CHAPTER V

EXPERIMENTAL INVESTIGATIONS AND RESULTS WITH THE NEW AIR QUALITY-MONITORING INSTRUMENT

5.0 Brief Introduction

This chapter contains three Sections. Section 5.1 describes the results obtained from the experimental observation performed in the simulation chamber with the new air quality-monitoring instrument [64,65]. Section 5.2 represents the comparisons between the experimental results with the theoretically derived results and points out the significant findings from the experimentally observed results. Finally, section 5.3 represents comparative assessment between the present work and similar work done by others.

5.1 Experimental investigations

To perform the investigation the simulation chamber is first evacuated to a pressure of 0.02mm of Hg and then this chamber is filled with pure dry air at 1 atmospheric pressure. The relative humidity $h_{rel}$ is recorded. The temperature measurement detector records the temperature variation from initial temperature to the final temperature inside the simulation chamber during the time of the experiment. The scattering detector is placed at some angle $\theta$. Then 100% pure Oxygen gas, 100% pure carbon-dioxide or 100% pure Nitrogen gas is then added to the pure air or the simulation chamber is left with the pure air alone so that the density of the particular gas is $\rho_{gas}$ (gm/cc). Then water vapour is allowed to enter the simulation chamber through a flow meter at a flow rate of $m_v$ (gm/sec) with the simultaneous starting of the data acquisition
system. The data acquisition rate of the DAS are 26 data units / second. Observation begins at an initial time $t_{\text{sec}} = 0.0$ sec and the observation is ended after $t_{\text{sec}} = 770$ sec. The data obtained from our experiment is stored in the file filename.dat. These data files are subsequently processed using the program "method.c" already developed in chapter V to yield values of volume scattering coefficient $\beta_{\text{av}}(\theta)$ and the extinction coefficient $\sigma$ presented below.

(1). Investigations on water vapour with varying oxygen levels

![Graph](image)

Figure 5.1 $\beta_{\text{av}}(22.5^\circ)$ versus water vapour density of air graphs for air having oxygen densities of
(a) $O_2 = 300.0 \times 10^{-6}$ gm/cc ($O_2$ density of pure air),
(b) $O_2 = 303.2 \times 10^{-6}$ gm/cc,
(c) $O_2 = 306.4 \times 10^{-6}$ gm/cc and
(d) $O_2 = 309.6 \times 10^{-6}$ gm/cc
Figure 5.2 $\beta_{aw}(45.0^\circ)$ versus water vapour density of air graphs for air having oxygen densities of 
(a) $O_2 = 300.0 \times 10^6$ gm/cc (O$_2$ density of pure air), (b) $O_2 = 303.2 \times 10^6$ gm/cc, 
(c) $O_2 = 306.4 \times 10^6$ gm/cc (d) $O_2 = 309.6 \times 10^6$ gm/cc

Figure 5.3 $\beta_{aw}(67.5^\circ)$ versus water vapour density of air graphs for air having oxygen densities of 
(a) $O_2 = 300.0 \times 10^6$ gm/cc (O$_2$ density of pure air), (b) $O_2 = 303.2 \times 10^6$ gm/cc, 
(c) $O_2 = 306.4 \times 10^6$ gm/cc (d) $O_2 = 309.6 \times 10^6$ gm/cc
Figure 5.4 $\beta_{\text{sr}}(90.0^\circ)$ versus water vapour density of air graphs for air having oxygen densities of:
(a) $O_2 = 300.0 \times 10^6 \text{ gm/cc}$ (O$_2$ density of pure air),
(b) $O_2 = 303.2 \times 10^6 \text{ gm/cc}$,
(c) $O_2 = 306.4 \times 10^6 \text{ gm/cc}$,
(d) $O_2 = 309.6 \times 10^6 \text{ gm/cc}$

Figure 5.5 $\beta_{\text{sr}}(112.5^\circ)$ versus water vapour density of air graphs for air having oxygen densities of:
(a) $O_2 = 300.0 \times 10^6 \text{ gm/cc}$ (O$_2$ density of pure air),
(b) $O_2 = 303.2 \times 10^6 \text{ gm/cc}$,
(c) $O_2 = 306.4 \times 10^6 \text{ gm/cc}$,
(d) $O_2 = 309.6 \times 10^6 \text{ gm/cc}$
Figure 5.6 $\beta_{aw}(135.0^\circ)$ versus water vapour density of air graphs for air having oxygen densities of
(a) $O_2 = 300.0 \times 10^{-6}$ gm/cc (O$_2$ density of pure air),
(b) $O_2 = 303.2 \times 10^{-6}$ gm/cc,
(c) $O_2 = 306.4 \times 10^{-6}$ gm/cc
(d) $O_2 = 309.6 \times 10^{-6}$ gm/cc

Figure 5.7 $\beta_{aw}(157.5^\circ)$ versus water vapour density of air graphs for air having oxygen densities of
(a) $O_2 = 300.0 \times 10^{-6}$ gm/cc (O$_2$ density of pure air),
(b) $O_2 = 303.2 \times 10^{-6}$ gm/cc,
(c) $O_2 = 306.4 \times 10^{-6}$ gm/cc
(d) $O_2 = 309.6 \times 10^{-6}$ gm/cc
Figure 5.8 Extinction coefficient $\sigma$ versus water vapour density of air graphs for air having oxygen densities of (a) $O_2 = 300.0 \times 10^6$ gm/cc (O$_2$ density of pure air), (b) $O_2 = 303.2 \times 10^6$ gm/cc, (c) $O_2 = 306.4 \times 10^6$ gm/cc and (d) $O_2 = 309.6 \times 10^6$ gm/cc.

