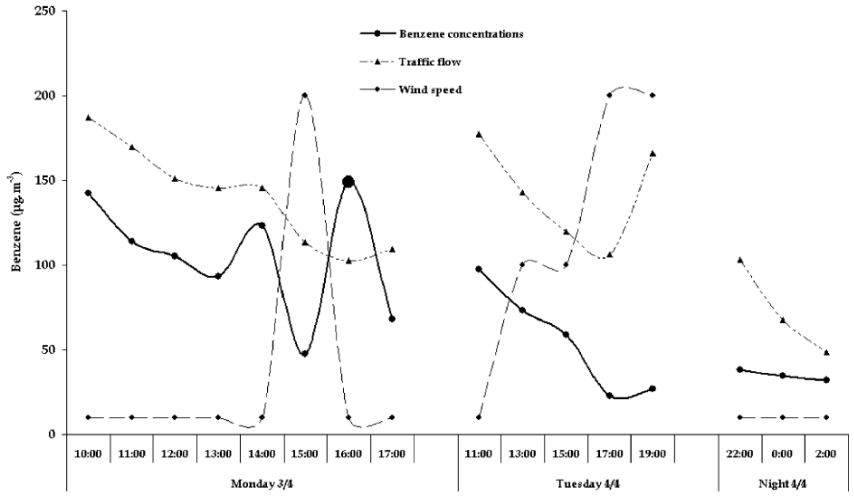


Figure 2.2 Benzene variation comparing to traffic flow and wind speed (Karakitsios,2007)

Traffic congestion is not only problem in megacity but also in urban area and scenery town because of a number of motor vehicles on roads. Traffic jam comes with air pollution problem. While engine is running, exhaust is released. Exhaust consists of CO_x, NO_x, SO_x, aldehyde, hydrocarbon and VOCs such as BTEX.

Another main BTEX source is filling station. Karakitsios et al. (2007) revealed in "Contribution to ambient benzene concentrations in the vicinity of petrol stations - Estimation of the associated health risk" that the population living in the vicinity of petrol station is exposed by benzene. The results from this study show a clear influence on the measured benzene concentrations, depending on the activity of the petrol station, the leaks of the fuel tanks and the meteorological conditions. As a consequence, the population living in the vicinity of the examined urban location is exposed to an additive concentration ranging from 3 to 6 $\mu g/m^3$, increasing the leukemia risk caused by benzene alone from 3% to 21%, also depending on exposure times.

2.3 Fate of BTEX in the atmosphere

BTEX from sources can be toxicity to human by dispersion. After they are released from different source to the atmosphere, they will react and transform to substances differently which affect to human health.

Benzene would be released through the atmosphere mostly from fugitive emissions and exhaust connected with its use in gasoline. When benzene enters to the atmosphere, it will exist in the gas phase. Gas-phase benzene will be photochemically reacted and produced hydroxyl radicals with a half-life of 13.4 days calculated using an experimental rate constant for the reaction. Products of photooxidation are phenol, nitrophenols, nitrobenzene, formic acid, and peroxyacetyl nitrate (figure 2.3). Benzene can dissolve in water and be removed from the atmosphere by the rain. The primary routes of exposure are inhalation of contaminated air, especially in areas with high traffic, and in the vicinity of gasoline service stations and consumption of contaminated drinking water.

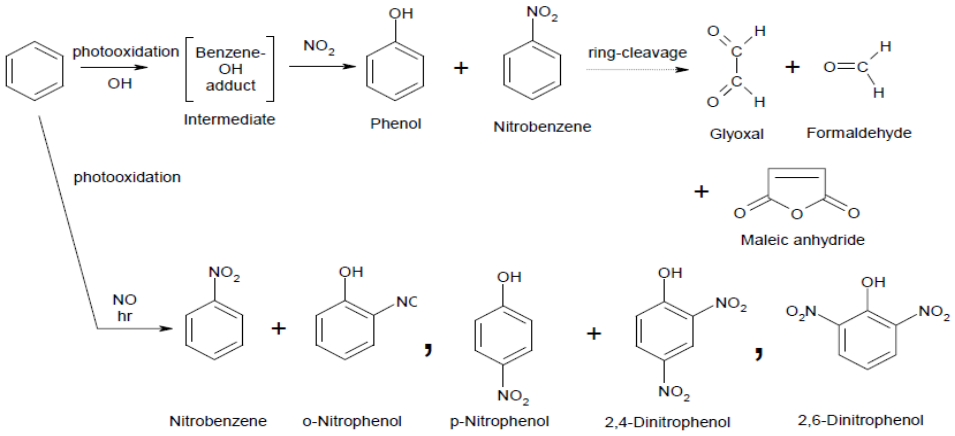


Figure 2.3 Photooxidation reaction of benzene (USEPA, 2009)

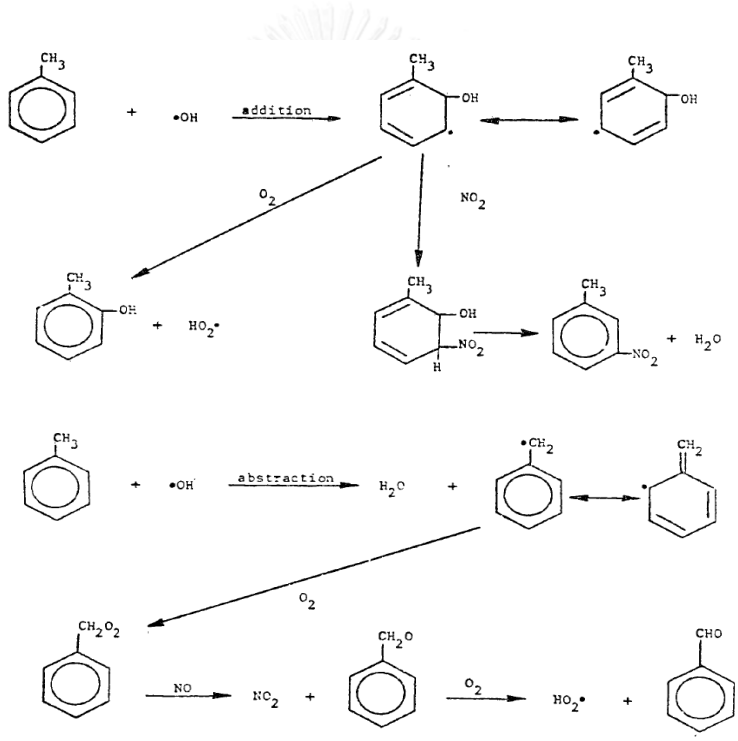


Figure 2.4 Reaction pathways of toluene in atmospheric conditions (USEPA, 2009)

Toluene is emitted into the atmosphere from the volatilization of petroleum fuels, toluene-based solvents, thinners and from motor vehicle exhaust. After toluene was polluted to the atmosphere, it will be degraded by reaction produced hydroxyl radicals (half-life 3 hr to slightly over 1 day) or be washed out by the rain. It will not be subject to direct photolysis. The primary sources of human exposure are

from inhalation of contaminated ambient air, especially in traffic or near filling stations, or in occupational atmospheres where toluene-based solvents are used.

Ethylbenzene will enter the atmosphere from fugitive emissions and exhaust connected with its use in gasoline. More localized sources are waste water, emissions, and spills from its production and industrial use. When ethylbenzene is released to the atmosphere, it will exist generally in the vapor phase, based on its vapor pressure. It will be degraded by reaction with hydroxyl radicals (half-life 0.5 to 2 days) and partially return to earth by the rain. It will not be subject to direct photolysis.

Xylenes are natural products of many plants, and are a component of petroleum and coal tar. It can be emitted from petroleum refining, gasoline and diesel engines, and its use as a solvent. Most of the xylenes are released into the atmosphere where they may photochemical degrade by reaction with hydroxyl radicals (half-life 1-18 hr).

2.4 Affecting factors of BTEX distribution

Distribution of BTEX is mostly affected by meteorological factors such as temperature, wind direction and wind speed, and relative humidity (rain). Karakitsios et al. (2007) founded that station workers have higher benzene exposure in summer than winter as seen in figure 2.5. The average temperature in summer is 23°C, while in winter is 7°C. Another study of Karakitsios et al. (2007) showed a cleared influence of wind speed to benzene concentration. In figure 2.2, benzene concentration decreased with high wind speed and increased when wind speed is lower.

In addition, BTEX can go with water. Consequently, they can be washed out by rain.

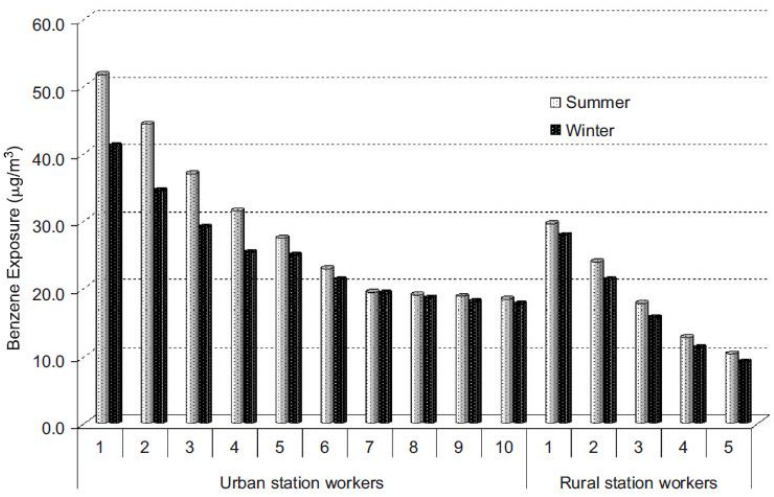


Figure 2.5 Average weekly benzene exposure of the filling station employees for summer and winter by passive. (Karakitsios et al. 2007)

2.5 Guideline of occupational exposure to BTEX

From the previous studies, petrol stations should be concerned as one of the BTEX point sources in city which BTEX can disperse to vicinity. There are some researches that determine the concentration of BTEX at petrol stations in inner and outer of Bangkok, but their period of time usually is 8 hours per day to evaluate risk of workers in petrol stations comparing with air quality standard. Although some countries have own standard, there are three agencies; NIOSH, OSHA, and ACGIH, which are acknowledge in guideline occupational standard of BTEX as shown in Table 2.2.

American Conference of Governmental Industrial Hygienists (ACGIH) is the private nongovernmental corporations which develop professional practice guidelines, such as Threshold Limit Values, Biological Exposure Indices and other occupational health hazard.

Occupational Health and Safety Administration (OSHA) is the main federal agency of United States of America, charged with the enforcement of safety and health legislation.

National Institute for Occupational Safety and Health (NIOSH) is the leading Federal agency conducting research and providing guidance on the occupational safety and health implications.

Table 2.2 Guideline Values for occupational exposure to BTEX

Agency / Substance	NIOSH (8hr)		OSHA (8hr)		ACGIH (8hr)	
	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3
Benzene	0.1	0.32	10	30	10	30
Toluene	100	375	200	750	100	375
Ethylbenzene	100	435	100	435	100	435
Xylene	100	434	100	435	100	435

Source: Kitwattanavong (2010)

Moreover, the results of these researches stated that workers in petrol stations have high risk to expose BTEX with exceeding occupational quality standard. Due to working as shift of workers in petrol stations, temporal profile of BTEX in petrol station should be held in order to manage workers shift to decrease risk to expose BTEX in work hour. Temporal profile of BTEX was observed in some foreign countries such as Hong Kong (Ho. et al., 2004) but not for the petrol stations in Bangkok and perimeter. In Hong Kong, Ho. et al. (2004) claimed that the temporal BTEX concentrations at the roadside monitoring station associated with traffic density and vehicle type which was the same result from study of roadside BTEX in Vietnam (Quynh Truc and Kim Oanh, 2007).

2.6 Related research articles

There are several studies about BTEX in different concern. Beginning with the roadside BTEX study named “Roadside BTEX and other gaseous air pollutants in relation to emission sources”. Quynh Truc and Kim Oanh studied in Hanoi, Vietnam in 2007. They monitored BTEX, CO, NO_x and SO_2 in periods of day at three streets:

the first one with high traffic volume, the second one with low traffic volume and the third one with high traffic volume running through an industrial estate. As figure 2.6 and 2.7, the pattern of vehicle number and BTEX concentration on high traffic density site are the same. Consequently, they suggested that the traffic may be the major source of BTEX at high traffic sampling site. Moreover, the study reported that BTEX levels are mainly peak at busy hour and have a high concentration in street with high traffic volume running through an industrial estate, with high traffic volume and low traffic volume, respectively.

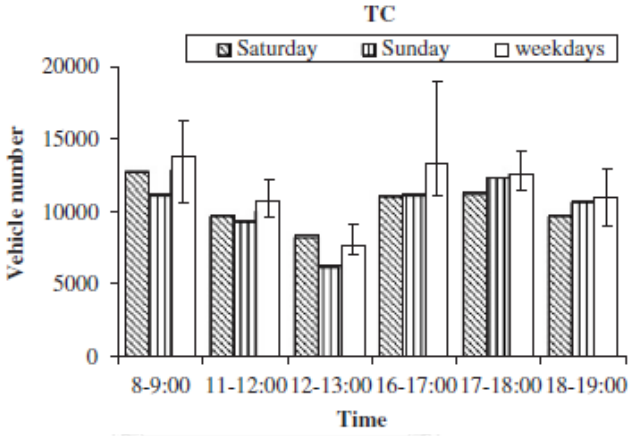


Figure 2.6 Hourly average traffic on high traffic volume site (Quynh Truc and Kim Oanh, 2007)

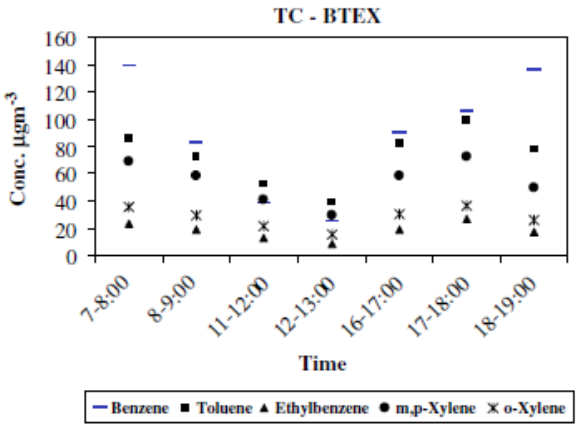


Figure 2.7 BTEX concentrations on high traffic volume site (Quynh Truc and Kim Oanh, 2007)

Quynh Truc and Kim Oanh also took BTEX samples at different downwind distance on 2 days with stable wind direction which was most perpendicular to the street orientation and found that the concentrations of TEX decreased considerably with the distance from roadside while benzene still has high concentration within 50 meters as shown in figure 2.8.

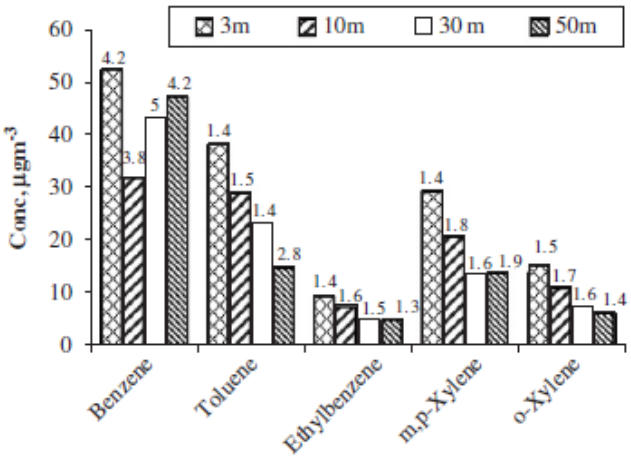


Figure 2.8 Geometric mean concentration and its geometric SD of BTEX (shown values) at distances of 3, 10, 30, and 50m downwind from sampling point (Quynh Truc and Kim Oanh, 2007)

The other study of BTEX is about BTEX in the area around petrol station named "Contribution to ambient benzene concentrations in the vicinity of petrol stations: Estimation of associated health risk" which was held in Greece. Karakitsios et al. (2007) revealed that gas stations have a significant contribution to ambient benzene concentrations in their vicinity. They monitored benzene at three filling stations which located in urban (figure 9), suburban and rural in Greece. The result of their study showed notable increase of the population risks in the vicinity, ranging from 3% (in rural) to 21% (in urban) in comparison to the population in the rest of the town. They also reported the influence of wind speed and traffic flow to benzene concentration in figure 2.9.

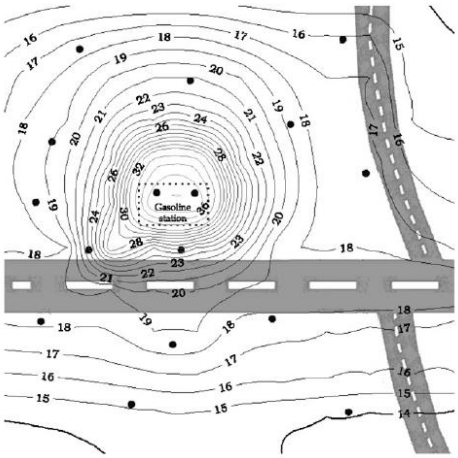


Figure 2.9 Benzene concentration in urban location (Karakitsios et al. 2007)

Hoque et al. (2008) reported in "Spatial and temporal variation of BTEX in the urban atmosphere of Delhi India" that the meteorology of Delhi and reactivity behavior of BTEX could be responsible for the seasonal variation and predominant source of concentration is vehicular emission. The samples were collected from Delhi which has low air quality because of traffic jam and industries, in October 2001-September 2002. Toluene has been detected as highest concentration among BTEX and xylenes is next on down.

Yimrungruang et al. (2008) investigates air samples from gas service stations in Thailand to evaluate the health risks following inhalation exposure. Sampling was held in October-December 2007, Chonburi Thailand. They have found that substances in the workplaces, which were significantly higher than in a control group of office workers at $p<0.05$, are benzene, toluene, ethylbenzene, xylenes, and hexane. Life time cancer risk of all gas service stations in this study had exceeding the normal risk of 1 per million and their noncancer risks are below the reference hazard level. In conclusion, they claimed that benzene may the most important cause of both cancer and noncancer risk followed by 1,3 butadiene.

Ongwandee and Chavalparit (2010) had studied VOCs in-vehicle BTEX concentrations, i.e. A/C bus, non A/C bus, sky train, and boat, in May, July, August 2007, and February 2008. From figure 2.10, BTEX concentrations have the highest levels in bus, in A/C bus is lower than non A/C bus. The number of private cars on roads has increased because of traffic problem, therefore, sky train is another choice

in rush hour. This study also reported that toluene and m,p-xylene in the sky trains were statistically lower than that in other three transportation modes at the *p*-value of 0.05.

Transportation mode	Route	Benzene (μg/m^3)	Toluene (μg/m^3)	Ethylbenzene (μg/m^3)	*m,p*-Xylene (μg/m^3)
A/C bus	A	10.9/2.6/14.3	84.6/81.5/13.6	4.7/0.5/5.1	28.0/27.7/14.1
	B	55.7/49.5/59.4	503/189/690	24.1/24.2/14.4	70.0/81.2/27.2
	C	50.7/66.4/39.1	139/129.3/71.5	16.2/13.6/17.2	45.2/44.7/39.8
Non-A/C bus	A	24.7/22.2/24.2	88.5/90.1/32.9	9.9/10.2/9.2	36.4/37.6/12.1
	B	82.9/87.1/64.6	216/188/126	24.6/30.0/18.9	97.1/91.4/52.9
	C	63.2/64.3/75.9	212/155/142	22.2/19.5/10.3	86.0/61.1/45.9
Sky train	D	13.2/2.0/17.4	39.5/36.9/21.5	0.5/0.5/4.2	1.0/0.5/8.3
Boat	E	45.5/3.1/63.3	65.7/58.5/27.7	3.9/0.5/5.6	8.4/6.2/9.6

Data are expressed as mean/median/standard deviation.

Figure 2.10 In-vehicle concentrations of BTEX and standard deviations

Another study of Karakitsios et al. (2007) about benzene in filling station is "Assessment and prediction of exposure to benzene of filling station employees". They estimated benzene exposure of employees in two stations, one urban and one rural, using passive sampling method. Additional data are also collected including traffic data, amount of gasoline traded (figure 2.11), and meteorological data.

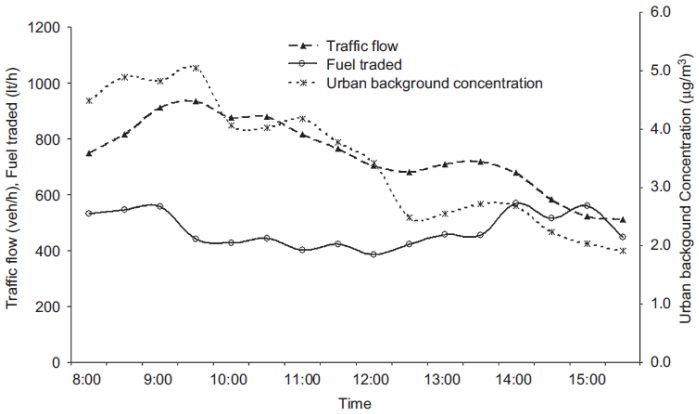


Figure 2.11 Averaged weekly daily variations of traffic flow, fuel traded, and urban background concentration of the urban filling station. (Karakitsios et al. 2007)

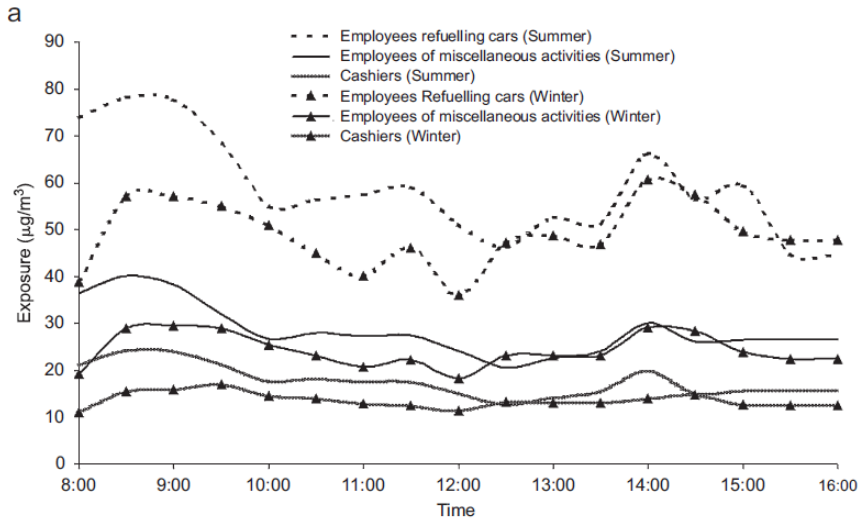


Figure 2.12 Averaged weekly daily variation of the exposure for three categories of employees in summer and winter of urban filling station (Karakitsios et al. 2007)

They claimed that filling station employees in urban area are exposed more than rural area because of gasoline traded and traffic flow. Higher temperature in summer caused higher amount of benzene than in winter as seen in figure 2.5. They also investigated separately in three different categories of employees; refueling cars, cashiers, and miscellaneous activities. Figure 2.12 has shown the exposure of employees in different categories who work in urban filling station while workers in rural filling station have the same trend in lower exposure.

Chapter 3

Methodology

3.1 Study area

Bangkok city is a capital which has the largest number of people in Thailand while Nonthaburi is one of five perimeter provinces around Bangkok. Two petrol stations; one in Bangkok and another one in Nonthaburi, were chosen to clarify the different between in the city and out town for the first part of study (Part I). One is in the urban area which located on Rama IV road wireless intersection in Bangkok called BKK station (figure 3.1). The other one is the represent of suburban area which located on Cheangwattana road in Nonthaburi called NBI station (figure 3.2).

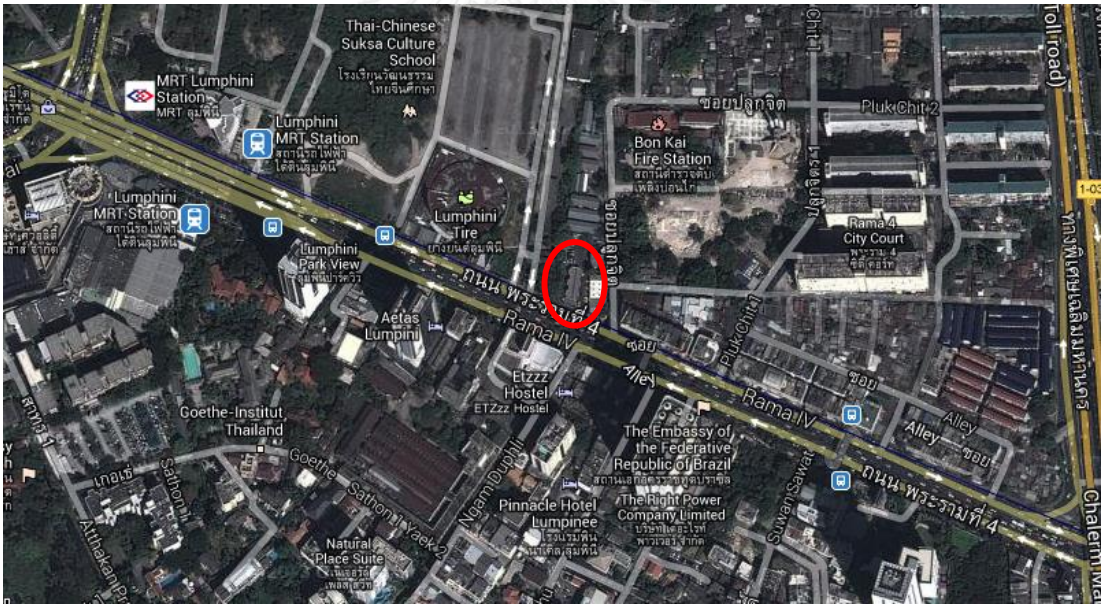


Figure 3.1 Location of the petrol station in Bangkok

These two stations are both 8 lanes roadside and crowded in rush hours. The differences of these two stations are surrounding area, area of station, location in the city and brand of the fuel. BKK station is in residential area on the main road, 300 meters far from a major intersection and 400 meters far from a junction to express

way. NBI station is also on the main road but located near shopping mall and far from major section 700 meters, in residential and business area.

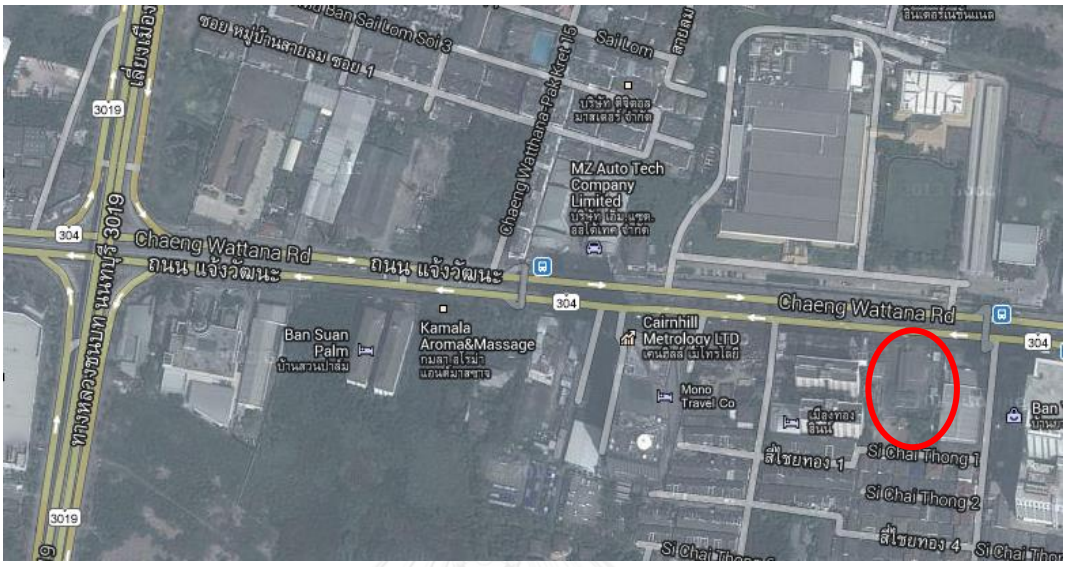
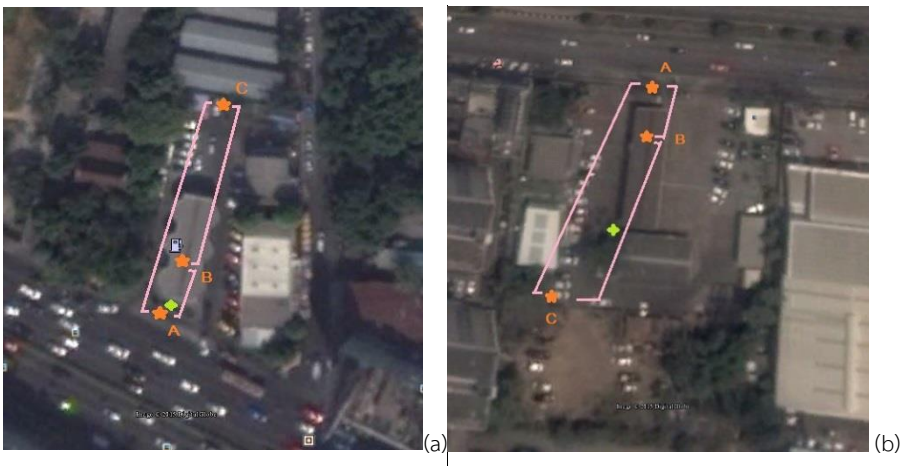


Figure 3.2 Location of the petrol station in Nonthaburi

The area of BKK station was 1,510.5 m^2 (26.5*57 m). Three sampling points and meteorological point at this station were shown in figure 3.3 (a). Point A (roadside) was 10 meters and 56 meters far from point B (filling nozzle) and point C (back of station), respectively, and point B was 46 meters far from point C. The roof area which covers all of filling nozzles was 251.75 m^2 (26.5*9.5 m). The area of covered roof was 16.7% of station area.



(a) (b)

Figure 3.3 The sampling point at BKK station (a) and NBI station (b)

NBI station was bigger than BKK station with 3,538 m^2 (61*58 m). BTEX sampling points and meteorological sampling point were also shown in figure 3.3 (b). Point A (roadside) was 16 meters and 58.5 meters far from point B (filling nozzle) and point C (back of station), respectively, and point B was 45.5 meters far from point C. The roof of filling nozzle area was 245 m^2 (31.7*7.76 m) which was 6.9% of station area.

For the second part of this study (Part II), the sampling was carried out at only one station, NBI station, to study BTEX concentrations in different seasons and their relationship with fuel circulation and the amount of customer car.

Three sampling points were selected in each station; roadside in front of the station, in the center and at the back of station, as mentioned above. Sampler was hanged with electricity post or other available post in front of the petrol station at the roadside (figure 3.4a) and was placed on the wall at the back of station (figure 3.4b), while the other sampler was placed above refueling machine in the center of the station (figure 3.4c).

(a) (b) (c)

Figure 3.4 On site sampling point at roadside(a), back of station(b), and filling area(c)

3.2 Gas Chromatography

Gas Chromatography, model HP 6890N produced by Agilent, connected with Flame Ionization Detector (GC/FID) at CU Research Building 10th floor, Chulalongkorn University, were used to analyze benzene, toluene, ethylbenzene, and xylenes. The

capillary column which was used in this model is HP-5, size 30 m x 0.32 mm x 0.25 µm (19091J-413) produced by Agilent. Nitrogen (N_2), Helium (He), Hydrogen (H_2) and Air zero were used as carrier gases. The initial temperature of oven was set at 45°C holding for 5 minutes. After that, temperature would increase 3°C every minute in ramp rate 1 until oven reach 80°C. Then increase 5°C per minute in ramp rate 2 and the final temperature of analysis is 85°C. The summary of optimum condition was shown in table 3.1.

Table 3.1 The condition of GC/FID for BTEX analysis

Capillary Column	HP-5 size 30 m × 0.32 mm × 0.25 µm (19091J-413)
Carrier Gas	Nitrogen (N_2) Helium (He) Hydrogen (H_2) Air Zero
Flow rate of He	1.5 ml/min
Type of Injection	Split less
Injection Volume	1 µl
Injector Temperature	300 $^{\circ}$C
Detector	Flame Ionization Detector (FID)
Detector Temperature	300 $^{\circ}$C

Source: Kitwattanavong (2010)

3.3 Preliminary experiments

3.3.1 Standard curves

The calibration curves were made by using mixed standard solution of benzene, toluene, ethylbenzene, m,p-xylene, and o-xylene. Seven difference concentrations, which are 125, 250, 500, 1,000, 2,000, 4,000, and 8,000 ng/ml (1,000 ng/ml = 1 ppm), were prepared for calibration curves of BTEX. The internal standard, 4-bromofluorobenzene, was added in each BTEX standard solution. The reliability of BTEX standard curve should have $R^2 \geq 0.99$ and %RSD should be less than 10% for each compound.

3.3.2 Limits of analysis instruments

From the study of Kitiwattanavong (2010), the Limit of Detection (LOD) and Limit of Quantification (LOQ) for GC/FID were examined by measurable lowest concentration of the mix standard BTEX using signal to noise ratio of 3:1 for LOD and 10:1 for LOQ. The concentration of sample lower than LOQ was reported as not detected (nd). The calculation for determining LOD and LOQ are shown in equation below.

$$LOD = \frac{3 \times \text{the lowest concentration used} \times \delta}{\overline{X}} \quad \text{(Eq.3.1)}$$

$$LOQ = \frac{10 \times \text{the lowest concentration used} \times \delta}{\overline{X}} \quad \text{(Eq.3.2)}$$

$$\delta = \sqrt{\sum_{i=1}^{n}(x_i - \overline{X})^2 / (n-1)} \quad \text{(Eq.3.3)}$$

where

δ = Standard deviation

x_i = Peak area of target compound observed

$\overline{X}$ = Average peak area of these observations

n = Number of observations

3.4 Study on BTEX concentration

3.4.1 Sampling technique

BTEX were collected by using a charcoal glass tube connected to a personal air pump and the sampling instrument was installed at the height about 2 meters from the ground ofthe petrol stations and roadside. Figure 3.5 shows one of sampling in the middle of petrol station. Sampling had been taken for 16 hours (4 hours per period in Part I and 2 hours per period in Part II).

