Air Quality Index Management of a Medium-Sized Community Space Through Nature-Based Solutions in Gurugram,Haryana

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Abstract. A case study details the Air Quality Index (AQI) audit and improvement conducted for office space in Gurugram, Haryana (Urban Air Labs Pvt. Ltd.). The parametric was the concentration of Particulate Matter (PM) of 2.5 (µg/m3) outdoors and indoors in the comparison. Due to the absence of volatile organic compounds, the AQI rating and PM2.5 concentration directly affect quality status representation. The safer rating of the AQI as per the NAQI standards is 50, and for PM2.5, the average of 24 hours is 30; the safer rating for 24 hours, the average PM2.5 as per the WHO revised standard is 15. In general, the measured AQI and PM2.5 rates of the site were 161 ± 20 & 85 ± 10 outdoors and 181 ± 20 & 105 ± 10 indoors. Hence, the test location was equally polluted outdoors and indoors and needed attention. With Urban Air Labs (patent applied) novel device UBreathe Life and UBreathe Mini, which uses Nature-based solutions (NBS) such as Phytoremediation and other bio-mimicked tech stacks for inducting air quality control. Using the mentioned equipment(s) and a few preventive measures, the AQI indoors was tracked down to ± 50, with single-pass efficiency being ~65%. The followed protocol lays a benchmark for future work on reducing AQI and PM in the workspace relevant to the discussion arena. The future scope includes improving efficiency with a multi-pass system and better regulating AQI with different devices suitable for various configurations.

Keywords: AQI, PM2.5, Nature-based solutions, UbLife.

1 Introduction and background

Air pollution is a real issue and a ticking time bomb. Not only developed but even developing countries with considerable populations need help in front of this challenge. As per the World Health Organisation report in 2022 [1], India has a 53.3 µg/m3 concentration of PM2.5 (Particulate Matter of size less than 2.5*10-6 m (micron)) against the recommendable limit of 15 µg/m3. Although it is slightly lower than 2021 (58.1 µg/m3), it is still four-fold higher than what makes air breathable. All this hazardous rise in PM concentrations and air pollution leads to many catastrophic consequences. These particulate matter and other unwanted gases in polluted air cause respiratory diseases, heart and pulmonary obstructive infections, strokes, and chronic issues such as lung cancer and asthma. The Government of India and its policymakers focus on this through the National Clean Air Programme, Pradhan Mantri Ujjwal

Yojana, and others. However, a long road is still ahead to travel for safer air. Generally, air quality is not directly referred to through concentration but through AQI (air quality index). AQI is better and more holistic than citing the concentration of only one-sized particulate matter. AQI is an index that summarizes the status of air quality daily [2]. It could be local, outdoor, and indoor in the environment in which it is evaluated. Generally, outdoor AQI is considered the most affected and polluted due to the many deterrents present. The following Table 1 with the value of AQI represents the quality of air:

Table 1. AQI range with the corresponding level of health concern

Air Quality Index (AQI)	Level of Health concern
0-50	Healthy
50-100	Moderate
101-150	Breathable
151-200	Unhealthy
201-300	Extremely Unhealthy
301-500	Hazardous

The factors affecting AQI values are ozone concentration, particle pollution, carbon monoxide, and sulfur dioxide [3]. Thus, the different purification techniques have other target species to purify the air. The choices of purification depend on the environment, design, economic factors, and after-effects of the process. Existing techniques to purify the air quality are categorized into two sections: Particulate matter and gaseous purification techniques. Many characteristics must be examined for selecting a particulate matter purification technique, including temperature, humidity, exhaust gas flow pattern, particle size, and chemical nature. Hence, there are different scrubbers, filters, and separators under the particulate matter purification technique. However, there are four phenomena through which gaseous pollutants can be removed from the air: absorption, adsorption, condensation, and combustion. The first three phenomena are recovery techniques and combustion phenomena that generate flares and destroy the pollutant. All the above discussion elucidates that the task of purification of air from its pollutants is time, energy, and economically challenging.
High-efficiency particulate air filter, abbreviated as HEPA filter, is used for the removal of tiny (micron/sub-micron) and harmful particles such as pollen, pet furs, smoke, dust, and air-borne viruses with an efficiency of 99.95% (or 99.97%) [2, 4]. It is the most utilized and referred filter for clinical to industrial usage. Activated carbon filters mainly capture VOC (volatile organic compound), which may diffuse the collected gases after a few days of use and spread a fouling smell [5]. They pose a significant drawback to the non-filtration of particles; hence, they are less used. Unlike activated carbon filters, ionizers remove smaller particles and odor by throwing negatively charged ions into the air. Still, they are ineffective against large particles such as pollens. The above discussion states that air purification (or technically filtration) is a largely mechanized industry; hence, different types of filters are only used to date. In the present article, we prove that Ubreathe devices are effective by following nature-based solutions with a 65 % reduction of AQI in a single pass for their UBreathe

Life stacked with their patent filed ‘Breathing Roots Technology’ & ‘Urban Munnar Effect.’ Also, it is reported that there is a 77% hourly decrease in AQI levels for a room size of 300 sq ft., as per the lab test reports from the National Aerosol Laboratory, IIT Kanpur. This will support the claim of better nature-based solutions for real-life problems, especially environment-related issues.