(2). Investigations on water vapour with varying carbon-dioxide levels

Figure 5.9 $\beta_a(22.5^\circ)$ versus water vapour density of air graphs for air having carbon dioxide densities of (e) $CO_2 = 6.25 \times 10^7$ gm/cc (CO$_2$ density of pure air), (f) $CO_2 = 2.796 \times 10^6$ gm/cc, (g) $CO_2 = 4.97 \times 10^5$ gm/cc and (h) $CO_2 = 7.14 \times 10^4$ gm/cc.
Figure 5.10 $\beta_v(45.0^\circ)$ versus water vapour density of air graphs for air having carbon dioxide densities of
(c) $CO_2 = 6.25 \times 10^{-3}$ gm/cc ($CO_2$ density of pure air), (f) $CO_2 = 2.796 \times 10^{-3}$ gm/cc,
(g) $CO_2 = 4.97 \times 10^{-3}$ gm/cc and (h) $CO_2 = 7.14 \times 10^{-3}$ gm/cc

Figure 5.11 $\beta_v(67.5^\circ)$ versus water vapour density of air graphs for air having carbon dioxide densities of
(c) $CO_2 = 6.25 \times 10^{-3}$ gm/cc ($CO_2$ density of pure air), (f) $CO_2 = 2.796 \times 10^{-3}$ gm/cc,
(g) $CO_2 = 4.97 \times 10^{-3}$ gm/cc and (h) $CO_2 = 7.14 \times 10^{-3}$ gm/cc
Figure 5.12 $\beta_{\nu}(90.0^\circ)$ versus water vapour density of air graphs for air having carbon dioxide densities of
(e) $\text{CO}_2 = 6.25 \times 10^{-7}$ gm/cc (CO$_2$ density of pure air),
(f) $\text{CO}_2 = 2.76 \times 10^{-6}$ gm/cc,
(g) $\text{CO}_2 = 4.97 \times 10^{-6}$ gm/cc and
(h) $\text{CO}_2 = 7.14 \times 10^{-6}$ gm/cc

Figure 5.13 $\beta_{\nu}(112.5^\circ)$ versus water vapour density of air graphs for air having carbon dioxide densities of
(e) $\text{CO}_2 = 6.25 \times 10^{-7}$ gm/cc (CO$_2$ density of pure air),
(f) $\text{CO}_2 = 2.76 \times 10^{-6}$ gm/cc,
(g) $\text{CO}_2 = 4.97 \times 10^{-6}$ gm/cc and
(h) $\text{CO}_2 = 7.14 \times 10^{-6}$ gm/cc
Figure 5.14 $\beta_{\text{a}}(135^0)$ versus water vapour density of air graphs for air having carbon dioxide densities of (e) $\text{CO}_2 = 6.25 \times 10^{-7}$ gm/cc (CO$_2$ density of pure air), (f) $\text{CO}_2 = 2.79 \times 10^{-6}$ gm/cc, (g) $\text{CO}_2 = 4.97 \times 10^{-5}$ gm/cc and (h) $\text{CO}_2 = 7.14 \times 10^{-4}$ gm/cc

Figure 5.15 $\beta_{\text{a}}(157.5^0)$ versus water vapour density of air graphs for air having carbon dioxide densities of (e) $\text{CO}_2 = 6.25 \times 10^{-7}$ gm/cc (CO$_2$ density of pure air), (f) $\text{CO}_2 = 2.79 \times 10^{-6}$ gm/cc, (g) $\text{CO}_2 = 4.97 \times 10^{-5}$ gm/cc and (h) $\text{CO}_2 = 7.14 \times 10^{-4}$ gm/cc
Figure 5.16 Extinction coefficient $\sigma$ versus water vapour density of air graphs for air having carbon dioxide densities of (e) $CO_2 = 6.25 \times 10^{-7} \text{gm/cc}$ ($CO_2$ density of pure air), (f) $CO_2 = 7.79 \times 10^{-6} \text{gm/cc}$, (g) $CO_2 = 4.97 \times 10^{-6} \text{gm/cc}$ and (h) $CO_2 = 7.14 \times 10^{-6} \text{gm/cc}$.

(3). Investigations on water vapour with varying nitrogen levels

Figure 5.17 $\beta_\text{av}(22.5^\circ)$ versus water vapour density of air graphs for air having nitrogen densities of (k) $N_2 = 976.12 \times 10^{-6} \text{gm/cc}$ ($N_2$ density of pure air), (l) $N_2 = 978.88 \times 10^{-6} \text{gm/cc}$, (m) $N_2 = 981.64 \times 10^{-6} \text{gm/cc}$ and (n) $N_2 = 984.41 \times 10^{-6} \text{gm/cc}$.
Figure 5.18 $\beta_{a}(45^\circ)$ versus water vapour density of air graphs for air having nitrogen densities of 
(k) $N_2 = 976.12 \times 10^{-6}$ gm/cc ($N_2$ density of pure air), (l) $N_2 = 978.88 \times 10^{-6}$ gm/cc,  
(m) $N_2 = 981.64 \times 10^{-6}$ gm/cc and (n) $N_2 = 984.41 \times 10^{-6}$ gm/cc

Figure 5.19 $\beta_{a}(67.5^\circ)$ versus water vapour density of air graphs for air having nitrogen densities of 
(k) $N_2 = 976.12 \times 10^{-6}$ gm/cc ($N_2$ density of pure air), (l) $N_2 = 978.88 \times 10^{-6}$ gm/cc,  
(m) $N_2 = 981.64 \times 10^{-6}$ gm/cc and (n) $N_2 = 984.41 \times 10^{-6}$ gm/cc

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Figure 5.20 $\beta_w(90^\circ)$ versus water vapour density of air graphs for air having nitrogen densities of 
(k) $N_2 = 976.12 \times 10^6 \text{gm/cc}$ (N$_2$ density of pure air), (l) $N_2 = 978.88 \times 10^6 \text{gm/cc}$,
(m) $N_2 = 981.64 \times 10^6 \text{gm/cc}$ and (n) $N_2 = 984.41 \times 10^6 \text{gm/cc}$.

