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DETERMINATION OF ATMOSPHERIC HYDROGEN CHLORIDE GAS BY DIFFUSION SCRUBBER COUPLED ION CHROMATOGRAPHY

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Abstract: This paper describes a method for the determination of hydrogen chloride gas in ambient air. The method involves analyte gas sampling in aqueous solution by using diffusion scrubber coupled ion chromatography with suppressed conductivity detection for subsequent ion analysis. Method detection limit is less than 0.05ppbv. Semi-automated a half hourly measurement results for Seoul air are presented.

Keywords: Hydrogen chloride, Ion chromatography, Diffusion scrubber, Ambient air.

1. INTRODUCTION

Due to its high abundance in atmospheric aerosol, chloride ion concentration in ambient aerosol is often measured. However, measurement data for gaseous hydrogen chloride in ambient air are scarce probably due to analytical difficulty. This gas occurs in ambient air in lower to sub parts per billion by volume level. Due to its acidic nature, it may contribute to precipitation acidification. It may also react with ammonia to form ammonium chloride aerosol affecting visibility and solar radiation reflection. Hydrogen chloride gas is likely to be involved in many gas - particle reactions.

2. EXPERIMENTAL

Reagents and Standards **:** High purity potassium hydroxide solution was prepared with a EG40 eluent generator (Dionex, USA) and was used as the eluent in ion chromatographic analysis. The deionized water was produced from a Milli-Q water purification system (Millipore). All other reagents used were of analytical reagent grade or equivalent.

Instrument Setup
The configuration for the diffusion scrubber ion chromatography (DS-IC) system is illustrated in Figure 1. Sample air is drawn into the bottom of DS at a flow rate of 0.5 L/min. Deionized water (DIW) as a scrubbing solution is continuously aspirated through the liquid channel into the sample injection valve of the IC system at a flow rate of 0.060 mL/min. The injection valve was programmed to inject 0.5mL of absorbing solution at the desired time interval, typically 60 minutes. The diffusion scrubber (DS) employed in this study is a parallel plate type modeled after Frenzel. The scrubber design, construction and applications are found elsewhere. For ion analysis of the scrubbing solution, a suppressor type ion chromatography system (DX-500, Dionex) is used. The system components and their operating condition are described in Table 1. System control and chromatogram recording were carried out using Dionex Chromeleon 6.60 software.

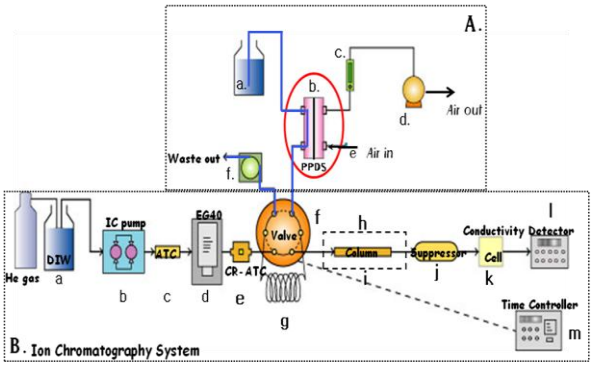

Figure 1. Schematic diagram of the DS-IC system.

A. Sampler Collection System : a. deionized water(DIW), b. parallel plate diffusion scrubber (PPDS), c. flow meter, d. air pump, e. three-way valve, f. peristaltic pump
B. Ion Chromatograph System : a. eluent (DIW), b. IC pump, c. ATC-3 trap column, d. EG40 eluent generator, e. CR-ATC trap column, f. Injection valve, g. sample loop, h. AG-11 & AS11 column, i. column heater, j. ASRS, k. conductivity cell, l. conductivity detector, m. time controller

Table 1. The system components and their operating condition employed in this study.

	Operating Conditions
Analytical Column	IonPac AS11 (4x250mm, Dionex)
Eluent	0.2 ~ 25 mM KOH (EG40 Gradient eluent)
Eluent Flow Rate	1.5 mL/min
Injection Volume	2000μL (0.03" id.PEEK Tubing)
Injection Interval	60 min
Suppressor	ASRS Ultra II (4mm, Dionex)
ASRS Current	100 mA
Background Conductivity	150~250 nS
Scrubber Solution	DIW
Scrubbing Solution Flow Rate	60 μL/min
Sample air Flow Rate	0.5 L/min

3. PRELIMINARY RESULTS

Detection limit of this method defined by three times of the standard deviation of repeated measurements of zero gas is 0.02 ppbv. Due to unavailability of standard air for hydrogen chloride gas at ppbv level, accuracy of the method can not be accessed directly. The collection efficiency of diffusion scrubber was higher than 95%.

To test field applicability the method was applied for Seoul air analysis over three months period. Temporal variations are depicted in Figure 2 along with other inorganic gases which were measured simultaneously.

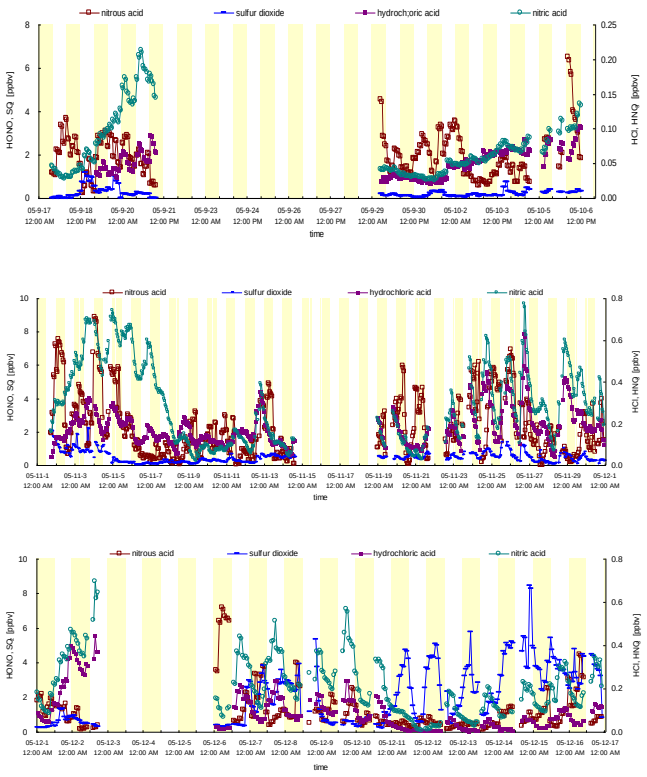

Figure 2. Time variation of hydrochloric acid and other acid gases in Seoul atmosphere. (Top: September ~ October, Middle: November, Bottom: December)

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