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"TO STUDY INDOOR ENVIRONMENTAL QUALITY PARAMETERS IN COMMERCIAL BUILDING"

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ABSTRACT: *Indoor environmental quality (IEQ) is a key component in the evaluation for meeting the concept of green building that aims towards sustainable development. People spend more than 90% of their daily life in indoor environments either inside the office, school, college, commercial, industrial buildings, or* inner *residential buildings. However, studies on the indoor air quality of commercial buildings are scarce in India.*

This paper describes an investigation into the indoor air quality of two offices. The present study was conducted in two offices and data was collected through the sensors in Ahmadabad. Carbon dioxide (co2), particulate matter 2.5, particulate matter 10, Temperature, Humidity, Formaldehyde (HCHO), carbon monoxide (co), total volatile organic compounds (TVOC)were measured inside each office at every 10 min interval between morning, early afternoon, late afternoon times duration (1 hour three time per day) for 5 days from Monday to Friday.

The data collecting indoor air pollutant in commercial building sensor and comparison with different standard guidelines. There are provide improvement suggestions such as Usage of air purifiers, increase the ventilation rate, replace air filters frequently, clean your ducts and filters, design proper mechanical ventilation, etc.

Keywords: Indoor environments quality, Pollutants, Office building, Indoor air quality.

1. Introduction

Indoor environmental quality (IEQ) is a major factor in the health, safety, and productivity of people. As ASHRAE guidelines stated (ASHRAE, 2010) since person spends about 80–90% of their time indoors and studies have indicated that a range of health& comfort-related effects is linked to characteristics of the building, there has been a growth in interest in both literature and academic on occupant health and building design. Poor indoor air quality can be especially harmful to vulnerable groups such as children, the elderly, or those with cardiovascular and chronic respiratory diseases viz. asthma. Apart from its profound effect on health, indoor air pollution reduces the productivity, or comfort of occupants of the building.

The Papers present the result of Indoor air quality pollutant concentration in a commercial building located at Naranpura Ahmadabad. The results of office building indoor air quality pollutants carbon dioxide (co2), particulate matter 2.5, particulate matter 10, temperature, humidity, formaldehyde (HCHO), carbon monoxide (co), total volatile organic compounds studies to understand the impact of human health. The simulations were carried out data collection from the sensor and during data analysis recommend indoor air quality improvement & suggestion in offices building.

2. Objective

- *To study concepts of green building and sustainability with context to indoor air quality standards.*
- *To study and measurable indoor environmental quality standards and parameters for offices building with appropriate methods.*
- *To analyzed the impact of measurable indoor environmental quality parameters and suggested improvement.*

3. Importance of Indoor Air Quality Management

- *According to the Environmental protection Agency (EPA), the level of indoor pollutants is usually two to five times higher than that of outdoor levels. In some, indoor pollutants can be 100 times more damaging than outdoor equivalents.*
- *On a median, a person spends 90% of their lives indoors.*
- *Good indoor air quality in workplaces enables an ideal working environment for staff to complete tasks with a clear head or, in turn, is likely to lead to*

a greater standard of work being done.

- *Poor air quality can lead to coughs, headaches, and eye irritation in the possibility of short-term more serious long-term problems if exposure to indoor air pollution is continuous.*
- *Exposure to indoor air pollution could lead to prolonged illnesses which would result in a person needing to take time off work, thus hampering productivity. Indeed, poor air quality results in a loss of productivity estimated to be worth tens of billions of pounds worldwide*

4. The key indoor Air Quality p*arameters*

Table 1: Indoor air quality parameters

Particulate Matter	10 micrometers or less in diameter: 50 µg/m3; 2.5 micrometers or less in diameter: 15 µg/m^3
Carbon Monoxide	Less than 9 ppm
VOCs	Less than 500 µg/m^3
Formaldehyde	Less than 27 ppm
Carbon Dioxide	About 700 ppm above outdoor air levels (usually about 1,000 to 1200 ppm)
Humidity	Below 60%, ideally between 30% and 50%
Temperature	68.5°F to 74°F (winter); and 75°F to 80.5°F (summer)

5. Weight of Indoor Air Quality According To Different institutions

Table 2: Weight of indoor air quality

Green Building Institution	Total Rating points	Weight of indoor air quality %
Leadership in Energy and Environmental Design	69	11%
Indian Green Building Council	100	12%
Green Rating for Integrated Habitat Assessment	104	21%
Assocham	130	8%

Indoor air quality parameter different organization derives the point system for approval of green building.