Figure 5.21 $\beta_w(112.5^\circ)$ versus water vapour density of air graphs for air having nitrogen densities of 
(k) $N_2 = 976.12 \times 10^6 \text{gm/cc}$ (N$_2$ density of pure air), (l) $N_2 = 978.88 \times 10^6 \text{gm/cc}$,
(m) $N_2 = 981.64 \times 10^6 \text{gm/cc}$ and (n) $N_2 = 984.41 \times 10^6 \text{gm/cc}$.
Figure 5.22 $\beta_{sw}(135^\circ)$ versus water vapour density of air graphs for air having nitrogen densities of
(k) $N_2 = 976.12 \times 10^4$ gm/cc ($N_2$ density of pure air), (l) $N_2 = 978.88 \times 10^4$ gm/cc,
(m) $N_2 = 981.64 \times 10^4$ gm/cc and (n) $N_2 = 984.41 \times 10^4$ gm/cc

Figure 5.23 $\beta_{sw}(157.5^\circ)$ versus water vapour density of air graphs for air having nitrogen densities of
(k) $N_2 = 976.12 \times 10^4$ gm/cc ($N_2$ density of pure air), (l) $N_2 = 978.88 \times 10^4$ gm/cc,
(m) $N_2 = 981.64 \times 10^4$ gm/cc and (n) $N_2 = 984.41 \times 10^4$ gm/cc
Summary of observation for graph from 5.1 to 5.24

The graphs in fig 5.1 to 5.24 shows that there is considerable variation in the volume scattering coefficient as well as extinction coefficient of water vapor laden air where the O₂, CO₂ or N₂ levels in air increases beyond the levels normally present in pure air. This signifies that the trend in which the density of water vapor in the air increases is a function of the proportions in which the gaseous constituents of air are present.

5.2 Correlation of theory and experimental results

In order to draw a correlation between the experimental results given in the last section with the theory developed in chapter II, at an experimental reading taken from the graphs in figures 5.1 to figure 5.24 of density of water vapor of the air containing a particular density of O₂, CO₂ or N₂ gas inside the simulation chamber, the corresponding β万元 (0)
values at all the angles θ is plotted on a graph as shown in fig 5.25 and a theoretical pattern corresponding to an aggregate of $S_{11}(\theta)$ values of water droplets having a particular size distribution $N(\alpha)$, that is $\beta(\theta)$ for all angles $\theta$ (given as in equation 2.3.70 is also plotted on the same graph fig 5.25. The similarity of the shapes of the experimental and theoretical curves indicates the size distribution, at that experimental density reading of water vapour, of the water vapour droplets in the air containing the particular density of O$_2$, CO$_2$ or N$_2$ inside the simulation chamber fig 5.25- fig 5.36.

![Graph showing $\beta(\theta)$ vs $\theta$](image)

**Fig 5.25** Experimentally measures $\beta_{ex}(\theta)$ and theoretical $\beta(\theta)$ versus scattering angle $\theta$ graphs. Experimental $\beta_{ex}(\theta)$ vs $\theta$ graphs are for air having O$_2$ density of $300.0 \times 10^{-6}$ gm/cc (O$_2$ density of pure air) and 1) water vapour density = $4.20 \times 10^{-5}$ gm/cc, 2) water vapour density = $4.40 \times 10^{-5}$ gm/cc and 3) water vapour density = $4.60 \times 10^{-5}$ gm/cc. Theoretical $\beta(\theta)$ vs $\theta$ graphs are for water vapour with a size distribution around 4) modal radius = 0.9 $\mu$m, 5) modal radius = 1.0 $\mu$m and 6) modal radius = 15.0 $\mu$m.
Fig 5.26 Experimentally measures $\beta_{pm}(0)$ and theoretical $\beta(0)$ versus scattering angle $\theta$ graphs. Experimental $\beta_{pm}(0)$ vs $\theta$ graphs are for air having O$_2$ density of $303.2 \times 10^{-4}$ gm/cc and 1) water vapour density = $4.20 \times 10^{-5}$ gm/cc, 2) water vapour density = $4.40 \times 10^{-5}$ gm/cc and 3) water vapour density = $4.60 \times 10^{-5}$ gm/cc. Theoretical $\beta(0)$ vs $\theta$ graph 4) is for water vapour with a size distribution around the modal radius = 20.0 $\mu$m.
Fig 5.27 Experimentally measures $\beta_{\text{exp}}(\theta)$ and theoretical $\beta(\theta)$ versus scattering angle $\theta$ graphs. Experimental $\beta_{\text{exp}}(\theta)$ vs $\theta$ graphs are for air having $O_2$ density of $306.4 \times 10^3 \text{ gm/cc}$ and 1) water vapour density = $4.20 \times 10^5 \text{ gm/cc}$, 2) water vapour density = $4.40 \times 10^5 \text{ gm/cc}$ and 3) water vapour density = $4.60 \times 10^5 \text{ gm/cc}$. Theoretical $\beta(\theta)$ vs $\theta$ graph 4) is for water vapour with a size distribution around the modal radius = $10.0 \mu m$. 
Fig 5.28 Experimentally measures $\beta_\text{ext}(\theta)$ and theoretical $\beta(\theta)$ versus scattering angle $\theta$ graphs. Experimental $\beta_\text{ext}(\theta)$ vs $\theta$ graphs are for air having $\text{O}_2$ density of $309.6 \times 10^5 \text{gm/cc}$ and 1) water vapour density = $4.20 \times 10^5 \text{gm/cc}$, 2) water vapour density = $4.40 \times 10^5 \text{gm/cc}$ and 3) water vapour density = $4.60 \times 10^5 \text{gm/cc}$. Theoretical $\beta(\theta)$ vs $\theta$ graph 4) is for water vapour with a size distribution around the modal radius = $28.0 \mu\text{m}$. 

Fig 5.28 Experimentally measures $\beta_\text{ext}(\theta)$ and theoretical $\beta(\theta)$ versus scattering angle $\theta$ graphs. Experimental $\beta_\text{ext}(\theta)$ vs $\theta$ graphs are for air having $\text{O}_2$ density of $309.6 \times 10^5 \text{gm/cc}$ and 1) water vapour density = $4.20 \times 10^5 \text{gm/cc}$, 2) water vapour density = $4.40 \times 10^5 \text{gm/cc}$ and 3) water vapour density = $4.60 \times 10^5 \text{gm/cc}$. Theoretical $\beta(\theta)$ vs $\theta$ graph 4) is for water vapour with a size distribution around the modal radius = $28.0 \mu\text{m}$. 

