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MODULE  
**15**

# Indoor & Site Environments: Air Quality

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Air quality significantly impacts health, economic outcomes, and social equity, necessitating urgent attention in urbanization to improve living conditions and public health outcomes.

# Learning Objectives +

- Energy Analysis: Envelope, Massing, and Orientation Optimization
- Energy Analysis: Initial Assessment
- Energy Analysis: Ventilation
- Energy compliance modeling
- Indoor and Site Environment: Thermal Comfort
- Indoor and site environments: air quality
- Indoor and Site Environment: Lighting
- Controls and monitoring: Control Hardware
- Controls and Monitoring: Control Strategies



## INTRODUCTION

### Defining Air Quality

- Air quality is determined by the concentration of pollutants, divided into primary and secondary pollutants.
- Primary pollutants include particulate matter (PM), nitrogen oxides (NOx), and sulfur dioxide (SO<sub>2</sub>).
- Secondary pollutants form when primary pollutants undergo chemical reactions in the atmosphere.

### Health Implications of Poor Air Quality

- Exposure to high levels of pollutants can lead to respiratory conditions, cardiovascular diseases, and cancer.
- Long-term exposure to fine particulate matter (PM<sub>2.5</sub>) is associated with a higher risk of developing heart disease and stroke.

### Indoor Air Quality (IAQ)

- Indoor air quality (IAQ) is significant as individuals typically spend a substantial portion of their time indoors.
- Common indoor pollutants include volatile organic compounds (VOCs), carbon monoxide (CO), and mold spores.

# IMPACT OF AIR QUALITY ON INDOOR AND SITE ENVIRONMENTS +



## Economic Impacts

- Poor air quality can lead to increased healthcare costs, reduced worker productivity, and decreased property values.
- A report by the World Bank estimated that air pollution costs the global economy over \$5 trillion annually in welfare costs.

## Environmental Justice and Disparities

- Disadvantaged communities often bear a disproportionate burden of air pollution.
- Factors such as socioeconomic status, race, and geographic location play significant roles in exposure levels.

## Mitigation Strategies

- Regulatory Frameworks: Governments must implement and enforce air quality standards to limit emissions from industrial and vehicular sources.
- Technological Innovations: Advances in technology can improve air filtration and ventilation systems in buildings.
- Public Awareness and Education: Educating the public about the sources and effects of air pollution can empower communities to advocate for cleaner air.

# CONTROL OF INDOOR AIR CONTAMINANTS/POLLUTANTS

- Indoor air quality (IAQ) is crucial for environmental health and influencing well-being and productivity.
- Contaminants can arise from various sources including building materials, furnishings, cleaning agents, and occupants.

## Types of Indoor Air Contaminants

- Biological Pollutants: Mold, mildew, dust mites, pet dander, and bacteria.
- Chemical Pollutants: Volatile organic compounds (VOCs), formaldehyde, carbon monoxide, and radon.





# CONTROL OF INDOOR AIR CONTAMINANTS/POLLUTANTS +

## Sources of Indoor Air Contaminants

- Building Materials: Particleboard, plywood, and certain types of flooring can emit VOCs due to adhesives and finishes.
- Household Products: Cleaning agents, air fresheners, and personal care products can release harmful chemicals into the air.
- Occupant Activities: Cooking, smoking, and burning candles can introduce particulate matter and other harmful substances.
- Inadequate Ventilation: Poor ventilation can lead to the accumulation of indoor pollutants.



# CONTROL STRATEGIES FOR INDOOR AIR CONTAMINANTS +

- Source Control: Eliminating or reducing the sources of pollutants.
- Ventilation: Proper ventilation is essential for diluting indoor pollutants and bringing in fresh outdoor air.
- Air Cleaning: Air cleaning devices like HEPA filters, activated carbon filters, and UV light air purifiers can effectively remove or neutralize airborne contaminants.
- Regular Maintenance: Routine maintenance of HVAC systems, including filter changes and duct cleaning, plays a critical role in preventing the buildup of contaminants.



# IDENTIFYING OUTDOOR AIR VENTILATION REQUIREMENTS

## Definition of Outdoor Air Ventilation

- Outdoor air ventilation involves the introduction of fresh air to dilute and remove indoor pollutants, regulate temperature, and enhance occupant comfort.
- It helps mitigate the effects of indoor air contaminants like volatile organic compounds (VOCs), carbon dioxide (CO<sub>2</sub>), and particulate matter.

## Regulatory Framework and Standards

- Building codes and standards dictate the requirements for outdoor air ventilation.
- ASHRAE Standard 62.1 and LEED Certification are key standards.
- These standards serve as benchmarks for determining necessary outdoor air ventilation rates based on building usage, occupancy density, and the presence of indoor air contaminants.