Figure 3.5 Sampling equipment for this study using a personal air pump connected with a charcoal glass tube

3.4.2 Sampling Day

For Part I, the sampling had been conducted at two stations to compare between station in urban and suburban area in 3 days a week; Tuesday, Friday, and Sunday. From gasoline station information, Friday had the highest fuel circulation and followed by Sunday, while Tuesday had the lowest circulation. Sampling was gathered in 2 weeks (one week for each station). Sampling time was divided into 4 periods per day, 4 hours per period, from 6 am. to 10 pm., and total samples are shown in Table 3.2.

In Part II, two days in a week were selected for sampling. The sampling had been performed for 3 months, July, August, and November, to compare between wet and dry season. Sampling time was divided into 8 periods per day, 2 hours per period, from 6:00 a.m. to 10:00 p.m., and total samples are shown in Table 3.3.

Table 3.2 Number of samples in part one

Petrol station	Number of Samplers	Total
NBI	Tuesday (12) Friday (12) Sunday (12)	72
BKK	Tuesday (12) Friday (12) Sunday (12)	

Table 3.3 Number of samples in part two (at NBI station)

Season	Number of Samplers	Total
Rainy season	June (48) July (48)	192
Dry season	December (48) January (48)	

3.4.3 Installation of meteorological instrument

The meteorological data was measured on-site during sampling using Autromet™ by Met One Instruments (Figure 3.6). Atmospheric variables which could be measured by this instrument are shown in table 3.4. Each variable was measured and recorded 5 minutes interval during the sampling day. Then, they were calculated as 4 hour average and 2 hour average to compare with result in Part I and Part II, respectively.

Table 3.4 Meteorological variables measured by Autromet™ and its unit

Variables	Unit	Variables	Unit
Barometric pressure	mHg	Temperature	^{o}C
Relative humidity	Percentage	Wind direction	Degree
Solar radiation	W/m^2	Wind speed	m/s

Figure 3.6 Autromet™ by Met One Instruments

3.4.4 Sampling preparation

3.4.4.1 BTEX Sampling

1) A flow of personal air pump which connected to a charcoal glass tube was adjusted to 100 ml/min by Gilibrator-2.

2) A charcoal glass tube was connected to a low flow personal air pump (figure 3.5). All of sampling equipment was placed at the height about 1.5 - 2 meters from ground at 3 sampling points as mentioned above.

3) At each sampling point, a charcoal glass tube had been changed every 4 hours for Part I, and every 2 hours for Part II. The samplings were collected from 6 am. to 10 pm. during a day.

4) After finished each sampling of the day, the air pumps were measured the air flow rate again.

5) After sampling, each charcoal tube sampler was sealed (as shown in figure 3.7) and put in a zipped-lock bag. Then the charcoal tube was stored at cold condition in box and transferred to 4 $^{\circ}$C refrigerator at the laboratory.

Figure 3.7 Charcoal tubes

3.4.4.2 Sample preparation and calculation

1) The charcoal sample from 2 parts of this study was extracted following the US EPA Compendium Method 1501.

2) The sorbent in each charcoal tube was separated into two parts, front and back, the front was extracted and represented for the BTEX of each sample, while extraction of the back was used for breakthrough checking.

3) The activated charcoal in a charcoal glass tube was poured into test tubes by separated front and back sections in each tube.

4) Internal standard 4-bromofluorobenzene solution of 40,000 ng/ml was spiked into those test tubes 100 µl and 50 µl, each for front and back, respectively.

5) A test tube was closed and let reaction occur for 30 minutes.

6) After that, carbon disulfide (CS_2) was added into activated charcoal in the tubes, 2 ml for each front section and 1 ml for each back section.

7) A test tube was closed and shaken for better reaction for 5 minutes, then let reaction occur for 1 hour.

8) Clear extracted solution in each tube was filtered by plait filter paper into each vials and kept it frozen until further analysis.

9) The sample solution had been analyzed by using Gas Chromatography (GC) with flame ionization detector (FID), and Helium (He) was used as carrier gas.

10) The amount of BTEX can be calculated by these following equations;

$$M_S = \frac{P_A - P_B}{P_C} \times C_S \times \frac{V_S}{V_I} \quad \text{(Eq. 3.4)}$$

where;

M_S (µg/sample) = Mass of BTEX

C_S (µg/ml) = Concentration of the mixed standard solution

P_A = Peak area of BTEX per peak area of 4-bromofluorbenzene in sample

P_B = Peak area of BTEX per peak area of 4-bromofluorbenzene in blank

P_C = Peak area of BTEX per peak area of 4-bromofluorbenzene in mixed standard solution

V_S (µl) = Sample volume (2 ml)

V_I (µl) = Injection Volume (1 µl)

$$Concentration\ of\ BTEX\ (\mu g/m^3) = \frac{Mass\ of\ BTEX\ (\mu g)}{Volume\ of\ air\ (m^3)} \quad \text{(Eq. 3.5)}$$

3.4.5 Data analysis

After got BTEX concentration and average of meteorological data, the data was calculated in period of BTEX sampling time depends on part of study and used to find relationship. The following statistics are used to find difference and correlation of the data.

1) T-test analysis was used to find difference of BTEX concentration from each petrol station in Part I, also each day in a week in Part II and each season in Part II.

2) One-way ANOVA was used for finding difference of BTEX concentration from each day in a week in Part I, each period of time, and each sampling point in both two parts.

3) Pearson's correlation was examined to find relationship between the amount of BTEX and meteorological data, fuel circulation, and number of customer's car.

4) Multiple regression analysis was performed to find which affecting factors including meteorological data, fuel circulation, and number of customer's car, could be predicted BTEX concentration.

Chapter 4

Result and Discussion

4.1 Preliminary study

4.1.1 Optimum condition of GC/FID for BTEX analysis

From previous study of Kitwattanavong (2010), the condition of GC/FID was set up by using standard solution of BTEX and toluene d-8 as an internal standard. However, retention time of toluene d-8 is usually closed to toluene and difficult to identify sometimes. Thus, Internal standard in this study was changed to 4-bromofluorobenzene which gave a clear peak at the retention time of 12.0 minutes. Besides, the optimum condition of oven temperature for BTEX analysis was adjusted and total run time was less than that of Kitwattanavong's study. The capillary column of HP-5, size 30 m x 0.32 mm x 0.25 µm (19091J-413) was used. The initial temperature of oven was set at 45 °C and hold for 5 minutes. After that, the temperature increased at the rate of 3 °C/min until the temperature reached 80 °C. Then, the final temperature of the oven was set at 85 °C using the increase rate of 5 °C/min. The chromatogram of BTEX and 4-bromofluorobenzene was shown in figure 4.1.

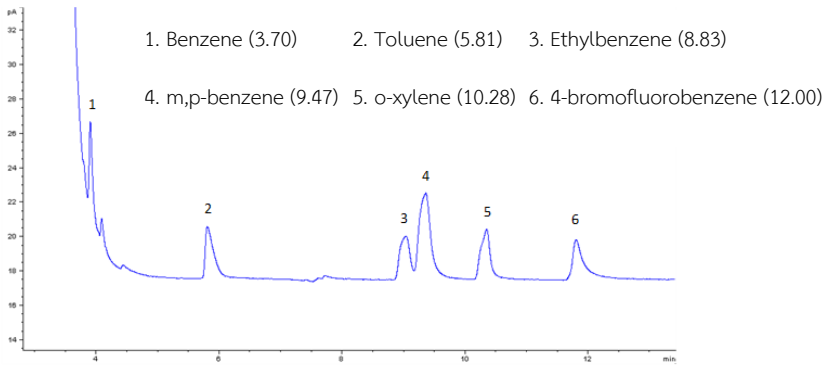


Figure 4.1 Chromatogram of 8,000 ng/ml BTEX standard with the concentration of 20,000 ng/ml 4-bromofluorobenzene as internal standard.
(The number in bracket represented retention time)

4.1.2 Calibration curve

The calibration curves of BTEX concentration were prepared from mixed standard solution of BTEX; 5 concentrations (e.g. 500, 1,000, 2,000, 4,000, and 8,000 ng/ml) for benzene and ethylbenzene, and 7 concentrations (e.g. 125, 250, 500, 1,000, 2,000, 4,000, and 8,000 ng/ml) for toluene, m,p-xylene, and o-xylene. The R^2 of the calibration curves were found between 0.9900-0.9993. The calibration curves of BTEX are shown in appendix A.

4.1.3 Detection limit of Gas Chromatography

Detection limit of GC/FID can be defined using LOD (Limit of Detection) and LOQ (Limit of quantification). The standard solution of BTEX containing 4-bromofluorobenzene was injected to GC/FID to find the lowest concentration which gave a readable peak. The lowest concentration of each substance, benzene, toluene, ethylbenzene, m,p-xylene, and o-xylene, might be different. The lowest concentration which gave signal to noise ratio of 3:1 was used to calculate as LOD and LOQ using equation 3.1 and 3.2 (in Chapter 3). The lowest LOD and LOQ were found in toluene and the highest LOD and LOQ were found in o-xylene. The results of all LOD and LOQ are shown in table 4.1. The range of LOD and LOQ were 1.60-11.08 ng/ml and 5.34-36.93 ng/ml, respectively, and could be reported in the unit of $\mu g/m^3$ which calculated by applied the volume of air sample as the range of 0.038-0.263 $\mu g/m^3$ and 0.127-0.877 $\mu g/m^3$, respectively. Moreover, determination of %RSD was performed to compare the uncertainty between different measurements of the same absolute concentration, and the result was shown in table below. %RSD of BTEX concentrations in this study were not exceed 5% which were acceptable.

The LOD of BTEX investigated by GC/FID in some previous studies were similar to this study, for examples the LOD of BTEX prepared by Japanese 52 component indoor air standard was 0.03-0.20 $\mu g/m^3$ (Poolma, 2005), and that of the BTEX standard was 0.05-0.79 $\mu g/m^3$ (Kitwattanavong, 2010) and 0.06-1.04 $\mu g/m^3$ (Esplugues et al., 2010).

Table 4.1 LOD, LOQ, and %RSD for BTEX analysis

Compound	%RSD	LOD		LOQ	
		ng/mL	μg/m^{3*}	ng/mL	μg/m^{3*}
Benzene	3.24	5.75	0.136	19.16	0.455
Toluene	3.73	5.32	0.126	17.74	0.421
Ethylbenzene	2.50	1.60	0.038	5.34	0.127
m,p-xylene	1.45	2.67	0.063	8.90	0.211
o-xylene	2.58	11.08	0.263	36.93	0.877

*Based on volume of air sample in the environment

4.2 Temporal variation of BTEX at petrol stations

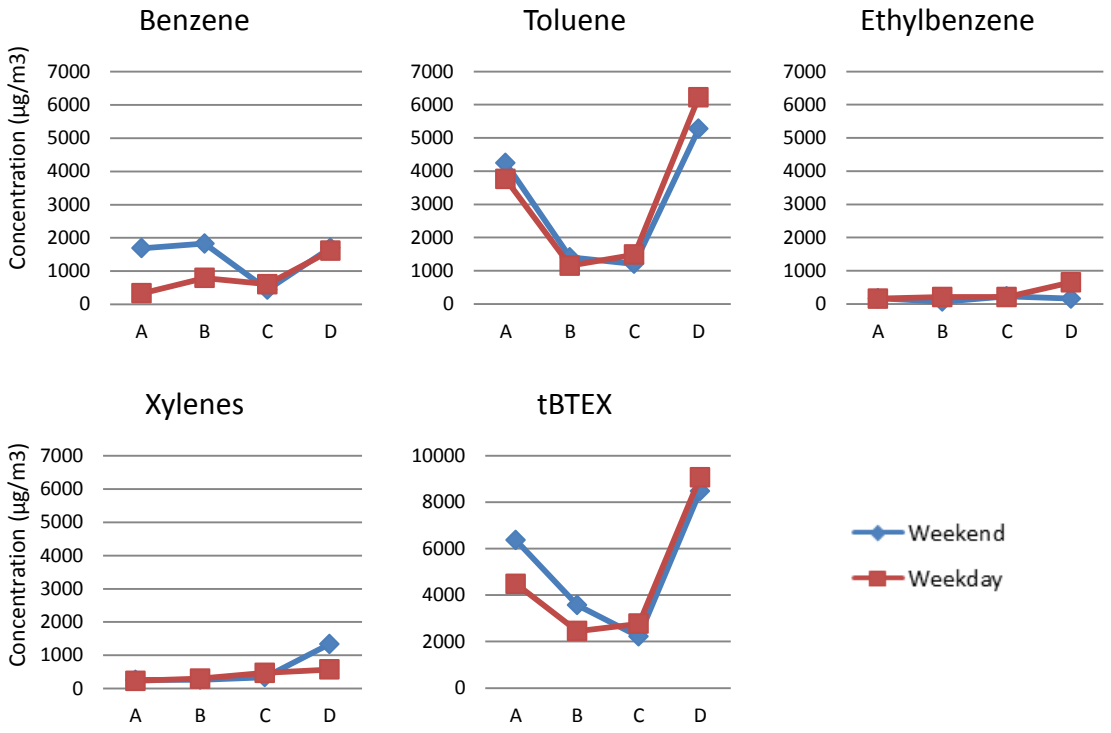
The sampling in Part I was taken at two petrol stations which represented station in urban (BKK station) and suburban area (NBI station). The sampling at each station was conducted for three days; Sunday represented weekend and Tuesday and Friday represented weekday. The sampling date were 9th (Sunday), 11th (Tuesday), and 14th (Friday) September 2012 at NBI station and 5th (Friday), 7th (Sunday), and 9th (Tuesday) October 2012 at BKK station. The sampling in each day was performed for 16 hours and divided into 4 periods of time; 6 am. - 10 am., 10 am. - 2 pm., 2 pm. - 6 pm., and 6 pm. - 10 pm.

In Part II, BTEX were collected at NBI station only, which was assigned to find the BTEX concentration in different seasons (e.g. wet and dry season). The samples were collected two days a week; i.e. Sunday and Tuesday, for two weeks in each season. Sampling days in this part were on 28th (Sunday), 30th (Tuesday) July and 4th (Sunday), 6th (Tuesday) August 2013 which were represented for wet season, including 10th (Sunday), 12th (Tuesday), 24th (Sunday), and 26th (Tuesday) November 2013 for dry season. The sampling time was changed to have more often periods than in Part I, 8 periods in 16 hours; as a result, concentration variation would be more explicitly than variation in Part I. The differences temporal variation of BTEX at station in urban and suburban area are displayed and discussed as follows.

4.2.1 Temporal variation of BTEX at petrol station in urban area

Sampling at BKK station was only conducted in Part I (2012) as 4-hr interval. Although it was not perform in 2-hr interval, concentration can gave the rough pattern of variation in the petrol station located on urban area. Temporal variation was separated in weekday and weekend due to different activities on those days. However, sampling days in weekday had higher relative humidity and solar radiation than in weekend. Therefore, BTEX concentration in weekday was not much different from concentration in weekend, despite the fact that BTEX concentration in weekday normally higher than in weekend because of location. BKK station was nearby business area, so traffic density and customer in weekday were regularly higher than in weekend. Concentration at each sampling point had different quantity and also pattern as its source.

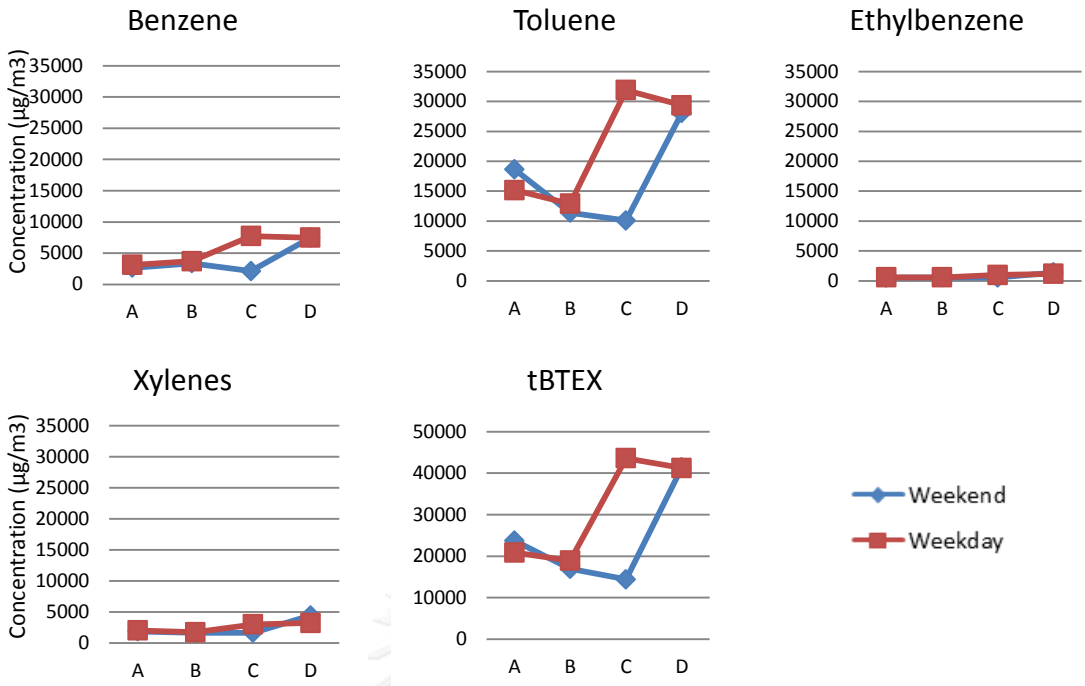
At roadside sampling point, toluene obviously was the dominant compound, thus total BTEX had the same pattern as toluene as seen in figure 4.2. Their variation was high in 6 am - 10 am and dropped in 10 am - 6 pm, then rose again in 6 pm - 10 pm. This pattern followed the traffic density on the road which had traffic congestion in rush hour; 6 am - 9 am in the morning and 5 pm - 8 pm in the evening. The other compounds were much lower than toluene. Ethylbenzene and xylenes variation were similar pattern, except for xylenes in 6 pm - 10 pm on weekend which was about 2 times higher than ethylbenzene. However, ethylbenzene and xylenes concentrations were not much vary comparing to toluene. Benzene concentration in 6 am - 2 pm on weekend was larger than weekday which contrasted to traffic congestion. This station located on official area, thus traffic density on weekday is normally higher than weekend.



A = 06:00-10:00, B = 10:00-14:00, C = 14:00-18:00, D = 18:00-22:00

Figure 4.2 Temporal variations of BTEX and tBTEX on weekday and weekend at roadside at BKK station in Part I

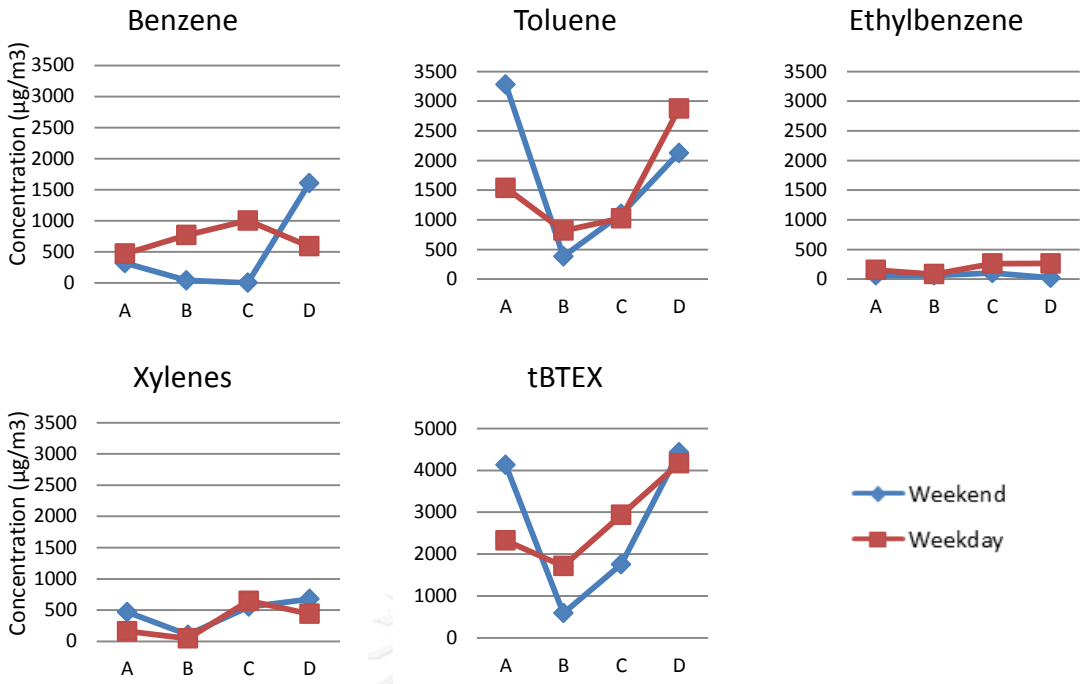
From figure 4.3, toluene nearby filling nozzle was the dominant substance of BTEX. It was reasonable that amount of toluene in 2 pm - 6 pm on weekday was extremely much higher than weekend because customers rarely refueled at this station on weekend, and also similar to benzene concentration in the same period on that day. Amount of BTEX in 6 pm. - 10 pm. in weekday and weekend were closed, because the road where BKK station located is thoroughfare to night entertainment venue. Ethylbenzene and xylenes variations were not different as they were minor compound. The fuel circulation at this station was not collected and also number of customer's car. However, study of Kitwattanavong (2010) had found the positive significant relationship between BTEX concentration and fuel circulation, and also with number of customer's car. Therefore, it could be assumed from the previous study that BTEX concentration found at this sampling point might be proportional to fuel circulation and number of car.



A = 06:00-10:00, B = 10:00-14:00, C = 14:00-18:00, D = 18:00-22:00

Figure 4.3 Temporal variations of BTEX and tBTEX on weekday and weekend at filling area at BKK station in Part I

For the last sampling point at back of station, tBTEX and toluene were had similar pattern due to dominant substance as display in figure 4.4. Toluene on weekend was the highest concentration in 6 am - 10 am then dropped to the lowest amount in next period, and rose up with time until last period of sampling. Whereas weekday toluene in 10 am - 2 pm was also dropped from previous period, but those were not much different like on weekend, and rose up with time too.



A = 06:00-10:00, B = 10:00-14:00, C = 14:00-18:00, D = 18:00-22:00

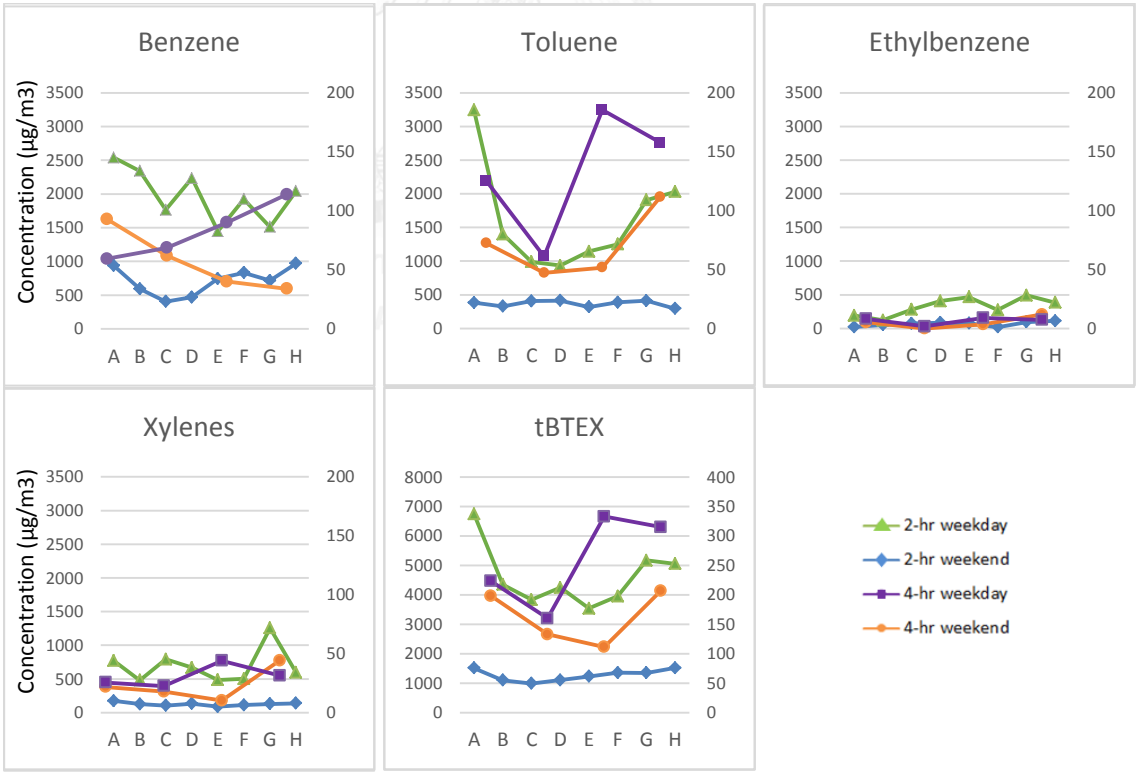
Figure 4.4 Temporal variations of BTEX and tBTEX on weekday and weekend at back of station at BKK station in Part II

4.2.2 Temporal variation of BTEX at petrol stations in suburban area

Considering the temporal profile, concentrations in two parts of study were averaged in terms of weekday and weekend. Sampling at suburban area was performed in both part of the study, so it was a bit divergent. Since 4-hr interval concentration (square and circle line) was compared with an average of 2-hr interval (triangle and diamond shaped line), their pattern was different between weekday and weekend. In addition, 2-hr interval concentration was the average of dry and wet season in 2013 while 4-hr interval concentration was collected only in wet season 2012. Thus the quantity of compound was different.

Average of BTEX and total BTEX concentrations in front of station (roadside sampling point) are illustrated in figure 4.5. Toluene was a dominant compound among BTEX, because it had the highest concentration followed by benzene. Consequently, the patterns of tBTEX and toluene were alike, also xylenes with lower amount. Their similar profiles on weekday, which decreased at 10 am - 2 pm then

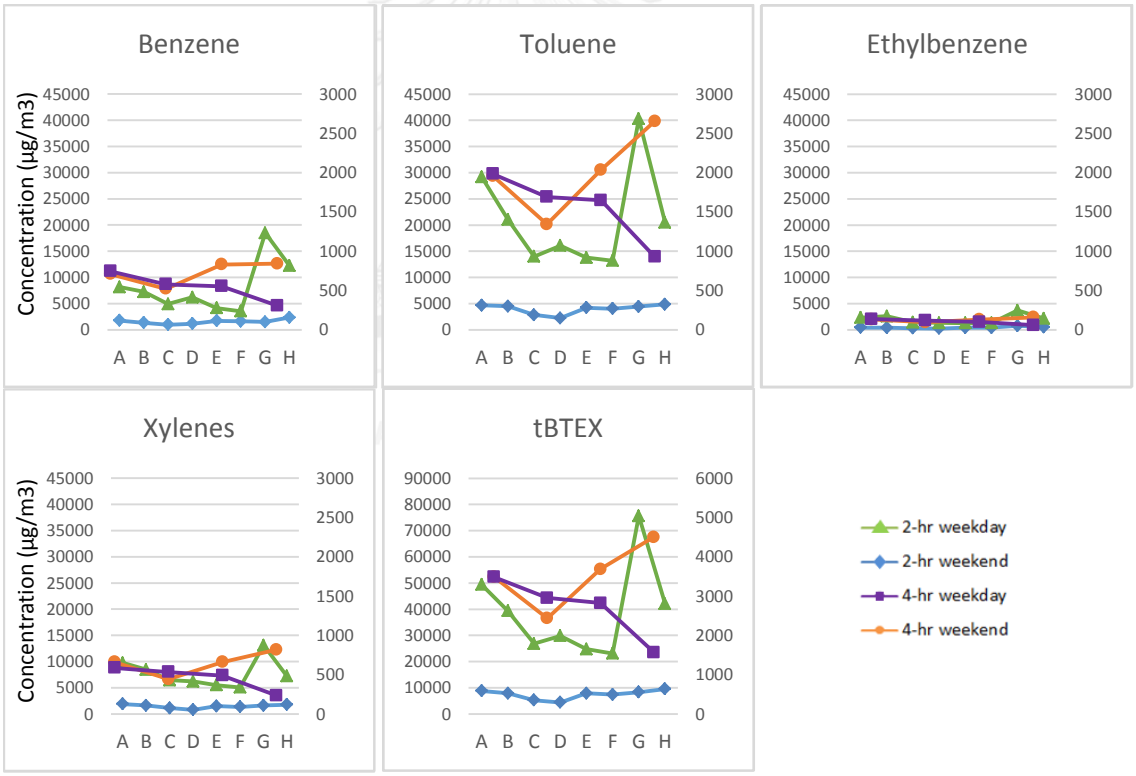
increased at 2 pm - 6 pm, could be observed. These substances were changed in accordant with the traffic density on the main road; high traffic density of this road was typically during 6 am - 9 am and 4 pm - 7 pm. However, concentration of toluene, xylenes, and tBTEX dropped on weekend evening (2 pm - 6 pm). It is possibly caused by less traffic congestion in weekend. Benzene had different pattern in the same condition, so that other conditions such as meteorological condition might have more effect on benzene than traffic density. On weekday, 2-hr interval average profile had vary concentration with the highest concentration in 6 am - 8 am while 4-hr interval concentration tended to higher along the time. In contrast, 4-hr interval concentration on weekend decreased with time. 2-hr interval benzene on weekend was dropped from 6 am until noon and then tended to rise with time. Whereas ethylbenzene concentration was not different in time period, its amount was very low compared to other substances.



A = 06:00-08:00, B = 08:00-10:00, C = 10:00-12:00, D = 12:00-14:00, E = 14:00-16:00, F = 16:00-18:00, G = 18:00-20:00, H = 20:00-22:00

Figure 4.5 Temporal variations of BTEX and tBTEX on weekday and weekend at roadside at NBI station in Part I and Part II

At filling nozzles area (figure 4.6), the variations of BTEX were all the same pattern. 2-hr interval concentration in 10 am - 6 pm was lower than other periods but divergent from 4-hr interval concentration on weekday which might cause from meteorological condition difference. Anywise, the BTEX concentration profiles at the center of station were similar to the customer's car profiles as illustrated in figure 4.7 (a) and also fuel circulation in figure 4.7 (b). The significant relationship of concentration of BTEX with fuel circulation and number of customer's car was not found in this study (shown in appendix D), but there were significant relationship between those in study of Kitwattanavong (2010) which also investigated at station in Bangkok city. Study of Kitwattanavong (2010) evaluated at vary stations while this study determined fuel circulation and number of customer's car only at NBI station.



A = 06:00-08:00, B = 08:00-10:00, C = 10:00-12:00, D = 12:00-14:00, E = 14:00-16:00, F = 16:00-18:00, G = 18:00-20:00, H = 20:00-22:00

Figure 4.6 Temporal variations of BTEX and tBTEX on weekday and weekend at filling area at NBI station in Part I and Part II

Therefore, data in this study might not enough to show the relationship of them. For the record, the average of fuel circulation was from actual sales of NBI station on sampling day in Part II including number of customer's car excluding customer who came in for shop without refueling.

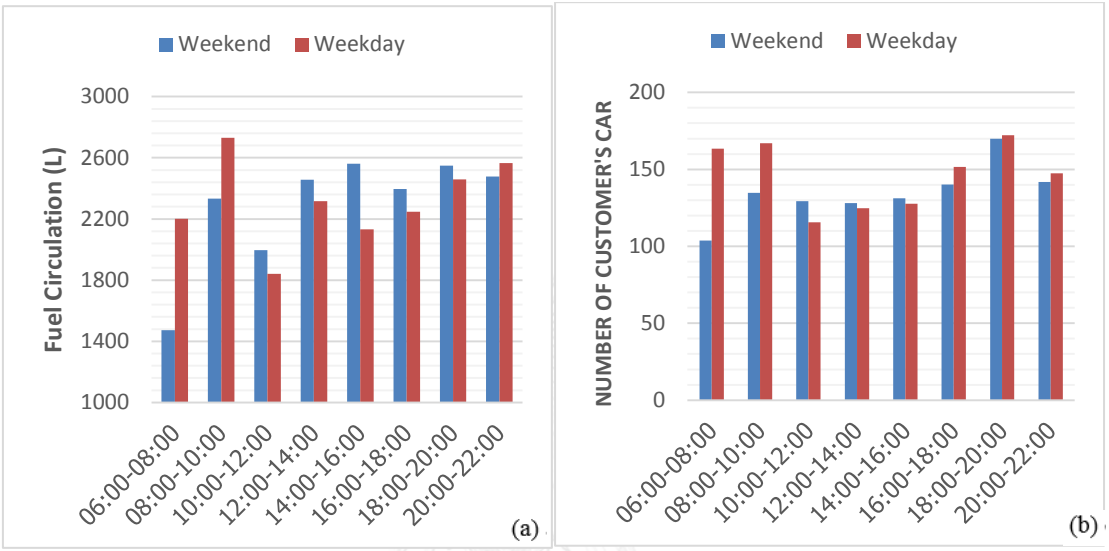
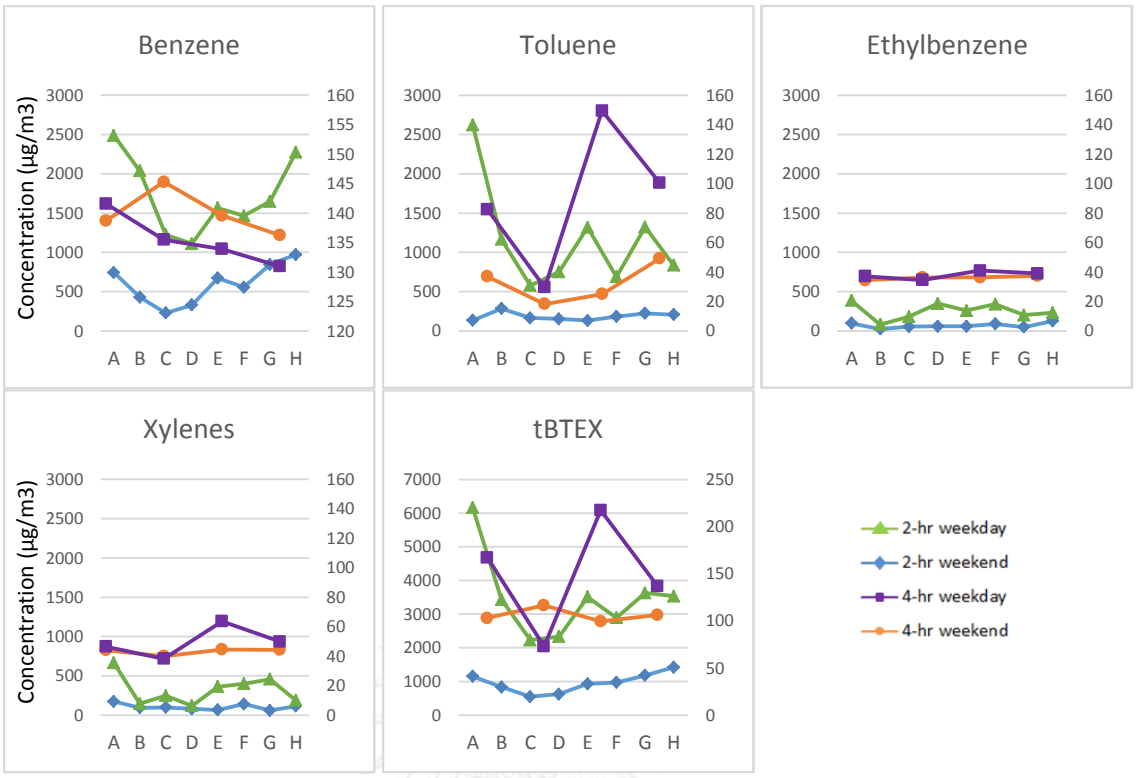


Figure 4.7 Average of number of customer's car (a) and fuel circulation (b) on sampling day at NBI station in Part II

Like the other sampling points, patterns of total BTEX concentration at the back of station (figure 4.8) were like toluene because the dominant compound of BTEX which were found was toluene and followed by benzene. Except for 4-hr interval concentration on weekend, peak of the lowest concentration of toluene was in 10 am - 2 pm while tBTEX had the highest concentration at the same period like benzene. Variation at this sampling point was similar to variation at roadside with lower concentration, excluding benzene which had contrast variation from roadside. Hence BTEX concentration at roadside might had partial effect on concentration at back of station, or source of concentration at these two sampling points was the same.



