INTRODUCTION

Air pollution problems are becoming increasingly complex on account of ever-growing consumption of fossil fuels, rapidly expanding transportation network, and fast pace of industrial development. Until recently, concern for air pollution has been largely confined to criteria pollutants, namely, sulphur dioxide (SO₂), oxides of nitrogen (NOₓ), suspended particulate matter (SPM), carbon monoxide (CO) and lead (Pb), in spite of rapidly growing emission of many other toxic air pollutants. It is estimated that over 3000 different types of chemicals are added to the atmosphere from various industrial and anthropogenic sources. Early studies on Los Angeles smog carried out by Haagen-Smit (1952) have convincingly demonstrated the critical role of volatile organic compounds (VOC) in photochemical reactions which give rise to highly toxic secondary pollutants such as O₃, peroxy acetyl nitrate (PAN), and other oxidants, which are the key toxic species in the smog. Since these early studies, photochemical smog had subsequently been detected in many major urban and industrial centres of the world. However, progress had been slow, because sophisticated equipments are required to make valid measurements of VOC in the atmosphere.

For the past few years, it has been realised that tropospheric ozone build up poses a serious threat to human health, vegetation, and public welfare (Jager et al., 1994; Lippman, 1991; PORG, 1995; Tilton, 1989). More recently, the growing evidence shows the potential health hazards associated with VOC, and their involvement with global climate change (IPCC, 1996). The rapidly growing concern for VOC is on account of the following reasons, 1. Involvement of VOC in the formation of ground level ozone; 2. Some VOC species are toxic, carcinogenic and mutagenic; 3. Direct and indirect contribution of VOC to global warming; 4. Involvement of VOC in the depletion of stratospheric ozone; and 5. Accumulation and persistence of VOC in the environment.

VOC are the primary air pollutants mostly consisting of hydrocarbons. They are composed of carbon and hydrogen, as well as species consisting partly of nitrogen, oxygen, sulphur, halogens and other substituted hydrocarbons with individual vapour pressure greater than or equal to 0.02 psi (pound per square inch, 1 psi = 0.070306958 kg cm⁻²). They can be classified into 4 different
types depending upon volatility, namely, very volatile organic compounds (boiling point, bp: 0 to 50-100°C); volatile organic compounds (bp: 50-100 to 240-260°C), semi volatile organic compounds (bp: 240-260 to 380-400°C); and persistent organic chemicals (bp: > 380°C) (Maroni et al., 1995).

VOC are among the trace gases, emitted or evaporated into the atmosphere, whose ambient concentration may vary from pptv to ppmv level. VOC can be broadly divided into methane and non-methane volatile organic compounds (NMVOC), which include, alkanes, alkenes, aromatics, alcohols, aldehydes, ketones, esters, halogenated and other hydrocarbons. The composition of VOC varies with source as well as over time.

In the troposphere, NMVOC having carbon atom between C_1-C_{10} constitute over 80 per cent of the total VOC (Lamb et al., 1980; Mayrsohn et al., 1977; Duce et al., 1983). A majority of NMVOC species are photochemically active and many others are toxic to humans. As far as oxidants formation in the atmosphere is concerned, both NMVOC and CH₄ take part in complex chemical reactions, however, the latter is comparatively less reactive.

The complexity of NMVOC emitted into the atmosphere from anthropogenic and biogenic sources is enormous and more than 1000 different species have been shown to involve. Motor vehicle exhaust has been found to contain as many as nearly 400 different species of organic compounds of which over 300 have been identified by Hampton et al. (1982, 1983). The composition and quantities of more than 40,000 VOC are found within the plant cell, vary greatly among large number of plant species (Harborne, 1991). VOC are emitted from a wide range of natural and anthropogenic sources, but their emission is rapidly increasing from anthropogenic sources.

In this study, the experimental work was undertaken to characterize the VOC levels in the ambient environment of Delhi and measurements of VOC emissions from selected tropical tree species. The specific objectives of the present study are as follows:
To prepare a detailed review on VOC in relation to air quality. In the review, an attempt has been made to present a comprehensive account of VOC in relation to their emission sources, atmospheric chemistry, and their implications for air quality and human health.

2. Measurement of ambient levels of total VOC as well as of methane and non-methane VOC diurnal and seasonal variations in the ambient atmosphere of Delhi during the period and the short term trend of VOC levels during the period of 1994-95 to 1998-99.

3. Measurement of ambient levels of some specific hazardous VOC, viz., benzene, toluene, xylene and chlorobenzene.

4. Measurements of biogenic VOC emission from selected local tree species including diurnal and seasonal variation.

5. Compilation of a VOC emission inventory including both anthropogenic and natural emission sources for India.