



KURSUS : INDOOR AIR QUALITY (IAQ) – MODUL I

PART 3 : **IAQ CONTAMINANTS AND HEALTH EFFECT**

Tarikh : 27 & 28 Mei 2014

Tempat : Bilik Latihan Tingkat 19 CKM IPJKR Malaysia

INDOOR AIR QUALITY

- Objective :

At the end of session, participant will be able to

- Understand magnitude of problem
- Describe indoor air pollutants and the sources
- Describe health effect due to poor IAQ

INDOOR AIR QUALITY

- Background

Indoor air pollution is estimated by US EPA to cause thousands of cancer deaths and hundred of thousand of respiratory health problem each year

Why it is an issue?

- ☐ People spends 90% time indoors
- ☐ Developed Country – 50% of workforce work in an office environment
- ☐ According WHO – 30% of all commercial building have significant problem

Common Indoor Air Pollutant

Factors Can Contribute to Airborne Pollution

Particulates
Respiratory
Problem

EST, Dust

Biological Agent

Spores, Molds,
bacteria, Parasites

Hazardous
Chemical
Substance

Formadehyde,
Asbestos,
VOC,CO,CO2

Common Indoor Air Pollutant

Factors Can Contribute to Airborne Pollution

Particulates
Respiratory
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EST, Dust

Biological Agent

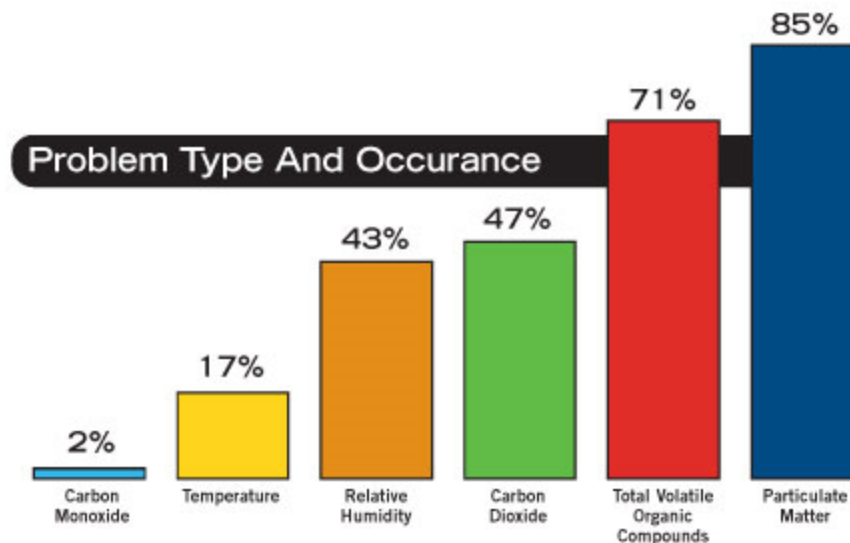
Spores, Molds,
bacteria, Parasites

Hazardous
Chemical
Substance

Formadehyde,
Asbestos,
VOC,CO,CO2

Dust, Smoke, Particulate

- Dust : Tiny solid particles
 - respirable particulate (<10 micron diameter)
 - Sources ETS, carpet, outdoor haze



Survey for
10,000 North
America home
by AirAdvice

Dust, Smoke, Particulate

- ETS : Environmental tobacco smoke
 - The substance in indoor air that originate from tobacco smoke
 - Gases :various toxic smoke : voc, formaldehyde, ammonia etc.
 - Smoke, particle, dust



