



Focus on IAQ in India

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Main Ambient Air Pollution in India

- Particulate matter (dust, fine and ultra-fine):
 - Traffic (especially diesel cars);
 - Energy production (especially coal power plants);
 - Chullahs and other open fire cooking;
 - Construction work;
 - Stubble burning;
 - Burning of waste;
 - Industrial process emissions.
- Gases (SO₂, NO₂, O₃, etc.)
 - Traffic;
 - Industrial processes;
 - Open sewage systems.



WHO: Ambient air pollution in cities database 2014

PM_{2.5} Annual average 2012 (µg/m³)

- **Top 5 most polluted cities in USA:**

– Fresno, CA	45
– Riverside-San Bernardino-Ontario, CA	21
– Los Angeles-Long Beach-Santa Ana, CA	20
– Fairbanks, AK	19
– Hanford-Corcoran, CA	17

**2-5 times
higher**

- **Top 5 most polluted cities in India:**

– Delhi	153
– Patna	149
– Gwalior	144
– Raipur	134
– Ahmedabad	100

**10-15 times
higher**

- **Top 5 most polluted cities in Australia:**

– Busselton	9
– Bunbury	8
– Adelaide	8
– Launceston	8
– Perth	7

**< WHO AQG
level**

WHO AQG level: < 10 µg/m³

UNEP: Economic Cost of Air Pollution

- Worldwide over 3.5 million people die each year from outdoor air pollution.
- Between 2005 and 2010, the death rate rose by 4% worldwide, by 5% in China and by 12% in India.
- Cost of air pollution to society in 2010 was estimated at USD 1.4 trillion in China and USD 0.5 trillion in India according to a recent study by the OECD.
- In US about 85% of the economic benefits would be due to fewer premature deaths linked to reducing PM_{2.5} in the outdoor environment.

Annually in India INR 30,000,000,000,000
INR 25,000 per person

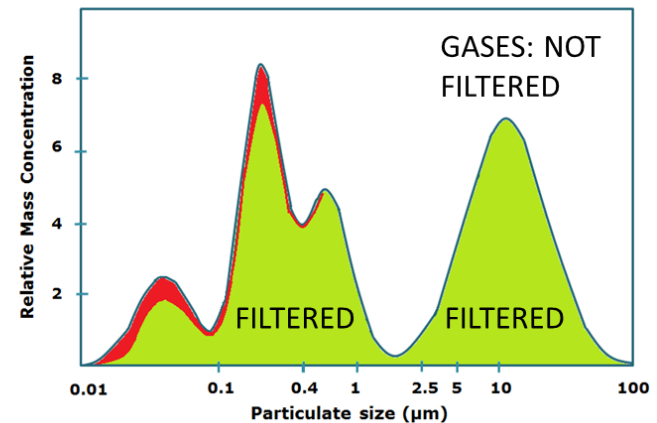
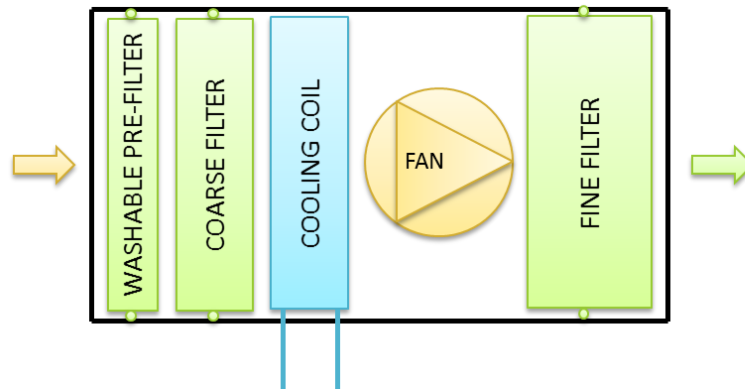
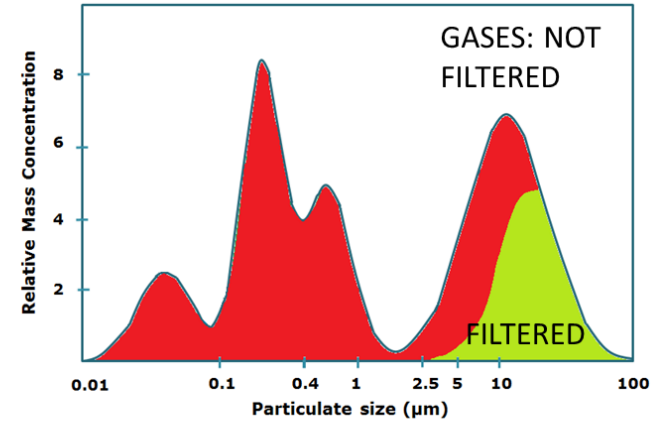
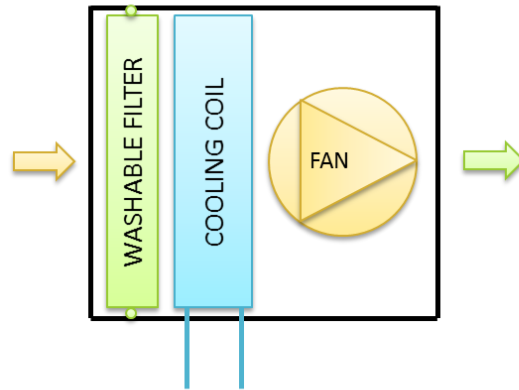
Indoor Air Quality