6. Methodology of Work

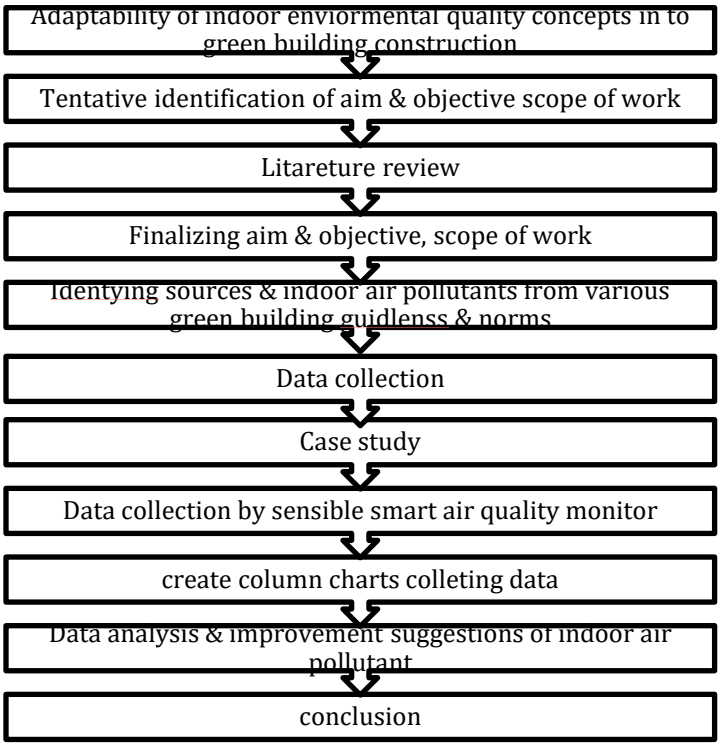


Figure 6.1: Flow chart of Methodology

7. Sensible Smart Air Quality Monitor

Figure 7.1: Sensible Smart Air Quality Monitor

We have designed our portable air monitor for easy indoor air monitoring that helps you understand the quality of the air you're breathing. The monitor collects air samples or shows PM 2.5, PM 10 & real-time (AQI) Air Quality Index.

The smart edge monitoring device also measures the level of Carbon Dioxide (CO2), Formaldehyde (HCHO), Total Volatile and Organic Compounds (TVOCs), Ozone (O3), and Carbon Monoxide (CO) present in the indoor air identified as hazardous air pollutants.

1.Technical Specification

Table 3: Technical Specification

Dimensions:	
Width	3 inches
Height	3 inches

2. Monitor screen

- Air Quality Values
- Particle concentration in Micrograms per Cubic Meter
- Temperature and Humidity Historical Graph
- CO_2,O_3,PM 2.5,HCHO Graph
- Concentration Values of real-time Pollutants
- Outdoor Pollutants information

8. Study Area Profile

1.Building Layout

Figure 8.1 A_1 Office Building Floor Plan Sahajanand complex at Naranpura Ahmedabad

Figure 8.2 A_2 Office Building Floor Plan Sahajanand complex at Naranpura Ahmedabad

