Chapter VI

Conclusion and Recommendation

To demonstrate the relationship and occurring of acid aerosol, measurements of acid sulfate were conducted during winter period in January 8-23,1996. In attempt to investigate the quantity of acidic species in acid aerosol; sulfate (SO_4^{2-}), ammonia (NH_3) and acidity (H^+) are of interest due to their toxicity as define by phase of their acidity and their existence in the atmosphere, and to study the relationship of parameters that involved in formation and concentration of sulfate aerosol. These parameters were sulfur dioxide (SO_2), iron (Fe), Manganese (Mn), Vanadium (V), Ozone (O_3), solar radiation and meteorological conditions (wind speed and wind direction). The study areas were in the vicinity of Mae Moh Power Plant located in Lampang province which is known to be the major SO_2 source of Thailand. The selected sampling sites were Ban Tha Si and Ban Sob Pat which the distance difference from the power plant are about 13 and 8 kilometers, respectively. Samples were collected twice per day (09.00-17.00 and 17.00-09.00) which represented daytime and nighttime period while concentrations of SO_2, O_3 and meteorological conditions were provided by Pollution Control Department (PCD) and Electricity Generating Authority of Thailand (EGAT) from continuous measurement apparatus.

The acid aerosols were collected by the annular denuder system (ADS) which designed to eliminate all particles with a DP_{50} of 2.5 μm or greater and to remove ammonia. Teflon membrane filters which a 2 μm pore size were selected to collect the acidic species. The filters were extracted by extracting solution (ES) and were analyzed for each acidic species (SO_4^{2-}, H^+) and NH_3. Sulfate concentrations were quantified by ion chromatography using Borate/Gluconate eluent. Daytime average concentrations of SO_4^{2-} were 293.15 and 272.56 neq/m^3, and nighttime values were 588.17 and 591.16 neq/m^3 for Ban Tha Si and Ban Sob Pat, respectively. Acidity (H^+) determinations were conducted by pH measurement using pH meter. The average daytime values were 78.86 and 62.77 neq/m^3 and the average nighttime values were 187.78 and 159.88 neq/m^3 for Ban Tha Si and Ban Sob Pat, respectively. Ammonia gas (NH_3) concentrations were determined by the colorimetric Nessler reagent method which average daytime values were 80.29 and 120.36 neq/m^3, and nighttime values were 163.31 and 114.21 neq/m^3 for Ban Tha Si and Ban Sob Pat, respectively.

Heavy metals (Fe, Mn and V) in total suspended particulate were collect on glass fiber filter of 0.3 μm pore size by the High Volume Air Samplers. After sampling, the filters were extracted by hot extraction method using 3M HNO_3 and then analyzed by atomic absorption spectrometry. The results indicated that there were slightly difference concentrations between day and nighttime periods at both sites. Average concentrations of Fe were 2.24 and 3.44 ppm, and average concentrations of Mn were 0.08 and 0.18 ppm for Ban Tha Si and Ban Sob Pat, respectively while V concentrations were found below the detection limit (<0.2 ppm).

The fluorescence sulfur dioxide analyzer performs a continuous analysis for SO_2. The average 1 h SO_2 were obtain during 15 sampling days for both sites, and were calculated for the average of 8 and 16 h in propose to comparing with another parameters which were taken for day and nighttime periods. Average daytime values were 27.73 and 9.47 ppb while nighttime values were 3.98 and 1.99 ppb for Ban Tha Si and Ban Sob Pat, respectively.

Determination of ozone in the atmosphere is obtained by using Gas-Phase Chemiluminescence Instrument provide by PCD at Ban Sob Pat. It was found that there were close relationship of ozone to solar radiation (measure by Pyranometer, data were provided by EGAT). The ozone concentrations found to be higher during daytime than nighttime similar with diurnal patterns of solar radiation. Average daytime ozone concentration was 12.41 ppb, and average nighttime value was 5.75 ppb while average daytime value of solar radiation were 415.42 and 18.02 w/m^2 for nighttime, respectively.