- Outdoor air is the biggest indoor air pollution source - if air is not properly filtered and purified before taken indoors;
 - Particulate pollution
 - Gases
- Other indoor air pollution sources are:
 - Tobacco smoking;
 - Copy machines and printers;
 - Cleaning products;
 - Moisture damages and mould growth;
 - Paints, solvents and other construction materials;
 - New furniture;
 - Scents (perfumes, temple sticks, etc.);
 - Other people.



Examples of Air Filtration Solutions

Industry norm
in India today



Are Room Air Purifiers Focusing on Essential Issues in India?

- Nearly every model is developed to solve IAQ problems in special cases:
 - Fungal and bacteria growth in moisture damaged buildings;
 - In environments with much lower dust and RSPM levels in outdoor air.
- Recommended for occupants who has reduced lung capacity, allergy or asthma and therefore most of room air purifiers are developed to remove or kill microbiological contamination.

1. HEPA filter to remove particulates and microbiological contamination
 - No proper coarse particulate filtration to protect HEPA filter
 - => Life time of HEPA is only 6-12 weeks
 - => High filtration cost

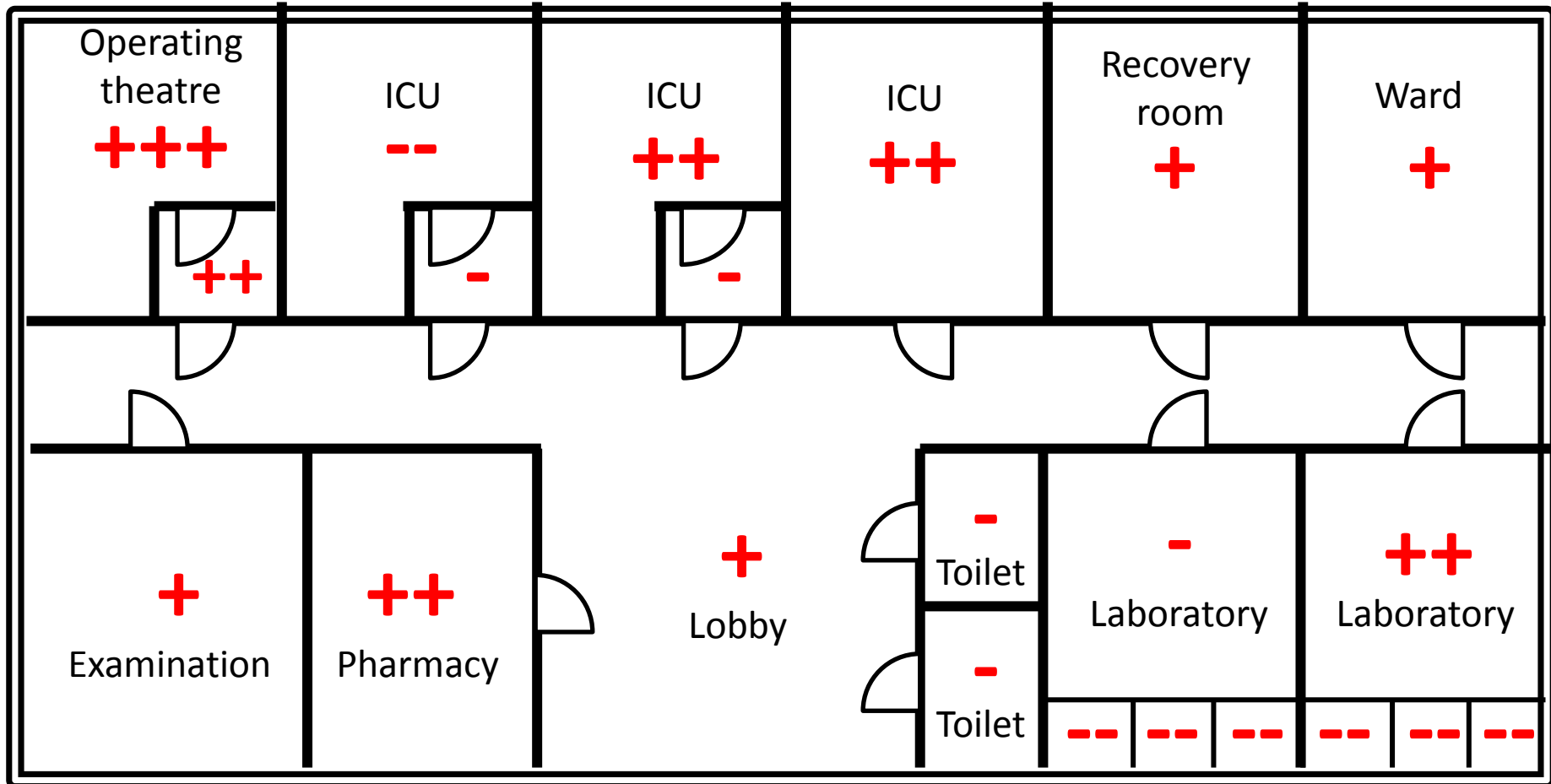


2. Different technologies to sterilize air:
 - UV-light
 - Gold plasma
 - Photo-hydro-ionization
 - etc.
3. Deodorization of air:
 - Oxidation
 - Ionizer unit
 - Ozoniser unit
 - Use of Silver ions, Diatoms & Vitamins
 - etc.

Are these really needed in every home, school and office?

Pressurization of Spaces

Ambient ± 0



Critical: air flow balancing and control, pressure measurement

Case study: Different solutions in office building

- Existing office building 2,000 m², 4 x AHU each 10,000 cfm.
- Room air purifier:
 - High quality air purifiers, 50 pcs (each 35 m²);
 - Filters changed annually 4 times, each package INR 10,000;
 - Energy use 80 W/unit, operating 10 h/day, 250 days a year.
- Ambient air purifier:
 - Fan-filter units, each 2,000 cfm, installed at the point of indoor air intake, 4 pcs;
 - Pre-filters washed annually 7 times, coarse filters changed 3 times and fine filters once a year;
 - Energy use 6.6 kW/unit (EC fan).
- Air handling unit retrofit – new filter package and EC fan:
 - New filter packages (pre, coarse and fine filter) retrofitted;
 - Pre-filters washed annually 7 times, coarse filters 3 times and fine filters once a year;
 - New EC-fan consumes 40% less energy, saving 6 kW/unit.

Investment and Annual Costs