Common Indoor Air Pollutant

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Respiratory
Problem

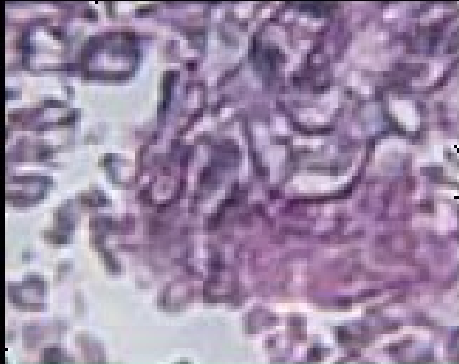
EST, Dust

Biological Agent

Spores, Molds,
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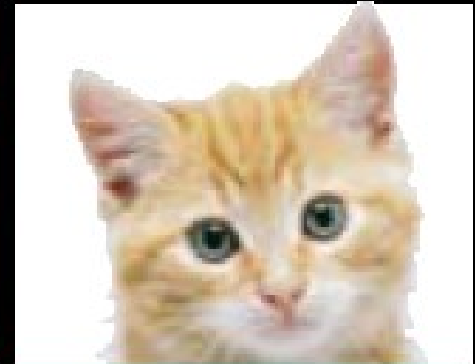
Formadehyde,
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VIRUSES