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Fig 5.29 Experimentally measures $\beta_\nu(\theta)$ and theoretical $\beta(r)$ versus scattering angle $\theta$ graphs.

Experimental $\beta_\nu(\theta)$ vs $\theta$ graphs are for air having CO$_2$ density of $6.25 \times 10^{-7}$ gm/cc (CO$_2$ density of pure air) and 7) water vapour density = $4.20 \times 10^{-5}$ gm/cc. 8) water vapour density = $4.40 \times 10^{-5}$ gm/cc and 9) water vapour density = $4.60 \times 10^{-5}$ gm/cc. Theoretical $\beta(r)$ vs $\theta$ graphs are for water vapour with a size distribution around 10) modal radius = 0.9 $\mu$m and 11) modal radius = 1.0 $\mu$m and (12) modal radius = 15.0 $\mu$m.
Fig 5.30 Experimentally measures $\beta_{\text{meas}}(\theta)$ and theoretical $\beta(\theta)$ versus scattering angle $\theta$ graphs. Experimental $\beta_{\text{meas}}(\theta)$ vs $\theta$ graphs are for air having CO$_2$ density of $2.796 \times 10^{-6}$ gm/cc (CO$_2$ density of pure air) and 7) water vapour density = $4.20 \times 10^{-5}$ gm/cc, 8) water vapour density = $4.40 \times 10^{-5}$ gm/cc and 9) water vapour density = $4.60 \times 10^{-5}$ gm/cc. Theoretical $\beta(\theta)$ vs $\theta$ graphs 10) is for water vapour with a size distribution around the modal radius = 30.0$\mu$m.
Fig 5.31 Experimentally measures $\beta_{\text{ext}}(0)$ and theoretical $\beta(0)$ versus scattering angle $\theta$ graphs. Experimental $\beta_{\text{ext}}(0)$ vs $\theta$ graphs are for air having CO$_2$ density of $4.97 \times 10^{-6}$ gm/cc (CO$_2$ density of pure air) and 7) water vapour density = $4.20 \times 10^{-5}$ gm/cc, 8) water vapour density = $4.40 \times 10^{-5}$ gm/cc and 9) water vapour density = $4.60 \times 10^{-5}$ gm/cc. Theoretical $\beta(0)$ vs $\theta$ graphs 10) is for water vapour with a size distribution around the modal radius = 30.0 $\mu$m.
Fig 5.32 Experimentally measures $\beta_m(0)$ and theoretical $\beta(0)$ versus scattering angle $\theta$ graphs. Experimental $\beta_m(0)$ vs $\theta$ graphs are for air having CO$_2$ density of $7.14 \times 10^{-6}$ gm/cc (CO$_2$ density of pure air) and 7) water vapour density = $4.20 \times 10^{-5}$ gm/cc, 8) water vapour density = $4.40 \times 10^{-5}$ gm/cc and 9) water vapour density = $4.60 \times 10^{-5}$ gm/cc. Theoretical $\beta(0)$ vs $\theta$ graphs 10) is for water vapour with a size distribution around the modal radius = 30.0 $\mu$m.
Fig 5.33 Experimentally measures $\beta_{\text{ex}}(\theta)$ and theoretical $\beta(\theta)$ versus scattering angle $\theta$ graphs. Experimental $\beta_{\text{ex}}(\theta)$ vs $\theta$ graphs are for air having N$_2$ density of 976.12x10$^{-6}$ gm/cc (N$_2$ density of pure air) and 13) water vapour density = 4.20x10$^{-5}$ gm/cc, 14) water vapour density = 4.40x10$^{-5}$ gm/cc and 15) water vapour density = 4.60x10$^{-5}$ gm/cc. Theoretical $\beta(\theta)$ vs $\theta$ graphs (10) is for water vapour with a size distribution around the 16) modal radius = 0.9 $\mu$m and (17) modal radius = 1.0 $\mu$m and (18) modal radius = 15.0 $\mu$m.
Fig 5.34 Experimentally measures $\beta_{\text{air}}(\theta)$ and theoretical $\beta(\theta)$-versus-scattering-angle $\theta$ graphs.
Experimental $\beta_{\text{air}}(\theta)$ vs $\theta$ graphs are for air having N$_2$ density of 978.88x10$^{-6}$ gm/cc and 13) water vapour density = 4.20x10$^{-5}$ gm/cc and 14) water vapour density = 4.40x10$^{-5}$ gm/cc and 15) water vapour density = 4.60x10$^{-5}$ gm/cc. Theoretical $\beta(\theta)$ vs $\theta$ graphs are for water vapour with a size distribution around the 16) modal radius = 0.9 $\mu$m and (17) modal radius = 20.0 $\mu$m.
Fig 5.35 Experimentally measures $\beta_{\text{meas}}(\theta)$ and theoretical $\beta(\theta)$ versus scattering angle $\theta$ graphs. Experimental $\beta_{\text{meas}}(\theta)$ vs $\theta$ graphs are for air having N$_2$ density of 981.64x10$^{-5}$ gm/cc and 13) water vapour density = 4.20x10$^{-5}$ gm/cc, 14) water vapour density = 4.40x10$^{-5}$ gm/cc and 15) water vapour density = 4.60x10$^{-5}$ gm/cc. Theoretical $\beta(\theta)$ vs $\theta$ graphs are for water vapour with a size distribution around the 16) modal radius = 30.0µm.
Fig 5.36 Experimentally measures $\beta_{\text{ex}}(\theta)$ and theoretical $\beta(\theta)$ versus scattering angle $\theta$ graphs. Experimental $\beta_{\text{ex}}(\theta)$ vs $\theta$ graphs are for air having N$_2$ density of $984.41 \times 10^{-6}$ gm/cc and 13) water vapour density = $4.20 \times 10^{-5}$ gm/cc, 14) water vapour density = $4.40 \times 10^{-5}$ gm/cc and 15) water vapour density = $4.60 \times 10^{-5}$ gm/cc. Theoretical $\beta(\theta)$ vs $\theta$ graphs are for water vapour with a size distribution around the 16) modal radius = 12.0 $\mu$m.
From Fig. 5.25 it can be seen that when air has an O\textsubscript{2} density of 300.0\times10^{-6}gm/cc (the density of O\textsubscript{2} present in pure air) and water vapour density of 4.20\times10^{-5}gm/cc, the experimental $\beta_{\text{av}}(\theta)$ vs $\theta$ plot (1) corresponds to the plot (6), which is the theoretical $\beta(\theta)$ vs $\theta$ plot for air having water droplets with model radius 15.0\mu m. When the water vapour density is 4.40\times10^{-5}gm/cc, experimental $\beta_{\text{av}}(\theta)$ vs $\theta$ plot (2) corresponds to the plot (5), which is the theoretical $\beta(\theta)$ vs $\theta$ plot for air having water droplets with model radius 1.0\mu m. Finally, when the water vapour density is 4.60\times10^{-5}gm/cc, experimental $\beta_{\text{av}}(\theta)$ vs $\theta$ plot (3) corresponds to the plot (4), which is the theoretical $\beta(\theta)$ vs $\theta$ plot for air having water droplets with model radius 0.9\mu m. This shows that while there has been a relatively large decrease, that is a change of 14.0\mu m, in the size of the water droplets when the density of water vapour increased from 4.20\times10^{-5}gm/cc to 4.40\times10^{-5}gm/cc, for an equal increase in water vapour density from 4.40\times10^{-5}gm/cc to 4.60\times10^{-5}gm/cc, the size of the water droplets changed by only 0.1\mu m.