	Room air purifiers 50 pcs, each 35 m2	Retrofit of existing AHU (new filters + EC fan)	Ambient air purifiers 4 pcs in outdoor air intake
Technical review, design, project management	0	☐ 4,00,000	☐ 4,00,000
Equipment, installation, civil and electrical work	☐ 50,00,000	☐ 43,00,000	☐ 18,00,000
Duct cleaning and retro-commissioning of existing system	0	☐ 3,00,000	☐ 3,00,000
Total investment	☐ 50,00,000	☐ 50,00,000	☐ 25,00,000
Annual filter change cost	☐ 20,00,000	☐ 3,00,000	☐ 1,50,000
Energy cost / saving	☐ 60,000	☐ -3,00,000	☐ 4,00,000
Total annual cost	☐ 20,60,000	0	☐ 5,50,000

Parameters to be Measured in Indoor Air

BASIC:

- Dry-bulb air temperature (T)
- Relative humidity (RH)
- Carbon Dioxide (CO₂)
- Respirable Suspended Particulate Matter PM_{2.5}
- Respirable Suspended Particulate Matter PM₁₀
- Carbon Monoxide (CO)
- Total Volatile Organic Compounds (TVOC)

ADDITIONAL:

- Formaldehyde (HCHO)
- Benzene (H₆C₆)
- Ozone (O₃)
- Sulphur Dioxide (SO₂)
- Oxides of Nitrogen (NO_x)
- Total Fungal Count

ISHRAE is preparing the IEQ standard for India:

- IAQ
- Thermal comfort
- Lighting
- Acoustics
- User feedback

Solutions for Good IAQ in India

- Clean the outdoor air before taken into a building:
 - Sufficient particulate filtration;
 - Chemical filtration if ambient air has high gas concentrations.
- Use sufficient ventilation to manage CO₂ and relative humidity indoors.
- Make sure that air flows are properly balanced.
- In case Room air purifiers are used, prefer the models with good particulate filtration. Avoid unnecessary sterilization of air.
- Use low or non-VOC construction materials, furniture and cleaning products.
- Locate copy machines and printers to separate rooms.
- Prevent moisture damages and act immediately to remove the cause and repair damages.
- Use of plants to reduce need for polluted ambient air intake – but remember maintenance of them.

WELL Building Standard & India

- INCREASED VENTILATION – no requirement for filtration.
- MICROBE AND MOLD CONTROL / COOLING COIL MOLD REDUCTION – safety issues related to retro-installation of UV-lights, cheap labour in India to maintain cooling coils.
- ADVANCED AIR PURIFICATION / AIR SANITIZATION – may reduce people's immunity against air pollution that is still much better than those in Western countries.
- DISPLACEMENT VENTILATION – in low ceiling height spaces not necessarily more energy efficient and improvement in air quality depends on the diffuser selection.

Clean Air