# IDENTIFYING OUTDOOR AIR VENTILATION REQUIREMENTS +

## Factors Influencing Ventilation Requirements

- Building Occupancy Type: Residential buildings typically require a lower ventilation rate than commercial buildings.
- Occupant Density and Activity Level: The density of occupants and their activities significantly influence ventilation requirements.
- Indoor Air Quality (IAQ) Contaminants: The presence of pollutants dictates the need for increased ventilation.

## Methodologies for Determining Ventilation Requirements

- Ventilation Rate Procedure (VRP): Calculates the minimum outdoor air intake based on the building's occupancy type, square footage, and number of occupants.
- Indoor Air Quality Procedure (IAQP): Allows for flexibility in meeting ventilation requirements based on actual IAQ measurements.



# ANALYZING AIR QUALITY STRATEGIES

## Regulatory Frameworks

- National Ambient Air Quality Standards (NAAQS) set by the EPA for six common air pollutants.
- Emissions Trading Systems (ETS) provide economic incentives for reducing emissions.
- EU ETS caps the total level of greenhouse gas emissions and allows industries with low emissions to sell their extra allowances to larger emitters.

## Technological Innovations

- Air Quality Monitoring Systems: Sophisticated sensor networks provide real-time data on air pollutants.
- Pollution Control Technologies: Scrubbers, electrostatic precipitators, and catalytic converters reduce emissions from industrial processes and vehicles.
- Data Analytics and Modeling: Advanced data analytics techniques like machine learning and artificial intelligence are used to analyze air quality data.



# ANALYZING AIR QUALITY STRATEGIES +

## Community Engagement and Education

- Public Awareness Campaigns: Inform the public about air pollution sources, health effects, and mitigation strategies.
- Citizen Science Initiatives: Engage citizens in air quality monitoring to enhance data collection and public involvement.

## Policy Interventions

- Incentives for Clean Technologies: Governments can promote the adoption of clean technologies through tax credits, subsidies, or grants.
- International Agreements: Agreements like the Paris Agreement aim to unite countries in their efforts to mitigate air pollution and address climate change.



# RECOGNIZING APPLICATIONS REQUIRING GOVERNMENTAL AND REGULATORY CODES FOR AIR QUALITY STANDARDS COMPLIANCE

## Regulatory Framework for Air Quality Standards

- Established through federal, state, and local regulations.
- In the US, the Clean Air Act (CAA) governs air pollution.
- EPA sets National Ambient Air Quality Standards (NAAQS) for six criteria pollutants.

## Industrial Applications

- Industries contribute significantly to air pollution.
- Compliance with standards is essential for industries producing chemicals.
- Examples include the installation of scrubbers and catalytic converters to reduce emissions of volatile organic compounds (VOCs) and nitrogen oxides (NOx).
- Failure to comply can lead to public health threats and legal penalties.



# RECOGNIZING APPLICATIONS REQUIRING GOVERNMENTAL AND REGULATORY CODES +

## Transportation Applications

- Transportation is a major source of air pollution.
- Regulatory frameworks like the EPA's Vehicle Emission Standards require automotive manufacturers to limit harmful substances emissions.
- Examples include the Clean Air Nonroad Diesel Rule, which mandates the reduction of emissions from diesel engines.

## Urban Development and Land Use Planning

- Zoning laws and development regulations directly impact air quality.
- An Environmental Impact Assessment (EIA) is required for new developments in high-traffic areas.
- Planners must ensure compliance with air quality standards to maintain a balanced ecosystem.



# RECOGNIZING APPLICATIONS REQUIRING GOVERNMENTAL AND REGULATORY CODES + Energy Production

- Regulatory codes govern emissions from power plants to ensure compliance with air quality standards.
- Examples include the Mercury and Air Toxics Standards (MATS), which require coal- and oil-fired power plants to limit emissions of mercury and other hazardous pollutants.

## Impact on Public Health

- Poor air quality is linked to respiratory diseases, cardiovascular conditions, and premature mortality.
- Compliance with air quality standards is likened to a vaccination program against diseases.