A = 06:00-08:00, B = 08:00-10:00, C = 10:00-12:00, D = 12:00-14:00, E = 14:00-16:00, F = 16:00-18:00, G = 18:00-20:00, H = 20:00-22:00

Figure 4.8 Temporal variations of BTEX and tBTEX on weekday and weekend at back of station

4.2.3 Comparison on temporal variation between petrol station at urban and suburban area

From figure 4.9, the triangle and diamond shaped line showed trend of 2-hr interval tBTEX on weekday and weekend, respectively, also square and circle line for 4-hr interval tBTEX on weekday and weekend. All of them represent tBTEX pattern at each sampling point of suburban station, while the other ones represent for urban station with red and diamond shaped line for weekday and weekend, successively.

Concentrations at NBI station, which were sampling in 2013 for Part II, were much higher than concentrations in 2012 at the same station; as a result of different area environment. Cheangwattana road, which NBI station located on, had more crowd and traffic congestion since increasing of condominium and shopping mall nearby.

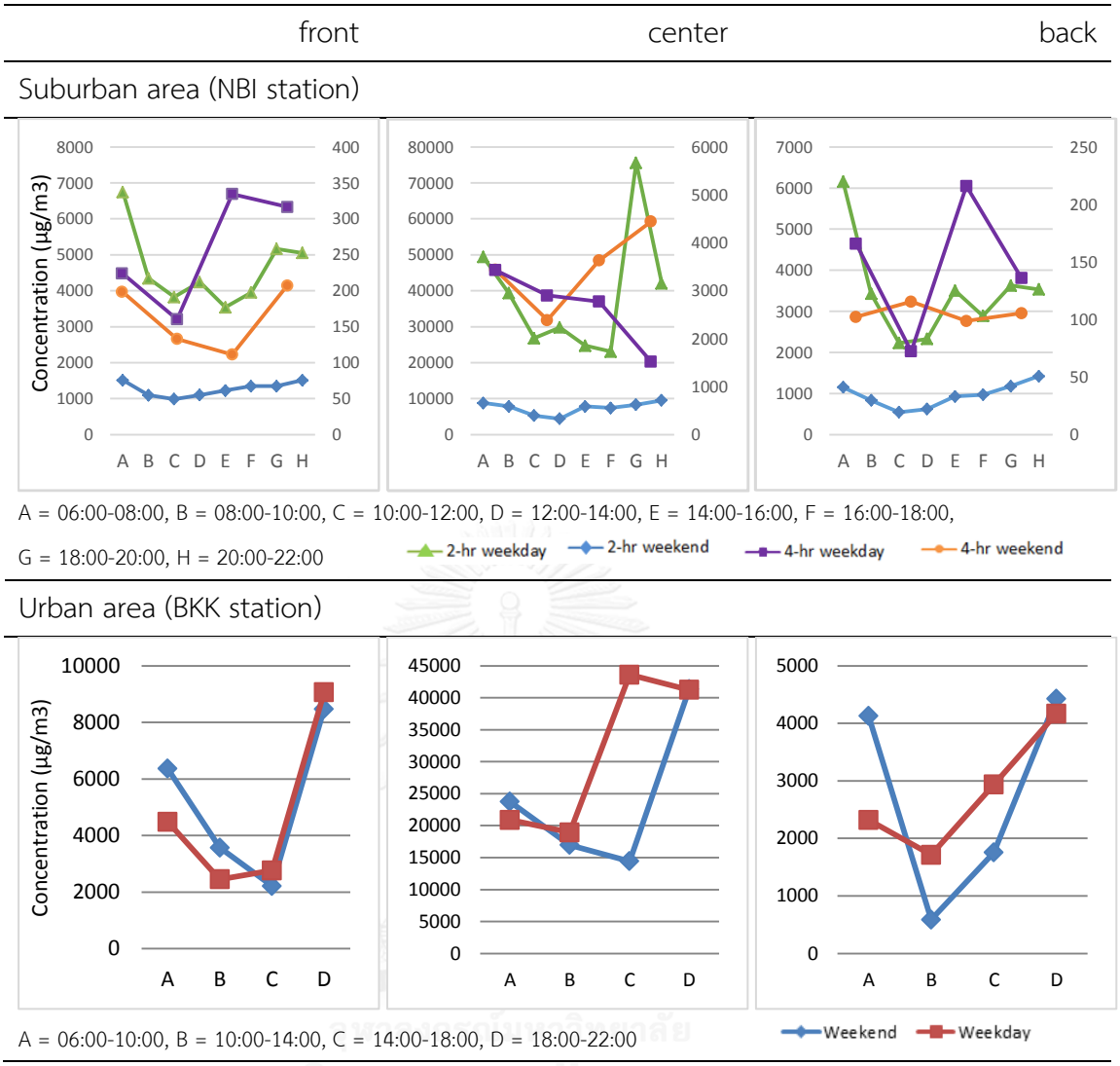


Figure 4.9 Temporal variations of tBTEX on weekday and weekend at NBI and BKK station

At roadside sampling point, most of tBTEX variation was similar to traffic congestion which was high in the morning and evening. Pattern of tBTEX were all the same as upturned bell-shaped, except for 4-hr interval on weekday at NBI station which its concentration exceeded the highest point in 2 pm - 6 pm.

Similar variation was found in the study in Vietnam which defined hourly roadside BTEX concentration as temporal and spatial distribution. Comparing with this study in table 4.2, Quynh Truc et al. (2007) found concentration of BTEX which were about 8.9, 36.0, 8.8, and 7.5 times lower, respectively. However, it was

reasonable because average concentrations in this study included concentration at refilling area.

For tBTEX concentration at the back of station, patterns of variation were most likely roadside pattern with half-less amount at urban station but barely different amount at suburban station. However, concentration of BTEX at BKK station was much higher than NBI station in same part of study. In Part I, they were significantly different for some of reasons; type of area, size of station, traffic congestion, and also wind speed and direction of wind flow. Type of area and size of station could be cause of accumulative concentration of compound. BKK station is located in urban area and more closer to intersection; therefore, emission from the traffic nearby was considerably to be additional source of BTEX. Moreover, size of BKK station is about half of NBI station and the area of BKK station is almost covered by the roof, lead to more accumulation of the substances, while the roof at NBI station covers only filling nozzles area and have more open area.

tBTEX at center of station was highest among three sampling point. By the reason of possible emission source, center of station was directly affected from refilling of the fuel at petrol station, and traffic congestion effected roadside at the front sampling point. Furthermore, the patterns of benzene, toluene, ethylbenzene, and xylenes concentration variation at filling nozzles area were all the same with different amount.

Most of studies in Thailand were determined BTEX concentrations in 8 work hours to evaluate risk assessment in workers. Consequently, it was hard to find study in Thailand which can exactly comparing the result of variation of BTEX concentration in gas service station, even in other countries. However, most of them investigate concentration of BTEX from 6 am to 2 pm. Thus it can be compare with this study by average concentration at every sampling point (assumed that workers have to work around the petrol station) and combine them in the same period of time as they studied. Here were some of studies which could be compared the concentrations.

Table 4.2 Comparison of BTEX concentration to other studies at roadside and gas service station

Study	Compound ($\mu g/m^3$)	Benzene	Toluene	Ethyl benzene	Xylenes
Chonburi (2008) (Personal exposure, 8 hrs)	Average conc.	876.40	1305.80	44.00	208.60
	Max conc.	2929.70	4142.10	91.50	415.30
	Min conc.	140.70	268.70	12.80	48.80
Bangkok (2010) (Personal exposure, 8 hrs)	Average conc.	220.29	297.03	34.96	109.89
	Max conc.	292.52	490.38	52.42	204.04
	Min conc.	55.22	94.77	22.64	56.43
Bangkok (2010) (Air concentration, 8 hrs)	Average conc.	166.23	302.64	44.72	150.10
	Max conc.	262.90	574.17	73.48	293.53
	Min conc.	95.47	167.74	24.61	64.30
Vietnam (2007) (Roadside, hourly)	Average conc.	123.00	87.00	24.00	86.00
	Max conc.	10170.00	260.00	69.00	158.00
	Min conc.	21.00	44.00	13.00	44.00
This study (Nearby filling nozzle, 8-hr averaged)	Average conc.	1144.79	3934.80	230.38	799.13
	Max conc.	7476.37	28922.02	1249.04	3633.43
	Min conc.	469.28	1492.01	77.48	441.05
This study (Roadside, 1-hr averaged)	Average conc.	36.08	62.44	6.43	12.12
	Max conc.	1645.76	5905.61	484.63	828.30
	Min conc.	69.24	57.54	2.92	22.45
This study (Ambient air at back of station, 8-hr averaged)	Average conc.	213.60	268.99	35.67	70.83
	Max conc.	1210.67	2624.40	207.60	616.57
	Min conc.	22.72	22.79	2.30	6.88

The study of Yimrungruang (2008), which was investigated VOCs including BTEX in gas service station workers in Chonburi, Thailand from October to December 2007, reported that mean of benzene, toluene, ethylbenzene, and xylenes concentration are following; 876.4, 1,305.8, 44.0, and 208.6 $\mu g/m^3$, respectively. Concentrations were collected from gas service station workers for 8 work hours. The study of

Kitwattanavong (2010) also determined VOCs in gas service station workers in different location, outer and inner Bangkok, Thailand.

However, Yimrungruang (2008) and Kitwattanavong (2010) collected concentration of BTEX in 8 work hours at Chonburi, average of benzene, toluene, ethylbenzene, and xylenes which were found nearby filling nozzle in this study are about 1.3, 3, 5.2, and 3.8 times of personal exposure in Chonburi, and 5.2, 13.2, 6.6, and 7.3 times of personal exposure in Bangkok, respectively. Kitwattanavong (2010) also report concentrations in ambient air. Benzene was lower than that was found in this study 1.3 times, but toluene, ethylbenzene, and xylenes were higher 1.1, 1.3, and 2.1, respectively. Hourly roadside BTEX concentration in this study was reported lower than in Vietnam as follows; 3.4, 1.4, 3.7, and 7.1 times respectively. As a result, studies of Yimrungruang (2008) and Kitwattanavong (2010) collected 8-hour BTEX in a single stretch in daytime. Whereas BTEX concentrations in this study were investigated in 2-hour interval and 4-hour interval, then the result were averaged to compare with those studies. Therefore, study in Vietnam reported BTEX concentrations higher than in this study, Vietnam investigated concentrations hourly. In addition, averaged concentrations in this study were computed from 16-hour including late night until 10 pm.

4.3 Spatial variation of BTEX at petrol station

Spatial variation is to compare concentration of substances between sampling points, to investigate proportion gap over time. The concentration of BTEX at filling area was different from roadside and back of station at 0.05 level of mean difference. After getting BTEX concentration, it was calculated to ratio of concentration between sampling point in the same period of time, i.e. front:back, center:back, and center:front, by which front, center, and back represented roadside, nearby filling nozzle, and back of station, respectively. When the substance amounts were made to ratio, it could only be compared between sampling point in the same period of time. Although toluene had the highest concentration followed by benzene, xylenes,

and ethylbenzene, the variations of the substances at the specific of time in each sampling point were slightly different as follows.

4.3.1 Spatial variation of BTEX at petrol station in urban area (Part I)

The urban area is represented by BKK station. When the substances amount were averaged in time period by each sampling point, the highest amount of each substance were found at filling area in the morning (6-10a.m.). The lowest of that were found at back of station in 10a.m.-2p.m. except for benzene which was in 6-10p.m. However, after calculated ratio of substances in the same time period, the results were different. The amount of each substance, at three sampling points in the same time period, were grouped and made to ratio as shown in figure 4.10. Ratio of benzene and toluene were quite similar. The highest ratio of center:back and

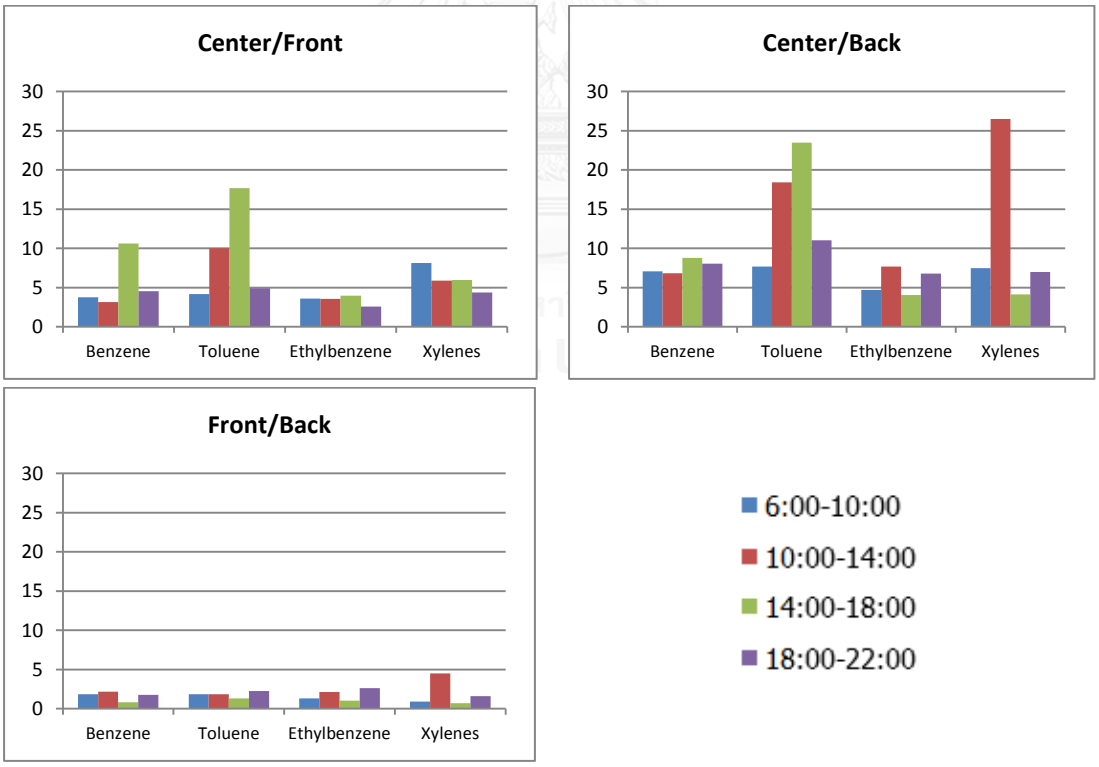


Figure 4.10 The ratio of BTEX at different sampling points in the same time period at BKK station

center:front of benzene and toluene were at 2-6p.m., while the lowest ratio of that of benzene was at 10a.m.-2p.m. and that of toluene was at 6-10a.m. Inasmuch, benzene and toluene at 2-6p.m. were mostly in the center of station, nearby filling nozzles. The front:back ratio of BTEX was extremely lower than center:front and center:back ratio. It unveiled that BTEX at roadside and back of station barely affected from filling area.

4.3.2 Spatial variation of BTEX at petrol station in suburban area observed in 2012

At NBI station which represents suburban area, samplings were collected in 2 parts. Part I was collected along with BKK station and part II was investigated the difference between wet and dry season. At three sampling points, the amount of BTEX at center of station was the highest followed by that at front and back of station, respectively. By the reason of possible emission source, center of station was directly affected from refilling of the fuel at petrol station, and traffic congestion had an effected on roadside at the front sampling point.

BTEX ratios at NBI station in Part I were more orderly than at BKK station. Benzene ratio was different from toluene, ethylbenzene, and xylenes. The center:front ratio of benzene was highest at 6-10a.m. and was lowest at 6-10p.m compare to period of time. While front:back and center:back ratio of benzene were highest in 6-10p.m. and was lowest in 10a.m.-2p.m. On the contrary, toluene, ethylbenzene and xylenes had the highest center:back ratio at 10a.m.-2p.m. and the lowest at 6-10p.m. The lowest center:front ratio of that was at the same time period and also the highest ratio; except for xylenes, which had the highest center:front ratio at 6-10a.m. Hence, main point source of BTEX was nearby filling nozzles at center of station. Except for 10a.m.-2p.m., roadside had an effect on TEX concentration. Plus, TEX tended to disperse to back of station. Like results of BKK station, front:back ratio of BTEX was extremely lower than center:front and center:back, so that BTEX at roadside and back of station were considerable from the same source.

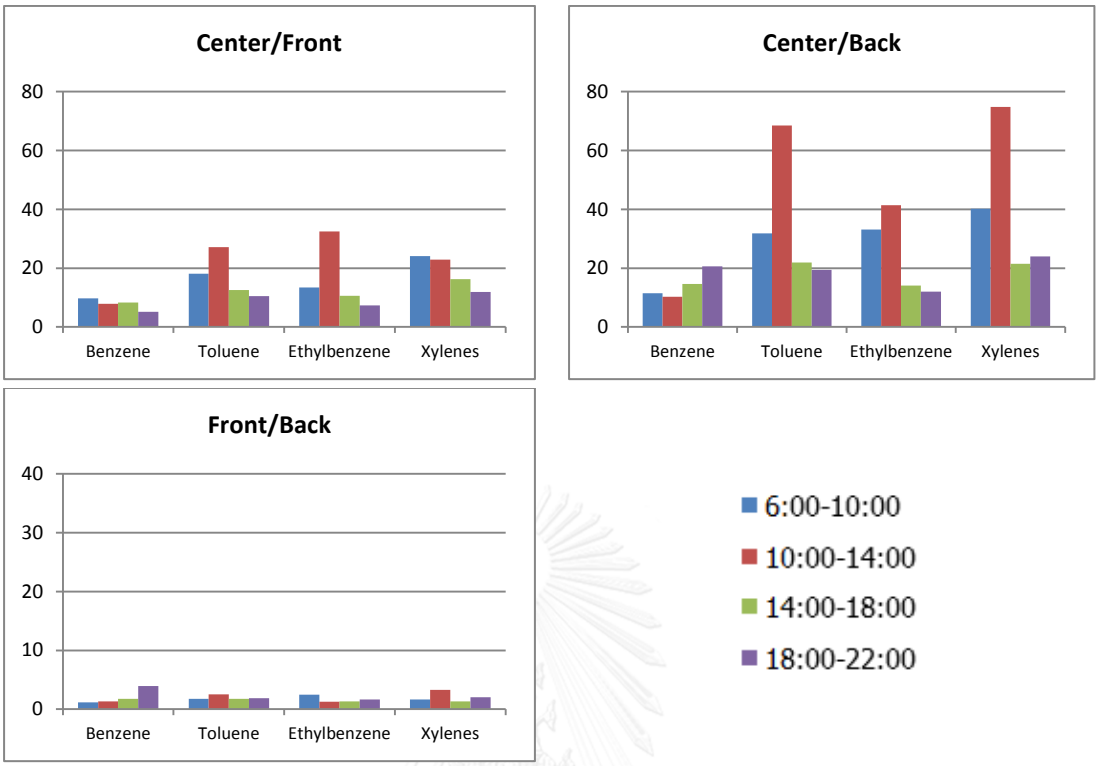


Figure 4.11 The ratio of BTEX at different sampling points in the same time period at NBI station studied in 2012

Spatial variation at BKK (urban) and NBI (suburban) station, which were collected in Part I, were different. From figure 4.12, the concentration ratio at suburban station was obviously higher than at urban station which means that, at the area of petrol station, BTEX at BKK station dispersed in a station more than at NBI station which was a result from follows;

- Wind flow also affected the disparity of BTEX. Figure 4.13 shows wind rose from 3 sampling days at each station. Wind blew from roadside and back of station to center of NBI station so the air including BTEX was blew to the center of station, while wind at BKK station blew one way from the left side of station to roadside. This might cause overestimated concentration nearby filling nozzle. Besides, wind speed at NBI station was higher than at BKK station, then dispersion over three sampling points at BKK station was better than at NBI station.

Consequently, BTEX ratio between center:back and center:front at BKK station was lower than at NBI station.

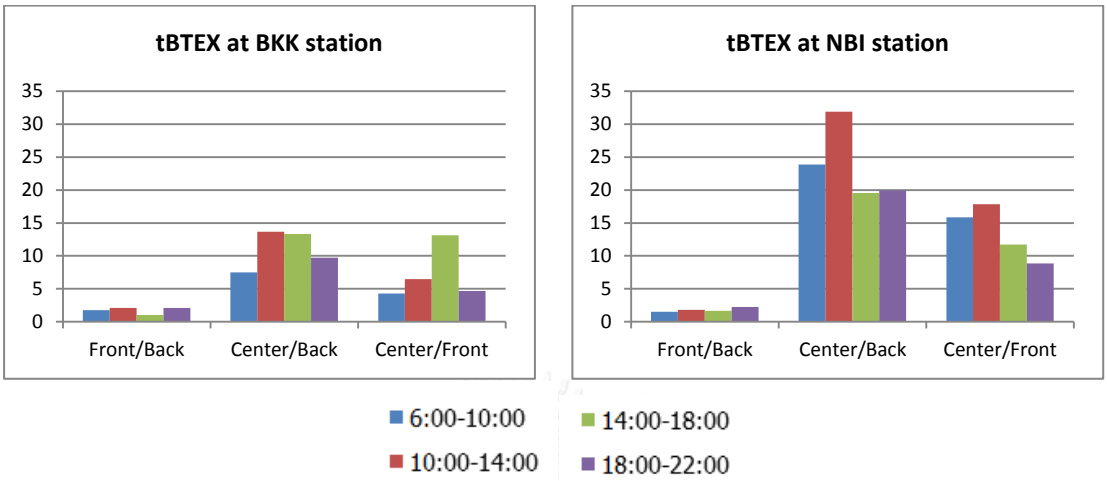


Figure 4.12 The ratio of tBTEX at different sampling points in the same time period at BKK and NBI station studied in 2012

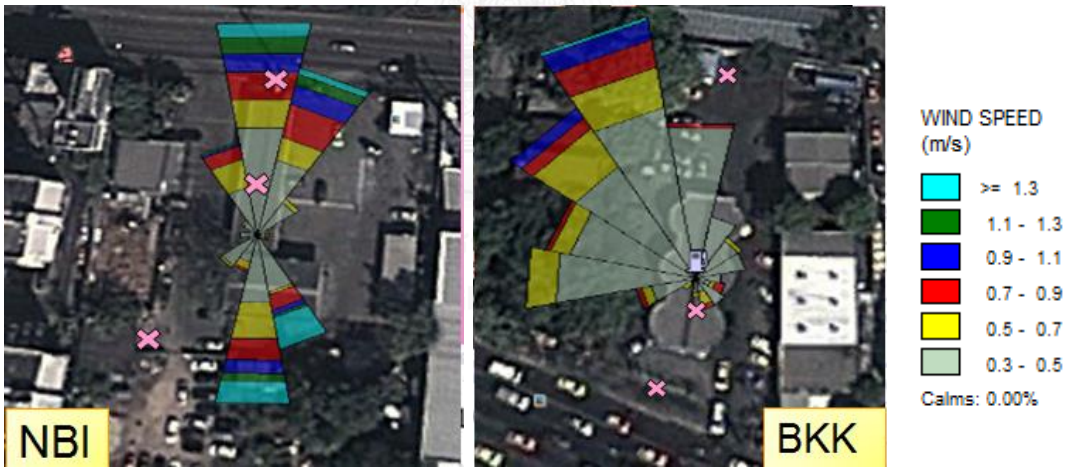


Figure 4.13 Wind rose in 3 sampling days at NBI and BKK station observed in 2012

- Urban station was smaller than suburban station. The area of BKK station was 1,510.5 m^2 while NBI station was bigger than BKK station with 3,538 m^2. Plus, surrounding of BKK station had massive trees while NBI station barely had them.

- Since, Urban station was smaller than suburban station. The distance between roadside sampling point and nearby filling nozzle at suburban station was longer than at urban station (figure 3.3).

- The roof which covers filling area in urban station was bigger than in suburban station. The roof area in BKK station was 17.6% of station area while in NBI station was only 6.9%. Filling nozzle was the main point source of BTEX in petrol station. BTEX nearby filling nozzle under the roof had barely gone with rain, so its transportation was lower than BTEX out of the roof and more accumulative.

4.3.3 Spatial variation of BTEX at petrol station in suburban area observed in 2013

The ration of sampling points in part II were different, begin with ratio of BTEX at different sampling points in wet season. Although the ratio of ethylbenzene had a quite high gap between the highest and lowest at 8-10 a.m., they had similar ratio trend, except for some periods. The center:back ratio of benzene and toluene were

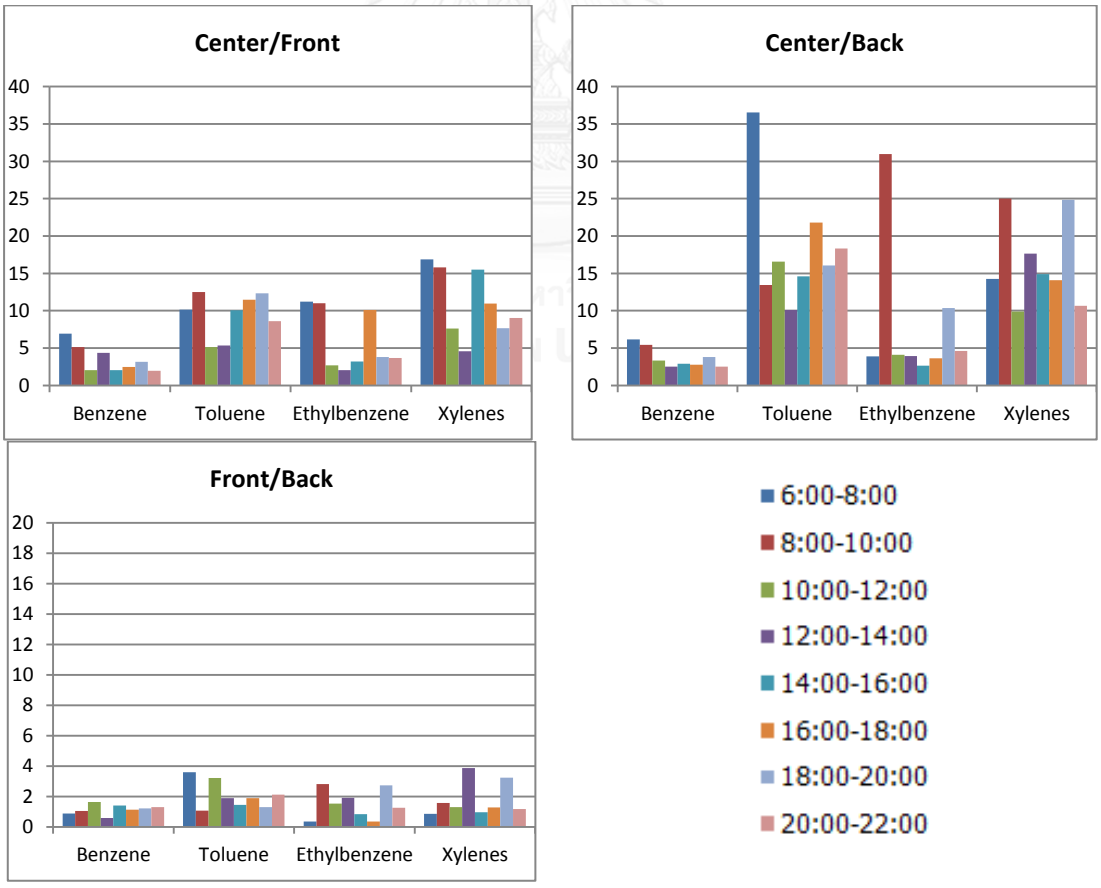


Figure 4.14 The ratio of BTEX at different sampling points in the same time period at NBI station observed in wet season, 2013

highest at 6-8 a.m., while that of ethylbenzene and xylenes were highest at 8-10 a.m. The highest center/front ratio of benzene, ethylbenzene, and xylenes were at 6-8a.m., only that of toluene were highest at 8-10a.m. The lowest ratio of each substance were at varies time period as shown in figure 4.14. High ration of concentration means that BTEX concentration had mainly affected from filling nozzles at the center of station. In addition, the front:back ratio of BTEX was very lower than center:front and center:back ratio. It supported that BTEX concentration at roadside and back of station came from the same source.

The sampling points of ratio in dry season (figure 4.15) were different from wet season. Both of center:back and center:front of xylenes were highest at 8-10p.m., while that of toluene were at 6-8p.m. and 10a.m.-12p.m. and that of benzene were at 12-2p.m. and 6-8p.m., respectively.

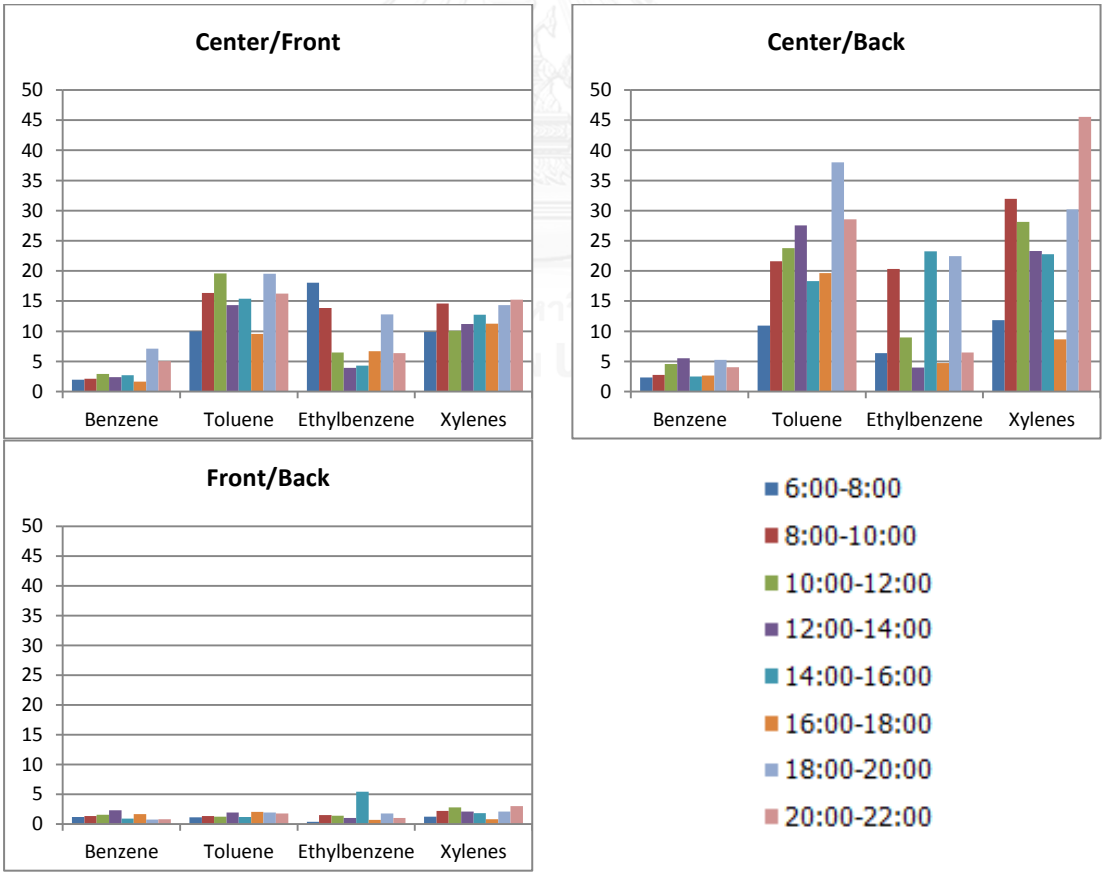


Figure 4.15 The ratio of BTEX at different sampling points in the same time period at NBI station observed in dry season, 2013

In part II, the ratio of sampling points of BTEX in wet season was highest in the first period of the day (6-10a.m.) then reach low peak at 10a.m.-2p.m., and increased after that until 4-8p.m., and got lower to 10p.m. The rations in dry season were opposite. This disparity might cause from different weather of season; relative humidity, wind speed, and wind direction. In wet season, morning of the sampling day (6am.-10pm.) mostly had rained, so some of BTEX outside of the roof (front and back of station) were gone with the rain. Consequently, concentration ration of center:front and center:back were higher.

From the all ration of sampling points, both of 2 parts (figure 4.10-4.11, 4.14-4.15), sampling point ratio of benzene were obviously lower than ratio of other substance in the same sampling set; toluene, ethylbenzene, and xylenes. This result is agreeable with study in Vietnam (Quynh Truc and Kim Oanh, 2007), which reported that benzene did not decrease considerably with the distance within 50 meters while toluene, ethylbenzene, and xylenes decreased. It was consequence from degradation of substance. Benzene in gas phased has 13.4 days of half-life, while max half-life of toluene, ethylbenzene, and xylenes is 1 day, 2 days, and 18 hours.

