

Air pollution and Control
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Lecture – 30
Specific Sources and Types of Indoor Air Pollutants


Hello friends, you may recall last time we discussed about introduction of indoor air pollution or indoor air quality. Today we will go beyond that and we will discuss about specific sources and types of indoor air pollutants. So, in detail we will go about different kind of sources which are available in micro environment, indoor micro environment and different types of pollutants which come from those specific sources.

So, in this we will have combustion related products like carbon monoxide, nitrogen dioxide or indoor particulate matter and then some second hand smoke due to like tobacco smoking etc. Then building material and furnishing related emissions may also be there because adhesive or those paints etc they also emit building materials they also emit certain pollutants like asbestos, formaldehyde, lead or some VOC's volatile organic compounds.

Then there may be some biological pollutants like dust mites or animal allergens or moulds depending upon what kind of environment is there, humidity is there or not all those. Then pesticides when we are using even for plants etc. So, those kind of exposure may be there, from outdoor also some pollution can intrude in inside the buildings and then some pollution come from surface and those kind of radioactive related pollutants may also be there. So, those kind of specific sources and pollutants we will discuss.

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Primary causes of Indoor Air Problems



- Indoor Pollutant sources that release gases or particles.
- Inadequate ventilation.
- High temperature and humidity levels.

Source: www.epa.gov image: doctorsforcleanair.org

3

So, if we focus on primary causes of indoor air problems, then you can see like sources may be many, even from outdoor like outdoor emissions or outdoor air pollution can also come to the indoor like from windows or when we are opening doors etc. Unless it is very tight building exchange of air is there and depending upon the outdoor air quality, indoor air quality can be influenced and from indoor emissions outdoor air quality can be influenced. So, this is two-way process basically.

But within the indoor environment like cooking activity can be there and depending upon the fuel whether we are using these biofuels or some solid fuels cow dungs or wood etc and if we are using liquid fuels like kerosene or LPG or we are using other kind of stoves. So, depending upon that some sort of pollutants may come from the kitchen. Well then, tobacco smoking means those people in those families where people smoke so those contribute to the indoor quality deterioration because whatever particulate matter or other pollutants are being emitted, they will be inside the house.


Then you can have this dust like when you are brooming or you are walking even then those dust resuspension is there. So, that is again another source of indoor air pollution. Mosquito repellants, when we are using some sort of these repellents now a days, they also emit something. Some particulate pollutants also and some gaseous pollutants also.

When we do some paint related activities again some aerosols are there in the air because of those activities and even in future also some paint can emit some sort of emissions depending upon what is the composition, chemical composition of the paint. Then like agarbatti, candle or whatever source of the burning is there, so they can contribute to one or other kind of the indoor air pollutants.

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Indoor pollutant sources (1/2)

- Fuel-burning combustion appliances
- Use of Tobacco products
- Building materials and furnishings
- Products for household cleaning and maintenance
- Central heating and cooling systems and humidification devices
- Pest control activities
- Outdoor air pollution.



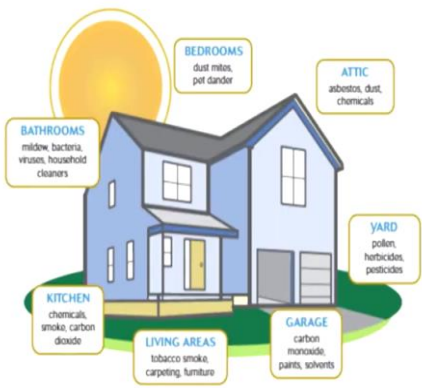
Source: www.epa.gov

4

So, the sources are like fuel burning combustion appliances, use of the tobacco products then building materials and furnishes. So, this is the summary kind of thing which I just discussed or products for household cleaning and maintenance, central heating and cooling systems and humidification devices. They also contribute. Then pest control activities because we are using some sort of chemicals, so those chemicals also get emitted into the air and outdoor air pollution, as I said it will come inside.

