H-P-2

AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF ENVIRONMENTAL AND FOG CONDENSATION NUCLEI PARAMETERS ON FOG VISIBILITY

Vivek Pratap[1], Bharath V.[2], Nikita Tripathi[2], S. N. Tripathi[2], Tarun Gupta[2], Anmol Mishra[3], Utpal Das[4]

[1]Environmental Engineering and Management Programme
[2]Department of Civil Engineering and Environmental Engineering and management Programme
[3]Laser Technology Programme
[4]Department of Electrical Engineering and Laser Technology Programme
Indian Institute of Technology Kanpur
Corresponding author e-mail: snt@iitk.ac.in

Abstract:
The effects of relative humidity (RH), temperature (T), and number concentration, size distribution and chemical nature of fog condensation nuclei (FCN) on the nature of fog generated and visibility through it in a newly developed Fog Chamber Facility is investigated using a He-Ne monochromatic laser. The IIT Kanpur Fog Chamber Facility has been conceptualized and built indigenously to study the fog formation and dissipation (fog life cycle) at various environmental conditions. The chamber is designed such that all the governing parameters can be controlled and optimized. Some results pertaining to effects of temperature, RH and FCN parameters on the nature of the fog generated and visibility through it will be presented.

Introduction

Atmospheric fog is a weather phenomenon wherein tiny water droplets suspend in the vicinity of the earth's surface and cause reduction in horizontal visibility. The poor visibility leads to severe disruptions and delays in rail and air traffic, which amounts to great economic loss. It is therefore necessary to have detailed information about the optical nature of fog particulate system (water droplet +FCN +vapors), which, in turn, governs the visibility. Keeping this goal in mind, we have developed a state-of-the-art fog chamber facility for characterising fog physical, chemical and optical properties as a function of T, RH, and FCN number, size and chemical parameters. The Facility is made up of various components, namely, a fog chamber, two types of aerosol generators, Scanning Mobility Particle Sizer (SMPS), two chillers, hygrometer and steam generator. Showers on the top of the chamber provide and distribute FCN and steam uniformly as they enter into the chamber. The chamber temperature can be varied between -6 ^{0}C to 14 ^{0}C.

Experiments were performed in Fog Chamber Facility using different types of FCN e. g. NaCl, $(NH_4)_2SO_4$, graphite etc. for a range of temperatures and RH. Experiments were carried out to determine the individual effects of RH, temperature and number, distribution and chemical nature of FCN on the nature of fog generated and visibility through fog because these are the most crucial parameters for the formation of fog. Steam and FCN with known properties are introduced simultaneously in the fog chamber through the showers provided on the top. RH, inside the chamber, can be varied by adjusting the steam flow rate. A He-Ne laser was used for visibility measurements. Fog chamber is thoroughly washed with distilled water before and after the experiments. The path length of the laser beam inside the fog chamber is 2 m.

Results and Discussions

The data obtained from the experiments using NaCl as FCN, for two temperature range, namely, 9.5-10.5 ^{0}C and 8.2-8.8 ^{0}C, suggest greater visibility at higher temperature (Fig1 a, b). This is due to lower temperatures being more favorable for FCN activation and growth. For higher aerosol flow rates, which yield higher FCN number concentration, we see large rate of decrease of visibility with increasing relative humidity.

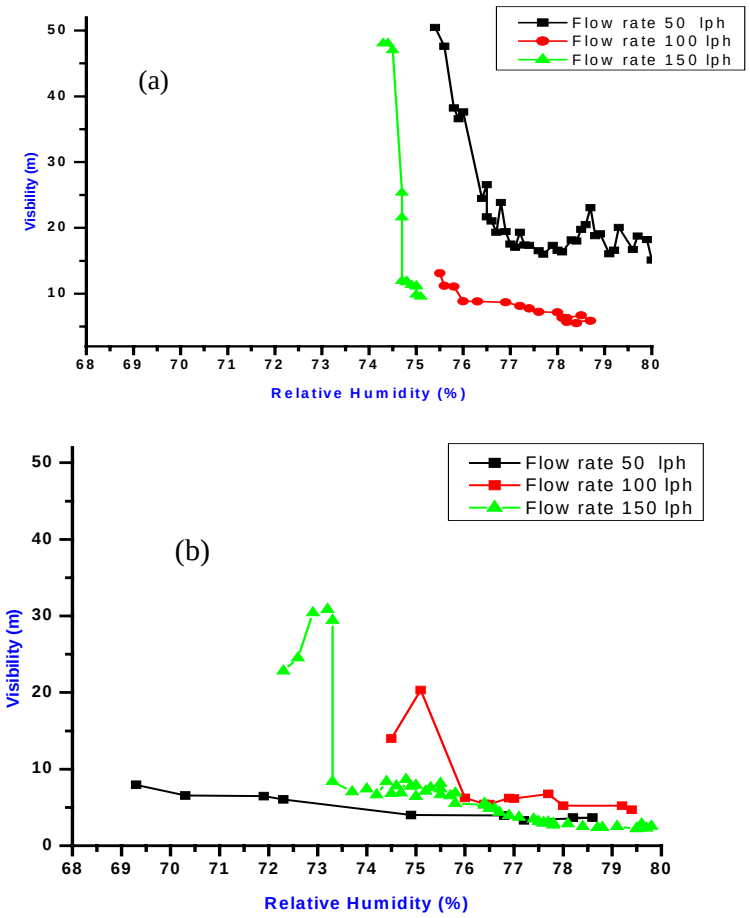

Fig1. Visibility of chamber generated fog as a function of relative humidity at (a) temperature range 8.2-8.8 ^{0}C.and (b) temperature range 9.5 – 10.5 ^{0}C. NaCl particles were used as FCN.

The size distribution function as a function of FCN diameter is shown in Fig. 2. From the Fig 2 it is clear that at high flow rate the number concentration of generated aerosol is 2-3 orders of magnitude higher and the mode is much smaller. Implications in terms of fog stability and persistence and attenuation of light by fog droplets of smaller size for the case of 50, 100 and 150 lph will be compared.

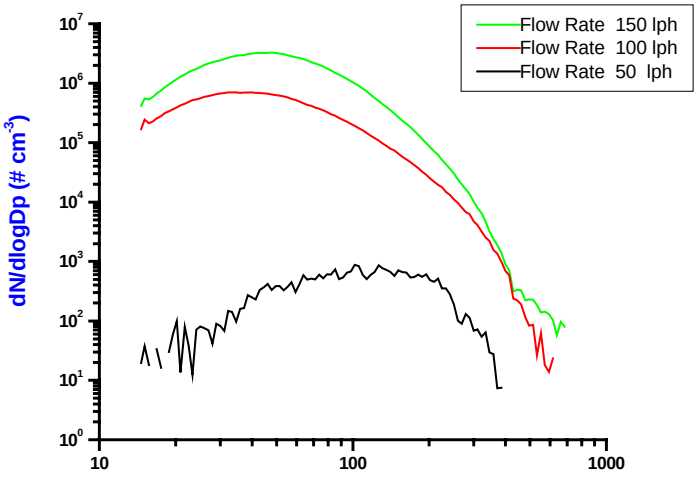

Fig2. Particle size distribution of aerosol generated from NaCl solution using Atomiser Aerosol Generator and measured using SMPS.

Acknowledgements
The present study was supported through a grant from Technology Mission for Railway Safety scheme of the Ministry of Railways and the Ministry of Human Resource Development of India.