4.4 BTEX concentration at the area of petrol station in different seasons

BTEX concentration in dry season was higher than that observed in wet season, clearly for benzene and toluene by seeing range of average BTEX concentration which were collected in wet and dry season in the table 4.3. The highest benzene in wet season was 1,567.58 μg/m^3 while in dry season was 7,735.90 μg/m^3. Likewise, the highest toluene in wet season was 5,356.67 μg/m^3 where in dry season was 14,942.34 μg/m^3. All of them were measured at filling nozzles area. Average concentration of benzene, toluene, ethylbenzene, xylenes, and tBTEX in dry season was about 2.7, 1.5, 1.6, 1.6, and 1.8 times higher than those of wet season, respectively. Apart from that, the statistically paired samples T-test of each BTEX concentrations in wet and dry season was performed as seen in appendix D. It can be concluded that all of BTEX concentrations in dry season was significantly higher than in wet season at *p*

value as follows; benzene = 0.000, toluene = 0.007, ethylbenzene = 0.000, and xylenes = 0.001.

Table 4.3 Range of BTEX and tBTEX concentration in wet and dry season by sampling point

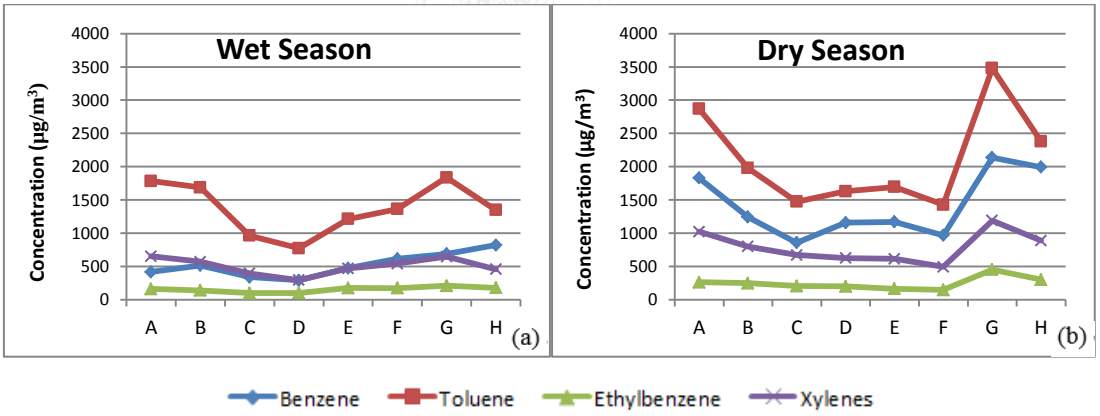
Substance	Conc. at front (roadside) $\mu g/m^3$	Conc. at center (filling area) $\mu g/m^3$	Conc. at back (ambient) $\mu g/m^3$	Average of 3 sampling points
Wet				
Benzene	76.88 - 736.40	403.92 - 1567.58	4.26 - 828.86	520.46±341.67
Toluene	208.03 - 640.88	1484.23 - 5356.67	70.64 - 454.17	1371.43±1677.84
Ethylbenzene	10.42 - 149.97	142.64 - 544.75	1.71 - 169.20	156.01±133.90
Xylenes	15.61 - 328.47	553.24 - 1835.45	12.94 - 223.86	504.39±616.67
tBTEX	402.98 - 1414.07	2837.56 - 9025.54	159.63 - 1277.2	2552.29±2763.42
Dry				
Benzene	322.08 - 1772.95	821.74 - 7735.90	141.18 -1335.66	1419.67±1002.31
Toluene	170.78 - 1176.60	2593.83 - 14942.34	99.70 - 1189.44	2117.15±2860.00
Ethylbenzene	1.60 - 155.00	285.68 - 1309.16	17.21 - 186.67	248.78±278.79
Xylenes	74.73 - 369.44	1055.35 - 4788.09	24.93 - 312.70	788.81±1052.66
tBTEX	644.56 - 2683.88	4718.65 - 28775.48	343.75 - 2919.6	4574.40±5180.71

The average BTEX concentrations of two different season, three points of sampling, two sampling days (Sunday and Tuesday of two seasons), four sampling days (Sunday and Tuesday in each season), and four periods of time were tested using SPSS 22.0 for window. Detail of calculation can be seen in appendix D. The result shows that concentration of BTEX, except for toluene and total BTEX in wet and dry season were significantly different at the confidence interval of 95%. The identical significantly difference was also found in average concentration of Sunday and Tuesday. Plus, the concentration of BTEX at filling nozzles area were different from roadside and back of station at 0.05 level of mean difference while BTEX concentrations in each period of sampling time were not different significantly.

Another difference which were found was the difference of benzene concentration between Sunday and Tuesday in wet season and Sunday in dry season, and between Sunday and Tuesday in wet season and Tuesday in dry season with significantly different at the confidence interval of 95%.

Comparing temporal variation between wet and dry season, concentrations of BTEX were averaged by substance to compare between concentration in wet and dry season as shown in figure 4.17. It is obviously that concentration of BTEX in dry season was higher than in wet season. Trends of BTEX concentration in wet season were similar to trends in dry season which is more legibly.

Concentrations in the middle of sampling time (10a.m.-6p.m.) between these two seasons were slightly different. Trend of benzene and toluene in dry season reached a high at 12a.m.-4 p.m., while in wet season reached a low of peak at 12a.m.-2 p.m. then got higher until 6-8 p.m. Concentrations at the end of sampling period were all lower than previous period except for benzene in wet season.



A = 06:00-08:00, B = 08:00-10:00, C = 10:00-12:00, D = 12:00-14:00, E = 14:00-16:00, F = 16:00-18:00, G = 18:00-20:00, H = 20:00-22:00

Figure 4.16 Temporal variations of BTEX and tBTEX in **wet** season (a) and **dry** season (b)

These results were in accordance with the study in Greece (Karakitsios et.al, 2007), which investigated the exposure of benzene in filling station employees during summer and winter time. They reported that the exposure values in summer were increased up to 20%, due to difference of temperature. The average temperature is

23 ºC for summer and 7 ºC for winter in Greece. Although temperature in Thailand between wet and dry season are not much different. The other meteorological and customer's behavior might cause different trend and BTEX amount.

4.5 Possible affecting factors of BTEX concentration variation

4.5.1 Fuel circulation and number of customer's car in the sampling day

Data of fuel circulation were collected from actual sales of NBI station and also customer's cars were counted on every sampling day in this second part. Trend of these two data were slightly different as illustrated in figure 4.16. However, most of them were similar but fuel circulation has more different amount; except for data at late night (8-10 p.m.). By the reason, some big trucks added fuel at late night. Anyhow, significant relationship of BTEX concentration with fuel circulation and number of customer's car were not found in this study. The statistics data can be found in appendix D. There is a study in Ioannina, Greece (Karakitsios et.al, 2007) which reported that fuel traded is the most significant parameter affecting to attendants exposure in filling station. Plus, study of Kitwattanavong (2010), which investigated BTEX and carbonyl compound at petrol station in Bangkok, also found that BTEX concentrations had significant correlation with fuel circulation and number of customer's car. Possible reason is that fuel circulation and number of customer's car were observed at one station and divided into 2-hr interval but studies which were mentioned above monitored many stations in 8-hr single stretch. Fuel circulation at one station in each sampling day was not much different, thus other factors such as meteorological factors had stronger effect on variation of BTEX in this study. Therefore, fuel circulation and number of customer's car have an effect on overall BTEX concentration at varies area of petrol station but may not affect time interval concentration at a one petrol station.

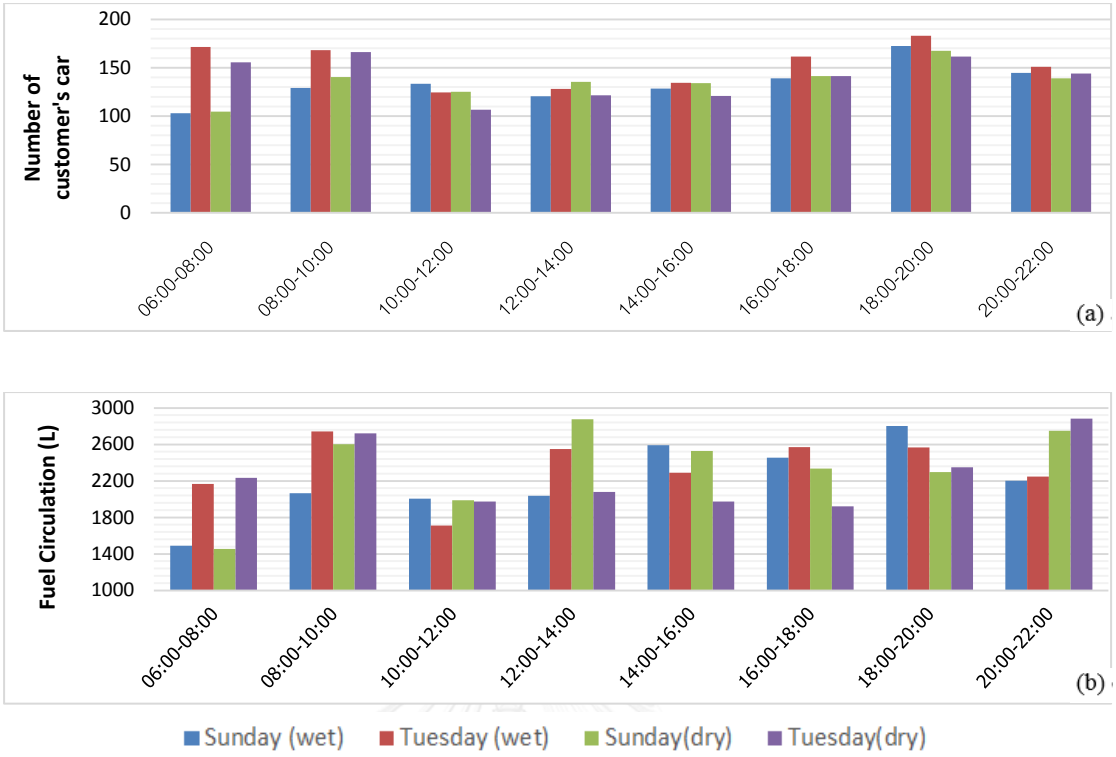


Figure 4.17 Average of number of customer's car (a) and fuel circulation (b) on the sampling day of wet season and dry season

4.5.2 Possible meteorological variables affecting to BTEX concentration

Meteorological data, i.e. wind speed, wind direction, temperature, percentage of relative humidity, solar radiation, and barometric pressure was performed using MET-One as already mentioned before. These data were collected along with 16-hour sampling days in both two parts of studies, 6 days in the first part of study and 8 days in the second part. Main wind direction was calculated using Lake Environmental WRPLOT View - Freeware V.7.0 while other factors were calculated as average by sampling day and period. The average of meteorological data by sampling day in the first part and the second part were illustrated in table 4.4 and in table 4.5. Meteorological data in detail, consist of data by period of sampling time in each day were shown in appendix C.

The averages of meteorological factors in table 4.4 showed that wind speed, temperature, and percentage of relative humidity were not much different between NBI and BKK station. However, the highest wind speed in this part of study was 1.313

m/s which was on September 14, 2012 during 2 pm - 6 pm. Barometric pressure at NBI station was about 3.3 times of at BKK station; on the other hand, solar radiation at BKK station was about 2.2 times of at NBI station.

Table 4.4 The average meteorological data in part one at NBI and BKK station

Station	Sampling date	WS* (m/s)	Main wind direction** (blowing from)	Temp (°C)	RH (%)	SR (W/m^2)	BP (mmHg)
NBI	9 Sep 2012	0.461	SSE	31.769	71.528	85.009	80.680
	11 Sep 2012	0.571	S	31.139	77.367	86.542	101.151
	14 Sep 2012	0.742	S	29.155	85.740	74.313	1116.684
average		0.591	-	30.688	78.212	81.955	432.838
BKK	7 Oct 2012	0.493	WNW	31.259	73.861	163.150	132.677
	9 Oct 2012	0.466	S	34.922	89.888	101.474	177.860
	5 Oct 2012	0.461	W	33.982	67.608	275.711	87.534
average		0.473	-	33.388	77.119	180.112	132.690

*Calm wind is less than 0.3 m/s

**Main wind direction was from wind rose of the sampling day. Direction of stations was in figure 4.13

At NBI station, main wind direction of three sampling days were in the same way, blowing from S and SSE as seen in figure 4.18, and the highest wind speed was found more than 1 m/s. Due to this flow direction, wind might blow some of BTEX concentration out of sampling point. In contrast, from figure 4.13, 1 in 3 days of sampling at BKK station had main direction wind from roadside through filling area and flow into the back of station. This effect might be one of a cause that BTEX concentration at NBI station was significantly lower than BKK station.

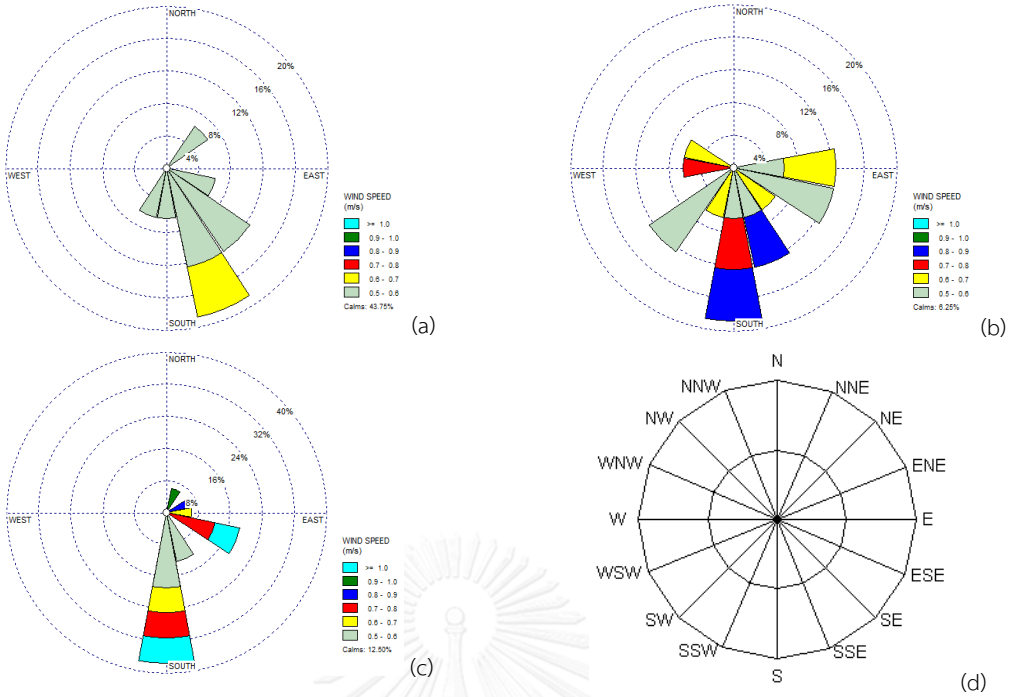


Figure 4.18 Wind rose plot at NBI station on September 9 (a), 11 (b), 14 (c), and wind direction illustration (d)

For Part II, table 4.5 displayed the approximate average wind speed, temperature, percentage of relative humidity on each sampling day with not much different of solar radiation and barometric pressure. Anyhow, 3 of 4 sampling days in wet season had a period with more than 1 m/s of wind speed. This wind speed also found in dry season, but only 1 in 4 sampling day. Two factors of meteorological data, wind direction and wind speed, were used for plotting wind rose graph to find wind direction on sampling site. Figure 4.13 presented sampling site, direction, and position of MET-One.

However, correlation between BTEX concentration and meteorological factors were defined using Pearson's correlation, separated by station and sampling point. Detail of statistical results was shown in appendix D. At BKK station, only toluene was correlated with temperature. Toluene at roadside and temperature had 95% significant correlation at -.628 and toluene at back of station also significantly correlated with temperature at -.626 (p<0.05). The significant correlation which was found at NBI station is shown in table 4.6.

Table 4.5 The average meteorological data in part two at NBI station in wet and dry season

Season	Sampling date	WS (m/s)	Main wind direction (blowing from)	Temp (°C)	RH (%)	SR (W/m^2)	BP (mmHg)
Wet	28 Jul 2013	0.503	SW	29.541	84.849	19.891	96.583
	30 Jul 2013	0.639	SW	30.725	85.332	31.495	174.927
	4 Aug 2013	0.821	SSW	33.918	77.635	31.354	121.134
	6 Aug 2013	0.566	ENE	32.694	70.371	37.469	113.865
average		0.632	-	31.720	79.547	30.052	126.627
Dry	10 Nov 2013	0.642	NE	33.579	69.388	72.813	102.778
	12 Nov 2013	0.486	SW	33.492	74.905	54.021	98.425
	24 Nov 2013	0.576	WSW	29.176	83.889	32.333	159.844
	26 Nov 2013	0.522	SSE	29.928	83.973	45.078	370.085
average		0.557	-	31.544	78.039	51.061	182.783

*Calm wind is less than 0.3 m/s

**Main wind direction was from wind rose of the sampling day. Direction of stations was in figure 4.13

Table 4.6 Meteorological factors which had significant correlation with BTEX concentration at NBI station

Sampling point	MET factor	Benzene	Toluene	Ethylbenzene	Xylenes	tBTEX
Roadside	Wind Speed	-.232*	ns	ns	ns	-.254*
	Solar Radiation	ns	-.269*	ns	ns	ns
	Pressure	ns	-.240*	ns	-.235*	ns
Filling Nozzle	Wind Speed	-.303**	-.296**	-.353**	-.357**	-.327**
Back	Wind Speed	-.352**	ns	ns	ns	-.390**
	Temperature	-.288*	ns	ns	ns	ns
	Relative Humidity	+.230*	ns	ns	ns	ns

ns = non-significant correlation

*Pearson Correlation (r) is significant at the 0.05 level (2-tailed)

**Pearson Correlation (r) is significant at the 0.01 level (2-tailed)

At roadside of NBI station, benzene and tBTEX were negative significantly correlated with wind speed. Plus, toluene had negative significant correlation with solar radiation and pressure. Correlation of xylenes and pressure was significant while ethylbenzene had no significant correlation with any meteorological factors.

Nearby filling nozzle, only wind speed was negative significantly correlated with BTEX concentration. Whilst benzene at back of station had significant correlation with wind speed, temperature, and relative humidity, tBTEX at the same sampling point was negative significantly correlated with only wind speed.

From study of Karakitsios et al. (2007), benzene exposure of gas station workers in summer which had 23°C as averaged temperature were higher than winter with 7°C. Despite the fact that temperature in Thailand is not much different in sampling season, BTEX concentration and temperature in this study did not have statistically significant correlation. Except for benzene in Part II, it had statistically negative significant correlation with temperature at 0.01 level, with *p* value = .002. Additionally, Houque et al. (2008), who investigated temporal and spatial variation of BTEX in Delhi, India, claimed that winter months the pollutants generally had higher level of concentration than in summer because of low mixing heights. As a matter of fact, sampling days in dry season in Part II are in cold season but have more only sun radiation than wet season, not temperature. However, correlation between temperature and BTEX concentration in dry season were not appeared.

From statistical result, it can be concluded that wind speed had strong effect on BTEX concentration at all sampling points. Some factors affected benzene at back of station, some affected toluene and ethylbenzene at roadside. However, main point source of BTEX at petrol station is filling nozzle. Since correlation of fuel circulation and BTEX concentration was not found as mentioned above, multiple regression analysis was performed to declare whether meteorological factors had stronger effect on BTEX concentration than fuel circulation and number of customer's car.

Only result from Part II nearby filling nozzle was analyzed using multiple regression analysis because fuel circulation and number of customer's car in Part I were not collected. BTEX concentration nearby filling nozzle, fuel circulation, number of car, wind speed, solar radiation, temperature, pressure, and relative

humidity were inputted in analysis using stepwise method. After analysis, just benzene and ethylbenzene were given satisfied adjusted R-square. The coefficients and model summary of analysis were shown in appendix D, and the equations were following;

- Predicted Benzene = -2163.035 - (4536.905* x_1) + (21.196* x_2) + (70.764* x_3)

  x_1 = Wind speed (m/s)

  x_2 = Solar radiation (W/m^2)

  x_3 = %Relative Humidity

- Predicted Ethylbenzene = 234.356 - (820.347* x_1) + (2.282* x_1) + (4.294* x_3)

  x_1 = Wind speed (m/s)

  x_2 = Solar radiation (W/m^2)

  x_3 = Number of customer's car

Adjusted R-square of predicted benzene and ethylbenzene model were 0.288 and 0.301, respectively. For both equations above, four factors i.e. wind speed, solar radiation, relative humidity and number of customer's are included for prediction of benzene and ethylbenzene. Solar radiation, relative humidity and number of customer's give relative low coefficient when compared with wind speed.

Like results from Pearson's correlation, it can be concluded that wind speed was the most important affecting factor on BTEX variation in petrol station.

Chapter 5
Conclusion and Recommendations

5.1 Conclusion

This study aimed to investigate the temporal profile of BTEX (benzene, toluene, ethylbenzene and xylene) and determine concentration of BTEX at petrol station, by collected BTEX in ambient air at back of the station, near filling nozzle, and roadside. Sampling is divided into two parts for different objectives. Part I were sampling in September and October 2012 for comparative studies between petrol station in urban area, Bangkok or BKK station, and station in suburban areas, Nonthaburi or NBI station with lighter traffic than in urban area. In Part II, the samples were collected in July, August and November 2013 to compare between wet and dry season. The correlations between BTEX concentrations and some of affecting factors were also considered. All of this study results can be concluded as following;

1) The dominant compound among BTEX was toluene, followed by benzene. Ethylbenzene and xylenes concentration were barely found comparing to dominant compounds.

2) The center of station nearby filling nozzle was the main point source of BTEX at petrol station. The concentrations of BTEX at roadside and back of station were not significantly different because it might come from the same source.

3) In Part I, the averaged 4-hr concentration of benzene, toluene, ethylbenzene, and xylenes at urban station was found with 2,214.37±1254.92, 8,431.07±3,514.07, 405.31±194.32, and 1,091.84±286.68 μg/m^3, respectively. The averaged 4-hr concentration of BTEX at suburban station which was detected in the same part is following; 237.47±88.79, 622.50±197.52, 36.45±10.29, and 193.43±60.33 μg/m^3 for benzene, toluene, ethylbenzene, and xylenes, respectively.

4) In Part II at suburban station, the averaged 2-hr concentration of benzene, toluene, ethylbenzene, and xylenes in wet season was found with 520.46±179.65, 1,371.43±384.58, 156.01±39.11, and 504.39±124.23 μg/m^3, respectively. The averaged 2-hr concentration of BTEX in dry season which was detected in the same part is

following; 1,419.67±460.38, 2,117.15±690.98, 248.78±90.88, and 788.81±218.99 μg/m^3 for benzene, toluene, ethylbenzene, and xylenes, respectively.

5) Temporal profile of BTEX was different at each sampling point, also each petrol station depended on affecting factors. Affecting factors observed in this study were traffic congestion condition, wind speed, wind direction, temperature, solar radiation, and relative humidity.

6) BTEX concentration at roadside variated by traffic congestion, while that at back of station had a same trend as roadside with lower concentration. BTEX variation nearby filling nozzle depended on fuel circulation and also had wind speed and wind direction as affecting factors.

7) The BTEX concentration in weekday was higher than in weekend because customers tended to refuel in weekday more than weekend and also traffic congestion. However, urban and suburban station had different variation due to activities, i.e. traffic density and customers' behavior, nearby station.

8) The difference of BTEX concentration between sampling day was not significant; therefore, averaged concentrations on weekday and weekend were not different. However temporal profile of BTEX on between weekday and weekend were different due to behavior of customer. For example, roadside concentration was high in rush hour and concentration nearby filling nozzle was low in noon when compare to other periods at the same sampling point.

9) The disparity of BTEX at the area of petrol station depended on size of station and surrounding environment and BTEX dispersion also affected by wind flow. BTEX was accumulated in small station with surrounding by a lot of trees and buildings.

10) Benzene was the only one compound among BTEX which was not disparity along the distance. Benzene had longer half-life than the others. Consequently, it was not decreased with longer range from point source while toluene, ethylbenzene, and xylenes did.

11) For part I, BTEX concentrations in urban area were significantly higher than in suburban area with p=0.000 because of different fuel circulation and traffic flow. For part II, BTEX concentrations in dry season were also significantly higher than in

wet season with $p<0.005$; even if, the weather between these two seasons were not different in sense of resident in the city.

12) The affecting factors on BTEX concentration, except for main point source, were fuel circulation, wind speed, and wind direction. Although the relationship of fuel circulation and BTEX concentration were not found in this study, it had been found in other studies. Possible reason was that fuel circulation was collected from only one station. Therefore, fuel circulation in each sampling day was not much different while BTEX concentration in each sampling day was different because of meteorological factors.

13) From Pearson's correlation, wind speed had strong effect on BTEX concentration at filling area, while it affected only benzene at roadside and back of station. From the multiple regression analysis, wind speed had a strongest effect on benzene and ethylbenzene nearby filling nozzle. It even was stronger than fuel circulation and number of customer's car inside a petrol station.

5.2 Recommendations

1) Due to high accumulation of BTEX nearby filling nozzle, customers should not stay at filling area after refueling was done. It seems that customer who refueling in the midday expose to BTEX less than in rush hour.

2) Even though BTEX contributed in the ambient air at the area of petrol station are not high as at refueling area, they still can accumulate in workers' and customers' body.

3) Workers in petrol station are strongly recommended to wear personal protection equipment during refueling. Moreover, the workers who work in filling area should have shorter shift than usual such as 3 to 4 hours then change to work in other area.

4) Cahier in petrol station should be placed far from filling area, or not built as a room.

5) The concentration of the other by-products of BTEX should be investigated for further study.

6) Fuel circulation and number of customer's car should be observed every sampling day and determined at varies petrol station to get precisely relationship between them and BTEX concentration.

7) This study should be applied to other petrol station in vary areas to prove what actually affect to BTEX behavior, to find the way to reduce exposure of workers and customers in petrol station.

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APPENDICES

APPENDIX A

Preliminary Study

A.1 Calibration curves

Table A.1 Peak area of standard BTEX of calibration curve

Compounds	Peak Area Ratio								
	125 ng/ml	250 ng/ml	500 ng/ml	1000 ng/ml	2000 ng/ml	4000 ng/ml	8000 ng/ml	Average	SD
Benzene	n/a	n/a	0.98	1.82	4.35	8.87	18.28	6.86	7.08
Toluene	1.38	1.53	2.70	3.99	8.78	15.26	30.25	9.13	10.56
Ethylbenzene	n/a	n/a	1.11	2.28	4.49	10.55	23.61	8.40	9.24
m,p-Xylene	2.24	2.91	5.39	9.72	16.45	31.96	66.47	19.30	23.23
o-Xylene	0.55	1.10	1.98	3.12	6.16	12.62	25.59	7.30	9.07

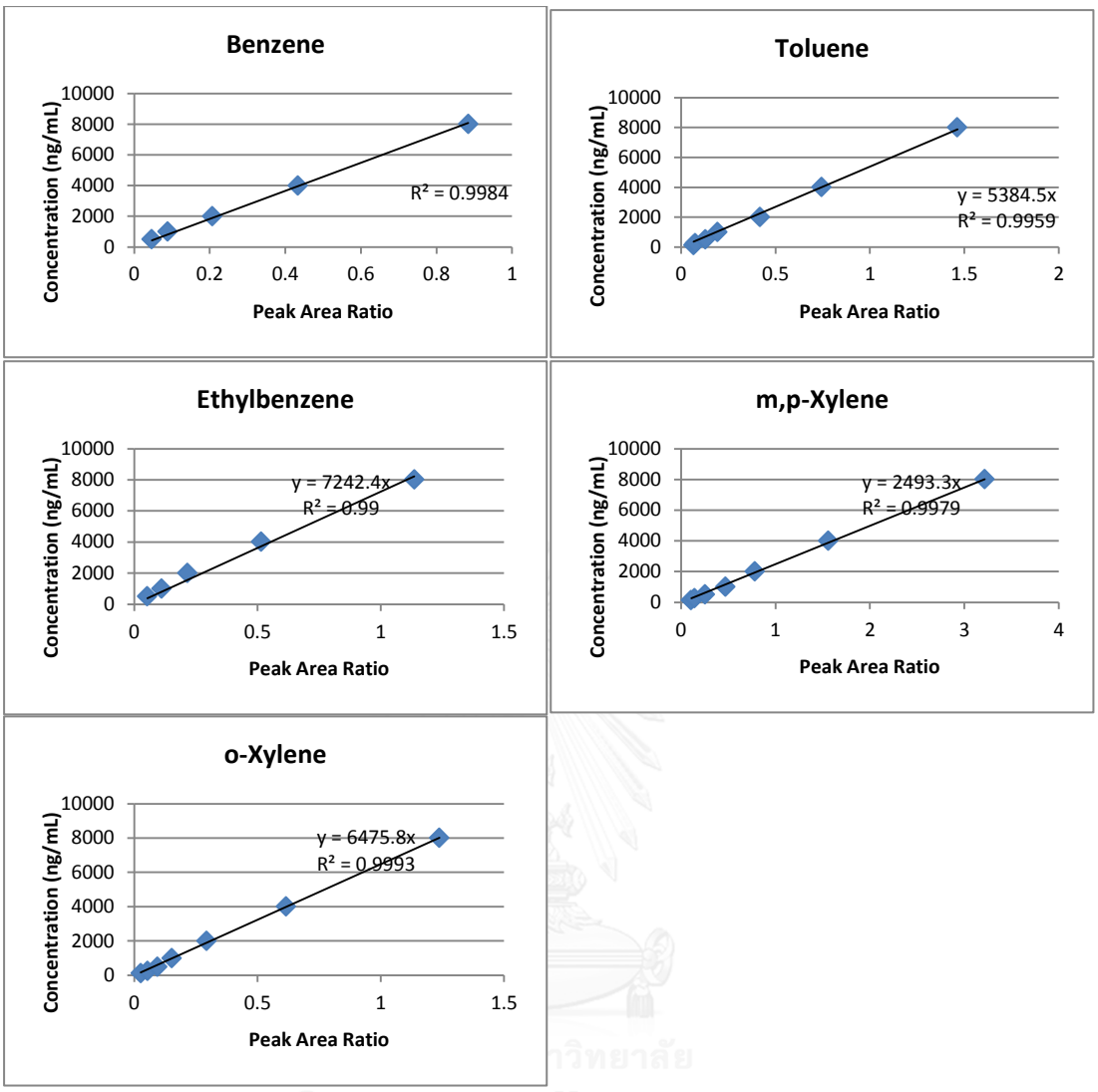

Figure A.1 Calibration curve of standard BTEX

APPENDIX B

Concentration of BTEX

B.1 BTEX in Part I (2012)

Table B.1 BTEX at NBI station on Sunday (Sep 9)

Compound	Position in station	Concentration ($\mu g/m^3$)					
		6:00-10:00	10:00-14:00	14:00-18:00	18:00-22:00	Average	SD
Benzene	Front	95.78	64.87	42.87	36.82	60.08	26.67
	Center	692.29	505.12	814.80	824.47	709.17	148.74
	Back	52.73	86.10	57.25	40.46	59.14	19.33
Toluene	Front	73.21	48.35	52.72	111.96	71.56	29.03
	Center	1945.41	1330.10	2021.11	2640.95	1984.39	536.05
	Back	33.19	15.77	22.06	44.67	28.92	12.73
Ethyl	Front	7.01	1.70	5.30	13.55	6.89	4.96
	Center	116.68	79.79	115.38	143.52	113.84	26.14
	Back	1.33	3.75	3.88	5.02	3.49	1.55
Xylenes	Front	23.22	19.20	11.73	45.56	24.93	14.56
	Center	669.40	454.81	669.40	825.38	654.75	152.23
	Back	13.48	8.37	14.00	13.77	12.41	2.70
tBTEX		3723.72	2617.93	3830.51	4746.13	3729.57	974.70

Table B.2 BTEX at NBI station on Tuesday (Sep 11)

Compound	Position in station	Concentration ($\mu g/m^3$)					
		6:00-10:00	10:00-14:00	14:00-18:00	18:00-22:00	Average	SD
Benzene	Front	55.21	39.29	94.54	135.53	81.14	43.06
	Center	564.00	392.28	537.63	423.89	479.45	84.10
	Back	41.25	47.22		27.31	38.59	10.22
Toluene	Front	100.16	56.18	148.36	160.80	116.38	47.90
	Center	1650.53	1278.85	1593.58	1236.65	1439.90	212.32
	Back	54.24	48.20		110.58	71.00	34.40
Ethyl	Front	7.31	5.01	4.59	5.84	5.69	1.20
	Center	121.41	90.27	80.03	58.45	87.54	26.19
	Back	3.55	2.97		6.93	4.48	2.14
Xylenes	Front	19.37	22.66	30.49	35.57	27.02	7.36
	Center	531.00	431.82	483.82	347.46	448.53	78.62
	Back	11.32	11.57	0.00	22.45	11.33	9.17
tBTEX		3159.35	2426.32	2973.05	2571.44	2811.06	556.67

Table B.3 BTEX at NBI station on Friday (Sep 14)

Compound	Position in station	Concentration (μg/m^3)					
		6:00-10:00	10:00-14:00	14:00-18:00	18:00-22:00	Average	SD
Benzene	Front	68.94	103.56	91.08	97.57	90.29	15.12
	Center	895.17	732.46	537.37	159.48	581.12	316.88
	Back	93.64	26.05	28.68	0.39	37.19	39.74
Toluene	Front	150.96	68.10	221.41	154.26	148.68	62.77
	Center	2291.25	2076.21	1675.98	598.42	1660.47	752.53
	Back	97.54	4.39	138.56	74.91	78.85	56.20
Ethyl	Front	12.42	2.06	16.91	12.41	10.95	6.29
	Center	120.87	115.24	88.72	30.49	88.83	41.34
	Back	5.96	0.17	9.60	7.43	5.79	4.03
Xylenes	Front	34.64	25.48	60.41	30.07	37.65	15.63
	Center	664.47	657.41	519.75	150.31	497.99	241.17
	Back	21.58	0.70	37.92	19.01	19.80	15.24
tBTEX		4457.43	3811.84	3426.38	1334.76	3257.60	1566.93