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Indoor pollutant sources in a typical household



Source: yellowbluetech.com

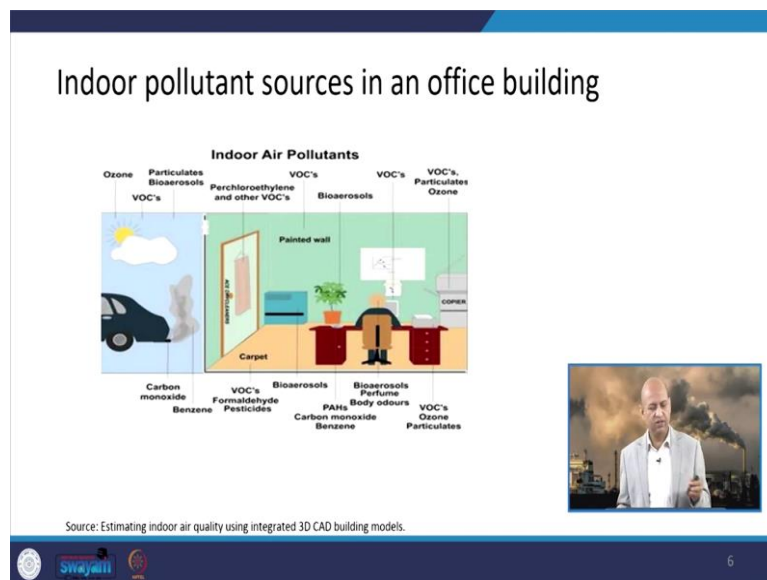
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When we try to visualize what is happening inside the building, so if this is a kind of residential building, dust, mites etc from bedrooms that can be one source. And pet, our pet whether it is cat or dog they are roaming around inside the building and they can be source of some sort of

allergens etc. Then this asbestos and dust chemicals can be from the sheets also, then from bathrooms because several chemicals are being used and moisture is there, humidity is there so bacteria can also grow.

So, those kind of viruses or bacteria can be sourced or emitted from the bathrooms etc. Kitchen can be source of different kind of smokes, carbon dioxides and other pollutants, living areas like if somebody is smoking in the living area then it can be a source of tobacco related pollutants. Garage can be source of like VOC's etc when some leakage of fuel is there and yard also like because of plants, some pollens may be there and when we are using some sort of pesticides, so they also come into the air as aerosols. So, all these are the kind of sources of indoor air pollution in household related environment.

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When we talk about business or office setting, then different kind of activities are there to contribute to indoor air pollution like photocopying machine is there so some emissions are there for of VOC's. When you are changing that toner again some aerosols will be in the air. And then again similar like moping and chemicals we are using so those VOC's will be in the air and then if it is a laboratory, then other chemicals utilization can contribute to indoor air pollution.

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Combustion products and their sources

Combustion Products	Sources
<ul style="list-style-type: none">• Carbon monoxide (CO)• Nitrogen dioxide (NO₂)• Sulphur dioxide (SO₂)• Nitrogenated compounds (NO_x)• Particulate matter (PM)	<ul style="list-style-type: none">• Gas stoves and appliances• Wood and coal stoves• Gas and propane engines• Fireplaces Tobacco smoke• Candles and incense• Mosquito coils



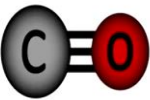

Source: www.who.int

7

Well, when we relate the combustion products and their sources. This is very very comprehensive list like different kind of pollutants are there combustion products basically like CO, NO₂, SO₂ and NO_x particulate matter and they are emitted from gas stoves or appliances, wood and coal stoves or fireplaces or mosquito coils, candles all those may be the sources inside the house.

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Combustion Products: Carbon Monoxide (CO)

<ul style="list-style-type: none">• Carbon monoxide is an odorless, colorless and toxic gas.• Carbon monoxide (CO) is produced when combustion reactions are not fully completed, either through lack of oxygen or due to low mixing.• Carbon monoxide correlates with the oxygen content in the flue gases. Low excess oxygen increases CO formation.	 
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Source: www.epa.gov

8

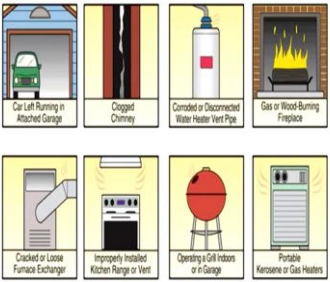
Now, if we talk about one by one for different pollutants. So, they have certain physico chemical properties characteristics and the dominating source also for each pollutant. We will go in detail now like carbon monoxide, this is odourless, colourless but toxic gas. It can go inside our body it can reduce the oxygen carrying capacity of the blood. We can get

unconscious, even high dose can kill the person. So, this is a silent killer because it does not smell and it is difficult to detect the poisons and it can kill.


