CHAPTER III

METHODOLOGY

3.1 Material and methods

3.1.1 Study area

The sampling sites were located in Bangkok, Thailand. The first sampling site is at Chulalongkorn Hospital (represented as commercial site: CH), which closes to Silom, the central business area of Bangkok, and is opposite to Lumpini Park, the oldest city park in the country. Because of its location, this area can be classified as commercial area with highly traffic. The second site is at Huay-Khwang Community Housing (represented as residential site: HCH), which is located in the central area of Bangkok, surrounded by houses and apartments. The third site is at Ministry of Science and Technology (represented as a heavily traffic area: MST). The areas around site are many government offices, a huge hospital, and a university's campus. This area is crowded especially in the working day. It has the elevated expressway and high buildings covering along the Rama VI road, which is the main road, and the last sampling sites is Ratburana Post Office (represented as industrial site: RPO) which is on the south of Bangkok, and closes to industrial area of Samutprakarn province and the Gulf of Thailand. All sites were chosen to contrast the content of metallic elements in the atmosphere and the sampling period is conducted from March 2006 to March 2007. The period of season in the study is determined by using the Thai Meteorological Department guideline. From the meteorological point of view the climate of Thailand may be divided into three seasons as follows: **Rainy** or southwest monsoon season is stated on mid-May to mid-October. The southwest monsoon prevails over Thailand and abundant rain occurs over the country. The wettest period of the year is August to September. The exception is found in the Southern Thailand East Coast where abundant rain remains until the end of the year that is the beginning period of the northeast monsoon and November is the wettest month. **Winter** or northeast monsoon season is started from mid-October to mid-February. This is the mild period of the year with quite cold in December and January in upper Thailand but there is a great amount of rainfall in Southern Thailand East Coast, especially during October to November. **Summer** or pre-monsoon season is started from mid-February to mid-May. This is the transitional period from the northeast to southwest monsoons. The weather becomes warmer, especially in upper Thailand. April is the hottest month (Thai Meteorological Department, 2008). The characterization of the air quality monitoring of four sampling sites are also shown in Table 3.1. The picture of the air quality monitoring of four sampling sites are shown in Figure 3.1.

Table 3.1 Characteristics of sample sites

No	Land use	Location	Characteristics
1	Commercial site	Chulalongkorn Hospital (CH)	This sampling site is close to the central business area of Bangkok, and is opposite to the oldest city park in the country. Because of its location, this area can be classified as commercial area with highly traffic.
2	Residential site	Huay-Khwang Community Housing (HCH)	This sampling site can be classified as residential area surrounded by playgrounds, streets, houses, condominium, residential multi-storied flats of government housing project, markets, shops, schools, and street vendors. The air quality is mainly influenced by vehicular traffic, open burning of leaves and garbage, and domestic activities
3	Traffic area	Ministry of Science and Technology (MST)	The areas around site are many government offices, a huge hospital, and a university's campus. This area is crowded especially in the working day. It has the elevated expressway and high buildings covering along the Rama VI road, which is the main road.
4	Industrial site	Ratburana Post Office (RPO)	This site is located close to main roads which have heavy vehicular traffic. It surrounds by shops, schools, and residential houses. Besides, It has many domestic activities and difference kinds of factories from small scale to large industries, for example, plastic industry, glass industry, metal and melting industry, electroplating industry, dyeing industry and others.

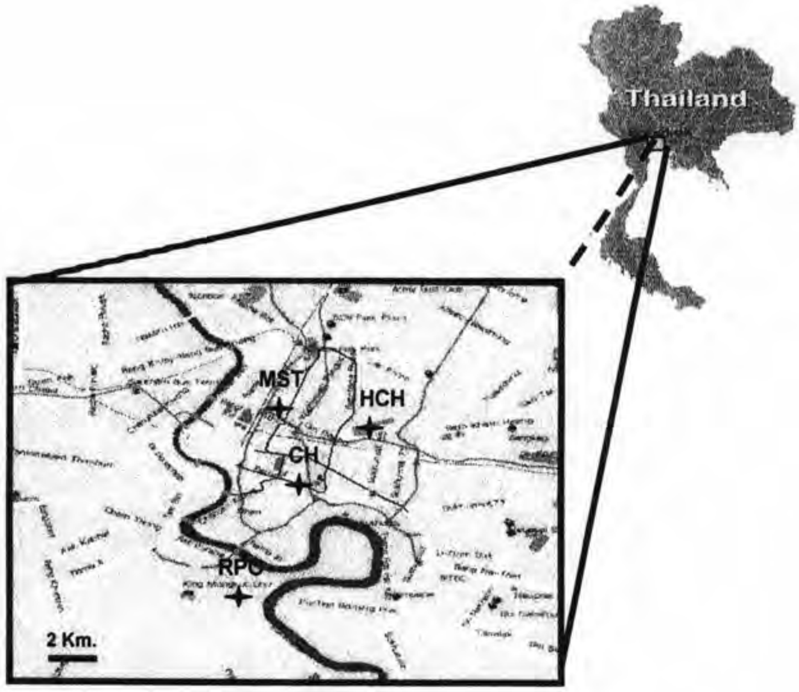

Figure 3.1 The location of the sampling sites in Bangkok.