It can thus be concluded that when air contains O\textsubscript{2} density equivalent to the density in pure air, with increasing density of water vapour in air, the droplet size of the water vapour will decrease non-linearly. From Fig. 5.26 it can be deduced that in case of air having increased O\textsubscript{2} density of 303.2\times10^{-6}gm/cc the modal radius of the water vapour droplets decreases slightly as the density of water vapour in the air increases from 4.20\times10^{-5}gm/cc to 4.60\times10^{-5}gm/cc with the modal radius being around 20.0\mu m. From Fig. 5.27 it can be deduced that in case of air having increased O\textsubscript{2} density of 306.4\times10^{-6}gm/cc the modal radius of the water vapour droplets increases slightly as the density of water vapour in the air increases from 4.20\times10^{-5}gm/cc to 4.60\times10^{-5}gm/cc with the modal radius being around 10.5\mu m.
From fig 5.28 it can be deduced that in case of air having increased O$_2$ density of $3.096 \times 10^{-6}$ gm/cc the modal radius of the water vapour droplets decreases slightly as the density of water vapour in the air increases from $4.20 \times 10^{-5}$ gm/cc to $4.60 \times 10^{-5}$ gm/cc with the modal radius being around 28.0 $\mu$m.

From fig 5.29 it can be seen that when air has an CO$_2$ density of $6.25 \times 10^{-7}$ gm/cc (the density of CO$_2$ present in pure air) and water vapour density of $4.20 \times 10^{-5}$ gm/cc, the experimental $\beta_w(0)$ vs $\theta$ plot (7) corresponds to the plot (12), which is the theoretical $\beta(0)$ vs $\theta$ plot for air having water droplets with model radius 15.0 $\mu$m. When the water vapour density is $4.40 \times 10^{-5}$ gm/cc, experimental $\beta_w(0)$ vs $\theta$ plot (8) corresponds to the plot (11), which is the theoretical $\beta(0)$ vs $\theta$ plot for air having water droplets with model radius 1.0 $\mu$m. Finally, when the water vapour density is $4.60 \times 10^{-5}$ gm/cc, experimental $\beta_w(0)$ vs $\theta$ plot (9) corresponds to the plot (10), which is the theoretical plot for air having water droplets with model radius 0.9 $\mu$m. This shows that while there has been a relatively large decrease, that is a change of 14.0 $\mu$m, in the size of the water droplets when the density of water vapour increased from $4.20 \times 10^{-5}$ gm/cc to $4.40 \times 10^{-5}$ gm/cc, for an equal increase in water vapour density from $4.40 \times 10^{-5}$ gm/cc to $4.60 \times 10^{-5}$ gm/cc, the size of the water droplets changed by only 0.1 $\mu$m. It can thus be concluded that when air contains CO$_2$ density equivalent to the density of CO$_2$ in pure air, with increasing density of water vapour in the air, the droplet size of the water vapour will decrease non-linearly.

From figure 5.30 it can be deduced that in case of air having increased CO$_2$ density of $2.796 \times 10^{-6}$ gm/cc the modal radius of the water vapour droplets decreases very slightly as the density of water vapour in the air increases from $4.20 \times 10^{-5}$ gm/cc to $4.60 \times 10^{-5}$ gm/cc with the modal radius being greater than 30.0 $\mu$m, which is the greatest possible modal
radius for which theoretical $\beta(\theta)$ vs $\theta$ plot is accurately given by the software "miescat.c" as mentioned in section 2.4.

From figure 5.31 and 5.32 it can be deduced that in air having increased CO$_2$ densities of 4.97x10^{-6}gm/cc and 7.14x10^{-6}gm/cc the modal radius of the water vapour droplet is almost constant as the density of water vapour in the air increases from 4.20x10^{-5}gm/cc to 4.60x10^{-5}gm/cc with the modal radius being greater than 30.0\mu m, which is again the greatest possible modal radius for which theoretical $\beta(\theta)$ vs $\theta$ plot is accurately given by the software "miescat.c".

The graphs in figure 5.33 are for air having N$_2$ density of 976.12x10^{-6}gm/cc (N$_2$ density of pure air) and hence the same as for air having O$_2$ density of 300.0x10^{-6}gm/cc (O$_2$ density of pure air) and 6.25x10^{-7}gm/cc (the density of CO$_2$ present in pure air) shown in figure 5.25 and 5.29.