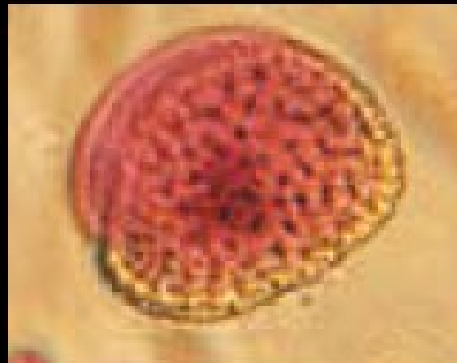
POLLEN



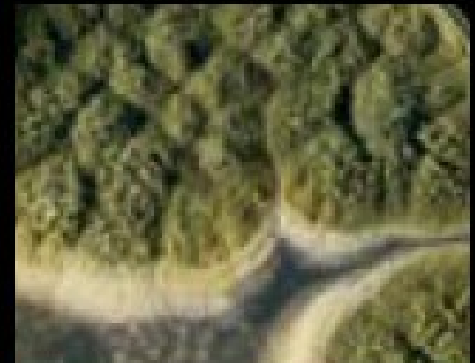
PET DANDER



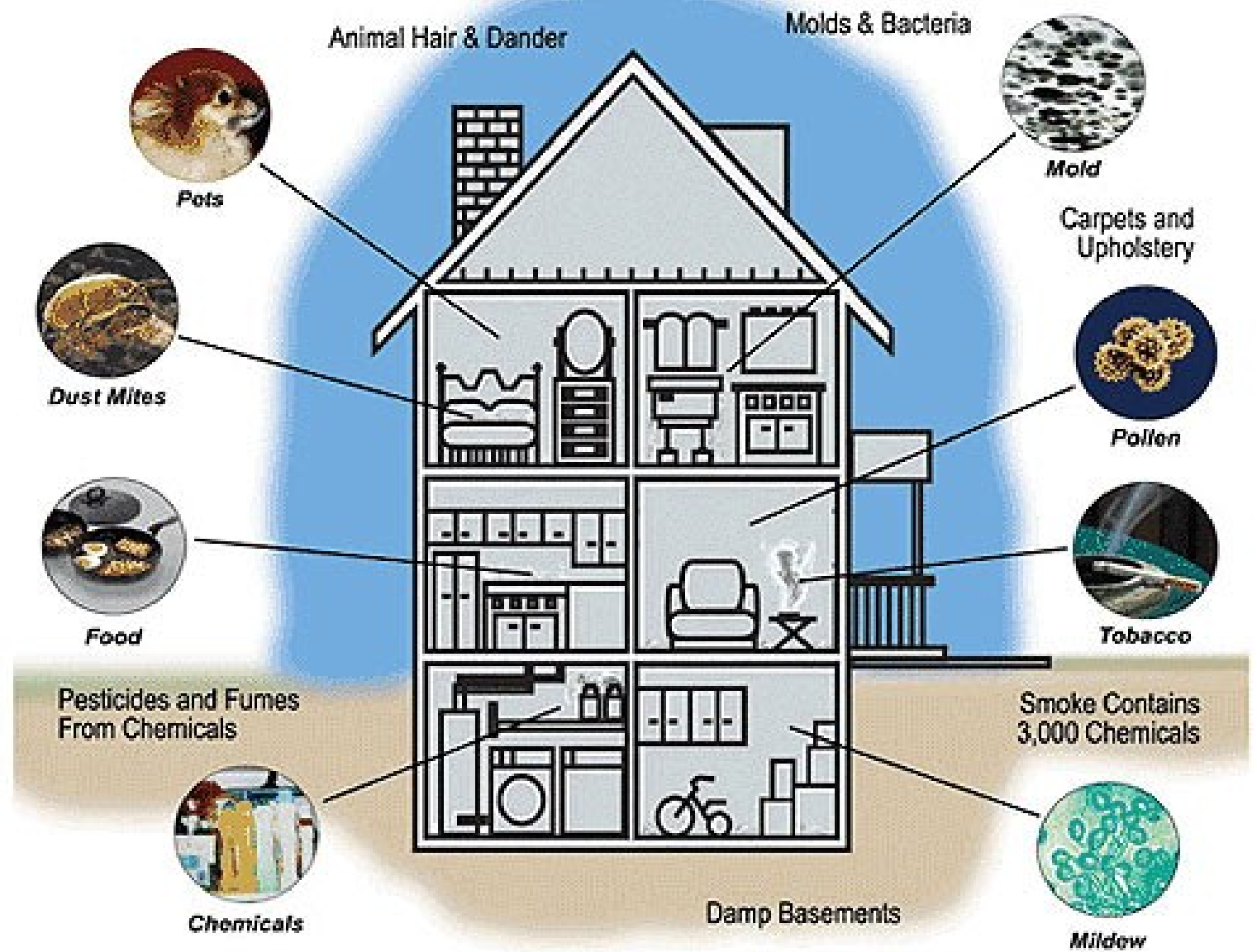
DUST MITES



BACTERIA



MOLD/FUNGI



- Type of Biological Contaminants

- Pollen
- Dander
- Insect
- Mites
- Virused
- Bacteria
- Fungi
- Protozoa

- Fungi

- Fungi are plant-like organism that lack chlorofyl
- Include mold & mildew
- Clasically there are two broad groups of fungi :Yeast and molds

- Fungi Spores

- Fungi disperse by releasing spores into the air
- They are resistant to environmental and adapt to airborne
- Aerosolized by air currents or mechanical disturbances

- Yeast

- Do not produce spores, become airborne by aerosolization of the liquid
- Inhalation of yeast can cause infectious diseases :-
 - Histoplasmosis
 - Aspergillosis

Mold

- Molds is organism. Not insect nor plant.
There are various type of molds
- A mold (US) or mould (UK) is a fungi that grows in the form of multicellular filaments called *hyphae*. In contrast, **fungi** that can adopt a single celled growth habit are called **yeasts**.
- Health effect from Molds
 - Allergy
 - Infection
 - Irritation
 - Toxicity