Table B.4 BTEX at BKK station on Sunday (Oct 7)

Compound	Position in station	Concentration (μg/m^3)					
		6:00-10:00	10:00-14:00	14:00-18:00	18:00-22:00	Average	SD
Benzene	Front	1688.82	1830.19	441.62	1701.72	1415.59	652.44
	Center	2661.75	3361.57	2122.73	7472.43	3904.62	2432.01
	Back	317.37	38.69	1.08	1603.59	490.18	755.56
Toluene	Front	4243.58	1402.70	1203.97	5273.29	3030.89	2040.23
	Center	18641.44	11382.00	10076.73	28067.02	17041.80	8259.53
	Back	3281.53	383.57	1097.60	2127.13	1722.46	1261.95
Ethyl	Front	168.46	68.77	223.37	157.02	154.41	64.02
	Center	562.32	581.82	562.45	1391.66	774.56	411.50
	Back	62.04	60.29	101.20	21.00	61.13	32.75
Xylenes	Front	259.94	267.75	344.53	1338.79	552.75	525.41
	Center	1875.32	1629.02	1666.57	4419.87	2397.69	1352.46
	Back	468.80	103.42	553.67	675.28	450.29	246.29
tBTEX		34231.38	21109.77	18395.52	54248.80	31996.37	18034.15

Table B.5 BTEX at BKK station on Tuesday (Oct 9)

Compound	Position in station	Concentration (μg/m^3)					
		6:00-10:00	10:00-14:00	14:00-18:00	18:00-22:00	Average	SD
Benzene	Front	659.51	1541.65	225.70	1914.17	1085.26	777.92
	Center	4655.73	4701.38	9954.38	11496.75	7702.06	3547.62
	Back	606.05	827.33	1372.04	1099.19	976.15	332.16
Toluene	Front	2331.33	1304.60	2089.39	8785.95	3627.82	3466.57
	Center	16034.72	16205.94	45716.78	39313.81	29317.81	15461.87
	Back	2433.69	1410.76	1343.66	3339.05	2131.79	946.87
Ethyl	Front	175.19	407.36	381.12	1025.44	497.28	367.10
	Center	704.85	621.36	1276.69	1425.40	1007.07	403.24
	Back	262.83	165.12	441.21	447.60	329.19	138.92
Xylenes	Front	220.97	435.59	532.45	607.31	449.08	167.53
	Center	1817.60	1936.95	3570.31	3748.36	2768.30	1032.59
	Back	118.17	25.18	788.36	444.96	344.17	346.55
tBTEX		30020.64	29583.21	67692.08	73647.99	50235.98	26988.93

Table B.6 BTEX at BKK station on Friday (Oct 5)

Compound	Position in station	Concentration (μg/m^3)					
		6:00-10:00	10:00-14:00	14:00-18:00	18:00-22:00	Average	SD
Benzene	Front	7.05	45.40	987.87	1321.38	590.43	665.74
	Center	1595.66	2722.06	5530.89	3459.94	3327.14	1657.14
	Back	333.31	709.16	631.61	77.46	437.88	289.80
Toluene	Front	5188.95	999.64	876.90	3657.58	2680.77	2107.55
	Center	14286.89	9595.37	18057.45	19385.22	15331.24	4391.58
	Back	643.35	224.04	705.72	2407.02	995.03	965.32
Ethyl	Front	140.30	10.18	34.25	271.43	114.04	119.18
	Center	472.35	539.98	691.23	930.07	658.41	202.91
	Back	42.92	1.36	80.38	82.23	51.72	38.15
Xylenes	Front	245.55	161.04	407.93	538.82	338.33	168.40
	Center	2213.92	1530.65	2416.31	2732.07	2223.24	508.58
	Back	203.70	63.71	507.69	435.86	302.74	205.48
tBTEX		25373.95	16602.59	30928.23	35299.07	27050.96	11319.83

B.2 BTEX in Part II (2013)

Table B.7 BTEX at NBI station on Sunday (Jul 28)

Compound	Position in station	Concentration (μg/m^3)									
		6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	Average	SD
Benzene	Front	193.9221	434.3577	483.8369	11.0509	499.2068	745.2522	804.2286	1275.1730	555.8785	390.2276
	Center	1036.1637	1062.3928	887.1406	959.0197	1193.8767	1760.6713	1501.4317	2232.8864	1329.1979	469.0871
	Back	446.5680	333.6874	586.6463	222.3086	625.4472	748.9196	611.7763	1543.3438	639.8372	403.1054
Toluene	Front	820.6431	647.3751	916.7773	631.9516	412.6786	243.6350	262.1768	315.1207	531.2948	259.6424
	Center	4923.1675	3821.6378	2883.8688	1857.2916	3795.1974	3540.3075	4145.6378	4509.4191	3684.5660	960.5794
	Back	258.7048	886.1429	338.4661	275.6752	243.4087	228.6287	350.8864	473.8769	381.9737	218.6653
Ethyl	Front	0.0459	114.2608	141.9274	189.7691	197.1860	25.2577	120.6131	106.5858	111.9557	70.0682
	Center	491.2829	370.6767	248.0153	347.9582	479.2252	576.4871	404.8485	507.6016	428.2619	105.3132
	Back	315.1402	27.0952	142.3338	171.7573	159.3395	194.2376	113.1709	100.7312	152.9757	83.3805
Xylene	Front	268.4321	280.7625	243.4765	159.3069	144.8772	242.8648	177.7416	133.9449	206.4258	58.7439
	Center	2705.0147	1505.3319	1396.4156	707.7668	1577.5842	1751.1825	1800.7016	1896.5012	1667.5623	558.3882
	Back	435.4604	207.4504	301.2153	91.4914	65.8675	143.9876	88.8602	274.4260	201.0948	129.0218
tBTEX		11894.5455	9691.1712	8570.1198	5625.3475	9393.8952	10201.4317	10382.0735	13369.6106	9891.0244	3706.2232

Table B.8 BTEX at NBI station on Tuesday (Jul 30)

Compound	Position in station	Concentration (μg/m^3)									
		6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	Average	SD
Benzene	Front	239.0476	78.7268	1.7363	70.5984	516.1703	541.1775	14.6962	717.3642	272.4396	279.9679
	Center	634.1067	1317.9676	199.9883	392.9006	1160.7509	907.7425	1783.9673	1473.9119	983.9170	549.6817
	Back	1.4498	129.5195	1.4428	280.3116	271.9556	235.7438	403.4231	281.9741	200.7275	143.8334
Toluene	Front	710.9497	436.9330	398.8528	224.6900	173.6433	183.0819	465.7669	765.9286	419.9808	227.4438
	Center	3180.2832	5050.4656	1007.4380	2335.4627	4010.5709	2975.2397	5182.6522	4368.8360	3513.8685	1424.0729
	Back	179.4356	347.9228	68.4187	160.3359	360.5744	72.2421	149.1901	205.2803	192.9250	110.5223
Ethyl	Front	71.0683	1.8196	81.9495	0.0702	24.5077	35.4766	163.0743	173.6270	68.9491	67.9670
	Center	283.2962	493.8526	141.3093	156.3566	325.1153	299.8211	518.3118	506.5431	340.5757	151.8711
	Back	8.9095	3.3305	35.9042	0.0079	81.8804	123.7325	24.1723	89.8018	45.9674	46.5040
Xylene	Front	18.4670	66.2779	219.1925	195.4143	31.2689	139.2762	393.0175	101.9677	145.6102	123.3942
	Center	922.3973	1880.2949	595.9358	1059.3573	1774.1493	1255.5143	2055.5030	1400.2762	1367.9285	507.6084
	Back	22.1324	13.8122	43.6465	37.4077	55.9228	123.9873	37.8441	63.9121	49.8332	34.0910
tBTEX		6271.5433	9820.9229	2795.8147	4912.9133	8786.5097	6893.0355	11191.6189	10149.4229	7602.7227	3666.9577

Table B.9 BTEX at NBI station on Sunday (Aug 4)

Compound	Position in station	Concentration (μg/m³)									
		6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	Average	SD
Benzene	Front	3.9695	275.9260	485.5442	172.1157	242.4245	43.3432	292.9236	197.6271	214.2342	151.1227
	Center	641.0845	1239.3933	584.2377	219.9411	174.9209	509.5716	718.7944	902.2733	623.7771	347.4464
	Back	166.9955	356.9489	43.7576	3.5720	3.3383	23.2325	97.2474	114.3684	101.1826	118.5702
Toluene	Front	163.4820	209.9105	364.9759	304.7925	409.6563	495.5430	292.4710	151.8179	299.0811	121.4599
	Center	3381.4141	4358.7017	2632.5642	1111.1766	2352.6366	2895.2916	4722.1046	3167.6661	3077.6945	1138.2768
	Back	18.2621	22.2056	75.9614	94.7308	84.7757	155.9872	322.2824	0.0236	96.7786	104.2159
Ethyl	Front	25.9267	0.8567	0.6693	42.5398	41.5796	46.5972	69.7432	42.9002	33.8516	23.6652
	Center	135.3477	243.5131	156.1536	73.2543	186.8793	172.8117	368.1780	265.6978	200.2294	90.6889
	Back	23.2656	17.8798	2.9815	1.3416	56.7779	1.6865	0.0046	33.0103	17.1185	20.1550
Xylene	Front	112.3971	31.5347	27.3163	126.0326	52.3404	80.0075	32.7764	109.1286	71.4417	40.6214
	Center	965.8784	1303.1314	786.3648	398.7146	751.5056	887.6805	1325.3956	736.7180	894.4236	307.2065
	Back	12.2641	14.5255	3.3927	20.7435	61.6609	23.1904	14.5392	14.5770	20.6117	17.5996
tBTEX		5650.2872	8074.5273	5163.9193	2568.9552	4418.4961	5334.9431	8256.4604	5735.8084	5650.4246	2481.0284

Table B.10 BTEX at NBI station on Tuesday (Aug 6)

Compound	Position in station	Concentration (μg/m³)									
		6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	Average	SD
Benzene	Front	114.6219	81.8088	152.0308	239.3301	251.0864	353.5686	547.7060	464.0110	275.5204	167.4490
	Center	1516.6857	864.3581	607.8490	581.5487	583.0754	1003.4074	1244.2891	554.2322	869.4307	360.5717
	Back	7.0682	7.0449	55.6047	341.3418	170.3459	490.4670	260.3164	103.2027	179.4239	173.2682
Toluene	Front	178.7036	107.8847	107.4343	194.5371	242.4244	334.2867	544.1974	372.8753	260.2929	149.5926
	Center	7533.0532	4311.3287	2680.1835	1919.6096	2325.2016	5033.0406	5219.8537	1771.8239	3849.2619	2028.1057
	Back	64.3881	50.3948	72.8584	184.5949	165.2037	206.2150	377.3017	74.5526	149.4386	110.2888
Ethyl	Front	31.0052	19.0214	51.3878	110.7531	130.5765	44.1505	136.8640	72.4400	74.5248	45.9461
	Center	527.9875	390.3152	199.1602	128.9177	269.8898	483.2898	571.1877	170.2912	342.6299	173.1652
	Back	23.0281	0.0878	0.2035	6.5031	176.5109	100.9994	42.6249	91.0460	55.1255	62.9346
Xylene	Front	12.7499	13.4948	15.9525	128.1731	92.3983	49.7636	263.9272	159.9273	92.0483	89.0365
	Center	2354.3285	1514.3230	1079.8212	611.0893	877.0631	1711.4993	1475.3203	525.0085	1268.5567	615.5446
	Back	16.9919	12.0637	41.1728	7.6762	150.9198	106.2762	126.7684	74.9406	67.1012	55.9663
tBTEX		12380.6117	7372.1260	5063.6588	4454.0745	5434.6958	9916.9642	10810.3568	4434.3513	7483.3549	4031.8693

Table B.11 BTEX at NBI station on Sunday (Nov 10)

Compound	Position in station	Concentration (μg/m³)									
		6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	Average	SD
Benzene	Front	13.8473	11.5275	468.2055	327.7592	636.7639	393.6563	585.5957	545.9191	372.9093	243.7387
	Center	748.1567	1327.2192	1649.4825	2091.0683	2093.7063	3179.4746	2772.7948	2554.2578	2052.0200	795.8471
	Back	227.4006	265.6837	282.0278	715.9538	564.4516	339.0214	780.9790	1089.6926	533.1513	309.6830
Toluene	Front	343.8237	263.4117	238.2219	352.6372	202.1867	236.6967	658.9098	557.9390	356.7283	166.0573
	Center	5523.1567	5134.8566	5031.2297	4769.7355	7103.2155	8331.3025	8102.6484	7487.4593	6435.4505	1473.4170
	Back	150.0909	85.9705	119.4625	64.2613	85.0221	191.0620	220.1644	118.3769	129.3013	54.4941
Ethyl	Front	53.8910	91.7358	57.7466	39.8251	40.3567	3.0373	154.7988	214.8359	82.0284	69.8633
	Center	494.6892	529.2029	575.5490	450.1416	640.1887	749.9708	726.0333	868.0300	629.2257	143.5050
	Back	42.4680	41.2533	23.2387	37.1896	7.4609	152.1748	79.6459	225.6867	76.1397	75.1581
Xylene	Front	277.1483	83.4449	144.1991	109.3735	113.2968	102.6562	205.6396	245.3318	160.1363	72.9295
	Center	1977.6277	1839.1071	1793.8448	1620.2505	2518.5205	2410.5449	3120.6809	2867.0610	2268.4547	545.3288
	Back	196.3076	116.7101	81.8977	192.2483	110.7959	322.5083	114.2927	118.9504	156.7139	78.2396
tBTEX		10048.6078	9790.1231	10465.1058	10770.4438	14115.9655	16412.1057	17522.1831	16893.5405	13252.2594	4028.2613

Table B.12 BTEX at NBI station on Tuesday (Nov 12)

Compound	Position in station	Concentration (μg/m³)									
		6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	Average	SD
Benzene	Front	544.4983	1013.3380	780.6964	1412.6554	607.0128	435.3084	653.9592	417.1587	733.0784	335.6922
	Center	3461.5270	2381.5482	2226.4969	3526.7798	1740.3834	692.6277	10869.9584	2094.0506	3374.1715	3162.7034
	Back	941.3933	688.0044	559.4534	487.5438	811.8102	107.2913	12.3200	1357.1658	620.6228	437.7663
Toluene	Front	2144.0864	810.1762	483.2455	483.0784	678.1802	440.9837	680.4611	706.6318	803.3554	557.3014
	Center	14183.6749	7612.0851	6849.9604	8622.4967	6062.5977	3945.6209	23360.9083	5203.4081	9480.0940	6398.0234
	Back	2180.8798	725.3059	411.4812	341.5095	386.2287	409.4923	641.5545	312.8080	676.1575	625.3041
Ethyl	Front	61.4102	73.2280	58.0714	272.9271	0.0042	191.3967	180.4938	97.8323	116.9205	89.7725
	Center	1014.4350	977.3703	658.4001	664.1623	481.8273	364.9605	1826.8415	532.3632	815.0450	467.6171
	Back	334.4106	51.8035	123.4738	299.3918	0.4651	41.5874	84.2755	0.0145	116.9278	130.3021
Xylene	Front	563.8711	324.3134	525.0897	327.8871	326.3932	269.6546	541.5691	238.7914	389.6962	131.4852
	Center	4507.6731	3004.6436	2951.5818	3287.8817	2145.7696	1412.1026	6959.7454	2012.2319	3285.2037	1757.1888
	Back	385.4858	85.1237	144.3397	69.8437	59.2316	149.3212	238.3794	42.1043	146.7287	115.7125
tBTEX		30323.3455	17746.9404	15772.2904	19796.1573	13299.9040	8460.3473	46050.4662	13014.5606	20558.0015	14208.8692

Table B.13 BTEX at NBI station on Sunday (Nov 24)

Compound	Position in station	Concentration (μg/m³)									
		6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	Average	SD
Benzene	Front	3532.0510	1641.4105	175.9468	1366.6603	1596.7048	2143.0127	1174.4257	1861.8198	1686.5039	948.8026
	Center	4628.6410	1763.4283	834.1559	1356.1536	3461.7768	1029.3720	1043.3318	3791.6011	2238.5575	1487.4778
	Back	2136.1227	762.5725	0.3229	375.5957	1495.6558	1115.2043	1890.3409	1138.6000	1114.3019	727.2970
Toluene	Front	198.7275	191.3677	103.3405	365.1138	250.8484	576.6543	428.5837	153.1272	283.4704	160.2876
	Center	4910.7434	4639.9195	823.5465	1107.2733	3629.9718	1300.3677	775.1032	4213.4239	2675.0437	1833.1490
	Back	110.7307	141.3029	122.2719	172.4314	114.3872	154.1830	5.2300	237.8989	132.3045	65.8516
Ethyl	Front	0.0199	0.0506	96.1983	70.9860	22.8902	0.1631	32.6456	77.8524	37.6008	38.9749
	Center	616.7959	426.4655	278.7649	121.2189	278.0352	67.8069	1509.7793	401.8132	462.5850	457.5749
	Back	10.2727	12.2896	49.9027	23.4319	9.7453	9.7634	1.9282	147.6586	33.1240	48.5730
Xylene	Front	35.8327	112.7196	5.2673	141.7946	41.0715	21.3896	98.1904	62.8169	64.8853	48.0684
	Center	1929.0622	1817.3988	543.9113	490.4516	1173.8076	401.5829	249.8068	1653.3335	1032.4193	693.6953
	Back	53.2141	36.1139	8.3762	18.5269	20.9069	77.2544	22.5405	46.5713	35.4380	22.6300
tBTEX		18162.2138	11545.0394	3042.0052	5609.6379	12095.8015	6896.7542	7231.9061	13786.5169	9796.2344	6532.3821

Table B.14 BTEX at NBI station on Tuesday (Nov 26)

Compound	Position in station	Concentration (μg/m³)									
		6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	Average	SD
Benzene	Front	1640.7349	1167.8274	830.3381	512.5165	72.6766	593.5201	294.1309	442.7525	694.3121	505.8942
	Center	2551.1909	2668.7583	1879.4632	1713.0138	666.3910	950.8587	4601.8357	8094.5267	2890.7548	2428.7681
	Back	1537.7605	1212.7838	606.7933	0.1687	311.1785	630.1663	972.7459	533.3001	725.6121	495.1524
Toluene	Front	209.1042	45.7375	0.0326	32.5644	48.0326	292.2435	216.6341	184.2527	128.5752	109.0328
	Center	4284.3453	4067.4236	3467.9918	3196.1171	1376.7790	1242.0396	6523.7665	9150.4008	4163.6079	2623.6337
	Back	198.0061	41.0440	26.2989	64.7353	406.4642	0.0239	153.4855	243.2659	141.6655	137.9284
Ethyl	Front	29.0419	27.7969	89.7661	23.1271	309.9911	2.3504	11.6585	41.4285	66.8951	101.6728
	Center	480.8700	735.3408	441.3895	371.5903	199.1713	130.2903	791.4762	956.3043	513.3041	291.4532
	Back	21.3795	26.0513	20.4908	41.6962	0.4939	73.4042	50.3913	50.9723	35.6099	22.9146
Xylene	Front	175.0101	76.0760	32.5488	15.7597	34.8523	43.6511	56.9791	96.5771	66.4318	50.8672
	Center	1955.0577	2058.8446	1828.6699	1249.7917	719.2298	698.8075	2616.4312	3274.6536	1800.1858	895.7396
	Back	239.9127	34.8140	18.2421	4.4569	97.2052	19.1747	53.4949	7.7486	59.3811	78.9684
tBTEX		13322.4137	12162.4983	9242.0250	7225.5375	4242.4653	4676.5303	16343.0298	23076.1832	11286.3354	7742.0255

B.3 Fuel Circulation and the number of customer's cars at NBI station

Table B.15 Fuel Circulation and the number of customer's cars in wet season

Date	Type	Period of time								Total
		06:00-08:00	08:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	
28-Jul-13	Circulation (L)	1532.48	2169.36	2004.89	2058.20	2555.90	2424.74	2761.40	2323.46	17830.43
	Number of Cars	91	131	130	124	121	139	160	142	1038
30-Jul-13	Circulation (L)	2324.80	2679.96	1779.09	2744.14	2445.98	2637.34	2558.77	2646.16	19816.24
	Number of Cars	180	165	135	142	155	158	181	172	1288
4-Aug-13	Circulation (L)	1448.97	1962.40	2003.26	2015.90	2626.56	2487.48	2839.35	2081.37	17465.29
	Number of Cars	115	127	137	117	136	139	185	147	1103
6-Aug-13	Circulation (L)	2010.58	2802.32	1639.69	2357.76	2133.21	2505.79	2578.25	1848.15	17875.75
	Number of Cars	163	171	114	114	114	165	185	130	1156

Table B.16 Fuel Circulation and the number of customer's cars in dry season

Date	Type	Period of time								Total
		06:00-08:00	08:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	20:00-22:00	
10-Nov-13	Circulation (L)	1586.31	2561.81	2165.24	3007.51	2297.20	2192.21	1997.97	2969.99	18778.24
	Number of Cars	115	139	125	137	128	142	163	151	1100
12-Nov-13	Circulation (L)	2679.63	2415.10	2078.55	1822.29	2062.88	1719.88	2409.57	2741.39	17929.29
	Number of Cars	172	149	112	105	122	142	159	156	1117
24-Nov-13	Circulation (L)	1324.69	2641.45	1814.25	2741.82	2761.21	2479.77	2597.85	2531.76	18892.80
	Number of Cars	94	142	125	134	140	141	172	127	1075
26-Nov-13	Circulation (L)	1789.94	3025.28	1866.61	2338.15	1886.44	2125.53	2289.93	3021.87	18343.76
	Number of Cars	139	183	101	138	120	141	164	132	1118

APPENDIX C

Meteorological data

C.1 Meteorological data in Part I (2012)

Table C.1 Meteorological data at NBI station on Sunday (Sep 9)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m^2)	BP (mHg)
6:00	0.4333	27.122	91.733	8.556	83.689
7:00	0.4250	28.025	86.467	70.167	106.500
8:00	0.4083	29.700	77.317	71.167	102.842
9:00	0.4417	30.792	73.992	79.167	94.300
10:00	0.4667	31.650	71.017	113.000	83.300
11:00	0.5083	32.750	67.100	149.250	82.183
12:00	0.5667	33.300	64.942	143.000	80.358
13:00	0.4417	34.283	62.042	189.000	77.000
14:00	0.4917	34.242	62.900	239.917	72.017
15:00	0.4833	34.450	63.450	203.167	69.892
16:00	0.4500	33.342	65.883	71.833	67.533
17:00	0.4833	32.725	67.400	21.333	72.608
18:00	0.4667	32.158	69.133	0.583	73.742
19:00	0.4250	31.492	71.450	0.000	72.717
20:00	0.4750	31.592	72.708	0.000	75.800
21:00	0.4167	30.683	76.908	0.000	76.400

Table C.2 Meteorological data at NBI station on Tuesday (Sep 11)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m^2)	BP (mHg)
6:00	0.4583	26.883	89.883	2.917	121.233
7:00	0.4583	27.575	88.125	85.500	125.117
8:00	0.4583	29.050	82.192	50.667	123.508
9:00	0.4917	30.375	77.983	59.833	114.425
10:00	0.6583	31.733	74.725	91.167	110.683
11:00	0.6250	32.658	71.708	120.750	104.267
12:00	0.5417	33.483	68.100	119.500	96.425
13:00	0.6500	34.400	66.708	240.667	92.575
14:00	0.6250	35.017	65.525	344.833	82.808

15:00	0.4333	35.675	62.725	208.000	73.233
16:00	0.4750	34.642	63.308	56.917	71.108
17:00	0.8417	31.125	76.967	3.917	86.867
18:00	0.5583	29.583	86.192	0.000	93.175
19:00	0.7917	28.992	86.650	0.000	106.308
20:00	0.5750	28.650	88.417	0.000	105.808
21:00	0.5000	28.383	88.658	0.000	110.875

Table C.3 Meteorological data at NBI station on Friday (Sep 14)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m^2)	BP (mHg)
6:00	0.4500	25.442	99.908	5.167	739.542
7:00	0.4417	26.383	99.133	38.500	1124.058
8:00	0.4500	27.708	92.150	56.333	1385.708
9:00	0.4333	29.542	82.325	69.667	1735.750
10:00	0.4833	30.642	78.633	97.500	2028.692
11:00	0.6083	31.650	75.250	108.333	2130.642
12:00	0.7250	32.225	74.208	112.667	1955.067
13:00	0.7333	33.717	69.575	295.750	1466.683
14:00	0.8500	34.492	66.925	309.917	1122.650
15:00	0.9083	33.775	68.658	90.333	557.358
16:00	2.0333	30.408	79.725	4.750	381.875
17:00	1.4583	25.658	95.583	0.083	443.617
18:00	0.6833	26.217	97.983	0.000	543.608
19:00	0.6167	26.333	96.517	0.000	646.875
20:00	0.5000	26.392	96.167	0.000	753.467
21:00	0.4917	25.892	99.092	0.000	851.350

Table C.4 Meteorological data at BKK station on Sunday (Oct 7)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m^2)	BP (mHg)
6:00	0.4091	26.891	94.473	5.727	202.500
7:00	0.4083	27.458	91.742	43.083	258.392
8:00	0.4167	29.025	84.842	120.500	279.225
9:00	0.4750	30.725	79.808	284.750	280.158
10:00	0.5500	33.458	70.617	491.500	232.850
11:00	0.5833	34.308	66.733	566.750	79.450
12:00	0.5500	34.375	64.483	344.917	78.825

13:00	0.5333	33.783	65.108	320.083	86.450
14:00	0.5083	33.167	67.200	192.750	79.533
15:00	0.5250	32.375	69.883	134.083	69.783
16:00	0.5167	32.183	69.267	90.083	73.450
17:00	0.4667	30.908	72.992	16.167	74.658
18:00	0.5167	30.750	68.117	0.000	80.050
19:00	0.5917	30.600	68.767	0.000	84.008
20:00	0.4250	30.217	71.892	0.000	81.600
21:00	0.4083	29.925	75.858	0.000	81.900

Table C.5 Meteorological data at BKK station on Tuesday (Oct 9)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m^2)	BP (mHg)
6:00	0.4167	25.967	98.367	0.333	165.700
7:00	0.4167	26.792	95.458	38.667	169.492
8:00	0.4750	27.850	91.725	144.500	169.975
9:00	0.5083	29.358	85.583	173.167	173.850
10:00	0.5083	31.108	79.900	378.333	172.325
11:00	0.5583	43.133	76.867	280.417	122.267
12:00	0.5083	44.825	77.483	127.833	114.742
13:00	0.5333	44.600	81.017	297.417	123.783
14:00	0.4917	46.383	87.308	97.333	121.150
15:00	0.4583	40.767	97.275	15.833	131.442
16:00	0.4333	41.000	97.308	43.833	148.408
17:00	0.4417	42.850	94.342	25.333	151.600
18:00	0.4167	30.967	94.508	0.583	241.092
19:00	0.4250	27.858	92.175	0.000	289.108
20:00	0.4583	27.733	93.375	0.000	275.367
21:00	0.4083	27.558	95.508	0.000	275.458

Table C.6 Meteorological data at BKK station on Friday (Oct 5)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.4000	27.950	86.350	4.833	95.500
7:00	0.4583	29.033	81.058	51.500	97.792
8:00	0.5083	30.517	76.358	162.167	98.900
9:00	0.5333	33.300	69.358	400.333	98.783
10:00	0.5000	35.283	64.892	570.500	84.408

11:00	0.4833	35.975	62.483	529.333	79.742
12:00	0.4417	36.975	59.500	597.500	82.908
13:00	0.4583	35.958	61.750	291.000	81.367
14:00	0.4667	36.367	61.167	331.500	84.633
15:00	0.4583	36.208	61.008	215.083	79.033
16:00	0.4250	35.625	62.100	102.667	82.200
17:00	0.4000	34.589	65.267	52.111	85.144
18:00	m/d	m/d	m/d	m/d	m/d
19:00	m/d	m/d	m/d	m/d	m/d
20:00	m/d	m/d	m/d	m/d	m/d
21:00	m/d	m/d	m/d	m/d	m/d

C.2 Meteorological data in Part II (2013)

Table C.7 Meteorological data at NBI station on Sunday (Jul 28)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.5167	27.283	92.525	0.000	92.167
7:00	0.5083	27.633	91.192	4.500	93.900
8:00	0.4417	28.475	89.008	12.417	98.600
9:00	0.5500	29.333	87.533	30.250	106.917
10:00	0.5750	30.475	81.600	37.833	104.075
11:00	0.7500	31.183	77.783	48.000	106.700
12:00	0.6417	31.792	75.808	60.417	95.517
13:00	0.6167	31.875	74.692	46.583	90.950
14:00	0.5333	31.450	76.408	25.417	88.700
15:00	0.4417	31.292	78.758	27.250	88.908
16:00	0.4083	30.367	80.517	21.583	88.900
17:00	0.4000	29.717	84.442	4.000	90.000
18:00	0.4000	28.7500	88.2333	0.0000	93.9000
19:00	0.4000	28.0333	90.8833	0.0000	98.6667
20:00	0.4000	27.6333	93.4417	0.0000	102.6250
21:00	0.4583	27.3667	94.7667	0.0000	104.8000

Table C.8 Meteorological data at NBI station on Tuesday (Jul 30)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.5833	26.450	99.583	0.000	170.392
7:00	0.5000	26.600	99.917	5.000	185.633
8:00	0.5333	28.108	96.692	32.167	187.875
9:00	0.9500	30.158	90.433	47.833	185.642
10:00	1.6417	30.858	87.433	65.167	219.025
11:00	0.8667	31.092	85.308	51.417	184.017
12:00	0.8417	31.683	83.142	69.167	186.658
13:00	0.6167	32.658	78.542	69.833	178.833
14:00	0.4667	34.008	73.517	66.417	161.458
15:00	0.4333	33.767	73.725	52.083	162.167
16:00	0.4250	32.800	76.517	32.667	157.267
17:00	0.4167	31.850	80.033	11.917	166.542
18:00	0.4083	31.083	83.050	0.250	166.025
19:00	0.4583	30.358	86.208	0.000	158.192
20:00	0.5333	30.117	86.600	0.000	165.408
21:00	0.5417	30.008	84.608	0.000	163.692

Table C.9 Meteorological data at NBI station on Sunday (Aug 4)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.5333	31.775	88.067	1.583	137.433
7:00	0.6667	30.867	86.083	16.833	144.850
8:00	0.8167	32.117	82.458	36.167	140.167
9:00	0.8917	33.150	79.225	47.167	141.192
10:00	0.8333	33.742	76.067	53.917	132.558
11:00	1.0250	34.467	73.125	62.833	130.100
12:00	0.9917	35.142	70.842	73.583	121.758
13:00	1.0000	35.692	68.992	74.333	116.975
14:00	0.6417	35.817	70.358	46.750	100.708
15:00	0.6417	36.167	70.458	44.583	100.408
16:00	0.5417	36.058	70.942	25.083	97.042
17:00	0.7417	35.442	74.533	18.167	101.225
18:00	0.8667	34.242	79.283	0.667	106.917
19:00	0.8417	33.158	82.058	0.000	112.092

20:00	0.9167	32.608	84.167	0.000	121.042
21:00	1.1917	32.250	85.500	0.000	133.675

Table C.10 Meteorological data at NBI station on Tuesday (Aug 6)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.4083	27.458	88.200	1.000	167.550
7:00	0.4417	28.342	85.383	24.500	171.700
8:00	0.4500	30.558	75.725	41.917	167.333
9:00	0.4750	31.342	71.817	48.917	150.842
10:00	0.4417	32.700	68.850	56.750	151.892
11:00	0.5000	33.567	65.033	65.250	137.333
12:00	0.4750	34.533	63.017	59.667	130.200
13:00	0.6250	35.158	60.908	83.250	118.292
14:00	0.5417	36.283	58.642	121.333	85.333
15:00	0.5250	35.875	60.175	48.333	68.667
16:00	0.5000	35.575	61.350	30.000	65.208
17:00	0.5000	34.958	62.800	18.000	65.300
18:00	0.4333	34.433	64.308	0.583	65.700
19:00	0.5333	32.608	72.675	0.000	71.117
20:00	0.9750	30.708	80.792	0.000	90.525
21:00	1.2250	29.000	86.258	0.000	114.842

Table C.11 Meteorological data at NBI station on Sunday (Nov 10)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.5083	31.950	88.983	0.167	116.358
7:00	0.4917	29.708	88.683	10.750	123.092
8:00	0.5250	29.942	84.192	72.417	124.833
9:00	0.8667	32.725	72.217	134.417	134.475
10:00	0.8167	33.667	65.917	93.750	120.650
11:00	0.8333	35.042	60.842	215.167	109.533
12:00	0.8583	35.483	60.142	353.167	97.042
13:00	0.9250	36.333	59.675	125.417	92.275
14:00	0.7583	35.717	59.442	110.500	81.683
15:00	0.6417	35.225	59.800	28.333	88.900
16:00	0.6000	35.808	62.308	17.750	92.083
17:00	0.6833	33.642	66.567	3.167	97.367

18:00	0.5000	33.692	68.383	0.000	95.133
19:00	0.4250	33.225	69.475	0.000	93.600
20:00	0.4417	32.758	71.100	0.000	89.117
21:00	0.4000	32.342	72.475	0.000	88.300

Table C.12 Meteorological data at NBI station on Tuesday (Nov 12)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.4000	29.917	90.700	0.333	100.400
7:00	0.4250	29.750	88.250	17.917	101.700
8:00	0.4583	31.608	87.550	76.000	105.675
9:00	0.4583	34.150	78.108	97.167	115.875
10:00	0.4917	35.250	73.225	84.000	111.792
11:00	0.6083	36.575	66.117	135.833	100.908
12:00	0.5500	37.808	58.650	221.333	92.283
13:00	0.5750	38.808	56.500	103.417	81.475
14:00	0.6167	36.725	66.117	68.250	77.000
15:00	0.4667	34.983	71.342	34.000	85.958
16:00	0.4083	34.525	72.717	23.000	93.100
17:00	0.4000	33.617	74.458	3.083	94.417
18:00	0.4250	31.933	76.542	0.000	98.283
19:00	0.4500	30.333	78.583	0.000	102.008
20:00	0.5167	30.100	78.625	0.000	103.867
21:00	0.5250	29.783	80.992	0.000	110.058