2. Occupancy Charts

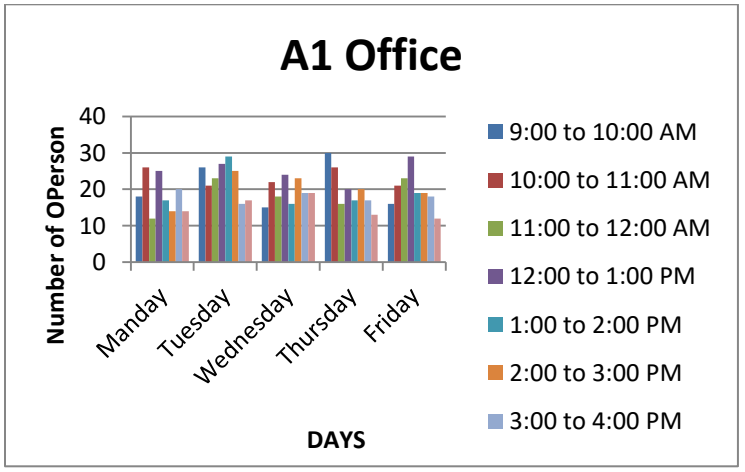


Figure 8.3 A_1 Office Occupancy Charts

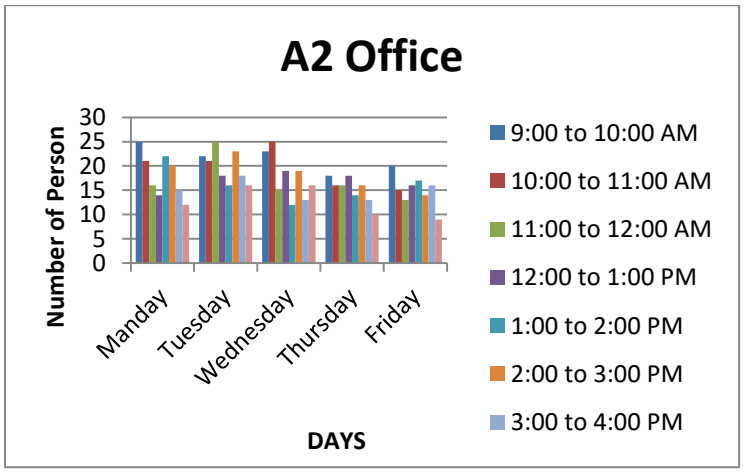


Figure 8.3 A_1 Office Occupancy Charts

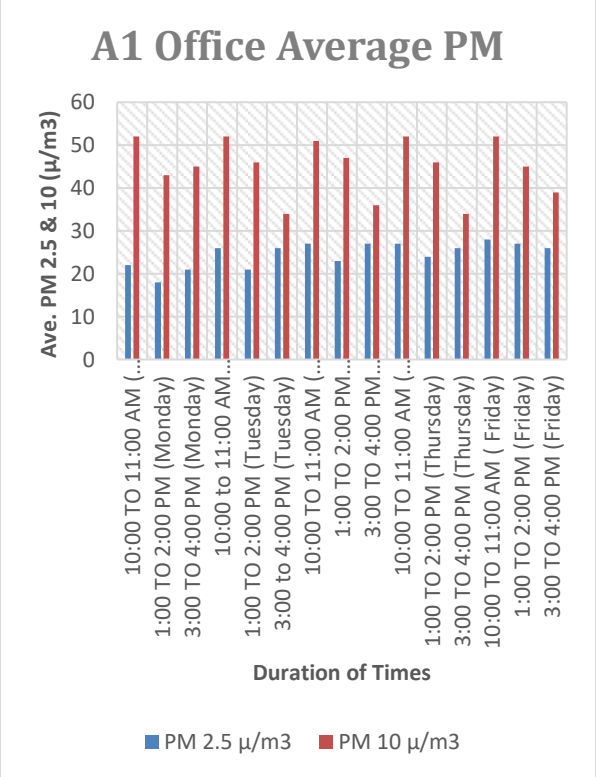
9. Data collection

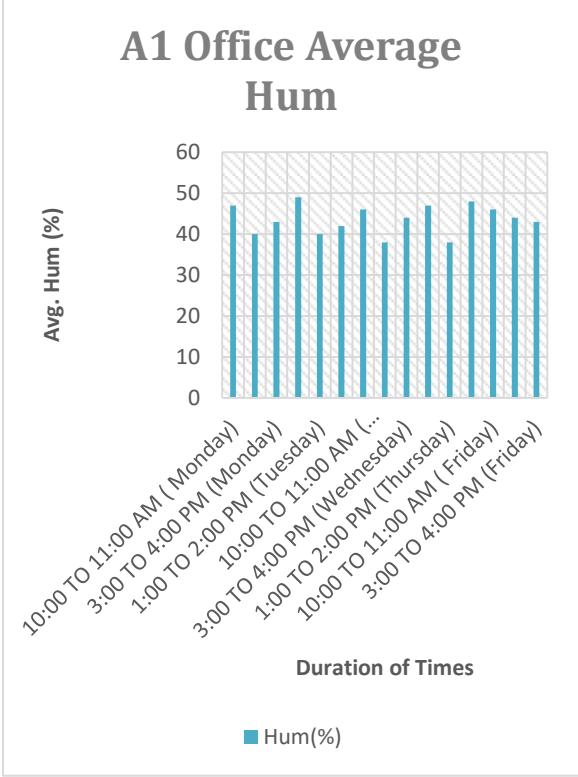
The measured 7 parameters carbon dioxide (co_2), particulate matter 2.5, particulate matter 10, temperature, humidity, formaldehyde(HCHO), carbon monoxide (CO), total volatile organic compounds (TVOC) different time in day A1 office 10:00 to 11:00 AM, 1:00 to 2:00 PM, and 3:00 to 4:00 PM and A2 offices measured 4:00 to 5:00 PM reading taken every 10 min interval. The study research papers and different green building institution guidelines & norms then decided the pollutant measured reading taken times.