# RECOGNIZING THE EXTERNAL ENVIRONMENT'S IMPACT ON AIR QUALITY

## Natural Environmental Factors

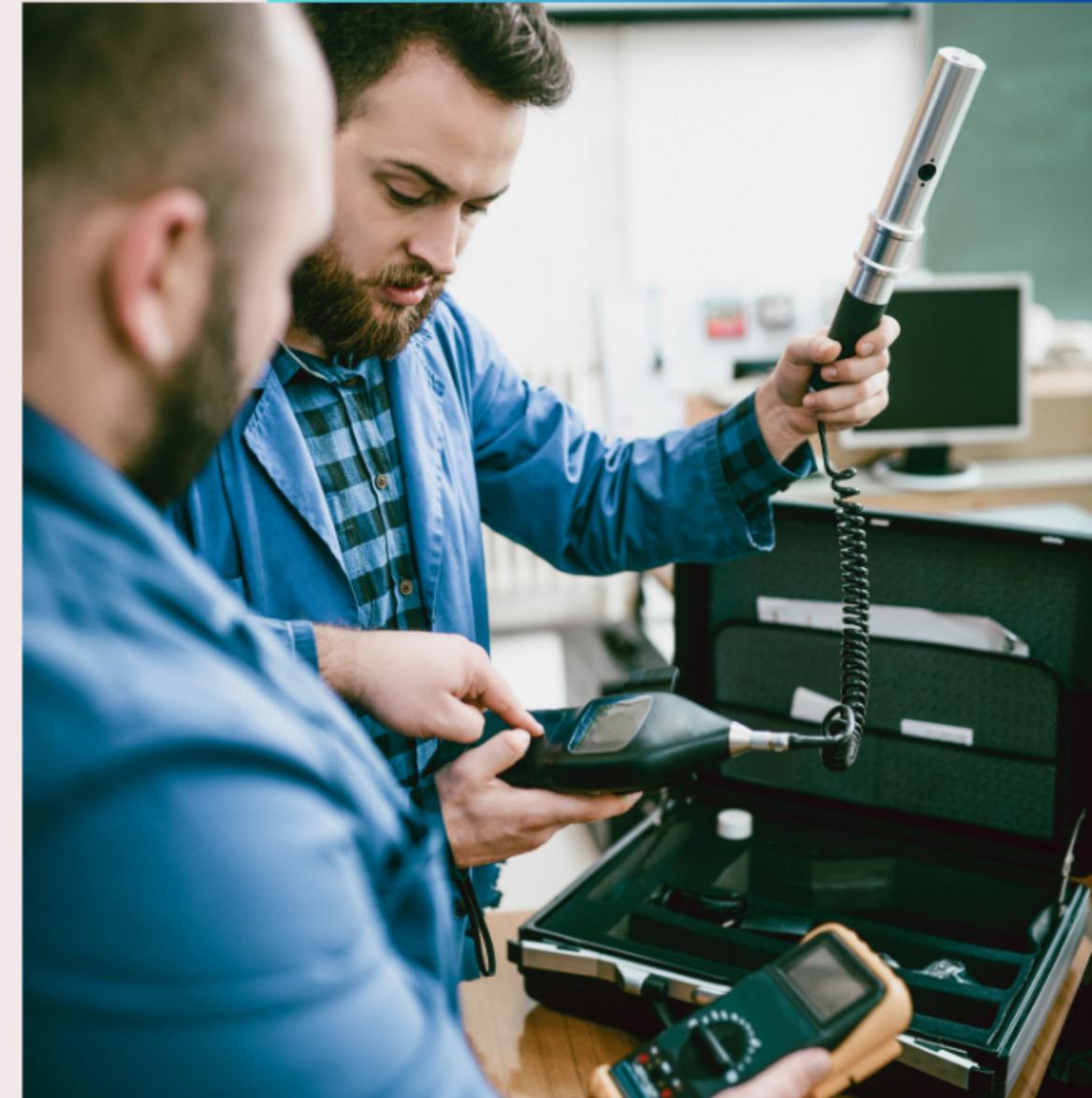
- Meteorological Conditions: Temperature inversions can lead to the accumulation of pollutants in urban areas.
- Geographical Features: Valleys and basins can trap air pollutants, while elevated regions may facilitate pollutant dispersion.
- Biological Processes: Forests release volatile organic compounds (VOCs) through photosynthesis, which can interact with anthropogenic emissions to form ground-level ozone.



# RECOGNIZING THE EXTERNAL ENVIRONMENT'S IMPACT ON AIR QUALITY +

## Anthropogenic Factors

- Industrial Emissions: Factories and power plants release sulfur dioxide, particulate matter, and heavy metals into the atmosphere.
- Transportation: Vehicles emit nitrogen oxides and particulate matter, exacerbate respiratory conditions and contribute to ground-level ozone formation.
- Agricultural Practices: Agricultural activities, particularly fertilizers and pesticides, release ammonia and other chemicals into the atmosphere.
- Regulatory Frameworks: Government policies and regulations, such as the Clean Air Act in the U.S., establish standards for air quality and emissions that industries must adhere to.





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# THANK YOU