Table C.13 Meteorological data at NBI station on Sunday (Nov 24)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.4167	28.517	87.192	0.000	124.808
7:00	0.4500	28.750	86.017	14.250	173.842
8:00	0.4083	30.208	80.250	42.583	183.517
9:00	0.4833	30.742	77.608	53.750	180.967
10:00	0.6250	31.292	75.758	55.500	179.442
11:00	0.9167	31.258	74.842	53.917	170.783
12:00	1.4667	29.633	82.275	69.417	187.883
13:00	0.6167	29.250	85.225	95.833	161.433
14:00	0.5750	29.042	85.767	70.917	158.900
15:00	0.4250	29.667	84.233	38.167	152.600

16:00	0.5083	29.108	85.592	18.500	149.933
17:00	0.5000	28.825	83.575	4.500	152.183
18:00	0.4833	28.158	86.342	0.000	144.850
19:00	0.4250	27.925	87.225	0.000	144.567
20:00	0.4750	27.408	89.133	0.000	145.600
21:00	0.4417	27.025	91.183	0.000	146.200

Table C.14 Meteorological data at NBI station on Tuesday (Nov 26)

Time Period	WS (mps)	AT (c)	RH (%)	SR (W/m2)	BP (mHg)
6:00	0.4083	27.567	94.608	0.000	243.608
7:00	0.4417	28.250	89.342	20.917	453.183
8:00	0.5083	29.433	84.783	83.167	485.933
9:00	0.4917	30.533	82.500	58.333	492.542
10:00	0.4833	32.183	77.325	92.417	491.733
11:00	0.5500	32.942	72.867	86.833	480.158
12:00	0.5833	34.017	69.017	158.083	442.083
13:00	0.7167	34.808	65.550	148.167	413.000
14:00	0.6750	34.217	67.467	72.083	346.075
15:00	0.5583	29.867	82.683	0.083	300.817
16:00	0.6000	28.400	87.817	1.167	316.567
17:00	0.6167	27.642	91.533	0.000	317.783
18:00	0.4667	27.083	95.467	0.000	300.492
19:00	0.4083	27.383	94.008	0.000	288.783
20:00	0.4083	27.233	93.900	0.000	277.508
21:00	0.4333	27.283	94.700	0.000	271.100

C.3 Wind rose plot in Part I (2012)

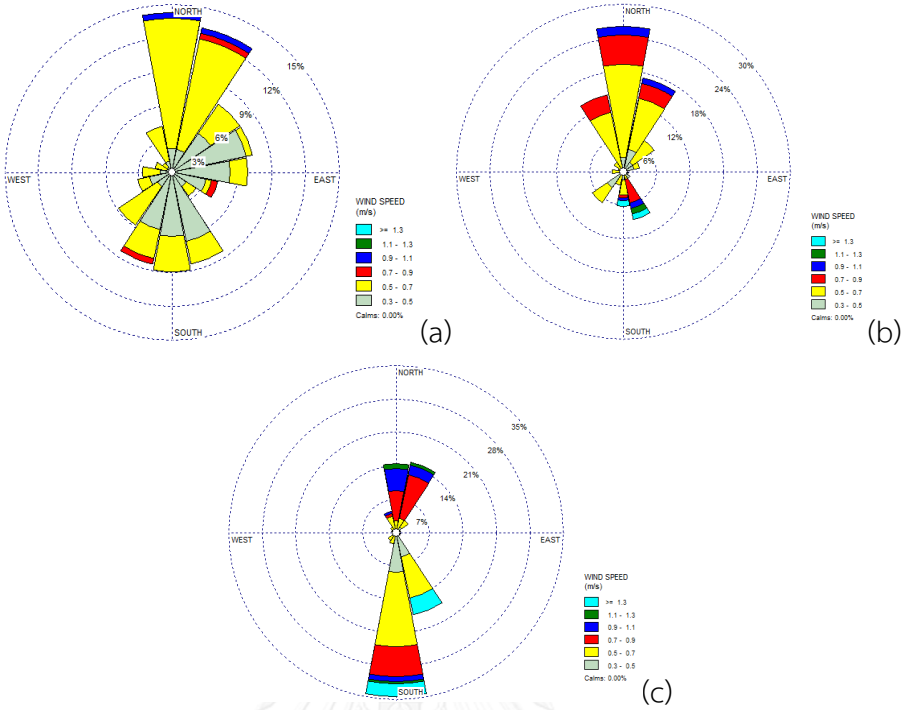

Figure C.1 Wind speed and wind direction at NBI station on September 9 (a), September 11 (b), and September 14 (c)

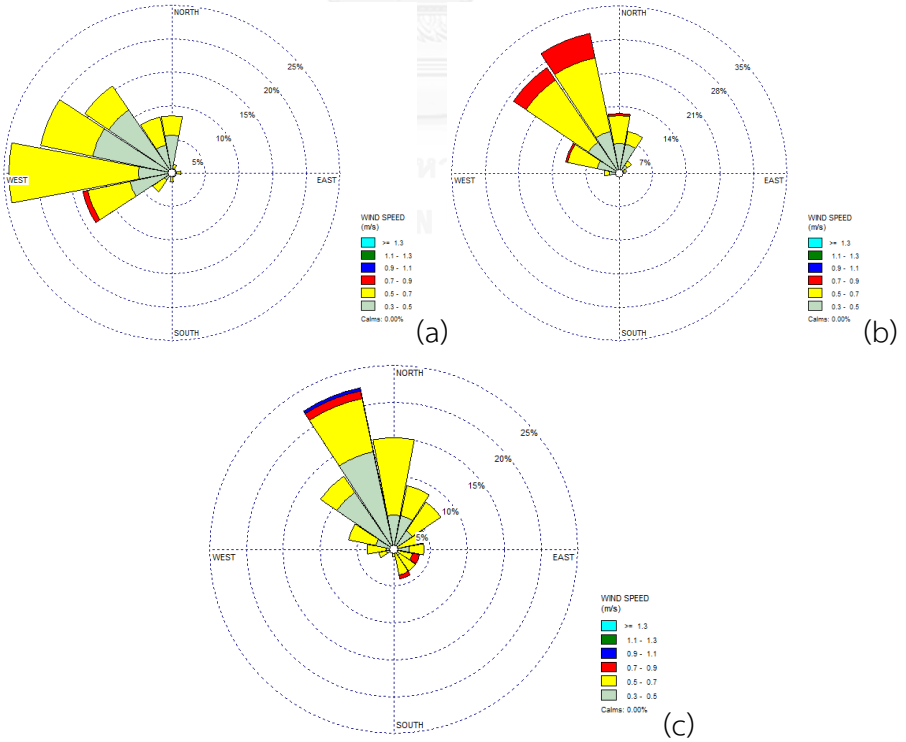

Figure C.2 Wind speed and wind direction at BKK station on October 5 (a), October 7 (b), and October 9 (c)

C.4 Wind rose plot in Part II (2013)

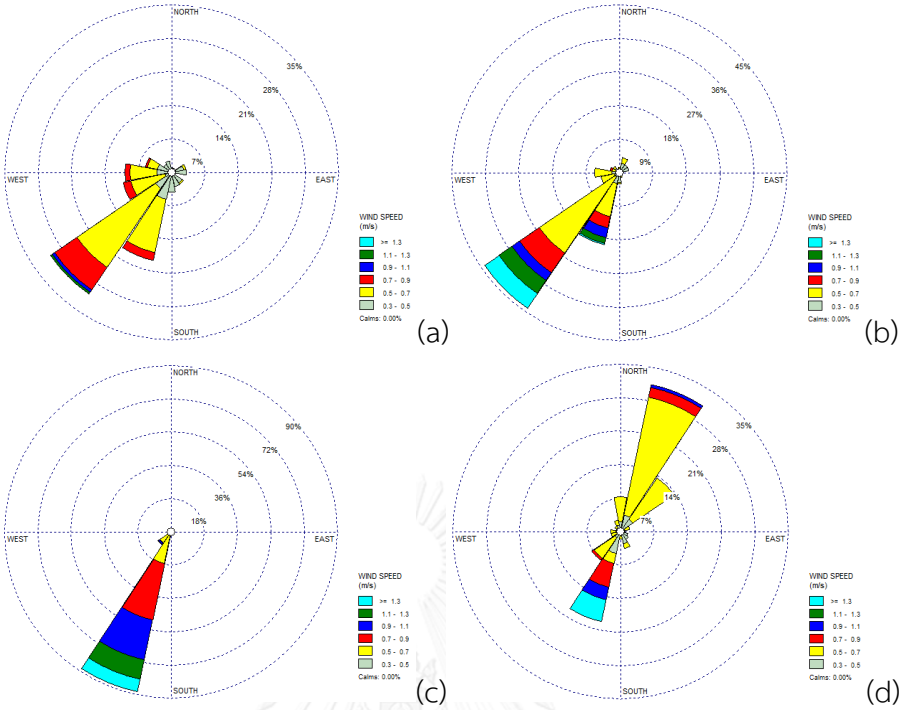

Figure C.3 Wind speed and wind direction in wet season at NBI station on July 28 (a), July 30 (b), August 4 (c), and August 6 (d)

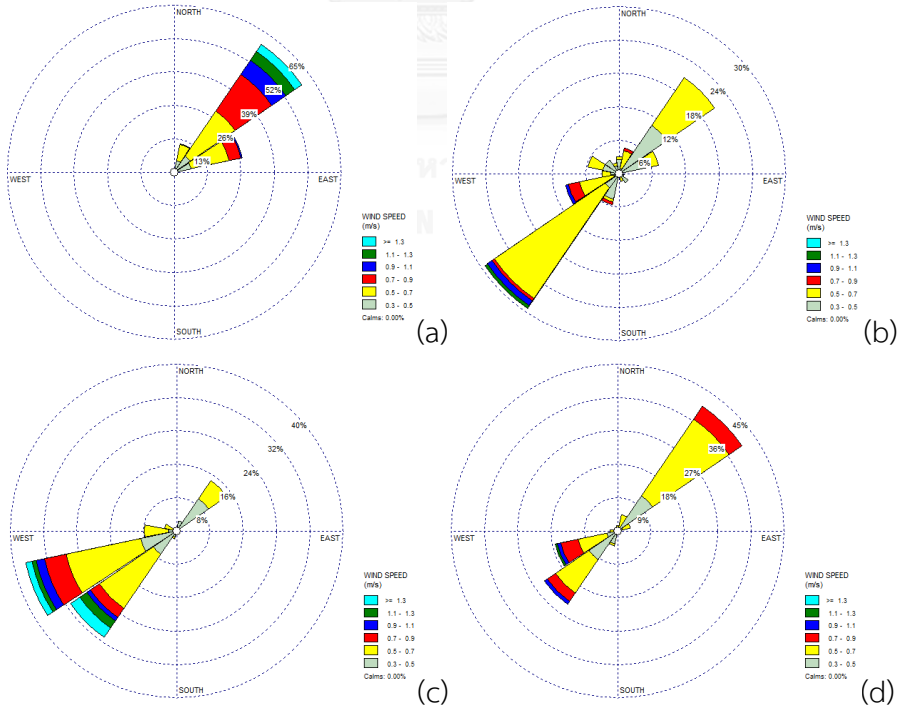

Figure C.4 Wind speed and wind direction in dry season at NBI station on November 10 (a), November 12 (b), November 24 (c), and November 26 (d)

APPENDIX D

Statistics Data

D.1 Correlation of BTEX concentrations

Table D.1 Correlations between BTEX concentrations at NBI and BKK station (Part I)

		Benzene.NBI	Toluene.NBI	Ethylbenzene.NBI	Xylene.NBI	tBTEX.NBI
Benzene.BKK	Pearson Correlation	.579**	.640**	.605**	.620**	.625**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	35	35	35	35	35
Toluene.BKK	Pearson Correlation	.658**	.709**	.666**	.686**	.695**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	35	35	35	35	35
Ethylbenzene.BKK	Pearson Correlation	.633**	.682**	.639**	.657**	.668**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	35	35	35	35	35
Xylene.BKK	Pearson Correlation	.757**	.817**	.778**	.795**	.802**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	35	35	35	35	35
tBTEX.BKK	Pearson Correlation	.661**	.715**	.673**	.692**	.700**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	35	35	35	35	35

**. Correlation is significant at the 0.01 level (2-tailed).

Table D.2 Correlations between BTEX concentrations at NBI station in wet and dry season (Part II)

		Benzene.Wet	Toluene.Wet	Ethylbenzen.Wet	Xylenes.Wet	tBTEX.Wet
Benenzene.Dry	Pearson Correlation	.390**	.507**	.430**	.469**	.496**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	96	96	96	96	96
Toluene.Dry	Pearson Correlation	.619**	.692**	.666**	.715**	.713**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	96	96	96	96	96
Ethylbenzene.Dry	Pearson Correlation	.645**	.759**	.709**	.749**	.767**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	96	96	96	96	96
Xylenes.Dry	Pearson Correlation	.645**	.746**	.706**	.766**	.763**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	96	96	96	96	96
tBTEX.Dry	Pearson Correlation	.596**	.691**	.647**	.698**	.704**
	Sig. (2-tailed)	.000	.000	.000	.000	.000
	N	96	96	96	96	96

**. Correlation is significant at the 0.01 level (2-tailed).

D.2 Correlations between BTEX concentrations and other variables

Table D.3 Correlations between BTEX concentrations at filling nozzle and fuel circulation in wet and dry season (Part II)

		Benzene. Center	Toluene. Center	Ethylbenzene. Center	Xylenes. Center	tBTEX.Center
FuelCirculation	Pearson Correlation	.178	.136	.229	.110	.155
	Sig. (2-tailed)	.160	.284	.068	.389	.220
	N	64	64	64	64	64
CustomersCars	Pearson Correlation	.067	.207	.301*	.135	.171
	Sig. (2-tailed)	.601	.101	.016	.289	.178
	N	64	64	64	64	64

D.3 Comparing of BTEX concentrations in groups

Table D.4 Paired sample T-test of BTEX concentrations in Part I between station

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Benzene.NBI - Benzene. BKK	-1995.40194	2587.55226	437.37616	-2884.25724	-1106.54664	-4.562	34	.000
Pair 2	Toluene.NBI - Toluene. BKK	-7995.57456	10450.02344	1766.37635	-11585.28321	-4405.86591	-4.527	34	.000
Pair 3	Ethylbenzene.NBI - Ethylbenzene.BKK	-366.98651	374.32579	63.27261	-495.57192	-238.40110	-5.800	34	.000
Pair 4	Xylene.NBI - Xylene.BKK	-902.29707	960.88357	162.41897	-1232.37213	-572.22202	-5.555	34	.000
Pair 5	tBTEX.NBI - tBTEX.BKK	-11260.26008	14135.30020	2389.30182	-16115.90559	-6404.61458	-4.713	34	.000

Table D.5 One way ANOVA of BTEX concentrations in Part I among sampling days

Multiple Comparisons

LSD

Dependent Variable	(I) Day	(J) Day	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Benzene.NBI	Sunday	Tuesday	61.75297	121.08511	.614	-184.8893	308.3953
		Friday	39.93079	118.42357	.738	-201.2901	281.1517
	Tuesday	Sunday	-61.75297	121.08511	.614	-308.3953	184.8893
		Friday	-21.82218	121.08511	.858	-268.4645	224.8201
	Friday	Sunday	-39.93079	118.42357	.738	-281.1517	201.2901
		Tuesday	21.82218	121.08511	.858	-224.8201	268.4645
Toluene.NBI	Sunday	Tuesday	109.67423	359.17897	.762	-621.9494	841.2979
		Friday	65.62676	351.28397	.853	-649.9153	781.1688
	Tuesday	Sunday	-109.67423	359.17897	.762	-841.2979	621.9494
		Friday	-44.04747	359.17897	.903	-775.6711	687.5762
	Friday	Sunday	-65.62676	351.28397	.853	-781.1688	649.9153
		Tuesday	44.04747	359.17897	.903	-687.5762	775.6711
Ethylbenzene.NBI	Sunday	Tuesday	6.28500	20.28735	.759	-35.0390	47.6090
		Friday	6.21868	19.84142	.756	-34.1970	46.6343
	Tuesday	Sunday	-6.28500	20.28735	.759	-47.6090	35.0390
		Friday	-.06632	20.28735	.997	-41.3903	41.2577
	Friday	Sunday	-6.21868	19.84142	.756	-46.6343	34.1970
		Tuesday	.06632	20.28735	.997	-41.2577	41.3903

Xylene.NBI	Sunday	Tuesday	53.64539	114.20818	.642	-178.9891	286.2798
		Friday	45.54801	111.69781	.686	-181.9730	273.0690
	Tuesday	Sunday	-53.64539	114.20818	.642	-286.2798	178.9891
		Friday	-8.09738	114.20818	.944	-240.7318	224.5371
	Friday	Sunday	-45.54801	111.69781	.686	-273.0690	181.9730
		Tuesday	8.09738	114.20818	.944	-224.5371	240.7318
tBTEX.NBI	Sunday	Tuesday	231.35759	613.24008	.708	-1017.7716	1480.4868
		Friday	157.32424	599.76063	.795	-1064.3482	1378.9967
	Tuesday	Sunday	-231.35759	613.24008	.708	-1480.4868	1017.7716
		Friday	-74.03335	613.24008	.905	-1323.1625	1175.0958
	Friday	Sunday	-157.32424	599.76063	.795	-1378.9967	1064.3482
		Tuesday	74.03335	613.24008	.905	-1175.0958	1323.1625
Benzene.BKK	Sunday	Tuesday	-1317.69194	1090.03771	.235	-3535.3903	900.0064
		Friday	484.98056	1090.03771	.659	-1732.7178	2702.6790
	Tuesday	Sunday	1317.69194	1090.03771	.235	-900.0064	3535.3903
		Friday	1802.67251	1090.03771	.108	-415.0259	4020.3709
	Friday	Sunday	-484.98056	1090.03771	.659	-2702.6790	1732.7178
		Tuesday	-1802.67251	1090.03771	.108	-4020.3709	415.0259
Toluene.BKK	Sunday	Tuesday	-4427.42568	4488.13286	.331	-13558.6006	4703.7493
		Friday	929.36883	4488.13286	.837	-8201.8061	10060.5438
	Tuesday	Sunday	4427.42568	4488.13286	.331	-4703.7493	13558.6006
		Friday	5356.79450	4488.13286	.241	-3774.3805	14487.9695
	Friday	Sunday	-929.36883	4488.13286	.837	-10060.5438	8201.8061
		Tuesday	-5356.79450	4488.13286	.241	-14487.9695	3774.3805
Ethylbenzene.BKK	Sunday	Tuesday	-281.14724	154.64144	.078	-595.7676	33.4731
		Friday	55.31061	154.64144	.723	-259.3098	369.9310
	Tuesday	Sunday	281.14724	154.64144	.078	-33.4731	595.7676
		Friday	336.45786*	154.64144	.037	21.8375	651.0782
	Friday	Sunday	-55.31061	154.64144	.723	-369.9310	259.3098
		Tuesday	-336.45786*	154.64144	.037	-651.0782	-21.8375
Xylene.BKK	Sunday	Tuesday	-53.60476	478.92801	.912	-1027.9911	920.7816
		Friday	178.80966	478.92801	.711	-795.5767	1153.1960
	Tuesday	Sunday	53.60476	478.92801	.912	-920.7816	1027.9911
		Friday	232.41442	478.92801	.631	-741.9719	1206.8008
	Friday	Sunday	-178.80966	478.92801	.711	-1153.1960	795.5767
		Tuesday	-232.41442	478.92801	.631	-1206.8008	741.9719
tBTEX.BKK	Sunday	Tuesday	-6079.86963	6122.77015	.328	-18536.7392	6376.9999
		Friday	1648.46966	6122.77015	.789	-10808.3999	14105.3392
	Tuesday	Sunday	6079.86963	6122.77015	.328	-6376.9999	18536.7392
		Friday	7728.33929	6122.77015	.216	-4728.5302	20185.2088
	Friday	Sunday	-1648.46966	6122.77015	.789	-14105.3392	10808.3999
		Tuesday	-7728.33929	6122.77015	.216	-20185.2088	4728.5302

*. The mean difference is significant at the 0.05 level.

Table D.6 One way ANOVA of BTEX concentrations in Part I among sampling periods

Multiple Comparisons

LSD

Dependent Variable	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Benzene.NBI	6:00-10:00	10:00-14:00	62.45071	138.24042	.655	-219.4925	344.3939
		14:00-18:00	8.80656	142.49496	.951	-281.8138	299.4270
		18:00-22:00	90.34302	138.24042	.518	-191.6002	372.2862
	10:00-14:00	6:00-10:00	-62.45071	138.24042	.655	-344.3939	219.4925
		14:00-18:00	-53.64415	142.49496	.709	-344.2645	236.9762
		18:00-22:00	27.89232	138.24042	.841	-254.0509	309.8355
	14:00-18:00	6:00-10:00	-8.80656	142.49496	.951	-299.4270	281.8138
		10:00-14:00	53.64415	142.49496	.709	-236.9762	344.2645
		18:00-22:00	81.53646	142.49496	.571	-209.0839	372.1569
	18:00-22:00	6:00-10:00	-90.34302	138.24042	.518	-372.2862	191.6002
		10:00-14:00	-27.89232	138.24042	.841	-309.8355	254.0509
		14:00-18:00	-81.53646	142.49496	.571	-372.1569	209.0839
Toluene.NBI	6:00-10:00	10:00-14:00	163.37130	410.66843	.693	-674.1925	1000.9351
		14:00-18:00	-23.50424	423.30733	.956	-886.8452	839.8368
		18:00-22:00	140.36565	410.66843	.735	-697.1981	977.9294
	10:00-14:00	6:00-10:00	-163.37130	410.66843	.693	-1000.9351	674.1925
		14:00-18:00	-186.87554	423.30733	.662	-1050.2165	676.4654
		18:00-22:00	-23.00566	410.66843	.956	-860.5694	814.5581
	14:00-18:00	6:00-10:00	23.50424	423.30733	.956	-839.8368	886.8452
		10:00-14:00	186.87554	423.30733	.662	-676.4654	1050.2165
		18:00-22:00	163.86988	423.30733	.701	-699.4711	1027.2109
	18:00-22:00	6:00-10:00	-140.36565	410.66843	.735	-977.9294	697.1981
		10:00-14:00	23.00566	410.66843	.956	-814.5581	860.5694
		14:00-18:00	-163.86988	423.30733	.701	-1027.2109	699.4711
Ethylbenzene.NBI	6:00-10:00	10:00-14:00	10.61809	23.18140	.650	-36.6607	57.8969
		14:00-18:00	3.50718	23.89484	.884	-45.2267	52.2410
		18:00-22:00	12.54279	23.18140	.592	-34.7360	59.8216
	10:00-14:00	6:00-10:00	-10.61809	23.18140	.650	-57.8969	36.6607
		14:00-18:00	-7.11091	23.89484	.768	-55.8448	41.6229
		18:00-22:00	1.92470	23.18140	.934	-45.3541	49.2035
	14:00-18:00	6:00-10:00	-3.50718	23.89484	.884	-52.2410	45.2267
		10:00-14:00	7.11091	23.89484	.768	-41.6229	55.8448
		18:00-22:00	9.03560	23.89484	.708	-39.6983	57.7695
	18:00-22:00	6:00-10:00	-12.54279	23.18140	.592	-59.8216	34.7360
		10:00-14:00	-1.92470	23.18140	.934	-49.2035	45.3541
		14:00-18:00	-9.03560	23.89484	.708	-57.7695	39.6983
Xylene.NBI	6:00-10:00	10:00-14:00	39.60537	130.91782	.764	-227.4033	306.6140
		14:00-18:00	-7.49761	134.94700	.956	-282.7238	267.7286
		18:00-22:00	55.43352	130.91782	.675	-211.5751	322.4422
	10:00-14:00	6:00-10:00	-39.60537	130.91782	.764	-306.6140	227.4033
		14:00-18:00	-47.10298	134.94700	.729	-322.3292	228.1232
		18:00-22:00	15.82815	130.91782	.905	-251.1805	282.8368
	14:00-18:00	6:00-10:00	7.49761	134.94700	.956	-267.7286	282.7238
		10:00-14:00	47.10298	134.94700	.729	-228.1232	322.3292
		18:00-22:00	62.93113	134.94700	.644	-212.2951	338.1574
	18:00-22:00	6:00-10:00	-55.43352	130.91782	.675	-322.4422	211.5751
		10:00-14:00	-15.82815	130.91782	.905	-282.8368	251.1805
		14:00-18:00	-62.93113	134.94700	.644	-338.1574	212.2951

tBTEX.NBI	6:00-10:00	10:00-14:00	276.04547	701.34846	.697	-1154.3642	1706.4551
		14:00-18:00	-18.68810	722.93345	.980	-1493.1206	1455.7444
		18:00-22:00	298.68497	701.34846	.673	-1131.7247	1729.0946
	10:00-14:00	6:00-10:00	-276.04547	701.34846	.697	-1706.4551	1154.3642
		14:00-18:00	-294.73357	722.93345	.686	-1769.1661	1179.6989
		18:00-22:00	22.63950	701.34846	.974	-1407.7701	1453.0491
	14:00-18:00	6:00-10:00	18.68810	722.93345	.980	-1455.7444	1493.1206
		10:00-14:00	294.73357	722.93345	.686	-1179.6989	1769.1661
		18:00-22:00	317.37307	722.93345	.664	-1157.0594	1791.8056
	18:00-22:00	6:00-10:00	-298.68497	701.34846	.673	-1729.0946	1131.7247
		10:00-14:00	-22.63950	701.34846	.974	-1453.0491	1407.7701
		14:00-18:00	-317.37307	722.93345	.664	-1791.8056	1157.0594
Benzene.BKK	6:00-10:00	10:00-14:00	-361.35293	1281.11225	.780	-2970.8932	2248.1873
		14:00-18:00	-971.40752	1281.11225	.454	-3580.9478	1638.1327
		18:00-22:00	-1957.93121	1281.11225	.136	-4567.4715	651.6091
	10:00-14:00	6:00-10:00	361.35293	1281.11225	.780	-2248.1873	2970.8932
		14:00-18:00	-610.05459	1281.11225	.637	-3219.5949	1999.4857
		18:00-22:00	-1596.57828	1281.11225	.222	-4206.1186	1012.9620
	14:00-18:00	6:00-10:00	971.40752	1281.11225	.454	-1638.1327	3580.9478
		10:00-14:00	610.05459	1281.11225	.637	-1999.4857	3219.5949
		18:00-22:00	-986.52369	1281.11225	.447	-3596.0640	1623.0166
	18:00-22:00	6:00-10:00	1957.93121	1281.11225	.136	-651.6091	4567.4715
		10:00-14:00	1596.57828	1281.11225	.222	-1012.9620	4206.1186
		14:00-18:00	986.52369	1281.11225	.447	-1623.0166	3596.0640
Toluene.BKK	6:00-10:00	10:00-14:00	2686.31893	5207.29987	.609	-7920.6038	13293.2417
		14:00-18:00	-1564.74683	5207.29987	.766	-12171.6696	9042.1759
		18:00-22:00	-5030.06529	5207.29987	.341	-15636.9880	5576.8574
	10:00-14:00	6:00-10:00	-2686.31893	5207.29987	.609	-13293.2417	7920.6038
		14:00-18:00	-4251.06576	5207.29987	.420	-14857.9885	6355.8570
		18:00-22:00	-7716.38422	5207.29987	.148	-18323.3069	2890.5385
	14:00-18:00	6:00-10:00	1564.74683	5207.29987	.766	-9042.1759	12171.6696
		10:00-14:00	4251.06576	5207.29987	.420	-6355.8570	14857.9885
		18:00-22:00	-3465.31846	5207.29987	.511	-14072.2412	7141.6043
	18:00-22:00	6:00-10:00	5030.06529	5207.29987	.341	-5576.8574	15636.9880
		10:00-14:00	7716.38422	5207.29987	.148	-2890.5385	18323.3069
		14:00-18:00	3465.31846	5207.29987	.511	-7141.6043	14072.2412
Ethylbenzene.BKK	6:00-10:00	10:00-14:00	15.00371	181.43345	.935	-354.5641	384.5716
		14:00-18:00	-133.40305	181.43345	.468	-502.9709	236.1648
		18:00-22:00	-351.17634	181.43345	.062	-720.7442	18.3915
	10:00-14:00	6:00-10:00	-15.00371	181.43345	.935	-384.5716	354.5641
		14:00-18:00	-148.40676	181.43345	.419	-517.9746	221.1611
		18:00-22:00	-366.18005	181.43345	.052	-735.7479	3.3878
	14:00-18:00	6:00-10:00	133.40305	181.43345	.468	-236.1648	502.9709
		10:00-14:00	148.40676	181.43345	.419	-221.1611	517.9746
		18:00-22:00	-217.77329	181.43345	.239	-587.3411	151.7946
	18:00-22:00	6:00-10:00	351.17634	181.43345	.062	-18.3915	720.7442
		10:00-14:00	366.18005	181.43345	.052	-3.3878	735.7479
		14:00-18:00	217.77329	181.43345	.239	-151.7946	587.3411

Toluene.BKK	6:00-10:00	10:00-14:00	2686.31893	5207.29987	.609	-7920.6038	13293.2417
		14:00-18:00	-1564.74683	5207.29987	.766	-12171.6696	9042.1759
		18:00-22:00	-5030.06529	5207.29987	.341	-15636.9880	5576.8574
	10:00-14:00	6:00-10:00	-2686.31893	5207.29987	.609	-13293.2417	7920.6038
		14:00-18:00	-4251.06576	5207.29987	.420	-14857.9885	6355.8570
		18:00-22:00	-7716.38422	5207.29987	.148	-18323.3069	2890.5385
	14:00-18:00	6:00-10:00	1564.74683	5207.29987	.766	-9042.1759	12171.6696
		10:00-14:00	4251.06576	5207.29987	.420	-6355.8570	14857.9885
		18:00-22:00	-3465.31846	5207.29987	.511	-14072.2412	7141.6043
	18:00-22:00	6:00-10:00	5030.06529	5207.29987	.341	-5576.8574	15636.9880
		10:00-14:00	7716.38422	5207.29987	.148	-2890.5385	18323.3069
		14:00-18:00	3465.31846	5207.29987	.511	-7141.6043	14072.2412
Ethylbenzene.BKK	6:00-10:00	10:00-14:00	15.00371	181.43345	.935	-354.5641	384.5716
		14:00-18:00	-133.40305	181.43345	.468	-502.9709	236.1648
		18:00-22:00	-351.17634	181.43345	.062	-720.7442	18.3915
	10:00-14:00	6:00-10:00	-15.00371	181.43345	.935	-384.5716	354.5641
		14:00-18:00	-148.40676	181.43345	.419	-517.9746	221.1611
		18:00-22:00	-366.18005	181.43345	.052	-735.7479	3.3878
	14:00-18:00	6:00-10:00	133.40305	181.43345	.468	-236.1648	502.9709
		10:00-14:00	148.40676	181.43345	.419	-221.1611	517.9746
		18:00-22:00	-217.77329	181.43345	.239	-587.3411	151.7946
	18:00-22:00	6:00-10:00	351.17634	181.43345	.062	-18.3915	720.7442
		10:00-14:00	366.18005	181.43345	.052	-3.3878	735.7479
		14:00-18:00	217.77329	181.43345	.239	-151.7946	587.3411
Xylene.BKK	6:00-10:00	10:00-14:00	141.18599	531.12249	.792	-940.6751	1223.0471
		14:00-18:00	-373.75996	531.12249	.487	-1455.6211	708.1011
		18:00-22:00	-835.25996	531.12249	.126	-1917.1211	246.6011
	10:00-14:00	6:00-10:00	-141.18599	531.12249	.792	-1223.0471	940.6751
		14:00-18:00	-514.94596	531.12249	.340	-1596.8071	566.9151
		18:00-22:00	-976.44596	531.12249	.075	-2058.3071	105.4151
	14:00-18:00	6:00-10:00	373.75996	531.12249	.487	-708.1011	1455.6211
		10:00-14:00	514.94596	531.12249	.340	-566.9151	1596.8071
		18:00-22:00	-461.50000	531.12249	.391	-1543.3611	620.3611
	18:00-22:00	6:00-10:00	835.25996	531.12249	.126	-246.6011	1917.1211
		10:00-14:00	976.44596	531.12249	.075	-105.4151	2058.3071
		14:00-18:00	461.50000	531.12249	.391	-620.3611	1543.3611
tBTEX.BKK	6:00-10:00	10:00-14:00	2481.15571	7096.51177	.729	-11973.9657	16936.2771
		14:00-18:00	-3043.31737	7096.51177	.671	-17498.4388	11411.8041
		18:00-22:00	-8174.43281	7096.51177	.258	-22629.5542	6280.6886
	10:00-14:00	6:00-10:00	-2481.15571	7096.51177	.729	-16936.2771	11973.9657
		14:00-18:00	-5524.47307	7096.51177	.442	-19979.5945	8930.6484
		18:00-22:00	-10655.58851	7096.51177	.143	-25110.7100	3799.5329
	14:00-18:00	6:00-10:00	3043.31737	7096.51177	.671	-11411.8041	17498.4388
		10:00-14:00	5524.47307	7096.51177	.442	-8930.6484	19979.5945
		18:00-22:00	-5131.11544	7096.51177	.475	-19586.2369	9324.0060
	18:00-22:00	6:00-10:00	8174.43281	7096.51177	.258	-6280.6886	22629.5542
		10:00-14:00	10655.58851	7096.51177	.143	-3799.5329	25110.7100
		14:00-18:00	5131.11544	7096.51177	.475	-9324.0060	19586.2369

Table D.7 One way ANOVA of BTEX concentrations in Part I among sampling points

Multiple Comparisons

LSD

Dependent Variable	(I) Position	(J) Position	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Benzene.NBI	Front	Center	-512.74167*	51.65806	.000	-617.9657	-407.5177
		Back	31.61815	52.81906	.554	-75.9708	139.2071
	Center	Front	512.74167*	51.65806	.000	407.5177	617.9657
		Back	544.35982*	52.81906	.000	436.7709	651.9487
	Back	Front	-31.61815	52.81906	.554	-139.2071	75.9708
		Center	-544.35982*	52.81906	.000	-651.9487	-436.7709
Toluene.NBI	Front	Center	-1582.71596*	132.04021	.000	-1851.6731	-1313.7589
		Back	53.65055	135.00778	.694	-221.3513	328.6524
	Center	Front	1582.71596*	132.04021	.000	1313.7589	1851.6731
		Back	1636.36652*	135.00778	.000	1361.3647	1911.3684
	Back	Front	-53.65055	135.00778	.694	-328.6524	221.3513
		Center	-1636.36652*	135.00778	.000	-1911.3684	-1361.3647
Ethylbenzene.NBI	Front	Center	-88.89408*	7.68084	.000	-104.5394	-73.2487
		Back	3.24295	7.85346	.682	-12.7540	19.2399
	Center	Front	88.89408*	7.68084	.000	73.2487	104.5394
		Back	92.13702*	7.85346	.000	76.1400	108.1340
	Back	Front	-3.24295	7.85346	.682	-19.2399	12.7540
		Center	-92.13702*	7.85346	.000	-108.1340	-76.1400
Xylene.NBI	Front	Center	-503.88612*	43.18613	.000	-591.8534	-415.9188
		Back	14.03384	44.15673	.753	-75.9105	103.9782
	Center	Front	503.88612*	43.18613	.000	415.9188	591.8534
		Back	517.91996*	44.15673	.000	427.9756	607.8643
	Back	Front	-14.03384	44.15673	.753	-103.9782	75.9105
		Center	-517.91996*	44.15673	.000	-607.8643	-427.9756
tBTEX.NBI	Front	Center	-2688.23784*	230.97982	.000	-3158.7283	-2217.7473
		Back	102.54549	236.17102	.667	-378.5191	583.6101
	Center	Front	2688.23784*	230.97982	.000	2217.7473	3158.7283
		Back	2790.78332*	236.17102	.000	2309.7187	3271.8480
	Back	Front	-102.54549	236.17102	.667	-583.6101	378.5191
		Center	-2790.78332*	236.17102	.000	-3271.8480	-2309.7187
Benzene.BKK	Front	Center	-3947.51277*	771.11189	.000	-5516.3517	-2378.6738
		Back	395.68547	771.11189	.611	-1173.1535	1964.5244
	Center	Front	3947.51277*	771.11189	.000	2378.6738	5516.3517
		Back	4343.19823*	771.11189	.000	2774.3593	5912.0372
	Back	Front	-395.68547	771.11189	.611	-1964.5244	1173.1535
		Center	-4343.19823*	771.11189	.000	-5912.0372	-2774.3593
Toluene.BKK	Front	Center	-17450.4580*	2772.52627	.000	-23091.2051	-11809.7109
		Back	1496.72920	2772.52627	.593	-4144.0179	7137.4763
	Center	Front	17450.45800*	2772.52627	.000	11809.7109	23091.2051
		Back	18947.18719*	2772.52627	.000	13306.4401	24587.9343
	Back	Front	-1496.72920	2772.52627	.593	-7137.4763	4144.0179
		Center	-18947.1872*	2772.52627	.000	-24587.9343	-13306.4401
Ethylbenzene.BKK	Front	Center	-558.10673*	111.22534	.000	-784.3964	-331.8171
		Back	107.89350	111.22534	.339	-118.3962	334.1832
	Center	Front	558.10673*	111.22534	.000	331.8171	784.3964
		Back	666.00023*	111.22534	.000	439.7106	892.2899
	Back	Front	-107.89350	111.22534	.339	-334.1832	118.3962
		Center	-666.00023*	111.22534	.000	-892.2899	-439.7106

Xylene.BKK	Front	Center	-2016.35653*	245.01793	.000	-2514.8493	-1517.8638
		Back	80.98788	245.01793	.743	-417.5048	579.4806
	Center	Front	2016.35653*	245.01793	.000	1517.8638	2514.8493
		Back	2097.34441*	245.01793	.000	1598.8517	2595.8371
	Back	Front	-80.98788	245.01793	.743	-579.4806	417.5048
		Center	-2097.34441*	245.01793	.000	-2595.8371	-1598.8517
tBTEX.BKK	Front	Center	-23972.4340*	3753.17998	.000	-31608.3361	-16336.5319
		Back	2081.29605	3753.17998	.583	-5554.6060	9717.1981
	Center	Front	23972.43401*	3753.17998	.000	16336.5319	31608.3361
		Back	26053.73006*	3753.17998	.000	18417.8280	33689.6322
	Back	Front	-2081.29605	3753.17998	.583	-9717.1981	5554.6060
		Center	-26053.7301*	3753.17998	.000	-33689.6322	-18417.8280

*. The mean difference is significant at the 0.05 level.