2 Test area and Pre-treatment

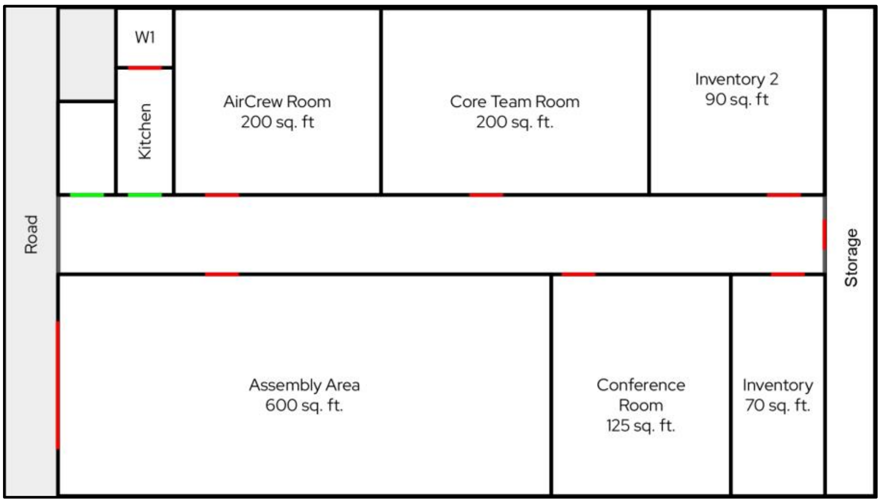

Fig. 1. 2D Layout of the Site (Red marked boundaries are doors & Green Marked Boundaries are Open Areas)

The test area includes three spaces: (a) Core-Team Room (CTR), (b) Assembly Room (AR), and (c) Air-Crew Room (ACR) with the area as below Table 2:

Table 2. Investigated spaces with the respective area

Space	Core-Team Room	Assembly Room	Air-Crew Room
Area	200 sqft	600 sqft	200 sqft

Initially, the Core-Team Room & Air-Crew Room were used as usual seating, discussion points, and product development activities, which included soldering and prototyping activities without specific attention to ventilation, infiltration, and air quality (see Fig. 1). The Assembly Room was dedicated to the manufacturing and assembly activities of products. The processes usually included cutting, grinding, soldering, bonding, scrubbing, buffing, etc. The assembly area acted as a significant source of pollution for other spaces. Therefore, AQI was very drastic (ranging from 160 to 200), and the concentration of PM2.5 particles varies from 85-125 µg/m3.

Before employing the proposed technique/solution for air quality improvement, a few pre-treatment steps were taken. Identification of the source of various pollutants, area segmentation, proper air ventilation, pollutant cut-off, and inter-mixing prevention mechanisms are deployed before the Ubreathe solution. This was initiated to practice checking on air quality at regular intervals and adapt to day-to-day life. The source of pollutant generation identification is crucial as a significant chunk of it can be easily avoided. Infiltration, renovation, manufacturing, and cooking activities are the leading causes of pollutant generation. Infiltration can be minimized by applying specific closure and air-masking arrangements for doors and windows. Renovation activities such as painting, glass cleaning, and others generate gaseous fumigants, leading to air pollution. Segmentation of spaces is also essential, as there are many spots with breathable concentrations of PM2.5. Still, due to the presence of sites with very high concentrations of PM2.5, the whole dynamics change to polluted. So, if balanced area segmentation is done, purification will be done in a targeted manner. Last but not least, there are three mechanisms of pollutant removal, namely: (1) Purification through an air conditioner, (2) Purification through an air purifier, and (3) Phytoremediation [6, 7] for the given space. A Standard operating procedure (SOP) is designed based on the general routine of the targeted space. Following are the steps of the SOP:

- The exhaust fan must be turned on continuously. Create a little amount of negative pressure.
- While the office is still open, the cabins 8 Ub Mini and 4 Ub Life units must be turned on. (Kept preferably in the middle of the area to prevent wall blockers).
- In the assembly room, two Ub Life units must be turned on and maintained close to the work area while conducting any machining.
- All of the cabins' doors should be kept closed, and the corners of the doors and windows should be adequately sealed with tape.
- The front door should always be locked. As per customary standards, infrequent door openings provide fresh air ventilation.
- The main entry door should always be slightly ajar when painting and spraying are done. In this situation, there ought to be two purifiers operating close to the activity.
- For appropriate sunshine and fresh air, all plants must be kept in an open environment every 15 days.
- The plant’s dead leaves must be routinely removed.
- All plants must receive the necessary amount of water.
- To dissolve the particles accumulating on the leaves cuticles and increase surface adsorption capacity, plants' leaves must be sprayed with moisture every two days.
- The workplace has to be cleaned often to prevent the accumulation of contaminants. Turn off the fan and purifiers while cleaning to prevent mixing up the contaminants and circulation of pollutants in the air.

Fig. 2. (a) Ub Life and (b) Ub Mini

3 Test area and Pre-treatment

Ub Mini and Ub Life (Fig. 2) are two novel products from Urban Air Labs that are nature-based solutions to curb air pollution. It is backed by the UNDP accelerator lab, Biotechnology Industry Research Assistance Council (BIRAC), and other research agencies working on air quality improvement. Ubreathe's technology works on the patent filed "Urban Munnar and Breathing Roots" technology and harnesses air purification coupled with 5-layer filtration techniques. The filtration technique includes UV, charcoal, HEPA, and a stack of pre-filters with specially selected plants to remove particulate matter, volatile organic compounds, and gaseous and biological contaminants. The size of Ub Mini and Ub Life are 0.34 and 2.82 sqft2. Hence, the installation area requirement is much less than a nominal office space. It is cost-efficient, low on maintenance, and increases available oxygen. Three essential parameters for air purification are the penetration, efficiency, and permeability of the process or technique. The efficiency is the easiest of the three as it is the ratio of the volume of clean air delivered to the total air filtered ($\eta = V\_clean/V\_total$). Penetration refers to the particle size that passes through the filter tested; it is a vital factor in deciding which filter is suitable. Permeability measures the extent of air passage through the given material. All three elements are taken care of in Ubreathe technology (see Table 3).

Table 3. Parameters of Ubreathe products

Parameters	**Ub Life**	**Ub Mini**
Single Pass Efficiency	65 %	15 %
Penetration (micron)	0.3	0.3
Permeability (m/s)	1.39	1.44

4 Result & Discussion

4.1 Month and Hour-wise Variation of AQI with Ubreathe:

As reported in Fig. 3, the monthly AQI of the investigated areas (with the devices) is much lesser (at least by 50%) as compared to the outdoors (without the devices). The data shown is a monthly average to negate the effort of sudden surges or shortfalls. The AQI of Air-crew space has the most significant change (60% <) due to the nearby placement of the Ubreathe device and other precautionary measures. This result signifies the deployment of Ubreathe technology for air quality improvement in the long run. The machines needed to be more capable to provide satisfactory air purification from mid-May to mid-August. The reason behind this outlier is construction activity in the vicinity of the test space for the given duration. Although a surge is noticed, AQI remains within breathable limits (< 100). For shorter or hourly exposure, Fig 3b explains the status of AQI from 10 AM to 7 PM (practical working hours). The spaces of the Assembly room only cross the regime of safe limit, and that too after lunch hours due to more gathering, higher manufacturing activities, and infiltration at the latter half of the day. Despite this, AQI is still very close to the safe limit, hence breathable (AQI Safe limit is 50).

