PC1) 모멘트 방법을 이용한 에어로졸 모델의 개발과 실험을 통한 검증

Development of Aerosol Model Using Moment Method and Validation by Experiments

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1. INTRODUCTION

Many important physical properties of natural or man-made aerosol particles such as light scattering, electrostatics charges, and toxicity, as well as their behavior involving physical processes like diffusion and thermophoresis depend strongly on their size distribution. Important aerosol behavior mechanisms affecting the size distribution of aerosol particles include condensation, deposition, and coagulation. Therefore, the evolution of the particle size distribution due to condensation, deposition, or coagulation is of fundamental importance and interest. The main objective of this research is to establish the aerosol model using moment method and to validate this model by experiments.

2. MODEL AND EXPERIMENT

Analytical solutions were obtained over the entire particle size spectrum approximating the size distribution as a unimodal lognormal function. Aerosol model that contains solutions about coagulation, deposition and condensation was developed based on the moment method. The analytical solution about was obtained (Park et al., 2000). The numerical solutions are calculated by Fortran code because analytical solutions are too complicated to solve.

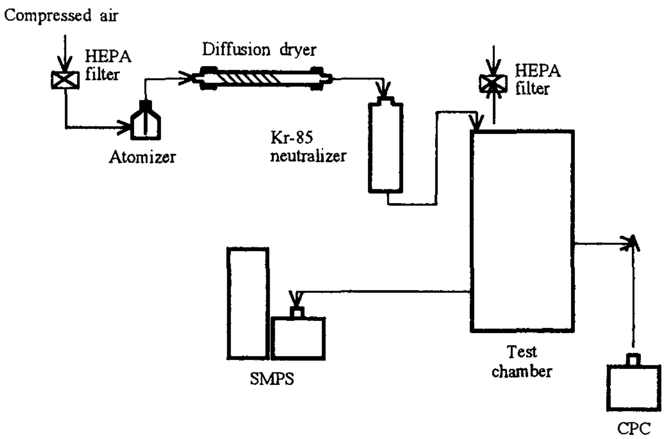

Figure 1: Experimental Set-up

The experiments of coagulation and deposition were performed. Figure 1 shows experimental set-up for coagulation and deposition tests. The aerosol coagulation chamber used in the present study is a cylindrical acrylic box with the diameter of its bottom surface of 60 cm and with the height 60 cm. A 10-cm steel fan was installed for stirring near the center of the chamber. This chamber is the same as the one used in the previous study for aerosol deposition (Park et al., 2000). The sodium chloride aerosols (NaCl, solid particles, 2.16 g/cm3) were used for the experiment. It was produced by an evaporation-condensation type generator, followed by passage through a Kr-85 charge neutralizer. Aerosol thus generated was introduced into the coagulation chamber and was mechanically stirred to maintain gentle mixing for a short time.

3. RESULTS AND DISCUSSION

The model predicted the changes of aerosol size distributions and number concentrations with respect to time. The effects of coagulation, condensation, and deposition on aerosol characteristics are investigated according to the initial condition, i.e., number concentration, geometric standard deviation, and geometric mean diameter. The results of this model were compared with analytical solutions.

Figure 2 represents the ratio of N to N_0 (dimensionless number concentration) as a function of coagulation time. The particle number concentrations were reduced by coagulation and deposition as time was passed. In this figure, the decrease of particle concentration by coagulation is much higher, compared to that of deposition. It is seen that the experimental results of deposition agree well with modeling results, but the coagulation rate of experiment were little higher than that of model. It is believed that little difference between the rates comes from different experimental conditions (the shape of a chamber, the change of particle size by coagulation, etc).

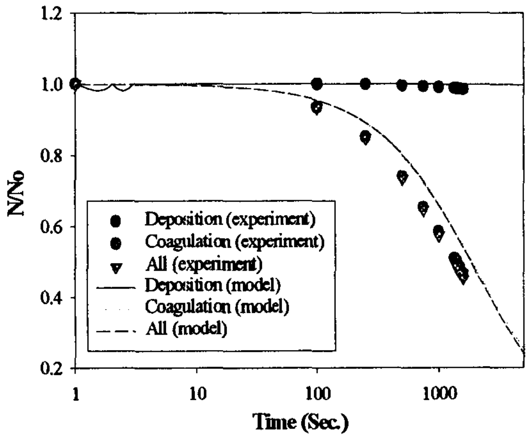

Figure 2. Comparison of number concentration between model and experiment

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REFERENCE

Lee, K. W. (1983) Change of particle size distribution during Brownian coagulation. J. Colloid Interface Sci., 92, 315-325.

Park, S. H., Lee, K. W., Otto, E. and Fissan, H. (1999) The log-normal size distribution theory of Brownian aerosol coagulation for the entire particle size range: Part 1-Analytical solution using the harmonic mean coagulation kernel. J. Aerosol Sci., 30, 3-16.

Park, S. H. and Lee, K. W. (2000) Lognormal size distribution theory for deposition of polydisperse aerosol particles. Nucl. Sci. Eng., 152, 288-295.