Table D.8 Paired samples T-test of BTEX concentrations in Part II between seasons

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Benzene.Wet - Benenzene.Dry	-899.20241	1462.70950	149.28716	-1195.57490	-602.82992	-6.023	95	.000
Pair 2	Toluene.Wet - Toluene. Dry	-745.71648	2673.01255	272.81320	-1287.31917	-204.11380	-2.733	95	.007
Pair 3	Ethylbenzen.Wet - Ethylbenzene.Dry	-92.77005	251.10935	25.62874	-143.64954	-41.89057	-3.620	95	.000
Pair 4	Xylenes.Wet - Xylenes.Dry	-284.41972	816.75695	83.35991	-449.91006	-118.92938	-3.412	95	.001
Pair 5	tBTEX.Wet - tBTEX.Dry	-2022.10867	4813.31505	491.25691	-2997.37695	-1046.84040	-4.116	95	.000

Table D.9 One way ANOVA of BTEX concentrations in Part II among sampling times

Multiple Comparisons

LSD

Dependent Variable	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Benzene.Wet	6:00-8:00	8:00-10:00	-98.37072	191.05145	.608	-478.0453	281.3039
		10:00-12:00	75.98899	191.05145	.692	-303.6856	455.6636
		12:00-14:00	125.63701	191.05145	.513	-254.0376	505.3116
		14:00-16:00	-57.57631	191.05145	.764	-437.2509	322.0983
		16:00-18:00	-196.78451	191.05145	.306	-576.4591	182.8901
		18:00-20:00	-273.25974	191.05145	.156	-652.9343	106.4149
		20:00-22:00	-404.89040*	191.05145	.037	-784.5650	-25.2158
	8:00-10:00	6:00-8:00	98.37072	191.05145	.608	-281.3039	478.0453
		10:00-12:00	174.35971	191.05145	.364	-205.3149	554.0343
		12:00-14:00	224.00773	191.05145	.244	-155.6669	603.6823
		14:00-16:00	40.79441	191.05145	.831	-338.8802	420.4690
		16:00-18:00	-98.41378	191.05145	.608	-478.0884	281.2608
		18:00-20:00	-174.88901	191.05145	.362	-554.5636	204.7856
		20:00-22:00	-306.51968	191.05145	.112	-686.1943	73.1549
	10:00-12:00	6:00-8:00	-75.98899	191.05145	.692	-455.6636	303.6856
		8:00-10:00	-174.35971	191.05145	.364	-554.0343	205.3149
		12:00-14:00	49.64802	191.05145	.796	-330.0266	429.3226
		14:00-16:00	-133.56530	191.05145	.486	-513.2399	246.1093
		16:00-18:00	-272.77350	191.05145	.157	-652.4481	106.9011
		18:00-20:00	-349.24873	191.05145	.071	-728.9233	30.4259
		20:00-22:00	-480.87939*	191.05145	.014	-860.5540	-101.2048

	12:00-14:00	6:00-8:00	-125.63701	191.05145	.513	-505.3116	254.0376
		8:00-10:00	-224.00773	191.05145	.244	-603.6823	155.6669
		10:00-12:00	-49.64802	191.05145	.796	-429.3226	330.0266
		14:00-16:00	-183.21333	191.05145	.340	-562.8879	196.4613
		16:00-18:00	-322.42152	191.05145	.095	-702.0961	57.2531
		18:00-20:00	-398.89675*	191.05145	.040	-778.5714	-19.2221
		20:00-22:00	-530.52741*	191.05145	.007	-910.2020	-150.8528
	14:00-16:00	6:00-8:00	57.57631	191.05145	.764	-322.0983	437.2509
		8:00-10:00	-40.79441	191.05145	.831	-420.4690	338.8802
		10:00-12:00	133.56530	191.05145	.486	-246.1093	513.2399
		12:00-14:00	183.21333	191.05145	.340	-196.4613	562.8879
		16:00-18:00	-139.20819	191.05145	.468	-518.8828	240.4664
		18:00-20:00	-215.68342	191.05145	.262	-595.3580	163.9912
		20:00-22:00	-347.31409	191.05145	.072	-726.9887	32.3605
	16:00-18:00	6:00-8:00	196.78451	191.05145	.306	-182.8901	576.4591
		8:00-10:00	98.41378	191.05145	.608	-281.2608	478.0884
		10:00-12:00	272.77350	191.05145	.157	-106.9011	652.4481
		12:00-14:00	322.42152	191.05145	.095	-57.2531	702.0961
		14:00-16:00	139.20819	191.05145	.468	-240.4664	518.8828
		18:00-20:00	-76.47523	191.05145	.690	-456.1498	303.1994
		20:00-22:00	-208.10590	191.05145	.279	-587.7805	171.5687
	18:00-20:00	6:00-8:00	273.25974	191.05145	.156	-106.4149	652.9343
		8:00-10:00	174.88901	191.05145	.362	-204.7856	554.5636
		10:00-12:00	349.24873	191.05145	.071	-30.4259	728.9233
		12:00-14:00	398.89675*	191.05145	.040	19.2221	778.5714
		14:00-16:00	215.68342	191.05145	.262	-163.9912	595.3580
		16:00-18:00	76.47523	191.05145	.690	-303.1994	456.1498
		20:00-22:00	-131.63067	191.05145	.493	-511.3053	248.0439
	20:00-22:00	6:00-8:00	404.89040*	191.05145	.037	25.2158	784.5650
		8:00-10:00	306.51968	191.05145	.112	-73.1549	686.1943
		10:00-12:00	480.87939*	191.05145	.014	101.2048	860.5540
		12:00-14:00	530.52741*	191.05145	.007	150.8528	910.2020
		14:00-16:00	347.31409	191.05145	.072	-32.3605	726.9887
		16:00-18:00	208.10590	191.05145	.279	-171.5687	587.7805
		18:00-20:00	131.63067	191.05145	.493	-248.0439	511.3053
Toluene.Wet	6:00-8:00	8:00-10:00	96.79864	722.41479	.894	-1338.8489	1532.4462
		10:00-12:00	822.05729	722.41479	.258	-613.5903	2257.7049
		12:00-14:00	1009.80320	722.41479	.166	-425.8444	2445.4508
		14:00-16:00	569.70962	722.41479	.432	-865.9380	2005.3572
		16:00-18:00	420.74898	722.41479	.562	-1014.8986	1856.3966
		18:00-20:00	-51.83618	722.41479	.943	-1487.4838	1383.8114
		20:00-22:00	436.27216	722.41479	.547	-999.3754	1871.9198
	8:00-10:00	6:00-8:00	-96.79864	722.41479	.894	-1532.4462	1338.8489
		10:00-12:00	725.25865	722.41479	.318	-710.3889	2160.9062
		12:00-14:00	913.00456	722.41479	.210	-522.6430	2348.6521
		14:00-16:00	472.91098	722.41479	.514	-962.7366	1908.5586
		16:00-18:00	323.95035	722.41479	.655	-1111.6972	1759.5979
		18:00-20:00	-148.63481	722.41479	.837	-1584.2824	1287.0128
		20:00-22:00	339.47352	722.41479	.640	-1096.1741	1775.1211
	10:00-12:00	6:00-8:00	-822.05729	722.41479	.258	-2257.7049	613.5903
		8:00-10:00	-725.25865	722.41479	.318	-2160.9062	710.3889
		12:00-14:00	187.74591	722.41479	.796	-1247.9017	1623.3935
		14:00-16:00	-252.34767	722.41479	.728	-1687.9953	1183.2999
		16:00-18:00	-401.30830	722.41479	.580	-1836.9559	1034.3393
		18:00-20:00	-873.89346	722.41479	.230	-2309.5410	561.7541
		20:00-22:00	-385.78512	722.41479	.595	-1821.4327	1049.8625

	12:00-14:00	6:00-8:00	-1009.80320	722.41479	.166	-2445.4508	425.8444
		8:00-10:00	-913.00456	722.41479	.210	-2348.6521	522.6430
		10:00-12:00	-187.74591	722.41479	.796	-1623.3935	1247.9017
		14:00-16:00	-440.09358	722.41479	.544	-1875.7412	995.5540
		16:00-18:00	-589.05421	722.41479	.417	-2024.7018	846.5934
		18:00-20:00	-1061.63937	722.41479	.145	-2497.2870	374.0082
		20:00-22:00	-573.53103	722.41479	.429	-2009.1786	862.1166
	14:00-16:00	6:00-8:00	-569.70962	722.41479	.432	-2005.3572	865.9380
		8:00-10:00	-472.91098	722.41479	.514	-1908.5586	962.7366
		10:00-12:00	252.34767	722.41479	.728	-1183.2999	1687.9953
		12:00-14:00	440.09358	722.41479	.544	-995.5540	1875.7412
		16:00-18:00	-148.96063	722.41479	.837	-1584.6082	1286.6870
		18:00-20:00	-621.54579	722.41479	.392	-2057.1934	814.1018
		20:00-22:00	-133.43746	722.41479	.854	-1569.0850	1302.2101
	16:00-18:00	6:00-8:00	-420.74898	722.41479	.562	-1856.3966	1014.8986
		8:00-10:00	-323.95035	722.41479	.655	-1759.5979	1111.6972
		10:00-12:00	401.30830	722.41479	.580	-1034.3393	1836.9559
		12:00-14:00	589.05421	722.41479	.417	-846.5934	2024.7018
		14:00-16:00	148.96063	722.41479	.837	-1286.6870	1584.6082
		18:00-20:00	-472.58516	722.41479	.515	-1908.2327	963.0624
		20:00-22:00	15.52318	722.41479	.983	-1420.1244	1451.1708
	18:00-20:00	6:00-8:00	51.83618	722.41479	.943	-1383.8114	1487.4838
		8:00-10:00	148.63481	722.41479	.837	-1287.0128	1584.2824
		10:00-12:00	873.89346	722.41479	.230	-561.7541	2309.5410
		12:00-14:00	1061.63937	722.41479	.145	-374.0082	2497.2870
		14:00-16:00	621.54579	722.41479	.392	-814.1018	2057.1934
		16:00-18:00	472.58516	722.41479	.515	-963.0624	1908.2327
		20:00-22:00	488.10834	722.41479	.501	-947.5392	1923.7559
	20:00-22:00	6:00-8:00	-436.27216	722.41479	.547	-1871.9198	999.3754
		8:00-10:00	-339.47352	722.41479	.640	-1775.1211	1096.1741
		10:00-12:00	385.78512	722.41479	.595	-1049.8625	1821.4327
		12:00-14:00	573.53103	722.41479	.429	-862.1166	2009.1786
		14:00-16:00	133.43746	722.41479	.854	-1302.2101	1569.0850
		16:00-18:00	-15.52318	722.41479	.983	-1451.1708	1420.1244
		18:00-20:00	-488.10834	722.41479	.501	-1923.7559	947.5392
Ethylbenzen.Wet	6:00-8:00	8:00-10:00	21.13287	65.98512	.750	-109.9987	152.2644
		10:00-12:00	61.19238	65.98512	.356	-69.9392	192.3239
		12:00-14:00	58.92291	65.98512	.374	-72.2087	190.0545
		14:00-16:00	-16.09703	65.98512	.808	-147.2286	115.0345
		16:00-18:00	-14.02031	65.98512	.832	-145.1519	117.1112
		18:00-20:00	-49.70747	65.98512	.453	-180.8390	81.4241
		20:00-22:00	-18.66434	65.98512	.778	-149.7959	112.4672
	8:00-10:00	6:00-8:00	-21.13287	65.98512	.750	-152.2644	109.9987
		10:00-12:00	40.05951	65.98512	.545	-91.0720	171.1911
		12:00-14:00	37.79004	65.98512	.568	-93.3415	168.9216
		14:00-16:00	-37.22990	65.98512	.574	-168.3615	93.9017
		16:00-18:00	-35.15318	65.98512	.596	-166.2847	95.9784
		18:00-20:00	-70.84034	65.98512	.286	-201.9719	60.2912
		20:00-22:00	-39.79721	65.98512	.548	-170.9288	91.3343
	10:00-12:00	6:00-8:00	-61.19238	65.98512	.356	-192.3239	69.9392
		8:00-10:00	-40.05951	65.98512	.545	-171.1911	91.0720
		12:00-14:00	-2.26947	65.98512	.973	-133.4010	128.8621
		14:00-16:00	-77.28941	65.98512	.245	-208.4210	53.8421
		16:00-18:00	-75.21269	65.98512	.257	-206.3442	55.9189
		18:00-20:00	-110.89985	65.98512	.096	-242.0314	20.2317
		20:00-22:00	-79.85672	65.98512	.229	-210.9883	51.2748

	12:00-14:00	6:00-8:00	-58.92291	65.98512	.374	-190.0545	72.2087
		8:00-10:00	-37.79004	65.98512	.568	-168.9216	93.3415
		10:00-12:00	2.26947	65.98512	.973	-128.8621	133.4010
		14:00-16:00	-75.01994	65.98512	.259	-206.1515	56.1116
		16:00-18:00	-72.94322	65.98512	.272	-204.0748	58.1883
		18:00-20:00	-108.63037	65.98512	.103	-239.7619	22.5012
		20:00-22:00	-77.58724	65.98512	.243	-208.7188	53.5443
	14:00-16:00	6:00-8:00	16.09703	65.98512	.808	-115.0345	147.2286
		8:00-10:00	37.22990	65.98512	.574	-93.9017	168.3615
		10:00-12:00	77.28941	65.98512	.245	-53.8421	208.4210
		12:00-14:00	75.01994	65.98512	.259	-56.1116	206.1515
		16:00-18:00	2.07672	65.98512	.975	-129.0548	133.2083
		18:00-20:00	-33.61043	65.98512	.612	-164.7420	97.5211
		20:00-22:00	-2.56731	65.98512	.969	-133.6989	128.5643
	16:00-18:00	6:00-8:00	14.02031	65.98512	.832	-117.1112	145.1519
		8:00-10:00	35.15318	65.98512	.596	-95.9784	166.2847
		10:00-12:00	75.21269	65.98512	.257	-55.9189	206.3442
		12:00-14:00	72.94322	65.98512	.272	-58.1883	204.0748
		14:00-16:00	-2.07672	65.98512	.975	-133.2083	129.0548
		18:00-20:00	-35.68715	65.98512	.590	-166.8187	95.4444
		20:00-22:00	-4.64402	65.98512	.944	-135.7756	126.4875
	18:00-20:00	6:00-8:00	49.70747	65.98512	.453	-81.4241	180.8390
		8:00-10:00	70.84034	65.98512	.286	-60.2912	201.9719
		10:00-12:00	110.89985	65.98512	.096	-20.2317	242.0314
		12:00-14:00	108.63037	65.98512	.103	-22.5012	239.7619
		14:00-16:00	33.61043	65.98512	.612	-97.5211	164.7420
		16:00-18:00	35.68715	65.98512	.590	-95.4444	166.8187
		20:00-22:00	31.04313	65.98512	.639	-100.0884	162.1747
	20:00-22:00	6:00-8:00	18.66434	65.98512	.778	-112.4672	149.7959
		8:00-10:00	39.79721	65.98512	.548	-91.3343	170.9288
		10:00-12:00	79.85672	65.98512	.229	-51.2748	210.9883
		12:00-14:00	77.58724	65.98512	.243	-53.5443	208.7188
		14:00-16:00	2.56731	65.98512	.969	-128.5643	133.6989
		16:00-18:00	4.64402	65.98512	.944	-126.4875	135.7756
		18:00-20:00	-31.04313	65.98512	.639	-162.1747	100.0884
Xylenes.Wet	6:00-8:00	8:00-10:00	83.62590	273.23140	.760	-459.3641	626.6159
		10:00-12:00	257.71760	273.23140	.348	-285.2724	800.7076
		12:00-14:00	358.61165	273.23140	.193	-184.3783	901.6016
		14:00-16:00	184.24631	273.23140	.502	-358.7437	727.2363
		16:00-18:00	110.94028	273.23140	.686	-432.0497	653.9303
		18:00-20:00	4.50988	273.23140	.987	-538.4801	547.4999
		20:00-22:00	196.26545	273.23140	.474	-346.7245	739.2554
	8:00-10:00	6:00-8:00	-83.62590	273.23140	.760	-626.6159	459.3641
		10:00-12:00	174.09170	273.23140	.526	-368.8983	717.0817
		12:00-14:00	274.98576	273.23140	.317	-268.0042	817.9758
		14:00-16:00	100.62041	273.23140	.714	-442.3696	643.6104
		16:00-18:00	27.31438	273.23140	.921	-515.6756	570.3044
		18:00-20:00	-79.11602	273.23140	.773	-622.1060	463.8740
		20:00-22:00	112.63955	273.23140	.681	-430.3504	655.6295
	10:00-12:00	6:00-8:00	-257.71760	273.23140	.348	-800.7076	285.2724
		8:00-10:00	-174.09170	273.23140	.526	-717.0817	368.8983
		12:00-14:00	100.89405	273.23140	.713	-442.0959	643.8840
		14:00-16:00	-73.47129	273.23140	.789	-616.4613	469.5187
		16:00-18:00	-146.77732	273.23140	.592	-689.7673	396.2127
		18:00-20:00	-253.20772	273.23140	.357	-796.1977	289.7823
		20:00-22:00	-61.45216	273.23140	.823	-604.4422	481.5378

	12:00-14:00	6:00-8:00	-358.61165	273.23140	.193	-901.6016	184.3783
		8:00-10:00	-274.98576	273.23140	.317	-817.9758	268.0042
		10:00-12:00	-100.89405	273.23140	.713	-643.8840	442.0959
		14:00-16:00	-174.36534	273.23140	.525	-717.3553	368.6247
		16:00-18:00	-247.67138	273.23140	.367	-790.6614	295.3186
		18:00-20:00	-354.10177	273.23140	.198	-897.0918	188.8882
		20:00-22:00	-162.34621	273.23140	.554	-705.3362	380.6438
	14:00-16:00	6:00-8:00	-184.24631	273.23140	.502	-727.2363	358.7437
		8:00-10:00	-100.62041	273.23140	.714	-643.6104	442.3696
		10:00-12:00	73.47129	273.23140	.789	-469.5187	616.4613
		12:00-14:00	174.36534	273.23140	.525	-368.6247	717.3553
		16:00-18:00	-73.30603	273.23140	.789	-616.2960	469.6840
		18:00-20:00	-179.73643	273.23140	.512	-722.7264	363.2536
		20:00-22:00	12.01913	273.23140	.965	-530.9709	555.0091
	16:00-18:00	6:00-8:00	-110.94028	273.23140	.686	-653.9303	432.0497
		8:00-10:00	-27.31438	273.23140	.921	-570.3044	515.6756
		10:00-12:00	146.77732	273.23140	.592	-396.2127	689.7673
		12:00-14:00	247.67138	273.23140	.367	-295.3186	790.6614
		14:00-16:00	73.30603	273.23140	.789	-469.6840	616.2960
		18:00-20:00	-106.43040	273.23140	.698	-649.4204	436.5596
		20:00-22:00	85.32517	273.23140	.756	-457.6648	628.3152
	18:00-20:00	6:00-8:00	-4.50988	273.23140	.987	-547.4999	538.4801
		8:00-10:00	79.11602	273.23140	.773	-463.8740	622.1060
		10:00-12:00	253.20772	273.23140	.357	-289.7823	796.1977
		12:00-14:00	354.10177	273.23140	.198	-188.8882	897.0918
		14:00-16:00	179.73643	273.23140	.512	-363.2536	722.7264
		16:00-18:00	106.43040	273.23140	.698	-436.5596	649.4204
		20:00-22:00	191.75556	273.23140	.485	-351.2344	734.7456
	20:00-22:00	6:00-8:00	-196.26545	273.23140	.474	-739.2554	346.7245
		8:00-10:00	-112.63955	273.23140	.681	-655.6295	430.3504
		10:00-12:00	61.45216	273.23140	.823	-481.5378	604.4422
		12:00-14:00	162.34621	273.23140	.554	-380.6438	705.3362
		14:00-16:00	-12.01913	273.23140	.965	-555.0091	530.9709
		16:00-18:00	-85.32517	273.23140	.756	-628.3152	457.6648
		18:00-20:00	-191.75556	273.23140	.485	-734.7456	351.2344
tBTEX.Wet	6:00-8:00	8:00-10:00	103.18669	1208.75102	.932	-2298.9520	2505.3253
		10:00-12:00	1216.95626	1208.75102	.317	-1185.1824	3619.0949
		12:00-14:00	1552.97477	1208.75102	.202	-849.1639	3955.1134
		14:00-16:00	680.28258	1208.75102	.575	-1721.8561	3082.4212
		16:00-18:00	320.88444	1208.75102	.791	-2081.2542	2723.0231
		18:00-20:00	-370.29350	1208.75102	.760	-2772.4322	2031.8452
		20:00-22:00	208.98287	1208.75102	.863	-2193.1558	2611.1215
	8:00-10:00	6:00-8:00	-103.18669	1208.75102	.932	-2505.3253	2298.9520
		10:00-12:00	1113.76957	1208.75102	.359	-1288.3691	3515.9082
		12:00-14:00	1449.78808	1208.75102	.234	-952.3506	3851.9267
		14:00-16:00	577.09590	1208.75102	.634	-1825.0428	2979.2346
		16:00-18:00	217.69776	1208.75102	.857	-2184.4409	2619.8364
		18:00-20:00	-473.48018	1208.75102	.696	-2875.6188	1928.6585
		20:00-22:00	105.79618	1208.75102	.930	-2296.3425	2507.9348
	10:00-12:00	6:00-8:00	-1216.95626	1208.75102	.317	-3619.0949	1185.1824
		8:00-10:00	-1113.76957	1208.75102	.359	-3515.9082	1288.3691
		12:00-14:00	336.01851	1208.75102	.782	-2066.1201	2738.1572
		14:00-16:00	-536.67367	1208.75102	.658	-2938.8123	1865.4650
		16:00-18:00	-896.07181	1208.75102	.460	-3298.2105	1506.0668
		18:00-20:00	-1587.24975	1208.75102	.193	-3989.3884	814.8889
		20:00-22:00	-1007.97339	1208.75102	.407	-3410.1120	1394.1653

	12:00-14:00	6:00-8:00	-1552.97477	1208.75102	.202	-3955.1134	849.1639
		8:00-10:00	-1449.78808	1208.75102	.234	-3851.9267	952.3506
		10:00-12:00	-336.01851	1208.75102	.782	-2738.1572	2066.1201
		14:00-16:00	-872.69219	1208.75102	.472	-3274.8308	1529.4465
		16:00-18:00	-1232.09032	1208.75102	.311	-3634.2290	1170.0483
		18:00-20:00	-1923.26827	1208.75102	.115	-4325.4069	478.8704
		20:00-22:00	-1343.99190	1208.75102	.269	-3746.1306	1058.1468
	14:00-16:00	6:00-8:00	-680.28258	1208.75102	.575	-3082.4212	1721.8561
		8:00-10:00	-577.09590	1208.75102	.634	-2979.2346	1825.0428
		10:00-12:00	536.67367	1208.75102	.658	-1865.4650	2938.8123
		12:00-14:00	872.69219	1208.75102	.472	-1529.4465	3274.8308
		16:00-18:00	-359.39814	1208.75102	.767	-2761.5368	2042.7405
		18:00-20:00	-1050.57608	1208.75102	.387	-3452.7147	1351.5626
		20:00-22:00	-471.29972	1208.75102	.698	-2873.4384	1930.8389
	16:00-18:00	6:00-8:00	-320.88444	1208.75102	.791	-2723.0231	2081.2542
		8:00-10:00	-217.69776	1208.75102	.857	-2619.8364	2184.4409
		10:00-12:00	896.07181	1208.75102	.460	-1506.0668	3298.2105
		12:00-14:00	1232.09032	1208.75102	.311	-1170.0483	3634.2290
		14:00-16:00	359.39814	1208.75102	.767	-2042.7405	2761.5368
		18:00-20:00	-691.17794	1208.75102	.569	-3093.3166	1710.9607
		20:00-22:00	-111.90158	1208.75102	.926	-2514.0402	2290.2371
	18:00-20:00	6:00-8:00	370.29350	1208.75102	.760	-2031.8452	2772.4322
		8:00-10:00	473.48018	1208.75102	.696	-1928.6585	2875.6188
		10:00-12:00	1587.24975	1208.75102	.193	-814.8889	3989.3884
		12:00-14:00	1923.26827	1208.75102	.115	-478.8704	4325.4069
		14:00-16:00	1050.57608	1208.75102	.387	-1351.5626	3452.7147
		16:00-18:00	691.17794	1208.75102	.569	-1710.9607	3093.3166
		20:00-22:00	579.27636	1208.75102	.633	-1822.8623	2981.4150
	20:00-22:00	6:00-8:00	-208.98287	1208.75102	.863	-2611.1215	2193.1558
		8:00-10:00	-105.79618	1208.75102	.930	-2507.9348	2296.3425
		10:00-12:00	1007.97339	1208.75102	.407	-1394.1653	3410.1120
		12:00-14:00	1343.99190	1208.75102	.269	-1058.1468	3746.1306
		14:00-16:00	471.29972	1208.75102	.698	-1930.8389	2873.4384
		16:00-18:00	111.90158	1208.75102	.926	-2290.2371	2514.0402
		18:00-20:00	-579.27636	1208.75102	.633	-2981.4150	1822.8623
Benenzene.Dry	6:00-8:00	8:00-10:00	588.26853	641.61670	.362	-686.8098	1863.3469
		10:00-12:00	972.49513	641.61670	.133	-302.5832	2247.5735
		12:00-14:00	673.12129	641.61670	.297	-601.9571	1948.1996
		14:00-16:00	658.73439	641.61670	.307	-616.3440	1933.8127
		16:00-18:00	862.81755	641.61670	.182	-412.2608	2137.8959
		18:00-20:00	-307.42447	641.61670	.633	-1582.5028	967.6539
		20:00-22:00	-163.12671	641.61670	.800	-1438.2051	1111.9516
	8:00-10:00	6:00-8:00	-588.26853	641.61670	.362	-1863.3469	686.8098
		10:00-12:00	384.22659	641.61670	.551	-890.8518	1659.3049
		12:00-14:00	84.85275	641.61670	.895	-1190.2256	1359.9311
		14:00-16:00	70.46586	641.61670	.913	-1204.6125	1345.5442
		16:00-18:00	274.54902	641.61670	.670	-1000.5293	1549.6274
		18:00-20:00	-895.69301	641.61670	.166	-2170.7714	379.3853
		20:00-22:00	-751.39525	641.61670	.245	-2026.4736	523.6831
	10:00-12:00	6:00-8:00	-972.49513	641.61670	.133	-2247.5735	302.5832
		8:00-10:00	-384.22659	641.61670	.551	-1659.3049	890.8518
		12:00-14:00	-299.37384	641.61670	.642	-1574.4522	975.7045
		14:00-16:00	-313.76074	641.61670	.626	-1588.8391	961.3176
		16:00-18:00	-109.67757	641.61670	.865	-1384.7559	1165.4008
		18:00-20:00	-1279.91960*	641.61670	.049	-2554.9980	-4.8412
		20:00-22:00	-1135.62184	641.61670	.080	-2410.7002	139.4565

	12:00-14:00	6:00-8:00	-673.12129	641.61670	.297	-1948.1996	601.9571
		8:00-10:00	-84.85275	641.61670	.895	-1359.9311	1190.2256
		10:00-12:00	299.37384	641.61670	.642	-975.7045	1574.4522
		14:00-16:00	-14.38689	641.61670	.982	-1289.4652	1260.6915
		16:00-18:00	189.69627	641.61670	.768	-1085.3821	1464.7746
		18:00-20:00	-980.54576	641.61670	.130	-2255.6241	294.5326
		20:00-22:00	-836.24800	641.61670	.196	-2111.3264	438.8304
	14:00-16:00	6:00-8:00	-658.73439	641.61670	.307	-1933.8127	616.3440
		8:00-10:00	-70.46586	641.61670	.913	-1345.5442	1204.6125
		10:00-12:00	313.76074	641.61670	.626	-961.3176	1588.8391
		12:00-14:00	14.38689	641.61670	.982	-1260.6915	1289.4652
		16:00-18:00	204.08316	641.61670	.751	-1070.9952	1479.1615
		18:00-20:00	-966.15886	641.61670	.136	-2241.2372	308.9195
		20:00-22:00	-821.86111	641.61670	.204	-2096.9395	453.2172
	16:00-18:00	6:00-8:00	-862.81755	641.61670	.182	-2137.8959	412.2608
		8:00-10:00	-274.54902	641.61670	.670	-1549.6274	1000.5293
		10:00-12:00	109.67757	641.61670	.865	-1165.4008	1384.7559
		12:00-14:00	-189.69627	641.61670	.768	-1464.7746	1085.3821
		14:00-16:00	-204.08316	641.61670	.751	-1479.1615	1070.9952
		18:00-20:00	-1170.24203	641.61670	.072	-2445.3204	104.8363
		20:00-22:00	-1025.94427	641.61670	.113	-2301.0226	249.1341
	18:00-20:00	6:00-8:00	307.42447	641.61670	.633	-967.6539	1582.5028
		8:00-10:00	895.69301	641.61670	.166	-379.3853	2170.7714
		10:00-12:00	1279.91960*	641.61670	.049	4.8412	2554.9980
		12:00-14:00	980.54576	641.61670	.130	-294.5326	2255.6241
		14:00-16:00	966.15886	641.61670	.136	-308.9195	2241.2372
		16:00-18:00	1170.24203	641.61670	.072	-104.8363	2445.3204
		20:00-22:00	144.29776	641.61670	.823	-1130.7806	1419.3761
	20:00-22:00	6:00-8:00	163.12671	641.61670	.800	-1111.9516	1438.2051
		8:00-10:00	751.39525	641.61670	.245	-523.6831	2026.4736
		10:00-12:00	1135.62184	641.61670	.080	-139.4565	2410.7002
		12:00-14:00	836.24800	641.61670	.196	-438.8304	2111.3264
		14:00-16:00	821.86111	641.61670	.204	-453.2172	2096.9395
		16:00-18:00	1025.94427	641.61670	.113	-249.1341	2301.0226
		18:00-20:00	-144.29776	641.61670	.823	-1419.3761	1130.7806
Toluene.Dry	6:00-8:00	8:00-10:00	889.89736	1482.30664	.550	-2055.8756	3835.6703
		10:00-12:00	1396.69051	1482.30664	.349	-1549.0825	4342.4635
		12:00-14:00	1238.78464	1482.30664	.406	-1706.9883	4184.5576
		14:00-16:00	1174.45462	1482.30664	.430	-1771.3183	4120.2276
		16:00-18:00	1443.05830	1482.30664	.333	-1502.7147	4388.8313
		18:00-20:00	-610.83999	1482.30664	.681	-3556.6130	2334.9330
		20:00-22:00	489.03143	1482.30664	.742	-2456.7415	3434.8044
	8:00-10:00	6:00-8:00	-889.89736	1482.30664	.550	-3835.6703	2055.8756
		10:00-12:00	506.79315	1482.30664	.733	-2438.9798	3452.5661
		12:00-14:00	348.88728	1482.30664	.814	-2596.8857	3294.6602
		14:00-16:00	284.55726	1482.30664	.848	-2661.2157	3230.3302
		16:00-18:00	553.16094	1482.30664	.710	-2392.6120	3498.9339
		18:00-20:00	-1500.73735	1482.30664	.314	-4446.5103	1445.0356
		20:00-22:00	-400.86593	1482.30664	.787	-3346.6389	2544.9070
	10:00-12:00	6:00-8:00	-1396.69051	1482.30664	.349	-4342.4635	1549.0825
		8:00-10:00	-506.79315	1482.30664	.733	-3452.5661	2438.9798
		12:00-14:00	-157.90587	1482.30664	.915	-3103.6788	2787.8671
		14:00-16:00	-222.23589	1482.30664	.881	-3168.0089	2723.5371
		16:00-18:00	46.36779	1482.30664	.975	-2899.4052	2992.1408
		18:00-20:00	-2007.53050	1482.30664	.179	-4953.3035	938.2425
		20:00-22:00	-907.65908	1482.30664	.542	-3853.4321	2038.1139