Wind speed and wind directions were provided from meteorological main station of EGAT. The 1 h average values during the study period at 10 and 100 m above ground were observed, and represented lower and upper wind, respectively. It indicated that during daytime period almost of lower wind were from southeast (SE) and eastern (E) directions while there had no dominant wind directions during nighttime period. There were found so many calm conditions at lower wind level, particularly in nighttime period (% calm = 94%). At the upper wind level, daytime wind always blew from south (S) and southwestern (SW), although calm presence was 29%. In addition to nighttime period which cannot identify the dominant wind direction because percent of calm was very high (84%).

Ban Tha Si always found to be higher concentrations for both acidic species and SO_2 than Ban Sob Pat which may be caused by the pattern of the winds during the studied period which affected the dispersion from source, and it can be summarized that the upper wind which blew from the south (S) would be the major wind direction affected to the spatial and temporal pattern of sulfate aerosol acidity and SO_2 concentration within these areas.

It can be summarized from the study that the quantities of sulfate in the vicinity of Mae Moh Power Plant were depend on SO_2 concentration which its dispersion from the Power Plant are affected by meteorological conditions while there were found the potentiality of the transformation of SO_2 to SO_4^{2-} due to the occurring of high SO_4^{2-} concentrations in these areas.

The formation of SO_4^{2-} in these areas during the study period will be caused by nonphotochemical processes which cause the local reaction while photochemical processes require longer reaction time and longer distance since there were higher SO_4^{2-} concentrations during nighttime than those during daytime periods, and there were abundant of catalysts (Fe and Mn) in these areas which are located in the vicinity of The Power Plant. Since nighttime or nonphotochemical processes are dominant

pathway of SO_4^{2-} formation while researchs in these processes are meager, there will require further research concerning about these processes especially in the tropical zone where there are high humidity in these areas.

To assess the potential acidity of sulfate aerosol, aerosol acidity were evaluated in terms of the H^+/SO_4^{2-} equivalent ratio. The calculated data showed that none of acid aerosol were found in sulfuric acid phase. Almost of them were found in partially neutralized acid phase (92.7%), and few of neutralized acid phase were found during these episode (8.3%) and only one time which found acid aerosol in bisulfate phase.

Since almost of acid aerosols were found in partially neutralized acid phase $(NH_4)_3H(SO_4)_2$, these indicated that there were no direct damage from sulfate aerosol although there were found high concentrations of SO_4^{2-} in these areas. Although SO_4^{2-} were found in the forms of ammonium salt, they may be affected to the environment due to their depositions, and their indirect effects to the health of people living in the vicinity of the Mae Moh Power Plant.

This study is only shown the spatial and temporal patterns in wintertime sulfate aerosol acidity and concentration at Ban Tha Si and Ban Sob Pat which were considered to be the critical areas affecting harmful effects from SO_2 which has emitted from the Mae Moh Power Plant. However during winter, a lot of calm conditions were found during the studied periods in Mae Moh areas. Calm condition will affected the dispersion of air pollution, so there are no manifest directions to the receptors which can be estimated. Since we found that acid aerosols are occurred from the transformation of SO_2, and it can caused damage to health and environment due to its acidity and its deposition. This study indicated the negative relationship of SO_4^{2-} and SO_2 which showed the higher sulfate, the lower SO_2 which concern that SO_2 in these areas are transformed to SO_4^{2-}. In the present, continuous monitoring of air quality do not measure SO_4^{2-} in routine. This is very important since we have known the opportunity to be damage not only from SO_2 but also from sulfate aerosol. This is by the fact that there were many times which people in the vicinity of Mae Moh Power Plant complained that they were affected by air pollution emitted from the power plant while SO_2 concentrations were detected below ambient standard at the same time.

Considering of sulfate aerosol can be useful to demonstrate about the toxicity from sulfur containing compounds which produce from these power plant more cover. These acid aerosol measurements should be performed in coordination with epidemiological studies related to respiratory measurements for communities exposed to SO_2 emissions from Mae Moh Power Plant. More data are necessary to elucidate the relationship between sulfate aerosol and SO_2 levels near these power plant both during the winter and the other seasons. It would be advisable to monitor sites further downwind of the power plant on the various of meteorological conditions. Acid aerosol should be considered as a criteria air pollutant which need more research about its concentration, formation, deposition, dispersion and the assessment of sulfate aerosol impact to the environment, particularly in the vicinity of SO_2 source region.