

Abstract

Semiconductor manufacturing industries contribute a lot to the economic growth in Taiwan. However, the semiconductor manufacturing processes use a large amount of inorganic acids, such as sulfuric acid, nitric acid, hydrogen fluoride, and hydrogen chloride. The emission of these acids from the industries may impact the health of local residents near the high-tech park. The chemical usage of H_2SO_4 , HNO_3 , HF and HCl by the semiconductor manufacturing industries was collected since 1999, which was the year that the industry has to report their use amount required by the regulations of air pollution. We evaluate the potential impact of inorganic acids emitted from the semiconductor manufacturing on air quality in the peripheral regions using air dispersion model (Industrial Source Complex Short Term, ISCST3) and geographic information system (GIS) in this study. The emission rates of the acids used in the ISCST3 were estimated based on the chemical use multiplied by the emission factor from literatures. Furthermore, the simulated values obtained from the air dispersion model were compared with measured concentrations from the air quality monitoring stations. The seasonal variations of acid concentrations in the air were discussed as well.

There is a high density emitted stacks in the high-tech park. H_2SO_4 is the most used acid, followed by HF, HCl and HNO_3 . The simulated quarterly average concentrations of inorganic acids were increased from 2004 to 2006. There were seasonal variations in the concentrations of acids and their distribution patterns. For example, the simulated levels of H_2SO_4 in the year of 2006 were higher at the second and the third quarters than these at the first and the fourth quarter in the short-term simulation. The maximum average daily concentration of H_2SO_4 in the villages of Shuangsi, Gaofong, and Jinshan were $1.40\text{--}1.60\ \mu\text{g}/\text{m}^3$, $1.03\text{--}1.31\ \mu\text{g}/\text{m}^3$, $0.82\text{--}1.277$

$\mu\text{g}/\text{m}^3$, respectively. The simulated levels were lower than those measured at monitoring stations; the main cause would be that not all emission sources were included., such as the waste water treatment plant. The multiple regression correlation coefficients (R^2) of the simulated and monitored data were ranged from 0.17 to 0.71, H_2SO_4 ($R^2=0.71$) has the best correlation. The emission of these acids from the industries may more or less impact the air quality nearby the semiconductor manufacturing industries. Besides, only one monitoring site is located at downwind side, and the levels of acids on this site were higher either on measured data or simulated results, indicating that more monitoring sites would be needed at potentially polluted area.

The maximum yearly average concentrations of H_2SO_4 were at Gaofong and Jinshan, which were $0.114 \mu\text{g}/\text{m}^3$ and $0.11 \mu\text{g}/\text{m}^3$, respectively, at the year of 2006. Although the averaged simulated concentrations were lower than the chronic reference exposure levels (cRELS) set at $1 \mu\text{g}/\text{m}^3$ by the Office of Environmental Health Hazard Assessment (OEHHA), state of California, USA, it is still a concern on the health impact on susceptible groups. This study demonstrated that the use of an air dispersion model coupled with the GIS can assess the potential influences of acid emissions on the air quality from the industries.

Keywords : ISCST3 ; geographic information system ; semiconductor manufacturing ; inorganic acids ; environmental impact