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Sources of CO

SOURCES OF CARBON MONOXIDE IN A HOME



- Unvented kerosene and gas space heaters
- Leaking chimneys and furnaces
- Back-drafting from furnaces, gas water heaters, wood stoves and fireplaces
- Gas stoves
- Generators and other gasoline powered equipment




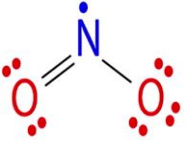
Source: www.epa.gov Image: roswell-nm.gov

Then there may be certain sources for that, for example you can see here all these kind of sources are there which contribute to the carbon monoxide emissions, whether it is gas or wood burning fireplace or car left running in the test garage so carbon monoxide is there in these exhaust emissions.

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Nitrogen Dioxide (NO₂)

- The two most prevalent oxides of nitrogen are nitrogen dioxide (NO₂) and nitric oxide (NO).
- Both are toxic gases with NO₂ being a highly reactive oxidant and corrosive.
- EPA National Ambient Air Quality Standards list 0.053 ppm as the average 24-hour limit for NO₂ in outdoor air.



Source: www.epa.gov

All these activities can contribute to the CO emissions. When we talk about nitrogen dioxide, whether it is NO₂ or NO these are having negative healthy facts. And this EPA National


Ambient Air Quality, they have given certain standards and beyond that they are quite toxic basically reactive.

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Sources of NO_x

The primary sources indoors are combustion processes, such as:

- Unvented combustion appliances, e.g. gas stoves
- Vented appliances with defective installations
- Welding
- Tobacco smoke
- Kerosene heaters



The diagram illustrates a house with various indoor air pollution sources. A chimney on the roof emits pollutants like CO, PM_{2.5}, VOC, and CO₂. Inside the house, a gas stove, a furnace, and a water heater are shown emitting pollutants such as NO_x, CO, VOC, and PM_{2.5}. A person is shown inside the house, and a video inset shows a man speaking in front of a background of industrial smokestacks.

Source: www.epa.gov

11



And the sources could be many again as like unvented combustion appliances, gas stoves etc. They emit lot of NO_x because NO_x emission is always there like CO and CO₂ is there whenever you are burning something because NO_x has to be there when burning activity is nothing but oxidation and oxygen is coming from the air and in air a lot of nitrogen is there.

So, NO_x emissions excluding is very very difficult unless you capture that and convert into something else through catalytic converters etc otherwise NO_x emissions are there, you can control many emissions but NO_x emissions controlling is a very difficult task basically. Well from welding, tobacco smoke, kerosene heaters all these are sources for the NO_x emissions.

(Refer Slide Time: 9:31)

Indoor Particulate Matter (PM)

- Particulate matter (also referred to as PM or particle pollution) is a complex mixture of solid and/or liquid particles suspended in air.
- EPA is especially concerned about particles that are 10 micrometers in diameter or smaller because these particles are inhalable.
- Particulate matter such as PM_{10} , $PM_{2.5}$, PM_1 and $PM_{0.1}$ is defined as the fraction of particles with an aerodynamic diameter smaller than 10, 2.5, 1 and $0.1 \mu m$ respectively.



Source: www.epa.gov

12

When we talk about the particulate matter, so they also come from different sources and you can see like when sunlight is coming in a dark place you can see different small particles which are detectable by naked eye but they may be very small particles, ultra-fine particles which are not visible, very very fine particles.

Now a days, people talk about nanoparticles also and they can go into our body into our blood also and if they are toxic they can really trigger some very chronic diseases. And there are certain standards and we have to be careful that the concentration whether indoor or outdoor pollution of these particulate matter etc should not exceed beyond that standards, but it may exceed depending upon the strength of the source and then the size and shape of the pollutants of the particulate nature also govern the health impacts like PM_{10} , $PM_{2.5}$, PM_1 , they have different range of affecting our health because they are respirable.

Coarser may be removed by our nostril, this filter system but small particles can go to respiratory system and influence our health as we discussed normally about this.

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Indoor PM sources

- PM may be either **directly emitted** from sources (**primary particles**) or formed in the atmosphere through **chemical reactions** of gases (**secondary particles**).
- **Wood-burning and coal-burning stoves** are both heavy emitters of $PM_{2.5}$. **Pet dander and mold spores** are also forms of particulate matter.
- Chemical reactions of gases like ammonia, volatile organic compounds, sulfur oxides, and nitrogen oxides can produce airborne particulates.



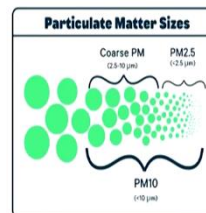
Source: learn.kaiterra.com



13

Coarse particles, PM_{10}

- PM_{10} denotes particles with an aerodynamic diameter of **10 μm or less**.
- Particles with a diameter of 10 microns or less (PM_{10}) are **inhalable into the lungs** and can induce adverse health effects.
- PM_{10} also includes dust from construction sites, landfills and agriculture, wildfires and brush/waste burning, industrial sources, wind-blown dust from open lands, pollen and fragments of bacteria.