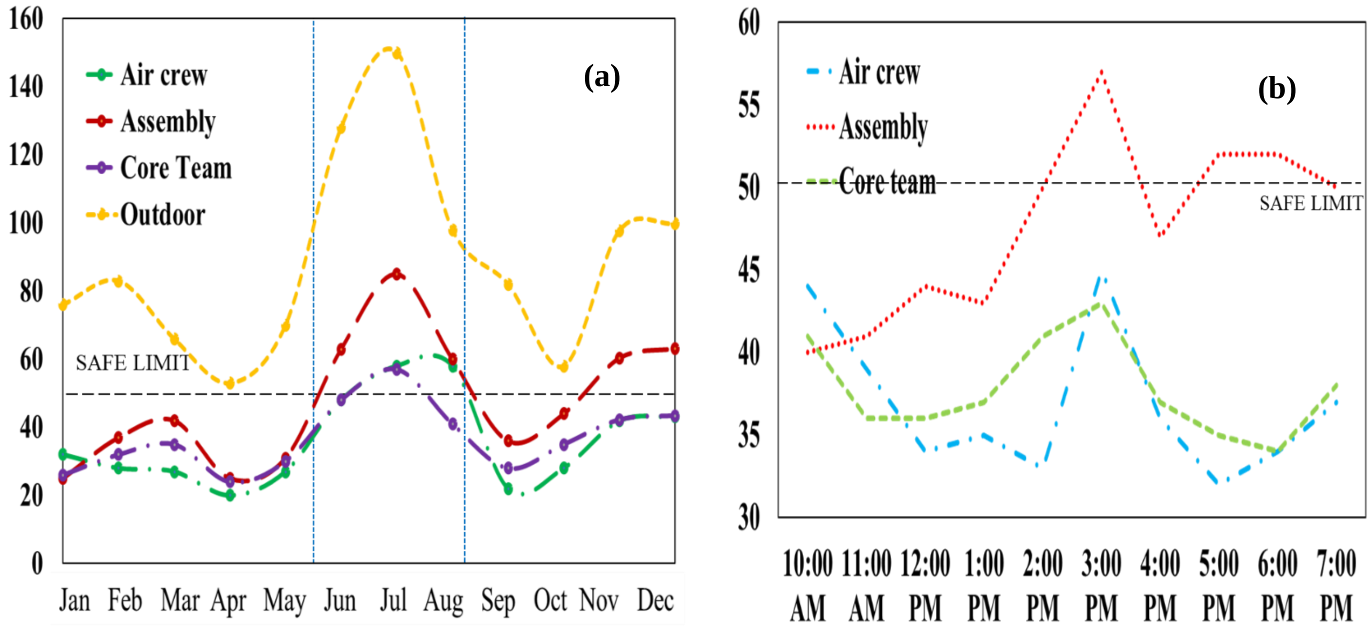

Fig. 3. (a) Month-wise variation of AQI with (investigated spaces) and without (outdoor) Ubreathe and (b) Hourly variation of AQI of the investigated spaces with Ubreathe.

4.2 PM2.5 Concentration Indoor vs. Outdoor with Ubreathe:

The second important parameter in air quality is the level (concentration) of PM2.5 particles. Figure 4 showcases the concentration of PM2.5 particles with and without Ubreathe (NBS). A 65% reduction is reported for indoor cases, from ~120 to ~35 μg/m^3. There were no changes in PM2.5 concentration for outdoor cases.

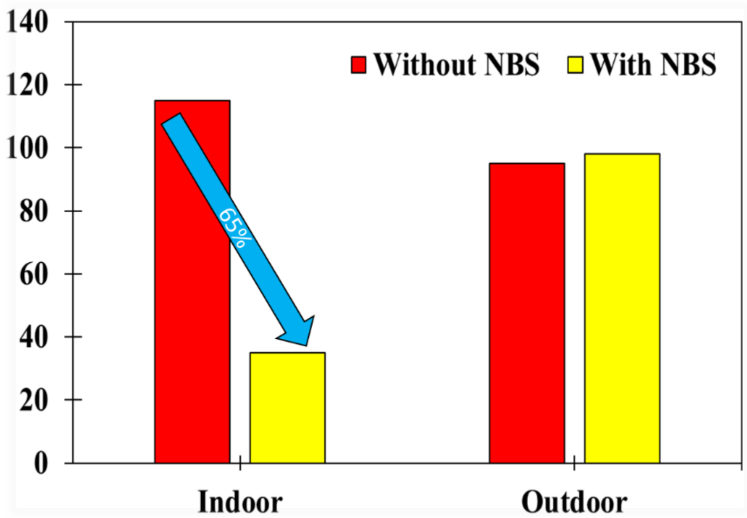

Fig. 4. Concentration of PM2.5 particle with and without nature-based solution (NBS-Ubreathe) for indoor (investigated space) and outdoor.

Combining the observations of Figures 3 and 4, it is evident that using the Ubreathe solution brings down the AQI and PM2.5 concentration to at least a breathable limit, if not less. Therefore, Ub Life and Ub Mini are highly recommended for offices, assembly, closed wall structures, and gathering places for better air quality.

5 Conclusion:

The air quality index (AQI) and concentration of particulate matter PM2.5 were targeted in the investigated spaces of different areas. Ub Life and Ub Mini were the products deployed to improve the task. The result shows that AQI is reduced by ~ 50% monthly and ~ 54% hourly with Ubreathe nature-based solution. For PM2.5 concentration, the investigated spaces generally report a ~ 65% reduction. These observations were made to make the truthful claim of Ubreathe for better air purification compared to existing filter-based purification.

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