CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The results from the study reveal that the average concentrations of TSP at CH, HCH, MST, and RPO are 114.96 $\mu g/m^3$, 110.93 $\mu g/m^3$, 111.11 $\mu g/m^3$ and 144.47 $\mu g/m^3$, respectively. It is found that the average concentration of TSP at site RPO sampling site, which located in industrial area, is the highest while the lowest is found at the residential sampling site, HCH. The highest TSP 24-h ambient concentration is at 361.93 $\mu g/m^3$ for RPO site and this number is the only value found in the all samples which exceeded the Thai ambient air standard of that 330 $\mu g/m^3$. Considering WHO clean air guideline criteria for the 24-h average TSP of that 120 $\mu g/m^3$ and Thai ambient air standard (annual average) of that 100 $\mu g/m^3$, it is found from the present study that it has numbers of samples exceed the WHO guideline and Thai ambient standard in all sites. The finding reveals that the airborne particulate pollution is still serious for health concern issue in the Bangkok atmosphere area.

The elemental quantification shows the results of that, the airborne elements can be divided into two groups: 1. major elements, which are Na, K, Al, Fe and Zn, and 2. minor elements, which are toxic metals like Cd, Cr, Cu, Mn, Ni and Pb. Among the toxic metals Cd and Cr are hardly found in sites. The TSP and elemental compositions found at the RPO site which located in industrial area are quite higher than other sites. Among the toxic elements, Ni and Cu are the highest toxic metal mass contributions found in the study in all sites.

The concentration at all the sites followed a similar pattern for seasonal variations. The metal concentrations are low during rainy season and increase through dry season. This study also found that Ni is mostly found in winter while Al, K and Zn are mostly found in summer. One of the most important sources of K and Zn found in the atmosphere is biomass burning. The explanation of high K and Zn found in summer should be people tend to burn the organic waste and household garbage at the summer period. Al and K can also have their origins from soil factor like soil and road dust. The low moisture contents in the atmosphere and dry environment increase the rate of soil re-suspension by wind. This can explain the high amounts of Al, K and Zn found in summer. Na is mostly found in rainy season. It may be from the monsoon which takes Na from the sea. The difference between seasonal concentrations could be attributed to the element levels. Cu is observed the only element which has similar amount in all different seasons. This might be the contaminant sources are mainly from motor vehicles. Almost of the metal concentration in weekend and weekdays are not different at the sites except Ni. The amount of Ni found in the weekday is higher than the weekend. The previous study showed that Ni in the atmosphere can come from oil combustion, tailpipe emission from diesel engine. At the weekday, the areas of the sites are crowed by the diesel truck for transporting purpose. This might be the reason of that why there is difference in Ni contents between weekdays and weekend at the sites.

An enrichment factor (EF) used in the present to evaluate anomalies of specific chemical species of ambient aerosols, with respect to representative compositions of a reference crustal material. Fe is used as reference material in the study. The finding reveals that the elements can be classified into three groups according to their EF values. The first group is elements with EF values lesser than 10 included Al, Cr, K, and Mn. These elements with their EF values indicate elements of crustal sources. The second group is the elements with intermediately enriched EF (EF values between 10 and 100) included Na, and Ni. This group implies the combination of anthropogenic and natural emission sources. The elements in this group also appear to be enrich even if to a lesser extend. The last group is elements with EF values greater than 100 included Cd, Cu, Pb, and Zn. This group strongly indicates elements of anthropogenic sources.

Pearson's correlation coefficients are used between metals measured in TSP and meteorological parameters in the study to investigate the relationship between metals. Low and medium correlation coefficients are mostly found between meteorological parameters and elements. The correlation analysis demonstrates that most of the metals exhibit a moderate to weak relationship with each other. Besides, these metals tend to be not correlated with the meteorological parameters. Only one meteorological parameter, relative humidity (RH), is found to have a negative correlation with TSP, Fe and Mn.

High correlation coefficients of Al-K are observed at all sites. In addition, high correlation coefficients of Fe-Mn, K-Zn and Al-Zn are noted in three sites. These results indicate that the higher correlation coefficients with metallic elements might come from the same pollutant sources which are waste burning, vehicles and soil dust at the sampling period.

A multivariate receptor model, principle component analysis (PCA) is applied to the data measured. Three components are extracted by factor analysis at the HCH and the CH, while four components are extracted at the RPO and MST. The factor loading indicates the main sources of metal components which are traffic and soil dust in air particulate in all sites.

At the HCH, the results show three possible factors representing three different contributing sources for airborne elements. Factor 1 explains 37.8% of the total variance of the data and has high loading for Al, K and Zn, which can be identified as soil and/or road dust, construction, vehicle, and biomass burning. Factor 2 is relative to vehicular emission, oil combustion and construction with high loading of Cd, Mn, Fe, and Ni. High load of Pb, Cu in the factor 3 represents sources from vehicular emission and incineration.

At the RPO, High loading of Zn, K, Al indicates that the contributing sources in factor 1 of the RPO are similar to the factor 1 of the HCH site. Factor 2 has high loading of Na, Cr, Cd represents the sea salt, vehicular emission and industry. Factor 3 is relative to construction, vehicular emission, and industry with high loading of Mn, Fe, Cu, and Ni. Leaded gasoline has been banned in Thailand since 1996 and therefore lead would not be a good indicator for vehicle emission in Bangkok atmosphere. Thus, high loading of Pb in factor 4 should indicate the industry sources.

At the CH sampling site, the results show three factors. Factor 1 has high loading for Al, K, Zn and Na which can be identified as soil and/or road dust, vehicle emission, construction, biomass burning and sea salt. Factor 2 is relative to vehicular emission, oil combustion and construction with high loading of Fe, Mn, Cr, and Cd. High load of Cu in the factor 3 represents source from vehicular emission.

At the MST site, factor 1. with high loading of Ni, Fe, Mn, Cr and Cd indicates the contributing sources in factor 1 of the MST are similar to the factor 2 of the HCH site. The possible sources of this factor are vehicular emission, oil combustion and construction. Factor 2 of MST has high loadings of K, Zn, Al which are closely similar to factor 1 of HCH site. It can be implied that the factor is influenced by soil or road dust, construction, vehicular emission, and biomass burning. Factor 3 is relative to incineration and sea salt with high loading of Pb (0.804), Na (0.641). Factor 4 with high loading of Cu indicates the vehicular emission sources.

Based on the overall study, it can be concluded that the airborne particles at all sampling sites are strongly impacted by anthropogenic sources especially traffic emissions.

5.2 Recommendation for further study

Because the airborne pollution problem still exists in Bangkok, this study is just one beginning of the steps try to understand more about the spatial and temporal pattern and also characteristics of airborne particulate matter in Bangkok atmosphere. The elemental components in airborne particulate are also identified in this study to investigate the possible sources of airborne particles. However, a number of elemental types are still limited only at 11 elements in the study. There might be other elements and compounds such as organic carbon or polycyclic aromatic hydrocarbons (PAHs) that are dominant components in the airborne particle. Therefore, the further study should be conducted in more details of airborne particulate composition for better understanding in its characteristic and source.

Moreover, the compositions should be conducted in different sizes of particles such as PM10 or PM2.5 for better understanding about airborne particles in Bangkok air. The toxicity of particle pollution and its components should be studied also to clarify the specific toxicity on human health.