Source: arb.ca.gov

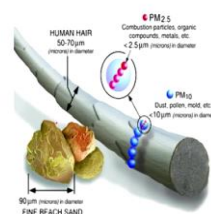
image: learn.kaiterra.com



14

Fine particles, $PM_{2.5}$

- Fine particulate matter is defined as particles that are **2.5 microns or less in diameter** ($PM_{2.5}$). Therefore, $PM_{2.5}$ comprises a portion of PM_{10} .
- Emissions from combustion of gasoline, oil, diesel fuel or wood produce much of the $PM_{2.5}$ pollution, as well as a significant proportion of PM_{10} .
- These particles are formed as a result of burning fuel and chemical reactions that take place in the atmosphere.



Source: learn.kaiterra.com

image: epa.gov



15

Then indoor PM sources are many whatever burning activity or we are working even then some suspension is there, so all those sources are there for particulate matter and the coarse particles and the PM₁₀ they have different nature as I said and they have different health effects. So, we need to be careful about small or fine particles basically like PM_{2.5} and you can see the comparison with this human hair. What is the size of these fine particles, so you can appreciate these are very very smaller or very fine particles which are difficult to imagine or look at and visualize.

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The slide is titled "Ultrafine particles, PM_{0.1}". It contains two bullet points in a blue-bordered box:

- PM_{0.1} is even smaller than fine dust, with an aerodynamic of 0.1 μm or smaller, and originates from similar sources as PM_{2.5}.
- Ultrafine dust poses a worse threat than PM_{2.5}, as the smaller particle size can infiltrate our bodies to an even greater extent.

To the right of the text is a diagram showing a cross-section of a human hair with a diameter of 60 μm. Inside the hair, three particles are shown: a large yellow circle for PM₁₀ (≤10 μm), a smaller orange circle for PM_{2.5} (≤2.5 μm), and a tiny red dot for PM_{0.1} (≤0.1 μm). Below the diagram, a legend defines particle sizes: Coarse: 2.5–10 μm, Fine: ≤2.5 μm, and Ultrafine: ≤0.1 μm. At the bottom right of the slide is a small video frame showing a man speaking.

Source: learn.kaiterra.com

16

While ultra fine particles like 0.1, PM_{0.1} they are very smaller and they can originate from similar sources like PM_{2.5} and they can pose very threatening like more than PM_{2.5} and as it is very small particles and can infiltrate in our bodies to the greater extent. So, we have to be careful about the presence of these kind of very small particles and if they are present then we should do something to remove them from our indoor environment.

(Refer Slide Time: 12:02)

Secondhand smoke (1/2)

- Secondhand smoke is a mixture of the smoke given off by the burning of tobacco products, such as cigarettes, cigars or pipes and the smoke exhaled by smokers.
- Secondhand smoke, classified by EPA as a Group A carcinogen, contains more than 7,000 substances.



Source: www.epa.gov

Image: teens.drugabuse.gov



17

Secondhand smoke (2/2)

Key findings:

- Secondhand smoke causes nearly **34,000 premature deaths** from heart disease each year in the United States among nonsmokers.
- Nonsmokers who are exposed to secondhand smoke at home or work **increase their risk of developing heart disease by 25-30%**.
- Nonsmokers who are exposed to secondhand smoke at home or at work **increases their risk of developing lung cancer by 20-30%**.

Middle and high school students who have never used tobacco are exposed to secondhand smoke:



14.7%
are exposed inside a vehicle



15.5%
are exposed at home



35.2%
are exposed in outdoor or indoor public areas



Source: www.epa.gov

Image: truthinitiative.org



18

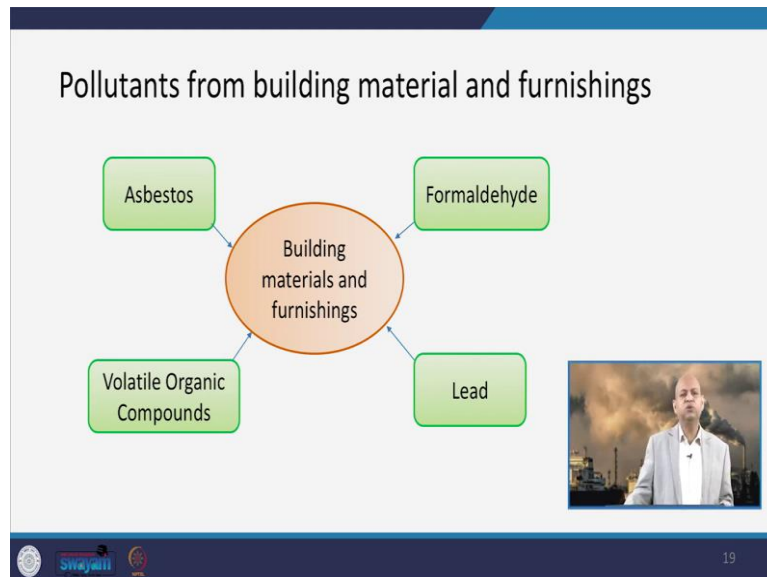
When we talk about this second hand smoke which is coming from like smoking activities so the passive smoking is there because even if you are non-smoker, somebody is smoking and in the air those particles, those gaseous components are there you are inhaling and that way again you are exposed to those pollutants which are dangerous to your health.

So, this kind of second head smoke sources can also be there and you can see like middle and high school students who have never used tobacco are exposed to second hand smoke that is the passive smoking. Around 15 percent are exposed inside a vehicle, some adults may smoke may be smoking there so this is not good thing.

Then around 16 percent are exposed at home and more than 35 percent are exposed in outdoor or indoor public areas where people are smoking. So, that way also now a days a lot of regulations are coming and specific places are there for smoking and public places are



prohibited from smoking but still there are ways because it is difficult to control the air pollutants, they can travel depending upon the wind direction and wind velocity.

(Refer Slide Time: 13:20)



Asbestos

- Asbestos is a mineral fiber that occurs in rock and soil.
- Because of its fiber strength and heat resistance asbestos has been used in a variety of building construction materials for insulation and as a fire retardant.
- In general, exposure may occur **only when the asbestos-containing material is disturbed or damaged in some way to release particles and fibers into the air.**



Source: www.epa.gov

20



So, in totality if we talk about like pollutants from building material and furnishing, then different kind of pollutants may be there like asbestos, formaldehyde, volatile organic compounds or lead those kind of things. So, these are the different pollutants and if we go one by one again so the asbestos is basically these are coming from mineral fibers.

And that occurs in rocks and soil but they may be like from sheets wherever they are present so they can get emitted in the air and exposure may occur when these asbestos containing material is disturbed or damaged in some way, then the particles are released and they becomes in the air and they can be part of our respiratory inhalation.

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Sources of Asbestos

- Asbestos fibers may be released into the air by the disturbance of asbestos-containing material during product use, demolition work, building or home maintenance, repair, and remodeling.
- Asbestos has also been used in a wide range of manufactured goods, mostly in building materials, friction products, heat-resistant fabrics, packaging, gaskets, and coatings.



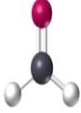

Source: www.epa.gov

21

Formaldehyde

- Formaldehyde is an important chemical used widely by industry to manufacture building materials and numerous household products.
- Formaldehyde concentrations in dwellings vary according to:
 - the age of the building, since the release of formaldehyde decreases with time
 - temperature and relative humidity
 - the air exchange rate

Formaldehyde


$$\begin{array}{c} \text{O} \\ || \\ \text{H}-\text{C}-\text{H} \end{array}$$


Source: www.epa.gov

22

Sources of asbestos can be different sheets whatever building material which they are using the asbestos, so those kind of tiles or sheets they may be there for these releasing asbestos. These heat resistant fabrics or packaging, gaskets, coatings all these they are using the asbestos. So, it is present there basically, so it can get released from there. Formaldehyde can be there like it is a very important chemical and it is widely used in industry to manufacture building materials.

So, again it will come from the building material basically and different concentrations in dwelling units depending upon the age of the building and the release of the formaldehyde can decrease with the time. The temperature, relative humidity all these influence the concentration into the air.

(Refer Slide Time: 15:00)

Sources of Formaldehyde

- Resins used in the manufacture of composite wood products
- Building materials and insulation
- **Household products** such as glues, permanent press fabrics, paints and coatings, lacquers and finishes, and paper products
- Preservatives used in some medicines, cosmetics and other consumer products such as dishwashing liquids and fabric softeners
- Fertilizers and pesticides



Source: www.epa.gov



23

And the sources can be all those kind of household products like glues, permanent price fabrics, paints, coatings all these finishes, paper products they are using all those kind of things where this formaldehyde may be present and they can come out depending upon the temperature etc.