From fig 5.34 it can be seen that in case of air having an increased N$_2$ density of 978.88x10^{-6}gm/cc and water vapour density of 4.20x10^{-5}gm/cc, the experimental plot (13) corresponds to the plot (17), which is the theoretical plot for air having water droplets with model radius 20.0\mu m. But as the water vapour density goes up to 4.40x10^{-5}gm/cc, the experimental plot (14) corresponds to the plot (16), which is a theoretical plot of $\beta(\theta)$ vs $\theta$ for air having water droplets with model radius 0.9\mu m. Again a further increased in water vapour density to 4.60x10^{-5}gm/cc does not change the size of the water droplets significantly as can be seen from the experimental plot (15) and corresponding theoretical plot (16). Air, with this N$_2$ density level, thus, seems to have a non-linear decrease in water droplet size with increasing density of water vapour.
density level, thus, seems to have a non-linear decrease in water droplet size with increasing density of water vapour.

From figure 5.35 it can be deduced that in case of air having increased N\textsubscript{2} density of 981.64\times10^{-6}gm/cc, the modal radius of the water vapour droplets decreases slightly as the density of water vapour in the air increases from 4.20\times10^{-5}gm/cc to 4.60\times10^{-5}gm/cc, with the modal radius being around 30.0\mu m, which is the greatest possible modal radius for which theoretical $\beta(\theta)$ vs $\theta$ plot is accurately given by the software "miescat c". From figure 5.36 it can be deduced that in case of air having increased N\textsubscript{2} density of 984.41\times10^{-6}gm/cc, the modal radius of the water vapour droplets decreases slightly as the density of water vapour in the air increases from 4.20\times10^{-5}gm/cc to 4.60\times10^{-5}gm/cc with the modal radius being around 12.0\mu m

The error $\varepsilon$, given by equation 4.8.7, of the experimental readings with the air quality monitoring system is given in the following tables in figure 5.37, figure 5.38 and figure 5.39.
<table>
<thead>
<tr>
<th>$\theta$</th>
<th>22.5°</th>
<th>45°</th>
<th>67.5°</th>
<th>90°</th>
<th>112.5°</th>
<th>135°</th>
<th>157.5°</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varepsilon$ for air having $O_2$ density = $300.0 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.011</td>
<td>0.026</td>
<td>0.011</td>
<td>0.036</td>
<td>0.052</td>
<td>0.089</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $O_2$ density = $303.2 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.145</td>
<td>0.010</td>
<td>0.001</td>
<td>0.026</td>
<td>0.105</td>
<td>0.033</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $O_2$ density = $306.4 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.034</td>
<td>0.033</td>
<td>0.038</td>
<td>0.099</td>
<td>0.008</td>
<td>0.011</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $O_2$ density = $309.6 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.088</td>
<td>0.023</td>
<td>0.003</td>
<td>0.042</td>
<td>0.002</td>
<td>0.049</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $CO_2$ density = $6.25 \times 10^{-7} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.011</td>
<td>0.026</td>
<td>0.011</td>
<td>0.036</td>
<td>0.052</td>
<td>0.089</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $CO_2$ density = $2.796 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.036</td>
<td>0.028</td>
<td>0.011</td>
<td>0.001</td>
<td>0.001</td>
<td>0.020</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $CO_2$ density = $4.97 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.071</td>
<td>0.011</td>
<td>0.024</td>
<td>0.002</td>
<td>0.011</td>
<td>0.022</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $CO_2$ density = $7.14 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.077</td>
<td>0.015</td>
<td>0.017</td>
<td>0.013</td>
<td>0.002</td>
<td>0.020</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $N_2$ density = $976.12 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.011</td>
<td>0.026</td>
<td>0.011</td>
<td>0.036</td>
<td>0.052</td>
<td>0.089</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $N_2$ density = $978.88 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.027</td>
<td>0.014</td>
<td>0.003</td>
<td>0.044</td>
<td>0.026</td>
<td>0.050</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $N_2$ density = $981.64 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.079</td>
<td>0.008</td>
<td>0.067</td>
<td>0.011</td>
<td>0.014</td>
<td>0.016</td>
</tr>
<tr>
<td>$\varepsilon$ for air having $N_2$ density = $984.41 \times 10^{-6} \text{gm/cc}$</td>
<td>0.000</td>
<td>0.054</td>
<td>0.018</td>
<td>0.095</td>
<td>0.057</td>
<td>0.017</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Figure 5.37 Table of error calculations when the density of water vapour in the simulation chamber is $= 4 \times 10^{-5} \text{gm/cc}$
<table>
<thead>
<tr>
<th>( \theta )</th>
<th>22.5°</th>
<th>45.0°</th>
<th>67.5°</th>
<th>90.0°</th>
<th>112.5°</th>
<th>135.0°</th>
<th>157.5°</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \varepsilon ) for air having ( O_2 ) density = 300.0 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.060</td>
<td>0.058</td>
<td>0.018</td>
<td>0.031</td>
<td>0.030</td>
<td>0.087</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( O_2 ) density = 303.2 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.103</td>
<td>0.003</td>
<td>0.014</td>
<td>0.027</td>
<td>0.099</td>
<td>0.049</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( O_2 ) density = 306.4 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.055</td>
<td>0.022</td>
<td>0.048</td>
<td>0.072</td>
<td>0.005</td>
<td>0.006</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( O_2 ) density = 309.6 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.050</td>
<td>0.024</td>
<td>0.002</td>
<td>0.041</td>
<td>0.002</td>
<td>0.057</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( CO_2 ) density = 6.25 ( \times 10^{-7} ) gm/cc</td>
<td>0.000</td>
<td>0.060</td>
<td>0.058</td>
<td>0.018</td>
<td>0.031</td>
<td>0.030</td>
<td>0.087</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( CO_2 ) density = 2.796 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.052</td>
<td>0.027</td>
<td>0.012</td>
<td>0.002</td>
<td>0.000</td>
<td>0.020</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( CO_2 ) density = 4.97 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.081</td>
<td>0.014</td>
<td>0.026</td>
<td>0.001</td>
<td>0.014</td>
<td>0.022</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( CO_2 ) density = 7.14 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.082</td>
<td>0.017</td>
<td>0.016</td>
<td>0.017</td>
<td>0.004</td>
<td>0.020</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( N_2 ) density = 9.76 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.060</td>
<td>0.058</td>
<td>0.018</td>
<td>0.031</td>
<td>0.030</td>
<td>0.087</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( N_2 ) density = 9.788 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.005</td>
<td>0.009</td>
<td>0.023</td>
<td>0.021</td>
<td>0.076</td>
<td>0.057</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( N_2 ) density = 9.816 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.014</td>
<td>0.010</td>
<td>0.065</td>
<td>0.022</td>
<td>0.003</td>
<td>0.010</td>
</tr>
<tr>
<td>( \varepsilon ) for air having ( N_2 ) density = 9.841 ( \times 10^{-6} ) gm/cc</td>
<td>0.000</td>
<td>0.019</td>
<td>0.024</td>
<td>0.087</td>
<td>0.069</td>
<td>0.009</td>
<td>0.026</td>
</tr>
</tbody>
</table>