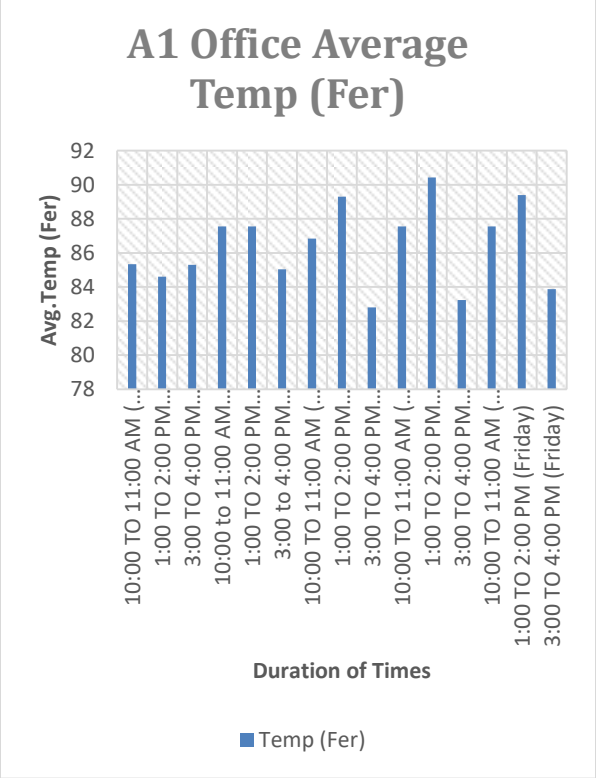
Table 4: Data collection

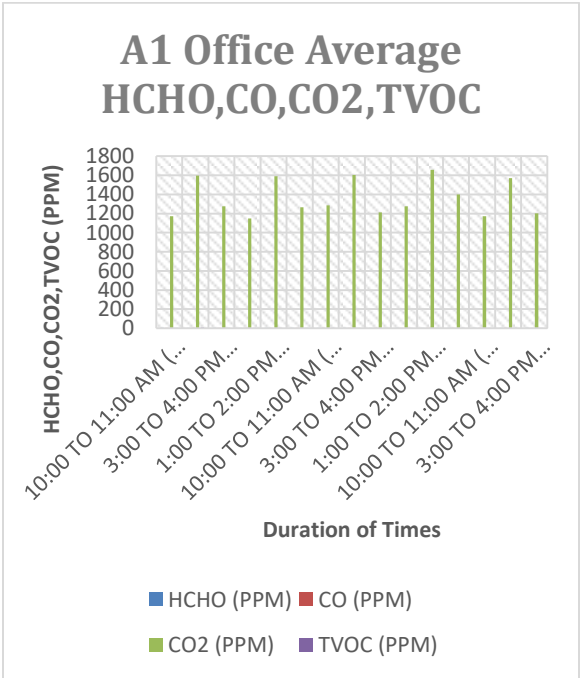
Date	Times	PM 2.5	PM10	Temp (Fer)	Hum	HCHO (PPM)	CO (PPM)	CO2 (PPM)	TVOC (PPM)
05-Apr-21	10:00 TO 10:10 AM	24	54	87	47	0.03	0.499	1236	3.041
05-Apr-21	10:10 TO 10:20 AM	21	52	85.5	45	0	0.499	1232	1.035
05-Apr-21	10:20 TO 10:30 AM	21	51	85.5	46	0	0.499	1125	0.194
05-Apr-21	10:30 TO 10:40 AM	21	48	86	43	0	0.499	1169	0.3
05-Apr-21	10:40 TO 10:50 AM	22	55	84.1	45	0	0.499	1136	0.189
05-Apr-21	10:50 TO 11:00 AM	22	52	84	44	0	0.499	1129	0
		PM 2.5	PM10	Temp (Fer)	Hum	HCHO (PPM)	CO (PPM)	CO2 (PPM)	TVOC (PPM)
05-Apr-21	1:00 TO 1:10 PM	17	48	86.6	39	0.233	0.499	1063	3.697
05-Apr-21	1:10 TO 1:20 PM	23	45	85.2	41	3.156	0.499	1602	1.665
05-Apr-21	1:20 TO 1:30 PM	16	43	83	38	0	0.499	1782	0.289
05-Apr-21	1:30 TO 1:40 PM	17	44	83.6	41	0	0.499	2000	0
05-Apr-21	1:40 TO 1:50 PM	15	39	84.2	36	0	0.499	1840	0.118
05-Apr-21	1:50 TO 2:00 PM	17	41	85.1	40	0	0.499	1259	0.274
		PM 2.5	PM10	Temp (Fer)	Hum	HCHO (PPM)	CO (PPM)	CO2 (PPM)	TVOC (PPM)
05-Apr-21	3:00 TO 3:10 PM	23	39	84	43	0.901	0.499	1295	3.674
05-Apr-21	3:10 TO 3:20 PM	22	42	84.9	41	0.349	0.499	1275	1.446
05-Apr-21	3:20 TO 3:30 PM	21	48	85	43	0.678	0.499	1325	1.398
05-Apr-21	3:30 TO 3:40 PM	19	45	87.3	40	0.442	0.499	1265	1.074
05-Apr-21	3:40 TO 3:50 PM	19	47	86	44	0.164	0.499	1245	0.639
05-Apr-21	3:50 TO 4:00 PM	21	45	84.6	39	0.214	0.499	1258	0.595