(Refer Slide Time: 15:17)

Lead

- Lead is a naturally occurring element found in small amounts in the earth's crust. While it has some beneficial uses, it can be toxic to humans and animals, causing health effects.
- Harmful exposures to lead can be created when lead-based paint is improperly removed from surfaces by dry scraping, sanding, or open-flame burning.
- High concentrations of airborne lead particles in homes can also result from lead dust from outdoor sources.



Source: www.epa.gov



24

Sources of Lead

- Activities like remodeling, dry scraping, and demolition also disturb and re-suspend lead based paint particles.
- Contaminated soil and dust tracked indoors from outside are also large contributors to indoor lead pollution.
- Levels of lead in soil are higher near sources such as lead smelters, mines, old agricultural fields and heavily trafficked roadways and runways.
- Lead dust from workplace exposures also may be brought home and contribute to indoor air pollution.



Source: www.lung.org/clean-air/at-home/indoor-air-pollutants/lead



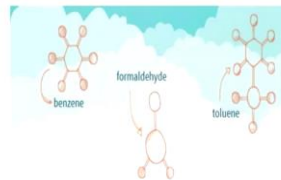
Similarly, lead is present in different kind of things like paints etc. That is why, now a days unleaded paint is becoming popular, like unleaded petrol or unleaded gasoline. It used to have lot of lead content but there this new policy came into existence because lead is very harmful for this memory growth or brain growth in the children. So, it was reduced and it is now very very negligible kind of thing.

Then sources of the lead can be like, you can see scraping, demolition, disturbance of those paint related things. Then the lead can get emitted into the air and it can be also through smelters or mines, old agricultural fields. So, there if it comes to the outdoor and if some from outdoor air also it can go inside the buildings in workplaces.

(Refer Slide Time: 16:20)

Volatile organic compounds (VOCs)

- Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids.
- Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors.



Source: www.epa.gov
Image: www.foobot.io/resources/volatile-organic-compounds



Common VOCs found in indoor environment (1/3)

- **Acetone**

A rather potent chemical, acetone is found in common products such as nail polish remover, furniture polish and wallpaper.

Alcohol-based nail polish removers and water-based furniture polishes are common and are much safer alternatives.

- **Acetic Acid**

The most common source of this chemical is vinegar. High doses of this organic gas can result in throat and breathing issues, so be sure to check vinegar products to ensure safe exposure levels.



Source: foobot.io/guides/list-of-common-volatile-organic-compounds



27

Common VOCs found in indoor environment (2/3)

- **Butanal**

Candles, barbecues and gas stoves increase the presence of butanal; one of the most common volatile organic chemical.

The best thing to do to prevent butanal from damaging IAQ is to keep these activities outside, ventilate the house when cooking and also use beeswax or soy-based candle wicks.

- **Carbon Disulfide**

This particular VOC is found in chlorinated tap water. To avoid exposure and decrease concentrations in the body, use a charcoal or carbon-filtration system, or drink only bottled water.



Source: foobot.io/guides/list-of-common-volatile-organic-compounds



28

Common VOCs found in indoor environment (3/3)

- **Ethanol**

Found in many cleaning products, it's hard to avoid this VOC. Glass cleaners, dishwasher detergents, laundry detergents and many other cleaners all have ethanol.

- **Methylene Chloride**

Also known as dichloromethane, this is one of the most common VOCs. It's present in paint removers, aerosol solvents and other flame retardant chemicals.



Source: foobot.io/guides/list-of-common-volatile-organic-compounds



29

When we talk about volatile organic compounds, VOC's so they can also come from paints etc. So, like in indoor environment it is 10 times more than the outdoors. So, this is very dangerous because many people are allergic to VOC's and this is not good for health. So, we should be careful about their concentration, it should not go beyond the allowed or permissible levels.

When we talk about like categories of VOC's there are many like acetone, acetic acid, all those kind of like butanol or carbon disulphide and then ethanol or methylene chloride, all these are there which are having different kind of health impacts on the body.

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Sources of VOCs

Household products, including:

- Paints, paint strippers and other solvents
- Wood preservatives
- Aerosol sprays
- Cleansers and disinfectants
- Moth repellents and air fresheners
- Pesticide

Other products, including:

- Building materials and furnishings
- Office equipment such as copiers and printers
- Graphics and craft materials

Source: www.epa.gov

The slide features a diagram of a house with various rooms and items labeled as VOC sources, such as 'Paints', 'Wood preservatives', 'Aerosol sprays', 'Cleansers and disinfectants', 'Moth repellents and air fresheners', 'Pesticide', 'Building materials and furnishings', 'Office equipment such as copiers and printers', and 'Graphics and craft materials'. A video inset shows a man speaking in front of an industrial background.