Figure 5.38 Table of error calculations when the density of water vapour in the simulation chamber is = 4.40 \( \times 10^{-5} \) gm/cc
<table>
<thead>
<tr>
<th>θ</th>
<th>22.5°</th>
<th>45.0°</th>
<th>67.5°</th>
<th>90.0°</th>
<th>112.5°</th>
<th>135°</th>
<th>157.5°</th>
</tr>
</thead>
<tbody>
<tr>
<td>ε for air having O₂ density = 300.0x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.084</td>
<td>0.098</td>
<td>0.038</td>
<td>0.037</td>
<td>0.028</td>
<td>0.075</td>
</tr>
<tr>
<td>ε for air having O₂ density = 303.2x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.048</td>
<td>0.006</td>
<td>0.027</td>
<td>0.031</td>
<td>0.087</td>
<td>0.057</td>
</tr>
<tr>
<td>ε for air having O₂ density = 306.4x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.089</td>
<td>0.013</td>
<td>0.055</td>
<td>0.061</td>
<td>0.010</td>
<td>0.008</td>
</tr>
<tr>
<td>ε for air having O₂ density = 309.6x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.003</td>
<td>0.023</td>
<td>0.003</td>
<td>0.040</td>
<td>0.001</td>
<td>0.058</td>
</tr>
<tr>
<td>ε for air having CO₂ density = 6.25x10⁻⁷ gm/cc</td>
<td>0.000</td>
<td>0.084</td>
<td>0.098</td>
<td>0.038</td>
<td>0.037</td>
<td>0.028</td>
<td>0.075</td>
</tr>
<tr>
<td>ε for air having CO₂ density = 2.796x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.067</td>
<td>0.027</td>
<td>0.013</td>
<td>0.005</td>
<td>0.001</td>
<td>0.019</td>
</tr>
<tr>
<td>ε for air having CO₂ density = 4.97x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.086</td>
<td>0.020</td>
<td>0.027</td>
<td>0.000</td>
<td>0.016</td>
<td>0.022</td>
</tr>
<tr>
<td>ε for air having CO₂ density = 7.14x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.085</td>
<td>0.011</td>
<td>0.017</td>
<td>0.022</td>
<td>0.005</td>
<td>0.020</td>
</tr>
<tr>
<td>ε for air having N₂ density = 976.12x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.084</td>
<td>0.098</td>
<td>0.038</td>
<td>0.037</td>
<td>0.028</td>
<td>0.075</td>
</tr>
<tr>
<td>ε for air having N₂ density = 978.88x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.073</td>
<td>0.010</td>
<td>0.012</td>
<td>0.035</td>
<td>0.110</td>
<td>0.079</td>
</tr>
<tr>
<td>ε for air having N₂ density = 981.64x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.049</td>
<td>0.012</td>
<td>0.073</td>
<td>0.036</td>
<td>0.019</td>
<td>0.001</td>
</tr>
<tr>
<td>ε for air having N₂ density = 984.41x10⁻⁶ gm/cc</td>
<td>0.000</td>
<td>0.042</td>
<td>0.013</td>
<td>0.078</td>
<td>0.065</td>
<td>0.021</td>
<td>0.033</td>
</tr>
</tbody>
</table>

Figure 5.39 Table of error calculations when the density of water vapour in the simulation chamber is = 4.60 x 10⁻⁶ gm/cc
The deviations of $\beta_{av}(\theta)$ from $\beta(\theta)$ seen from the fig 5.25-5.36, is given by $\varepsilon$, is not only due to the systematic error which is introduced in the measurement of $\beta(\theta)$ due to the finite angular resolution of the nephelometer part of the air quality monitoring system as mentioned earlier, but may also be on account of non-uniform size distribution of water droplets at any particular density of water vapour in air having different amounts of $O_2$, $CO_2$ or $N_2$. However, the values $\varepsilon$ obtained from the experiments given in the above tables are minimal and hence emphasizes the efficiency and reliability of the designed and fabricated new air quality monitoring system.
Comparison of extinction coefficient