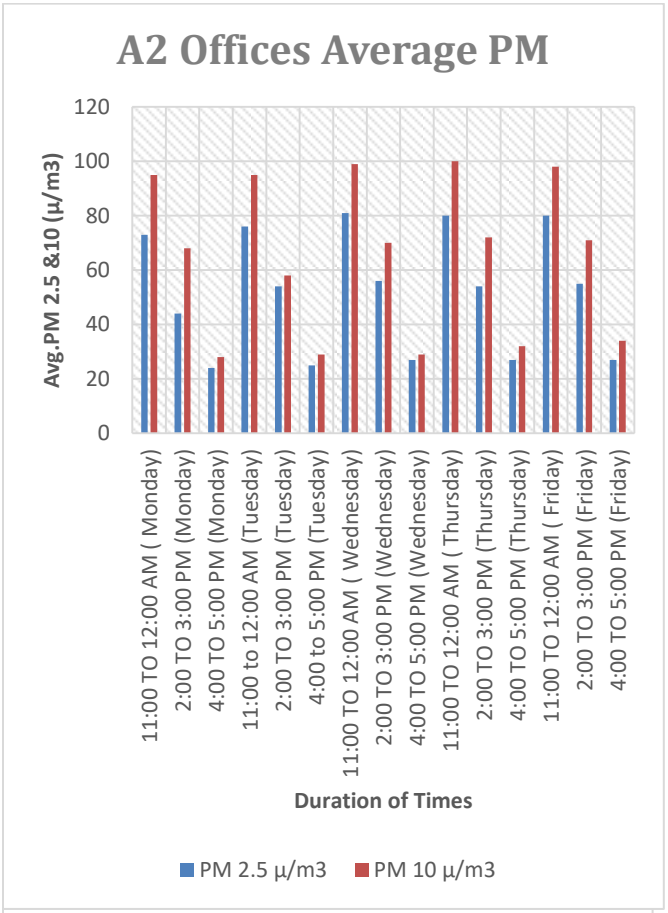
10. Data Analysis

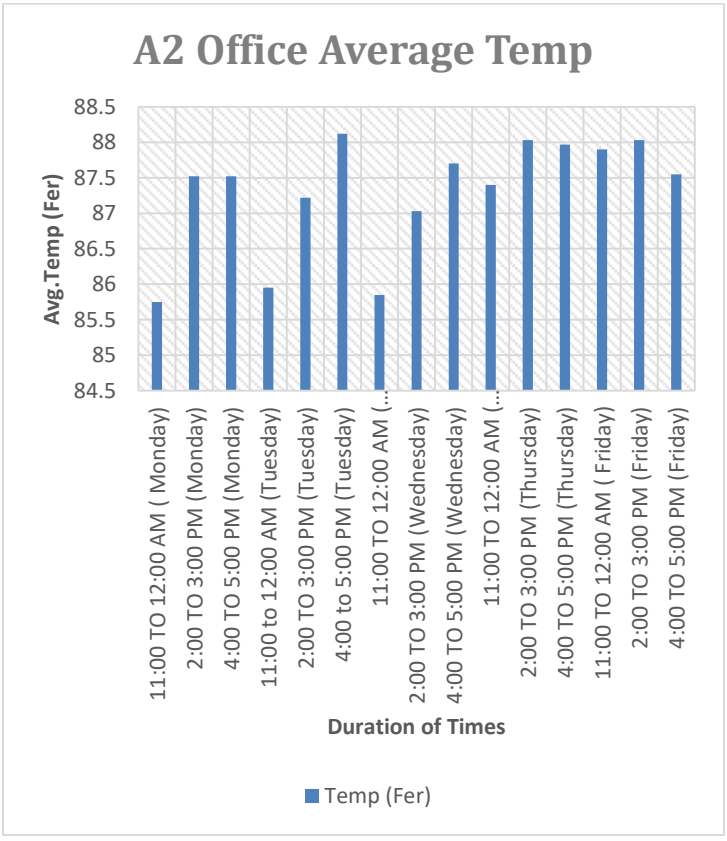


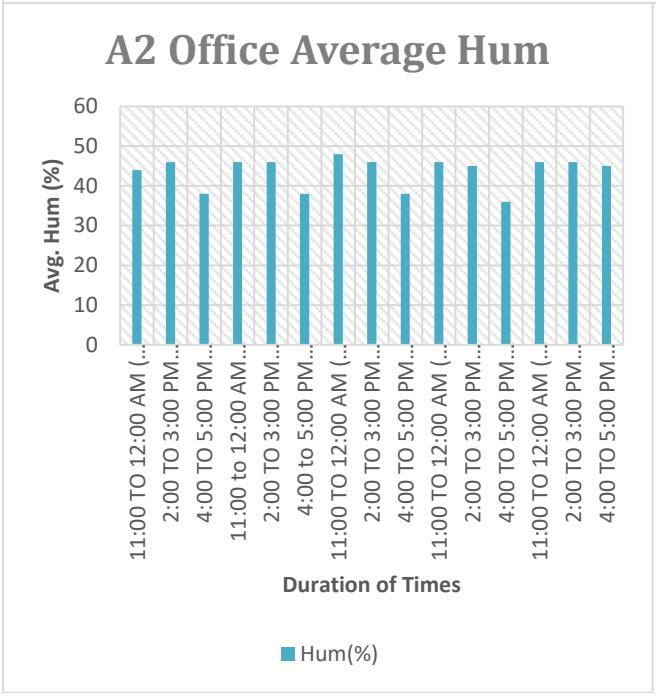


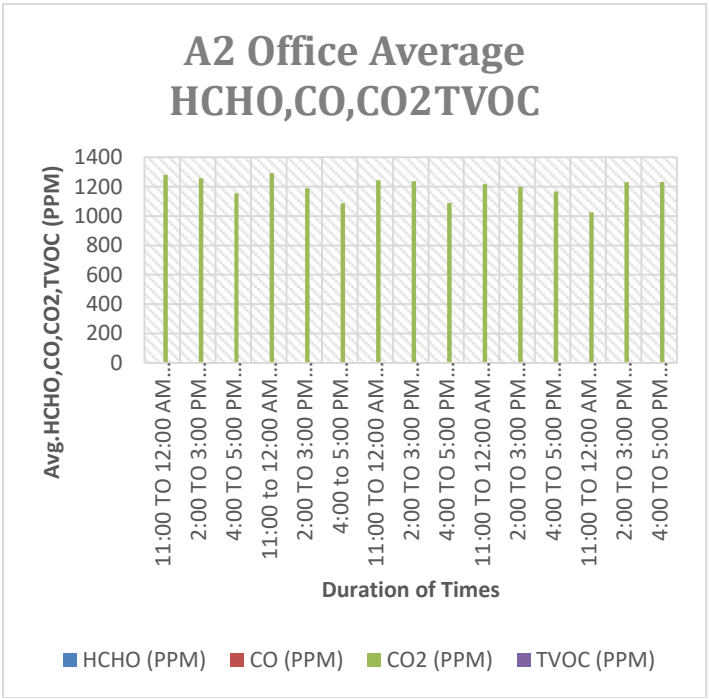





A2 Offices Average PM
Avg.PM 2.5 &10 (µ/m3)
120
100
80
60
40
20
0
11:00 TO 12:00 AM (Monday)
2:00 TO 3:00 PM (Monday)
4:00 TO 5:00 PM (Monday)
11:00 to 12:00 AM (Tuesday)
2:00 TO 3:00 PM (Tuesday)
4:00 to 5:00 PM (Tuesday)
11:00 TO 12:00 AM (Wednesday)
2:00 TO 3:00 PM (Wednesday)
4:00 TO 5:00 PM (Wednesday)
11:00 TO 12:00 AM (Thursday)
2:00 TO 3:00 PM (Thursday)
4:00 TO 5:00 PM (Thursday)
11:00 TO 12:00 AM (Friday)
2:00 TO 3:00 PM (Friday)
4:00 TO 5:00 PM (Friday)
Duration of Times
PM 2.5 µ/m3
PM 10 µ/m3


A2 Office Average Temp
Avg.Temp (Fer)
88.5
88
87.5
87
86.5
86
85.5
85
84.5
11:00 TO 12:00 AM (Monday)
2:00 TO 3:00 PM (Monday)
4:00 TO 5:00 PM (Monday)
11:00 to 12:00 AM (Tuesday)
2:00 TO 3:00 PM (Tuesday)
4:00 to 5:00 PM (Tuesday)
11:00 TO 12:00 AM (...
2:00 TO 3:00 PM (Wednesday)
4:00 TO 5:00 PM (Wednesday)
11:00 TO 12:00 AM (...
2:00 TO 3:00 PM (Thursday)
4:00 TO 5:00 PM (Thursday)
11:00 TO 12:00 AM (Friday)
2:00 TO 3:00 PM (Friday)
4:00 TO 5:00 PM (Friday)
Duration of Times
Temp (Fer)