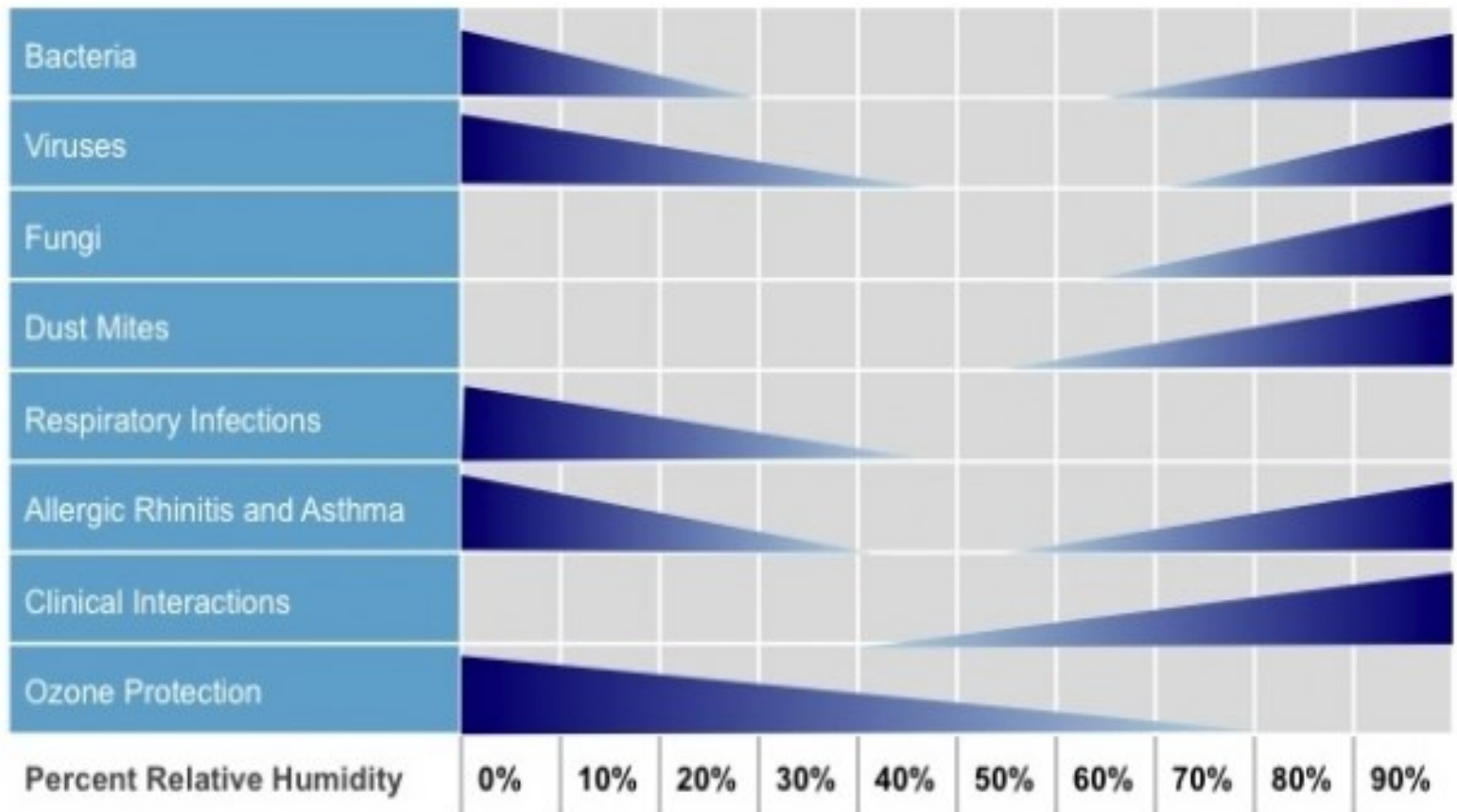
Mold

- Molds Growth require:-
 - ☐ Mould spores
 - ☐ nutrient sources – dust, cellulose, starch
 - ☐ proper temperature – 5-50 deg C
 - ☐ moisture – 75-80%RH
 - ☐ Oxygen

Mold

Relative Humidity and Indoor Air Quality Relationships

Decrease in bar width indicates decrease in effect



- **Bacteria**

- Single celled organisms ranging from 0.8 – 5 microns in diameter
- Appear in a lot of form straight rods, spiral rods, and branched filaments
- Produce endospores, resistant through environmental stressed

- **Viruses**

- Intracellular parasites that can reproduce only inside a host cell
- Consist of DNA and little else
- Found as part of droplet nuclei or attached to airborne particle
- Specific cause infectious disease as cold, flu, chicken pox