Fig. 5.40 Extinction coefficient $\sigma$ versus water vapour density of air graphs for air having

i). $O_2 = 300.0 \times 10^{-6} \text{ gm/cc (O}_2\text{ density of pure air)}$,
$CO_2 = 6.25 \times 10^{-7} \text{ gm/cc (CO}_2\text{ density of pure air)}$,
$N_2 = 976.12 \times 10^{-6} \text{ gm/cc (N}_2\text{ density of pure air)}$,

ii) $O_2 = 303.2 \times 10^{-6} \text{ gm/cc, (higher than the density in pure air )}$
$CO_2 = 6.25 \times 10^{-7} \text{ gm/cc (CO}_2\text{ density of pure air)}$,
$N_2 = 976.12 \times 10^{-6} \text{ gm/cc (N}_2\text{ density of pure air)}$,

iii). $O_2 = 300.0 \times 10^{-6} \text{ gm/cc (O}_2\text{ density of pure air)}$,
$CO_2 = 6.25 \times 10^{-7} \text{ gm/cc (CO}_2\text{ density of pure air)}$,
$N_2 = 978.88 \times 10^{-6} \text{ gm/cc, (higher than the density in pure air )}$

iv) $O_2 = 300.0 \times 10^{-6} \text{ gm/cc (O}_2\text{ density of pure air)}$,
$CO_2 = 2.796 \times 10^{-6} \text{ gm/cc, (higher than the density in pure air )}$
$N_2 = 976.12 \times 10^{-6} \text{ gm/cc (N}_2\text{ density of pure air)}$, 

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Fig. 5.41 Extinction coefficient $\sigma$ versus water vapour density of air graphs for air having

v). $O_2 = 300.0 \times 10^6 \text{ gm/cc (O}_2\text{ density of pure air)},$
$CO_2 = 6.25 \times 10^7 \text{ gm/cc (CO}_2\text{ density of pure air)},$
$N_2 = 976.12 \times 10^6 \text{ gm/cc (N}_2\text{ density of pure air)},$

vi) $O_2 = 306.4 \times 10^6 \text{ gm/cc, (higher than the density in pure air)}$
$CO_2 = 6.25 \times 10^7 \text{ gm/cc (CO}_2\text{ density of pure air)},$
$N_2 = 976.12 \times 10^6 \text{ gm/cc (N}_2\text{ density of pure air)},$

vii). $O_2 = 300.0 \times 10^6 \text{ gm/cc (O}_2\text{ density of pure air)},$
$CO_2 = 6.25 \times 10^7 \text{ gm/cc (CO}_2\text{ density of pure air)},$
$N_2 = 981.64 \times 10^6 \text{ gm/cc, (higher than the density in pure air)}$

viii) $O_2 = 300.0 \times 10^6 \text{ gm/cc (O}_2\text{ density of pure air)},$
$CO_2 = 4.97 \times 10^6 \text{ gm/cc, (higher than the density in pure air)}$
$N_2 = 976.12 \times 10^6 \text{ gm/cc (N}_2\text{ density of pure air)},$
Fig. 5.42 Extinction coefficient $\sigma$ versus water vapour density of air graphs for air having

ix). $O_2 = 300.0 \times 10^{-6}$ gm/cc ($O_2$ density of pure air),
$CO_2 = 6.25 \times 10^{-7}$ gm/cc ($CO_2$ density of pure air),
$N_2 = 976.12 \times 10^{-6}$ gm/cc ($N_2$ density of pure air),

x) $O_2 = 309.6 \times 10^{-6}$ gm/cc, (higher than the density in pure air)
$CO_2 = 6.25 \times 10^{-7}$ gm/cc ($CO_2$ density of pure air),
$N_2 = 976.12 \times 10^{-6}$ gm/cc ($N_2$ density of pure air),

xi). $O_2 = 300.0 \times 10^{-6}$ gm/cc ($O_2$ density of pure air),
$CO_2 = 6.25 \times 10^{-7}$ gm/cc ($CO_2$ density of pure air),
$N_2 = 984.41 \times 10^{-6}$ gm/cc, (higher than the density in pure air)

xii). $O_2 = 300.0 \times 10^{-6}$ gm/cc ($O_2$ density of pure air),
$CO_2 = 7.14 \times 10^{-6}$ gm/cc, (higher than the density in pure air)
$N_2 = 976.12 \times 10^{-6}$ gm/cc ($N_2$ density of pure air),

Fig:- 5.40, 5.41, 5.42 shows the comparison of extinction coefficient of air having different water vapour densities and laden with different levels of Oxygen, Carbon
dioxide and Nitrogen gases and hence proves that there is an impact of different gases at different densities upon the density of water vapour droplets in air.

5.3 Comparison with reported works.

The new air quality monitoring system reported in this thesis is based on phototransistor detectors, laser source and digital recording system. But Pritchard and Elliot's [7] constructed nephelometer and transmissiometer and Tyler's [79] invented instrument are all based on bulky and expensive photo-multiplier detectors and incoherent white light sources. This new air quality monitoring system is capable of measuring volume scattering coefficients and extinction coefficients far more quickly than the earlier instruments. The outcome of experiments by Kuik, Stammes and J.W. Hovenier [80] where an electro-optic modulator has been used agree fairly well with the volume scattering coefficient results of the air quality monitoring system reported in this thesis. The measurements of volume scattering coefficient made in varying humidity conditions by Quinby-Hunt, Erskine and Hunt [81] are also in correspondence with the consequences reported in this thesis by using the air quality monitoring system. The design considerations talk about by Mishchenko, Hovenier and Travis [82] for measurement of scattering matrices are also in agreement with the air quality monitoring system reported here.

In comparison to reported works, the exploration with our designed and fabricated air quality monitoring system on extinction coefficient and volume scattering coefficient of humid air having varying levels of O₂, CO₂ and N₂ reported in this thesis, is relatively unique.
The newly designed and fabricated air quality monitoring system reported in this thesis, which is very reliable, efficient and far more economic than other instruments. The advantages of our system are

(a) The phototransistors used in the detectors are commercially available which consume very low power and also very cheap.

(b) Synthesis of the design principles of a transmissiometer and a nephelometer is made,

(c) Provision for measuring rapid variation in the medium under observation by incorporating fast electronic components.

(d) Original techniques and software for correction of errors due to the finite angular resolution of the nephelometer have been developed and incorporated.

(e) The variation of temperature in the simulation chamber recorded digitally through data acquisition system.

(f) PC based data acquisition systems and associated original software, with the capacity to monitor and record data very quickly and for long durations accurately and also process the data to give extinction and volume scattering coefficients for constituents over size distributions, have been developed and incorporated,
REFERENCES