A2 Office Average Hum
Avg. Hum (%)
60
50
40
30
20
10
0
11:00 TO 12:00 AM (...
2:00 TO 3:00 PM...
4:00 TO 5:00 PM...
11:00 to 12:00 AM...
2:00 TO 3:00 PM...
4:00 to 5:00 PM...
11:00 TO 12:00 AM (...
2:00 TO 3:00 PM...
4:00 TO 5:00 PM...
11:00 TO 12:00 AM (...
2:00 TO 3:00 PM...
4:00 TO 5:00 PM...
11:00 TO 12:00 AM (...
2:00 TO 3:00 PM...
4:00 TO 5:00 PM...
Duration of Times
Hum(%)


A2 Office Average HCHO,CO,CO2TVOC
Avg.HCHO,CO,CO2,TVOC (PPM)
1400
1200
1000
800
600
400
200
0
11:00 TO 12:00 AM...
2:00 TO 3:00 PM...
4:00 TO 5:00 PM...
11:00 to 12:00 AM...
2:00 TO 3:00 PM...
4:00 to 5:00 PM...
11:00 TO 12:00 AM...
2:00 TO 3:00 PM...
4:00 TO 5:00 PM...
11:00 TO 12:00 AM...
2:00 TO 3:00 PM...
4:00 TO 5:00 PM...
11:00 TO 12:00 AM...
2:00 TO 3:00 PM...
4:00 TO 5:00 PM...
Duration of Times
HCHO (PPM)
CO (PPM)
CO2 (PPM)
TVOC (PPM)

❖ **Improvement and Suggestion:**

- ✓ Usage of air purifiers: To reduce PM 2.5 and PM 10 use air purifiers with HEPA filters they do an excellent job of filtering contaminants from the air. Most air purifiers capture particulate matter but do not remove gas or other chemicals.
- ✓ Increase the ventilation Rate: To remove a higher level of co_2 in an office building, more doors and windows needs to be added and also installation of exhaust fans inside the office building.
- ✓ Replace air filters frequently: To reduce PM 2.5 and PM 10 maintain your heating source or air purifier by replacing or cleaning the filter often to prevent pollutants from being reissued into the air.
- ✓ Clean your ducts and filters: To reduce PM 2.5 and PM 10 Clean your duct and filters regularly to make sure you get filtered clean air. Dirty filters increase the level of pollutants inside the Office.
- ✓ Temp, Hum, Formaldehyde, Co, Tvoc acceptable limits according to the standards.

11. CONCLUSIONS

Working people spend most of their daytime in office buildings. It is important to maintain the IAQ in the office buildings from the perspective of maximum output and health of the people working inside the building. The study indicates that the occupant density in the office buildings plays a vital role in controlling indoor air pollution levels inside the office building. Significant concentrations of different air pollutants (PM2.5, PM10, CO2, VOC, TEMP, HUM, HCHO, CO,) were recorded in all Two office buildings under the present study. Suggests A1 and A2 offices building that the indoor concentration of PM2.5 PM10 and co_2 plays a major role and VOC, TEMP, HUM, HCHO, CO contributes minor role among Seven pollutants. A significantly higher range of pollutant A1 and A2 office buildings indicates immediate action is required to reduce the PM2.5, PM10, and Co_2 concentrations inside the building. However, apart from the Data analysis prepared Bar charts and Pie charts A1and A2 offices building five days duration PM 2.5, PM10, and CO_2 concentration of pollutants higher. Indoor air quality improvement and suggestion A1 and A2 office building This study also indicates that there is a need for regular study of air-circulation, inside the air-conditioned building, large improve its indoor air quality. However, a year-long study of IAQ can support to development seasonal plan to improve the air quality inside the buildings.

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