And household products which include these VOC's are like paints or wood preservatives, aerosol sprays. So, whenever you are going to have like good spray which smells good, in the indoor environment but it is not good for the health because it is having these toxic view VOC's. And then these cleanliness and disinfectants, they also have these kind of VOC's. Moth replants or rear fresheners, as I said, pesticides all those can be source of VOC's and other products like building materials and furniture, office equipment such as copiers, photocopiers, printers, graphics and craft materials, all these can be the source of VOC's.


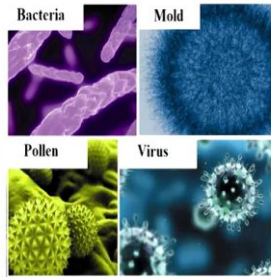
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Biological pollutants

Animal dander, dust mites, moulds, infectious agents, pollen

Sources of biological agents:

- Water-damaged surfaces and materials
- Humidifiers and stagnant water
- Water vapor from cooking and showering
- Air conditioning systems
- Mattresses, upholstered furniture and carpets
- Dirt



Source: www.epa.gov

31

Dust mites



Feed on human dander and Prefer warm, humid environments

Sources:

- bedding, carpets, upholstery, soft toys

Prevention:

- Encasing mattress and pillows
- Washing bedding in hot water
- Frequent vacuuming / damp mopping
- Decreasing clutter
- Removing carpets



Source: Arshad SH et al. (2007)

32

Now, if you talk about biological pollutants which can come from humid corners or moisture or leakage seepage etc that kind of if thing is available or present in the building that is not a healthy sign of the building. So, the water damage surfaces, materials, humidifiers stagnant water they can be source of biological pollutants basically and like dust mites may be there if we are not cleaning bad sheets and the bad periodically, if we do not vacuum it properly then these kind of dust mites may be there and they are very allergic and they have those kind of effects.

Then if you want to prevent them, then you should go for better mattresses and pillows washing them regularly, cleaning them properly and we should not have much clutter in the room where we are using it for longer periods and we should not have the carpets, if we cannot maintain it.



Carpets can be a big source of small particles or these biological pollutants or dust mites etc. If you do not vacuum it very regularly. So, instead of carpets it is better to have the tiles, you can clean it regularly, very easily comfortably.

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Animal Allergens

Cat dander (most allergenic) , Dog dander, Birds, Cockroach parts and faeces

Prevention:
Remove animals from indoors
[Allergens persist for many months after removal of source](#)
Clean environment and pet(s) frequently
Ventilate adequately
Control dust and moisture





Source: Becker AB (2005)

33

Molds

- A frequently undetected environmental problem.
- Occur in damp indoor areas.
- Allergies and nonspecific symptoms are common, but infections are rare.

Chemical agents produced by molds:
Mycotoxins are associated with human disease and cause acute and chronic effects



Source: Etzel RA et al. (1999)
Image: www.hgtv.com/design/remodel/interior-remodel/common-types-of-mold-in-homes

34

When we talk about like animal allergens so from like cats or dogs, from waste or their hair fall all those can contribute even cockroach etc birds many people have birds also. So, if they are in the indoor environment they can contribute these kind of allergens which come from the their hair fall etc.



Then moulds can be there as I said from this moist corners or these leakages or seepage related corners. So, various kinds of moulds have different kind of allergies to people. Many people if

they enter and this moulds kind of thing is there they start sneezing, their eyes get red and those kind of symptoms may occur because of these VOC's as well as these moulds kind of thing.

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Pesticides

- Pesticides are chemicals that are used to kill or control pests which include bacteria, fungi and other organisms, in addition to insects and rodents. Pesticides are inherently toxic.
- According to a recent survey, 75 percent of U.S. households used at least one pesticide product indoors during the past year.
- 80 percent of most people's exposure to pesticides occurs indoors.





Source: www.epa.gov

35

Sources of pesticides

- Products used to kill household pests (insecticides, termiticides and disinfectants)
- Products used on lawns and gardens that drift or are tracked inside the house
- Pesticides are classed as semi-volatile organic compounds and include a variety of chemicals in various forms.



Source: www.epa.gov


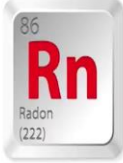
36

Then pesticides may be there when you are using for gardening etc. So, that can also go inside the building because we have indoor plants also and sometimes we use pesticides etc. So, the sources of the pesticides can be all these kind of chemicals which we are using to protect the plants and to repel those unwanted kind of pests.