3.1.2 Sample collection and analysis

The samples were collected from March 2006 to March 2007. The sampling duration was 24 hours sampling and the air particulate samples would be taken two to four times a month. The date of sampling included weekday and weekend. The detail of sampling date is shown at the appendix in this book. High volume samplers as shown in Figure 3.2 were used to collect TSP at monitoring sites. The sampling substrate used was 8" × 10" size glass fiber filter. Filters were weighed to a constant weight after conditioning over self-indicating silica gel for 24 hours before and after exposure to determine the weight of the sampled particles. The filter storage chamber is illustrated in Figure 3.3. The gravimetric method was used to determine the particulate mass. All sampling procedure is followed by the Pollution Control Department (PCD) guideline. It was assumed in this study that the TSP deposited on the filter papers were uniformly distributed over the entire area. A known portion of the exposed filter paper sample was taken and digested in 30 ml of 65% pure nitric acid at 150–200 °C for 2 hours, and then diluted to 50 ml with distilled-deionized water (Fang, 2004). Metals were analyzed for quantification using HORIBA Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES) model type

ULTIMA2C as shown in Figure 3.4 for eleven metallic elements namely: Al, Cd, Cr, Cu, Fe, K, Mn, Na, Ni, Pb and Zn. Meteorological parameters like wind speed, relative humidity, temperature and atmospheric pressure at the same time of sample collecting at all sites were also recorded for correlation analysis. Twenty-four hours consecutive samplings for ambient particles were performed two to four times per month from March 2006 to March 2007 at all sampling sites simultaneously. The JEOL Scanning Electron Microscope (SEM) model type JSM 6480LV as shown in Figure 3.5 was used to illustrate the shape and characteristics of air particles attached on the filter.

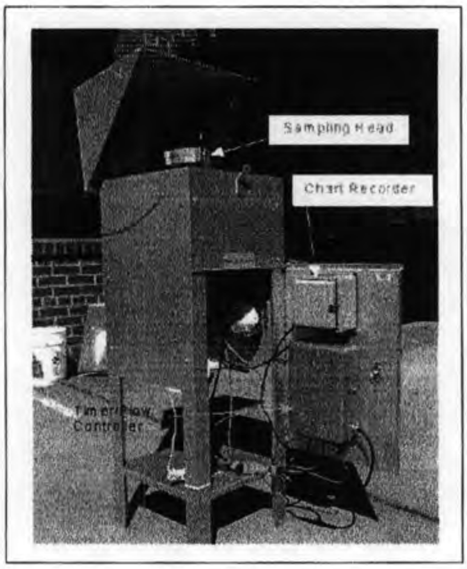

Figure 3.2 Total Suspended Particulate (TSP) Air Sampler.