- Pollen

- Relatively large, near-spherical particles
- Anemophilous (wind pollinated) plants
 - Produce abundant bioaerosol content

Causes allergic eg ; Hay fever

Particle size in microns

.01 .30 .50 1.0 2.0 3.0 5.0 10-100

VIRUSES

RESPIRABLE DUST

TOBACCO SMOKE

BACTERIA

COOKING OIL

MOLD

POLLEN

VISIBLE
DUST

1" Filter

HC16

90%

95%

96.5%

98.4%

99.3%

99.8%

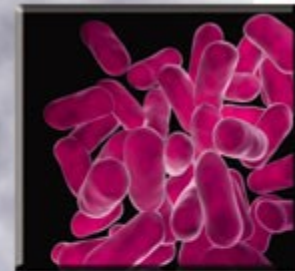
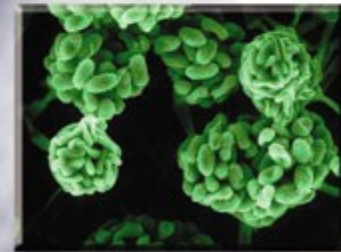
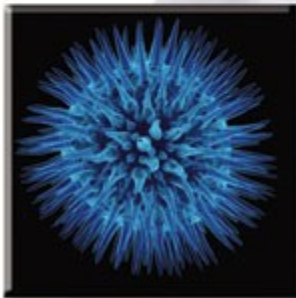
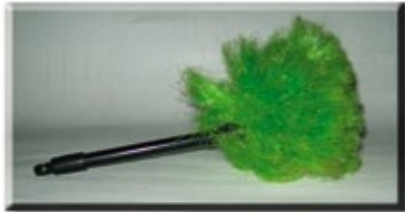
99.9%

100%

< 20%

< 20%

< 20%



Common Indoor Air Pollutant

Factors Can Contribute to Airborne Pollution

Particulates
Respiratory
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Biological Agent

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bacteria, Parasites

Chemical
Substance

Formadehyde,
Asbestos,
VOC,CO,CO2, Radon

Chemical contaminants

- Form – Gases, vapors and particulates
- Sources : Outdoor or indoor
- Major chemical contaminants :
 - ☐ Carbon Dioxide (CO₂)
 - ☐ Carbon Monoxide (CO)
 - ☐ Organic Compound (VOC, Formadehyde)

CO₂

- One of the common gases found in atmosphere
- Product of combustion (human respiration and ETS)
- Not hazardous in normal level in building.
- Ventilation play role.



CO



- Colorless, odorless, and tasteless gas
- Slightly lighter than air
- Highly toxic to human in higher quantity
- Produced from partial oxidation of carbon containing compounds, it forms when there is not enough oxygen to produce CO₂ (such as internal combustion engine in an enclosed space)

VOC

- Emitted as gas by wide array of product
- *Organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions*
- Example : paints, cleaning supplies, pesticides, carpets, building materials and furnishings, office equipment such as copiers and printers, graphics and craft materials including glues and adhesives, permanent markers, carpets, air fresheners



Formaldehyde

- Colorless gas with a pungent odor from a family of gases called aldehydes
- Important chemical used widely by industry to manufacture building materials and numerous household products
- Emissions will generally decrease as products age. When the products are new, high indoor temperatures or humidity can cause increased release of formaldehyde from these products
- Sources :
 - pressed wood products made using adhesives that contain urea-formaldehyde (UF) resins.
 - particleboard (used as sub-flooring and shelving and in cabinetry and furniture);
 - hardwood plywood paneling (used for decorative wall covering and used in cabinets and furniture);



Radon

- Radon is radioactive gas formed from the decay of uranium in rock, soil and groundwater.
- Naturally radioactive gas can cause a lung cancer
- Enter building in soil gas through joints, cracks (when building negative pressure relative to soil)