	12:00-14:00	6:00-8:00	-1238.78464	1482.30664	.406	-4184.5576	1706.9883
		8:00-10:00	-348.88728	1482.30664	.814	-3294.6602	2596.8857
		10:00-12:00	157.90587	1482.30664	.915	-2787.8671	3103.6788
		14:00-16:00	-64.33002	1482.30664	.965	-3010.1030	2881.4429
		16:00-18:00	204.27365	1482.30664	.891	-2741.4993	3150.0466
		18:00-20:00	-1849.62463	1482.30664	.215	-4795.3976	1096.1483
		20:00-22:00	-749.75322	1482.30664	.614	-3695.5262	2196.0198
	14:00-16:00	6:00-8:00	-1174.45462	1482.30664	.430	-4120.2276	1771.3183
		8:00-10:00	-284.55726	1482.30664	.848	-3230.3302	2661.2157
		10:00-12:00	222.23589	1482.30664	.881	-2723.5371	3168.0089
		12:00-14:00	64.33002	1482.30664	.965	-2881.4429	3010.1030
		16:00-18:00	268.60367	1482.30664	.857	-2677.1693	3214.3766
		18:00-20:00	-1785.29461	1482.30664	.232	-4731.0676	1160.4784
		20:00-22:00	-685.42320	1482.30664	.645	-3631.1962	2260.3498
	16:00-18:00	6:00-8:00	-1443.05830	1482.30664	.333	-4388.8313	1502.7147
		8:00-10:00	-553.16094	1482.30664	.710	-3498.9339	2392.6120
		10:00-12:00	-46.36779	1482.30664	.975	-2992.1408	2899.4052
		12:00-14:00	-204.27365	1482.30664	.891	-3150.0466	2741.4993
		14:00-16:00	-268.60367	1482.30664	.857	-3214.3766	2677.1693
		18:00-20:00	-2053.89829	1482.30664	.169	-4999.6713	891.8747
		20:00-22:00	-954.02687	1482.30664	.522	-3899.7998	1991.7461
	18:00-20:00	6:00-8:00	610.83999	1482.30664	.681	-2334.9330	3556.6130
		8:00-10:00	1500.73735	1482.30664	.314	-1445.0356	4446.5103
		10:00-12:00	2007.53050	1482.30664	.179	-938.2425	4953.3035
		12:00-14:00	1849.62463	1482.30664	.215	-1096.1483	4795.3976
		14:00-16:00	1785.29461	1482.30664	.232	-1160.4784	4731.0676
		16:00-18:00	2053.89829	1482.30664	.169	-891.8747	4999.6713
		20:00-22:00	1099.87142	1482.30664	.460	-1845.9016	4045.6444
	20:00-22:00	6:00-8:00	-489.03143	1482.30664	.742	-3434.8044	2456.7415
		8:00-10:00	400.86593	1482.30664	.787	-2544.9070	3346.6389
		10:00-12:00	907.65908	1482.30664	.542	-2038.1139	3853.4321
		12:00-14:00	749.75322	1482.30664	.614	-2196.0198	3695.5262
		14:00-16:00	685.42320	1482.30664	.645	-2260.3498	3631.1962
		16:00-18:00	954.02687	1482.30664	.522	-1991.7461	3899.7998
		18:00-20:00	-1099.87142	1482.30664	.460	-4045.6444	1845.9016
Ethylbenzene.Dry	6:00-8:00	8:00-10:00	13.92462	137.88945	.920	-260.1017	287.9509
		10:00-12:00	57.22434	137.88945	.679	-216.8020	331.2506
		12:00-14:00	61.99968	137.88945	.654	-212.0266	336.0260
		14:00-16:00	97.42119	137.88945	.482	-176.6051	371.4475
		16:00-18:00	114.39817	137.88945	.409	-159.6281	388.4245
		18:00-20:00	-190.85699	137.88945	.170	-464.8833	83.1693
		20:00-22:00	-37.92568	137.88945	.784	-311.9520	236.1006
	8:00-10:00	6:00-8:00	-13.92462	137.88945	.920	-287.9509	260.1017
		10:00-12:00	43.29972	137.88945	.754	-230.7266	317.3260
		12:00-14:00	48.07506	137.88945	.728	-225.9512	322.1014
		14:00-16:00	83.49657	137.88945	.546	-190.5297	357.5229
		16:00-18:00	100.47356	137.88945	.468	-173.5528	374.4999
		18:00-20:00	-204.78160	137.88945	.141	-478.8079	69.2447
		20:00-22:00	-51.85029	137.88945	.708	-325.8766	222.1760
	10:00-12:00	6:00-8:00	-57.22434	137.88945	.679	-331.2506	216.8020
		8:00-10:00	-43.29972	137.88945	.754	-317.3260	230.7266
		12:00-14:00	4.77534	137.88945	.972	-269.2510	278.8016
		14:00-16:00	40.19685	137.88945	.771	-233.8295	314.2232
		16:00-18:00	57.17383	137.88945	.679	-216.8525	331.2001
		18:00-20:00	-248.08132	137.88945	.075	-522.1076	25.9450
		20:00-22:00	-95.15001	137.88945	.492	-369.1763	178.8763

	12:00-14:00	6:00-8:00	-61.99968	137.88945	.654	-336.0260	212.0266
		8:00-10:00	-48.07506	137.88945	.728	-322.1014	225.9512
		10:00-12:00	-4.77534	137.88945	.972	-278.8016	269.2510
		14:00-16:00	35.42151	137.88945	.798	-238.6048	309.4478
		16:00-18:00	52.39849	137.88945	.705	-221.6278	326.4248
		18:00-20:00	-252.85667	137.88945	.070	-526.8830	21.1696
		20:00-22:00	-99.92535	137.88945	.471	-373.9517	174.1010
	14:00-16:00	6:00-8:00	-97.42119	137.88945	.482	-371.4475	176.6051
		8:00-10:00	-83.49657	137.88945	.546	-357.5229	190.5297
		10:00-12:00	-40.19685	137.88945	.771	-314.2232	233.8295
		12:00-14:00	-35.42151	137.88945	.798	-309.4478	238.6048
		16:00-18:00	16.97698	137.88945	.902	-257.0493	291.0033
		18:00-20:00	-288.27817*	137.88945	.039	-562.3045	-14.2519
		20:00-22:00	-135.34686	137.88945	.329	-409.3732	138.6794
	16:00-18:00	6:00-8:00	-114.39817	137.88945	.409	-388.4245	159.6281
		8:00-10:00	-100.47356	137.88945	.468	-374.4999	173.5528
		10:00-12:00	-57.17383	137.88945	.679	-331.2001	216.8525
		12:00-14:00	-52.39849	137.88945	.705	-326.4248	221.6278
		14:00-16:00	-16.97698	137.88945	.902	-291.0033	257.0493
		18:00-20:00	-305.25516*	137.88945	.029	-579.2815	-31.2289
		20:00-22:00	-152.32385	137.88945	.272	-426.3502	121.7025
	18:00-20:00	6:00-8:00	190.85699	137.88945	.170	-83.1693	464.8833
		8:00-10:00	204.78160	137.88945	.141	-69.2447	478.8079
		10:00-12:00	248.08132	137.88945	.075	-25.9450	522.1076
		12:00-14:00	252.85667	137.88945	.070	-21.1696	526.8830
		14:00-16:00	288.27817*	137.88945	.039	14.2519	562.3045
		16:00-18:00	305.25516*	137.88945	.029	31.2289	579.2815
		20:00-22:00	152.93131	137.88945	.270	-121.0950	426.9576
	20:00-22:00	6:00-8:00	37.92568	137.88945	.784	-236.1006	311.9520
		8:00-10:00	51.85029	137.88945	.708	-222.1760	325.8766
		10:00-12:00	95.15001	137.88945	.492	-178.8763	369.1763
		12:00-14:00	99.92535	137.88945	.471	-174.1010	373.9517
		14:00-16:00	135.34686	137.88945	.329	-138.6794	409.3732
		16:00-18:00	152.32385	137.88945	.272	-121.7025	426.3502
		18:00-20:00	-152.93131	137.88945	.270	-426.9576	121.0950
Xylenes.Dry	6:00-8:00	8:00-10:00	225.57446	501.09111	.654	-770.2388	1221.3877
		10:00-12:00	351.51956	501.09111	.485	-644.2937	1347.3328
		12:00-14:00	397.32809	501.09111	.430	-598.4852	1393.1414
		14:00-16:00	411.26018	501.09111	.414	-584.5531	1407.0735
		16:00-18:00	530.62960	501.09111	.293	-465.1837	1526.4429
		18:00-20:00	-165.12891	501.09111	.743	-1160.9422	830.6844
		20:00-22:00	135.83594	501.09111	.787	-859.9773	1131.6492
	8:00-10:00	6:00-8:00	-225.57446	501.09111	.654	-1221.3877	770.2388
		10:00-12:00	125.94511	501.09111	.802	-869.8682	1121.7584
		12:00-14:00	171.75363	501.09111	.733	-824.0596	1167.5669
		14:00-16:00	185.68573	501.09111	.712	-810.1276	1181.4990
		16:00-18:00	305.05514	501.09111	.544	-690.7581	1300.8684
		18:00-20:00	-390.70337	501.09111	.438	-1386.5166	605.1099
		20:00-22:00	-89.73851	501.09111	.858	-1085.5518	906.0748
	10:00-12:00	6:00-8:00	-351.51956	501.09111	.485	-1347.3328	644.2937
		8:00-10:00	-125.94511	501.09111	.802	-1121.7584	869.8682
		12:00-14:00	45.80852	501.09111	.927	-950.0048	1041.6218
		14:00-16:00	59.74062	501.09111	.905	-936.0727	1055.5539
		16:00-18:00	179.11003	501.09111	.722	-816.7032	1174.9233
		18:00-20:00	-516.64847	501.09111	.305	-1512.4618	479.1648
		20:00-22:00	-215.68362	501.09111	.668	-1211.4969	780.1297

	12:00-14:00	6:00-8:00	-397.32809	501.09111	.430	-1393.1414	598.4852
		8:00-10:00	-171.75363	501.09111	.733	-1167.5669	824.0596
		10:00-12:00	-45.80852	501.09111	.927	-1041.6218	950.0048
		14:00-16:00	13.93209	501.09111	.978	-981.8812	1009.7454
		16:00-18:00	133.30151	501.09111	.791	-862.5118	1129.1148
		18:00-20:00	-562.45700	501.09111	.265	-1558.2703	433.3563
		20:00-22:00	-261.49214	501.09111	.603	-1257.3054	734.3211
	14:00-16:00	6:00-8:00	-411.26018	501.09111	.414	-1407.0735	584.5531
		8:00-10:00	-185.68573	501.09111	.712	-1181.4990	810.1276
		10:00-12:00	-59.74062	501.09111	.905	-1055.5539	936.0727
		12:00-14:00	-13.93209	501.09111	.978	-1009.7454	981.8812
		16:00-18:00	119.36942	501.09111	.812	-876.4439	1115.1827
		18:00-20:00	-576.38909	501.09111	.253	-1572.2024	419.4242
		20:00-22:00	-275.42424	501.09111	.584	-1271.2375	720.3890
	16:00-18:00	6:00-8:00	-530.62960	501.09111	.293	-1526.4429	465.1837
		8:00-10:00	-305.05514	501.09111	.544	-1300.8684	690.7581
		10:00-12:00	-179.11003	501.09111	.722	-1174.9233	816.7032
		12:00-14:00	-133.30151	501.09111	.791	-1129.1148	862.5118
		14:00-16:00	-119.36942	501.09111	.812	-1115.1827	876.4439
		18:00-20:00	-695.75851	501.09111	.168	-1691.5718	300.0548
		20:00-22:00	-394.79365	501.09111	.433	-1390.6069	601.0196
	18:00-20:00	6:00-8:00	165.12891	501.09111	.743	-830.6844	1160.9422
		8:00-10:00	390.70337	501.09111	.438	-605.1099	1386.5166
		10:00-12:00	516.64847	501.09111	.305	-479.1648	1512.4618
		12:00-14:00	562.45700	501.09111	.265	-433.3563	1558.2703
		14:00-16:00	576.38909	501.09111	.253	-419.4242	1572.2024
		16:00-18:00	695.75851	501.09111	.168	-300.0548	1691.5718
		20:00-22:00	300.96485	501.09111	.550	-694.8484	1296.7781
	20:00-22:00	6:00-8:00	-135.83594	501.09111	.787	-1131.6492	859.9773
		8:00-10:00	89.73851	501.09111	.858	-906.0748	1085.5518
		10:00-12:00	215.68362	501.09111	.668	-780.1297	1211.4969
		12:00-14:00	261.49214	501.09111	.603	-734.3211	1257.3054
		14:00-16:00	275.42424	501.09111	.584	-720.3890	1271.2375
		16:00-18:00	394.79365	501.09111	.433	-601.0196	1390.6069
		18:00-20:00	-300.96485	501.09111	.550	-1296.7781	694.8484
tBTEX.Dry	6:00-8:00	8:00-10:00	1717.66497	2643.64257	.518	-3536.0191	6971.3491
		10:00-12:00	2777.92954	2643.64257	.296	-2475.7546	8031.6136
		12:00-14:00	2371.23369	2643.64257	.372	-2882.4504	7624.9178
		14:00-16:00	2341.87038	2643.64257	.378	-2911.8137	7595.5545
		16:00-18:00	2950.90362	2643.64257	.267	-2302.7805	8204.5877
		18:00-20:00	-1274.25036	2643.64257	.631	-6527.9345	3979.4337
		20:00-22:00	423.81498	2643.64257	.873	-4829.8691	5677.4991
	8:00-10:00	6:00-8:00	-1717.66497	2643.64257	.518	-6971.3491	3536.0191
		10:00-12:00	1060.26457	2643.64257	.689	-4193.4195	6313.9487
		12:00-14:00	653.56873	2643.64257	.805	-4600.1154	5907.2528
		14:00-16:00	624.20541	2643.64257	.814	-4629.4787	5877.8895
		16:00-18:00	1233.23865	2643.64257	.642	-4020.4454	6486.9227
		18:00-20:00	-2991.91533	2643.64257	.261	-8245.5994	2261.7688
		20:00-22:00	-1293.84999	2643.64257	.626	-6547.5341	3959.8341
	10:00-12:00	6:00-8:00	-2777.92954	2643.64257	.296	-8031.6136	2475.7546
		8:00-10:00	-1060.26457	2643.64257	.689	-6313.9487	4193.4195
		12:00-14:00	-406.69584	2643.64257	.878	-5660.3799	4846.9882
		14:00-16:00	-436.05916	2643.64257	.869	-5689.7432	4817.6249
		16:00-18:00	172.97408	2643.64257	.948	-5080.7100	5426.6582
		18:00-20:00	-4052.17990	2643.64257	.129	-9305.8640	1201.5042
		20:00-22:00	-2354.11456	2643.64257	.376	-7607.7987	2899.5695

	12:00-14:00	6:00-8:00	-2371.23369	2643.64257	.372	-7624.9178	2882.4504
		8:00-10:00	-653.56873	2643.64257	.805	-5907.2528	4600.1154
		10:00-12:00	406.69584	2643.64257	.878	-4846.9882	5660.3799
		14:00-16:00	-29.36331	2643.64257	.991	-5283.0474	5224.3208
		16:00-18:00	579.66992	2643.64257	.827	-4674.0142	5833.3540
		18:00-20:00	-3645.48405	2643.64257	.171	-8899.1681	1608.2000
		20:00-22:00	-1947.41871	2643.64257	.463	-7201.1028	3306.2654
	14:00-16:00	6:00-8:00	-2341.87038	2643.64257	.378	-7595.5545	2911.8137
		8:00-10:00	-624.20541	2643.64257	.814	-5877.8895	4629.4787
		10:00-12:00	436.05916	2643.64257	.869	-4817.6249	5689.7432
		12:00-14:00	29.36331	2643.64257	.991	-5224.3208	5283.0474
		16:00-18:00	609.03324	2643.64257	.818	-4644.6509	5862.7173
		18:00-20:00	-3616.12074	2643.64257	.175	-8869.8048	1637.5634
		20:00-22:00	-1918.05540	2643.64257	.470	-7171.7395	3335.6287
	16:00-18:00	6:00-8:00	-2950.90362	2643.64257	.267	-8204.5877	2302.7805
		8:00-10:00	-1233.23865	2643.64257	.642	-6486.9227	4020.4454
		10:00-12:00	-172.97408	2643.64257	.948	-5426.6582	5080.7100
		12:00-14:00	-579.66992	2643.64257	.827	-5833.3540	4674.0142
		14:00-16:00	-609.03324	2643.64257	.818	-5862.7173	4644.6509
		18:00-20:00	-4225.15398	2643.64257	.114	-9478.8381	1028.5301
		20:00-22:00	-2527.08864	2643.64257	.342	-7780.7727	2726.5955
	18:00-20:00	6:00-8:00	1274.25036	2643.64257	.631	-3979.4337	6527.9345
		8:00-10:00	2991.91533	2643.64257	.261	-2261.7688	8245.5994
		10:00-12:00	4052.17990	2643.64257	.129	-1201.5042	9305.8640
		12:00-14:00	3645.48405	2643.64257	.171	-1608.2000	8899.1681
		14:00-16:00	3616.12074	2643.64257	.175	-1637.5634	8869.8048
		16:00-18:00	4225.15398	2643.64257	.114	-1028.5301	9478.8381
		20:00-22:00	1698.06534	2643.64257	.522	-3555.6188	6951.7494
	20:00-22:00	6:00-8:00	-423.81498	2643.64257	.873	-5677.4991	4829.8691
		8:00-10:00	1293.84999	2643.64257	.626	-3959.8341	6547.5341
		10:00-12:00	2354.11456	2643.64257	.376	-2899.5695	7607.7987
		12:00-14:00	1947.41871	2643.64257	.463	-3306.2654	7201.1028
		14:00-16:00	1918.05540	2643.64257	.470	-3335.6287	7171.7395
		16:00-18:00	2527.08864	2643.64257	.342	-2726.5955	7780.7727
		18:00-20:00	-1698.06534	2643.64257	.522	-6951.7494	3555.6188

*. The mean difference is significant at the 0.05 level.

Table D.10 One way ANOVA of BTEX concentrations in Part II among sampling points

Multiple Comparisons

LSD

Dependent Variable	(I) Position	(J) Position	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Benzene.Wet	Front	Center	-622.06245*	93.55330	.000	-807.8408	-436.2841
		Back	49.22541	93.55330	.600	-136.5529	235.0037
	Center	Front	622.06245*	93.55330	.000	436.2841	807.8408
		Back	671.28786*	93.55330	.000	485.5095	857.0662
	Back	Front	-49.22541	93.55330	.600	-235.0037	136.5529
		Center	-671.28786*	93.55330	.000	-857.0662	-485.5095
Toluene.Wet	Front	Center	-3153.68530*	206.69323	.000	-3564.1371	-2743.2335
		Back	172.38342	206.69323	.406	-238.0684	582.8352
	Center	Front	3153.68530*	206.69323	.000	2743.2335	3564.1371
		Back	3326.06871*	206.69323	.000	2915.6169	3736.5205
	Back	Front	-172.38342	206.69323	.406	-582.8352	238.0684
		Center	-3326.06871*	206.69323	.000	-3736.5205	-2915.6169

Ethylbenzen.Wet	Front	Center	-255.60394*	26.03453	.000	-307.3034	-203.9045
		Back	4.52355	26.03453	.862	-47.1759	56.2230
	Center	Front	255.60394*	26.03453	.000	203.9045	307.3034
		Back	260.12749*	26.03453	.000	208.4281	311.8269
	Back	Front	-4.52355	26.03453	.862	-56.2230	47.1759
		Center	-260.12749*	26.03453	.000	-311.8269	-208.4281
Xylenes.Wet	Front	Center	-1170.73626*	83.31299	.000	-1336.1793	-1005.2932
		Back	44.22131	83.31299	.597	-121.2218	209.6644
	Center	Front	1170.73626*	83.31299	.000	1005.2932	1336.1793
		Back	1214.95756*	83.31299	.000	1049.5145	1380.4007
	Back	Front	-44.22131	83.31299	.597	-209.6644	121.2218
		Center	-1214.95756*	83.31299	.000	-1380.4007	-1049.5145
tBTEX.Wet	Front	Center	-5202.08794*	364.49449	.000	-5925.9018	-4478.2741
		Back	270.35369	364.49449	.460	-453.4601	994.1675
	Center	Front	5202.08794*	364.49449	.000	4478.2741	5925.9018
		Back	5472.44163*	364.49449	.000	4748.6278	6196.2554
	Back	Front	-270.35369	364.49449	.460	-994.1675	453.4601
		Center	-5472.44163*	364.49449	.000	-6196.2554	-4748.6278
Benenzene.Dry	Front	Center	-1767.17502*	334.12150	.000	-2430.6741	-1103.6759
		Back	123.27894	334.12150	.713	-540.2201	786.7780
	Center	Front	1767.17502*	334.12150	.000	1103.6759	2430.6741
		Back	1890.45395*	334.12150	.000	1226.9549	2553.9530
	Back	Front	-123.27894	334.12150	.713	-786.7780	540.2201
		Center	-1890.45395*	334.12150	.000	-2553.9530	-1226.9549
Toluene.Dry	Front	Center	-5295.51670*	631.54933	.000	-6549.6485	-4041.3849
		Back	123.17513	631.54933	.846	-1130.9567	1377.3069
	Center	Front	5295.51670*	631.54933	.000	4041.3849	6549.6485
		Back	5418.69184*	631.54933	.000	4164.5600	6672.8236
	Back	Front	-123.17513	631.54933	.846	-1377.3069	1130.9567
		Center	-5418.69184*	631.54933	.000	-6672.8236	-4164.5600
Ethylbenzene.Dry	Front	Center	-529.17877*	56.42891	.000	-641.2354	-417.1221
		Back	10.41080	56.42891	.854	-101.6458	122.4674
	Center	Front	529.17877*	56.42891	.000	417.1221	641.2354
		Back	539.58958*	56.42891	.000	427.5329	651.6462
	Back	Front	-10.41080	56.42891	.854	-122.4674	101.6458
		Center	-539.58958*	56.42891	.000	-651.6462	-427.5329
Xylenes.Dry	Front	Center	-1926.27849*	192.27180	.000	-2308.0922	-1544.4648
		Back	70.72196	192.27180	.714	-311.0917	452.5356
	Center	Front	1926.27849*	192.27180	.000	1544.4648	2308.0922
		Back	1997.00045*	192.27180	.000	1615.1868	2378.8141
	Back	Front	-70.72196	192.27180	.714	-452.5356	311.0917
		Center	-1997.00045*	192.27180	.000	-2378.8141	-1615.1868
tBTEX.Dry	Front	Center	-9518.14898*	1125.27996	.000	-11752.7320	-7283.5660
		Back	327.58684	1125.27996	.772	-1906.9961	2562.1698
	Center	Front	9518.14898*	1125.27996	.000	7283.5660	11752.7320
		Back	9845.73581*	1125.27996	.000	7611.1528	12080.3188
	Back	Front	-327.58684	1125.27996	.772	-2562.1698	1906.9961
		Center	-9845.73581*	1125.27996	.000	-12080.3188	-7611.1528

*. The mean difference is significant at the 0.05 level.

D.4 Correlations between BTEX concentrations and meteorological variables

Table D.11 Correlations between BTEX concentrations at BKK station and meteorological variables (Part I) at roadside

		Benzene.Front	Toluene.Front	Ethylbenzene.Front	Xylenes.Front	tBTEX.Front
WindSpeed.Front	Pearson Correlation	.064	-.141	.193	.060	-.076
	Sig. (2-tailed)	.852	.679	.570	.860	.825
	N	11	11	11	11	11
Temperature.Front	Pearson Correlation	-.111	-.628*	-.388	-.190	-.571
	Sig. (2-tailed)	.745	.038	.239	.576	.067
	N	11	11	11	11	11
RelativeHumidity.Front	Pearson Correlation	-.265	.136	-.298	-.101	.012
	Sig. (2-tailed)	.431	.689	.373	.768	.971
	N	11	11	11	11	11
SolarRadiation.Front	Pearson Correlation	.412	-.449	-.008	-.286	-.257
	Sig. (2-tailed)	.236	.193	.982	.423	.473
	N	10	10	10	10	10
Pressure.Front	Pearson Correlation	-.160	-.006	-.246	-.112	-.071
	Sig. (2-tailed)	.639	.985	.467	.744	.835
	N	11	11	11	11	11

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table D.12 Correlations between BTEX concentrations at BKK station and meteorological variables (Part I) at filling nozzle

		Benzene.Center	Toluene.Center	Ethylbenzene.Center	Xylenes.Center	tBTEX.Center
WindSpeed.Center	Pearson Correlation	.253	.182	.070	.034	.190
	Sig. (2-tailed)	.454	.592	.837	.921	.575
	N	11	11	11	11	11
Temperature.Center	Pearson Correlation	-.077	-.291	-.259	-.306	-.253
	Sig. (2-tailed)	.823	.386	.442	.360	.454
	N	11	11	11	11	11
RelativeHumidity.Center	Pearson Correlation	-.208	-.123	-.119	.066	-.133
	Sig. (2-tailed)	.540	.719	.727	.847	.697
	N	11	11	11	11	11
SolarRadiation.Center	Pearson Correlation	-.132	-.332	-.363	-.532	-.314
	Sig. (2-tailed)	.716	.348	.302	.113	.378
	N	10	10	10	10	10
Pressure.Center	Pearson Correlation	-.306	-.277	-.141	-.121	-.277
	Sig. (2-tailed)	.360	.410	.679	.722	.409
	N	11	11	11	11	11

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table D.13 Correlations between BTEX concentrations at BKK station and meteorological variables (Part I) at back of station

		Benzene.Back	Toluene.Back	Ethylbenzene.Back	Xylenes.Back	tBTEX.Back
WindSpeed.Back	Pearson Correlation	.577	-.207	.133	-.262	-.013
	Sig. (2-tailed)	.063	.542	.697	.436	.969
	N	11	11	11	11	11
Temperature.Back	Pearson Correlation	.039	-.626*	-.334	-.055	-.506
	Sig. (2-tailed)	.910	.039	.316	.872	.112
	N	11	11	11	11	11
RelativeHumidity.Back	Pearson Correlation	-.103	.080	-.267	-.018	-.002
	Sig. (2-tailed)	.763	.815	.428	.957	.996
	N	11	11	11	11	11
SolarRadiation.Back	Pearson Correlation	-.054	-.374	-.161	-.599	-.462
	Sig. (2-tailed)	.883	.286	.656	.067	.179
	N	10	10	10	10	10
Pressure.Back	Pearson Correlation	-.273	.168	-.209	-.285	-.024
	Sig. (2-tailed)	.417	.621	.538	.395	.944
	N	11	11	11	11	11

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table D.14 Correlations between BTEX concentrations at NBI station in both 2 seasons and meteorological variables (Part I+II) at roadside

		WindSpeed	Temperature	RelativeHumidity	SolarRadiation	Pressure
Benzene.Front	Pearson Correlation	-.232*	-.201	.159	-.101	-.084
	Sig. (2-tailed)	.044	.082	.170	.437	.473
	N	76	76	76	61	76
Toluene.Front	Pearson Correlation	-.095	-.041	.161	-.269*	-.240*
	Sig. (2-tailed)	.414	.724	.165	.036	.037
	N	76	76	76	61	76
Ethylbenzene.Front	Pearson Correlation	-.107	.186	-.179	-.038	-.183
	Sig. (2-tailed)	.359	.107	.121	.773	.114
	N	76	76	76	61	76
Xylenes.Front	Pearson Correlation	-.144	.132	-.001	-.129	-.235*
	Sig. (2-tailed)	.215	.254	.995	.320	.041
	N	76	76	76	61	76
tBTEX.Front	Pearson Correlation	-.254*	-.135	.173	-.214	-.217
	Sig. (2-tailed)	.027	.243	.136	.098	.060
	N	76	76	76	61	76

Table D.15 Correlations between BTEX concentrations at NBI station in both 2 seasons and meteorological variables (Part I+II) at filling nozzle

		WindSpeed	Temperature	RelativeHumidity	SolarRadiation	Pressure
Benzene.Center	Pearson Correlation	-.303**	-.157	.124	.010	-.062
	Sig. (2-tailed)	.008	.174	.284	.937	.596
	N	76	76	76	61	76
Toluene.Center	Pearson Correlation	-.296**	.062	-.019	-.132	-.169
	Sig. (2-tailed)	.009	.593	.869	.312	.144
	N	76	76	76	61	76
Ethylbenzene.Center	Pearson Correlation	-.353**	-.060	.060	-.115	-.177
	Sig. (2-tailed)	.002	.606	.606	.377	.126
	N	76	76	76	61	76
Xylenes.Center	Pearson Correlation	-.357**	.034	.009	-.113	-.175
	Sig. (2-tailed)	.002	.769	.938	.387	.132
	N	76	76	76	61	76
tBTEX.Center	Pearson Correlation	-.327**	-.007	.029	-.103	-.149
	Sig. (2-tailed)	.004	.955	.806	.428	.198
	N	76	76	76	61	76

Table D.16 Correlations between BTEX concentrations at NBI station in both 2 seasons and meteorological variables (Part I+II) at back of station

		WindSpeed	Temperature	RelativeHumidity	SolarRadiation	Pressure
Benzene.Back	Pearson Correlation	-.352**	-.288*	.230*	-.146	-.109
	Sig. (2-tailed)	.002	.012	.047	.266	.351
	N	75	75	75	60	75
Toluene.Back	Pearson Correlation	-.220	-.040	.143	-.199	-.164
	Sig. (2-tailed)	.058	.732	.222	.127	.160
	N	75	75	75	60	75
Ethylbenzene.Back	Pearson Correlation	-.203	.063	-.045	-.085	-.214
	Sig. (2-tailed)	.081	.591	.702	.517	.065
	N	75	75	75	60	75
Xylenes.Back	Pearson Correlation	-.193	-.017	.028	-.206	-.218
	Sig. (2-tailed)	.098	.882	.809	.114	.060
	N	75	75	75	60	75
tBTEX.Back	Pearson Correlation	-.390**	-.216	.221	-.224	-.199
	Sig. (2-tailed)	.001	.062	.056	.085	.087
	N	75	75	75	60	75

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table D.17 Multiple regression analysis between benzene concentrations at NBI station nearby filling nozzle and affecting factors

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.348[a]	.121	.103	1658.00225	.121	6.758	1	49	.012
2	.467[b]	.218	.185	1580.18032	.097	5.945	1	48	.019
3	.575[c]	.331	.288	1477.48344	.113	7.905	1	47	.007

a. Predictors: (Constant), WindSpeed

b. Predictors: (Constant), WindSpeed, SolarRadiation

c. Predictors: (Constant), WindSpeed, SolarRadiation, RelativeHumidity

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3634.643	744.709		4.881	.000
	WindSpeed	-3095.233	1190.689	-.348	-2.600	.012
2	(Constant)	3676.208	709.959		5.178	.000
	WindSpeed	-4196.348	1221.356	-.472	-3.436	.001
	SolarRadiation	12.041	4.938	.335	2.438	.019
3	(Constant)	-2163.035	2180.401		-.992	.326
	WindSpeed	-4536.905	1148.385	-.510	-3.951	.000
	SolarRadiation	21.196	5.650	.590	3.751	.000
	RelativeHumidity	70.764	25.169	.414	2.812	.007

a. Dependent Variable: Benzene.Center

Table D.18 Multiple regression analysis between ethylbenzene concentrations at NBI station nearby filling nozzle and affecting factors

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.435[a]	.189	.172	287.01674	.189	11.421	1	49	.001
2	.505[b]	.255	.224	277.88223	.066	4.274	1	48	.044
3	.586[c]	.343	.301	263.74030	.088	6.286	1	47	.016

a. Predictors: (Constant), WindSpeed

b. Predictors: (Constant), WindSpeed, SolarRadiation

c. Predictors: (Constant), WindSpeed, SolarRadiation, CustomersCars

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	880.434	128.917		6.829	.000
	WindSpeed	-696.569	206.120	-.435	-3.379	.001
2	(Constant)	886.632	124.850		7.102	.000
	WindSpeed	-860.756	214.781	-.537	-4.008	.000
	SolarRadiation	1.795	.868	.277	2.067	.044
3	(Constant)	234.356	285.885		.820	.416
	WindSpeed	-820.347	204.487	-.512	-4.012	.000
	SolarRadiation	2.282	.847	.352	2.695	.010
	CustomersCars	4.294	1.713	.309	2.507	.016

a. Dependent Variable: Ethylbenzene.Center

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