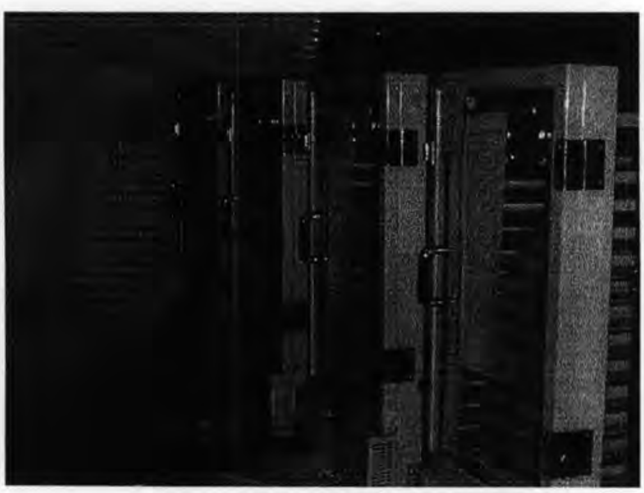

Figure 3.3 Filter Desicator

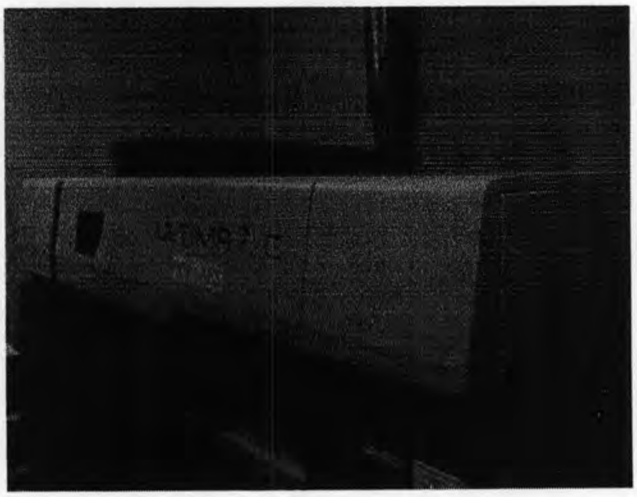

Figure 3.4 Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES) HORIBA model type ULTIMA2C

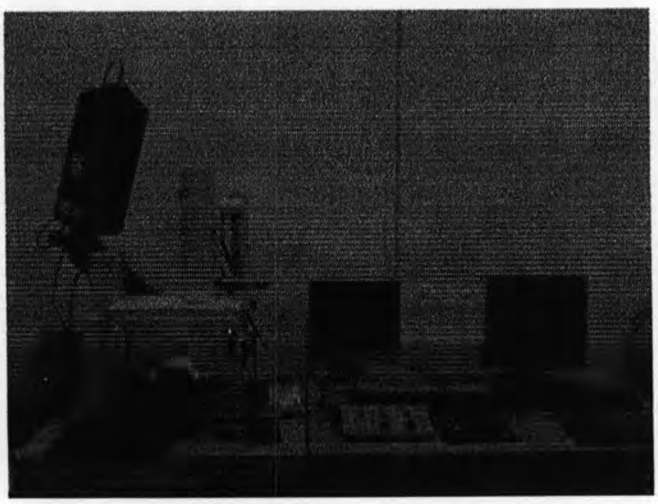

Figure 3.5 Scanning Electron Microscopy (SEM) JEOL model type 6480LV

3.2 Statistical analysis

3.2.1 Pearson correlation

Pearson correlation was used to illustrate the relation of two parameters without controlling other parameters. The Pearson correlation coefficient is a measure of linear association between two variables. The values of the correlation coefficient range from -1 to 1. The sign of the correlation coefficient indicates the direction of the relationship (positive or negative). The absolute value of the correlation coefficient indicates the strength, with larger absolute values indicating stronger relationships. The correlation coefficients on the main diagonal are always 1.0, because each variable has a perfect positive linear relationship with itself. The significance level is the probability of obtaining results as extreme as the one observed. If the significant level is very small (less than 0.05) then the correlation is significant and the two variables are linearly related. If the significance level is relatively large (for example, 0.50) the correlation is not significant and the two variables are not linearly related.

3.2.2 Receptor Model

Receptor models have been developed to identify and apportion the contributions of various sources to the airborne particulate matter concentrations. Factor analysis (FA) techniques are multivariate data analysis methods that are used in environmental studies to estimate the number and compositions of the sources as well as their contributions to the samples taken at the receptors. Principal Components Analysis (PCA) is one of the common forms of FA. This method extracts the principal components, explaining the majority of variance of the data matrix that are then qualitatively interpreted as possible sources (Begum, 2004).

3.2.3 Principal component analysis (PCA)

PCA is a multivariate statistical technique commonly used for source apportionment of particulate matter. PCA is basically a statistical technique, which can be applied to a set of variables in order to reduce their dimensionality. That is to replace a large set of intercorrelated variables with a smaller number of independent variables. These new variables, which are called as components are derived from the original variables, and are simply linear combinations of those variables. The PCA assumes that the total concentration of each element is made up of the sum of elemental contributions from each of the specific pollution source components.

The primary objective of applying PCA is to derive a small number of components, which explain a maximum of the variance in the data. Initially, the PCA results in as many principal components (PCs) as there are original variables. Usually, however, only a limited number of these uncorrelated PCs (e.g. five or six) are required to explain virtually all of the variance in a data set of original (intercorrelated) variables. In order for this reduction in the dimensionality to be useful, the new variables (components) must have simple substantive interpretations. For this reason, a limited number of components are usually subjected to rotation using a criterion such as varimax. After PCA rotation, the resulting components have been found to often be more representative of individual underlying sources of variation (Thurston *et al.*, 1985).