Contaminants sources

Site	Sources of Emission	Pollutant
Outdoor	<u>Fixed Sources</u> Motor Vehicles	CO, Lead, Nitrogen Oxides
	Soil	Radon, Mikroorganism
Indoor	<u>Construction material</u> Stone, Concrete	Radon
	Wood Composite	Formaldehyde
	Insulation	Formaldehyde, Fiberglass
	Paint	VOC, lead
	<u>Equipment</u> Heating system, kitchen	CO, CO ₂ , VOC
	Photocopier	VOC, Ozone

Contaminants sources

Site	Sources of Emission	Pollutant
Indoor	<u>Occupants</u> Metabolic activity	CO ₂ , Water Vapor, Odors
	<u>Human Activity</u> Smoking	CO, particulate
	Air fresheners	VOC, Fluorocarbon, Odors
	Cleaning	VOC, odor

Other sources you should know!



Formaldehyde?



Diesel
gas/particulate?



Failure to respond promptly and effectively on IAQ Problems

- Increasing health problem
- Reducing productivity due to discomfort or increase absenteeism
- Accelerating deterioration of furnishings and equipment



Contd...(Failure to respond promptly and effectively on IAQ Problems)

- Straining relations between employers and employees
- Creating negative publicity that can put rental properties at a competitive disadvantage
- Opening potential liability problems

Increasing health effect

- Health effect due to Environmental Tobacco Smoke (ETS)
- Sick Building Syndrome (SBS)
- Building Related Illness (BRI)
- Legionella Diseases

Increasing health effect

- Sick Building Syndrome (SBS)
 - An increase in the frequency of building occupant reported complaints associated with acute nonspecific symptom that improve while the occupants are away from the building (WHO 1988)
 - Symptom : Headache, Fatigue, Irritation, Feeling dryness (dry eyes, sore throat, blocked nose), skin problem (redness)

Increasing health effect

- Building Related Illness (BRI)
 - Where the illness with clinical abnormalities like hypersensitivity diseases (fever, pneumonitis, infections)
 - Mikrobial contaminant contribute significantly.
 - Legionnaires Diseases

Increasing health effect

- Legionella Diseases

- ☐ First identified in 1976, when outbreak cause severe illness and death among occupants in Philadelphia
- ☐ Cooling tower, humidifier, shower head provide ideal condition of growth for bacteria

INDOOR AIR QUALITY

- END OF PART 3
- ANY QUESTIONS



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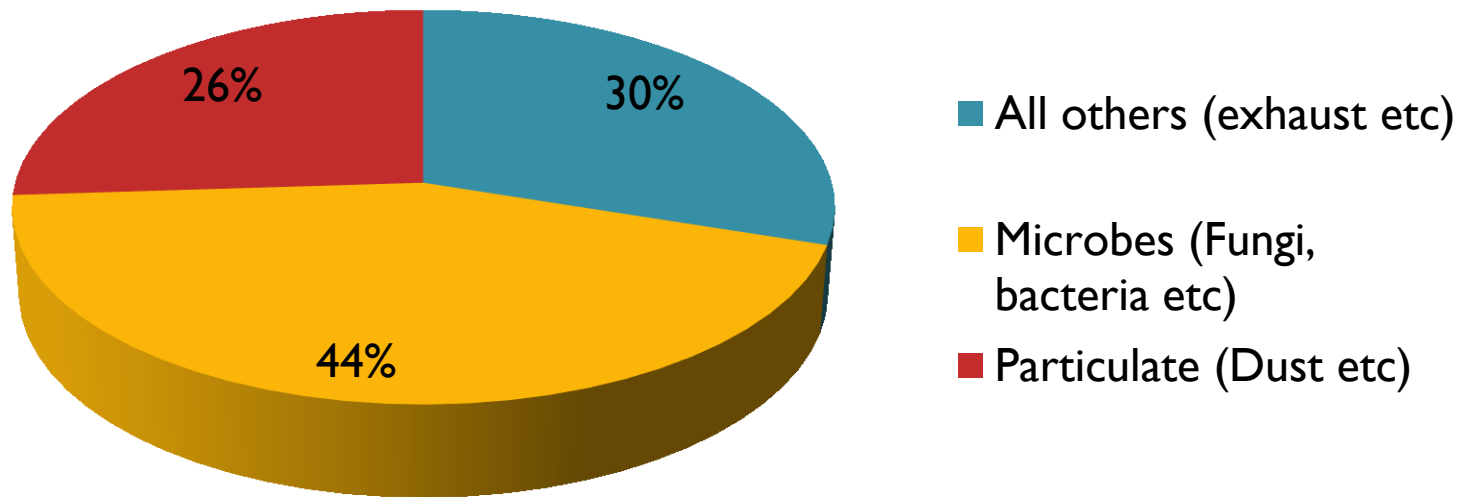
PART 4 : CAUSES OF IAQ PROBLEMS