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Radon

- Radioactive gas released from soil and rocks
- Second leading cause of lung cancer (in adults)
- Geology of the area can predict levels in soil and water.
- Concentrations indoors depend on construction site and building materials.
- Highest levels occur in basements and on the ground floor


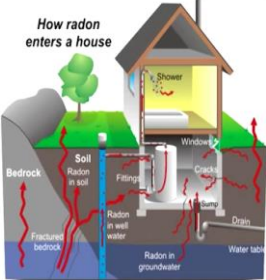


Source: www.epa.gov

37

Sources of Radon

- Radon has a variety of sources, including uranium, and contains rocks like granite, shale, phosphate rock, and pitchblende.
- Radon can escape from these sources and migrate into the surrounding air and water supplies.
- It can be found in well water, natural gas sources, and building materials.
- Due to its heavy density, radon typically floats downward and is often found in the basements of buildings.



Source: courses.lumenlearning.com

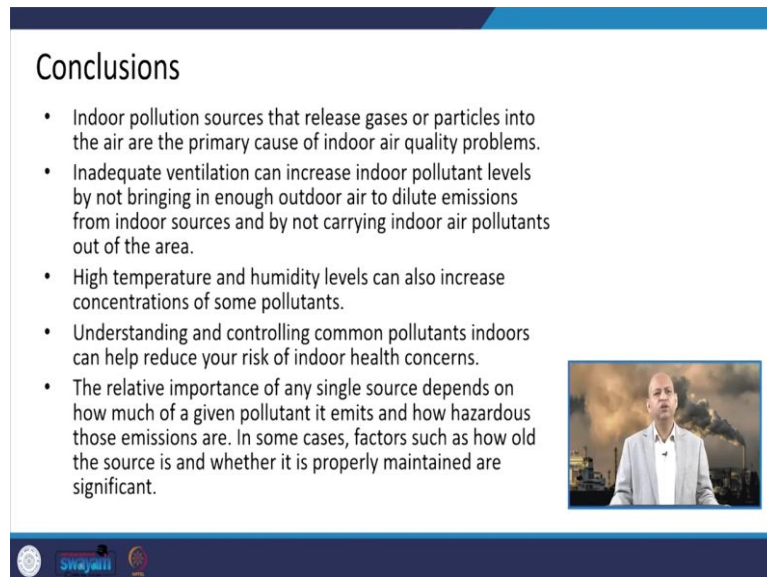
38

Radon radioactive gas can be released from the soil and rocks and this is the second leading cause of the lung cancer in adults. So, the geological formations of that particular area can influence this radon presence in particular localities. So, if it is present then one should take care otherwise it can influence the health and later on even cancer related problems may also occur.

So, the sources can be different rocks or these kind of granite or shale or phosphate, all those kind of rocks can have these particular pollutants or radioactive entities. Well so, due to the heavy density of the radon they typically floats downward, it is often found in the basement buildings. So, if somebody is spending lot of time in the basement and if you find that radon is


present then it is better that you make it fully ventilated and flush it out otherwise it may be very problematic.


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Conclusions

- Indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems.
- Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the area.
- High temperature and humidity levels can also increase concentrations of some pollutants.
- Understanding and controlling common pollutants indoors can help reduce your risk of indoor health concerns.
- The relative importance of any single source depends on how much of a given pollutant it emits and how hazardous those emissions are. In some cases, factors such as how old the source is and whether it is properly maintained are significant.





So, all in all we can say that indoor air pollution is a big problem and there are specific sources for some specific air pollutants which are significant in indoor environment and it can vary from household to the office kind of setting and accordingly we have to be careful about their monitoring and their levels and they should not go beyond those kind of levels which can be health hazard.

So, the knowledge about these specific sources and specific pollutants of indoor air pollutants can give us an idea how to keep our environment micro environment, indoor environments clean and we remain healthy because now a day's lifestyle is such that the most people live indoors. You live inside house then you go to the office you do sitting job etc, those who are not doing much outdoor activities.

So, most of the part of this 24 hours daily routine is inside the houses or inside these industries or offices and if indoor air is not clean then it can result into several diseases or health related problems. So, that is why it is very important and I am sure you will go for more information through the additional resources like these references and you will learn about more those indoor air pollutants which I have described.

And you can get more information about that because it is very interesting and it is directly related to most of us. So, thank you for your kind attention and see you in the next lecture again. Thanks.