Tarikh : 27 & 28 Mei 2014

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Study Shows...

Causes of Poor IAQ



Healthy Building International (HBI) over
953 buiodings with 147 nillion square
feet

INDOOR AIR QUALITY

Why is there an increase in IAQ problem?

- More time indoors
- More chemical pollutants in buildings
- Tighter building and reduced ventilation
- Deferred Maintenance

INDOOR AIR QUALITY

IAQ – Growing Public Concern

- Changed from natural ventilation to tight building concept
- Rely on HVAC to provide general ventilation but may suffer from insufficient IAQ as a result of energy conservation measures to reduce operational cost
- Changing on building materials. Synthetic had largely replaced the natural construction/finishing materials, e.g wood/stone
- Modern finishing emits VOC into building environment
- Additional VOC from cleaning etc

INDOOR AIR QUALITY

Factor Affecting IAQ

- Emission from building material
- Permeability of the wall structures
- Ventilation practices and rate
- Building maintenance and cleaning habit
- Emission of product /equipment
- Body effluent
- Ambient air quality

INDOOR AIR QUALITY

Common IAQ Issues

(summary of US NIOSH Studies in 1990)
(over 500 buiding investigated)

◦ Inadequate ventilation	53%
◦ Indoor Pollutant sources	15%
◦ Entrainment of outdoor contaminants	10%
◦ Mikrobial problem	5%
◦ Building fabric contamination	4%
◦ Unknown sources	13%

INDOOR AIR QUALITY

IAQ is literally HVAC and HVAC is IAQ

- Poor indoor air quality closely related to insufficient HVAC Operation&Maintenance
 - Insufficient air circulation
 - Outside contaminant pathway
 - Temperature and humidity
 - Extremes

INDOOR AIR QUALITY

Causes of IAQ Problem

- Temperature and/or Humidity
- Inadequate fresh air – Lead to CO₂ buildup
 - Normal Outdoor CO₂ 350PPM
 - Indoor CO₂ 600 PPM
 - >1000PPM Tired Sleepiness

INDOOR AIR QUALITY

- Common Health Effects of Indoor Contaminants
 - Eye, nose and throat irritation
 - Coughing and sneezing
 - Headaches
 - Fatigue
 - Irritability
 - Allergies, sinus congestion
 - Dizziness
 - Difficulty in concentrating

INDOOR AIR QUALITY

Health Effects Depend on Several Factors

- The Contaminant
- The amount of the contaminant present
- The length of time a person is exposed to contaminant
- The vulnerability of the person

INDOOR AIR QUALITY

- IAQ directly affect occupant health, comfort and productivity
- When IAQ is good, building are more desirable place to work, to learn, to conduct business, and to rent.



INDOOR AIR QUALITY

END OF PART 4

ANY QUESTIONS??