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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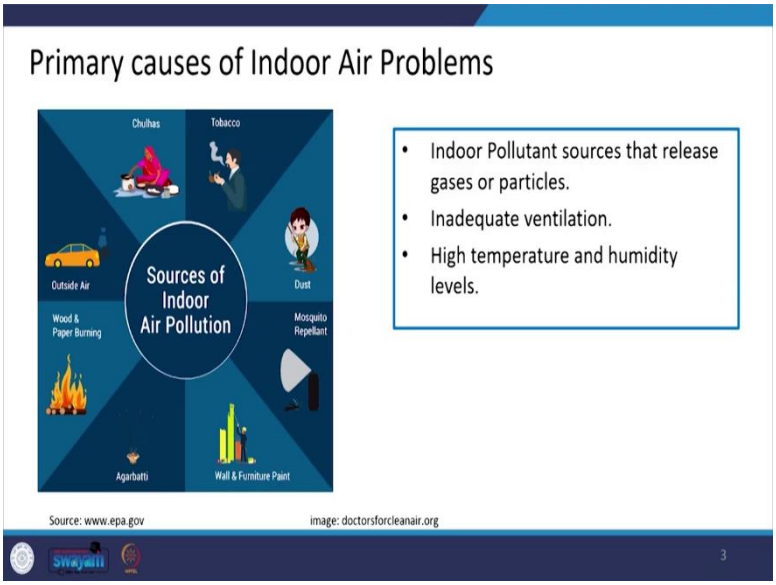

So, if we focus on primary causes of indoor air problems, then you can see like sources may be many, even from outdoor like outdoor emissions or outdoor air pollution can also come to the indoor like from windows or when we are opening doors etc. Unless it is very tight building exchange of air is there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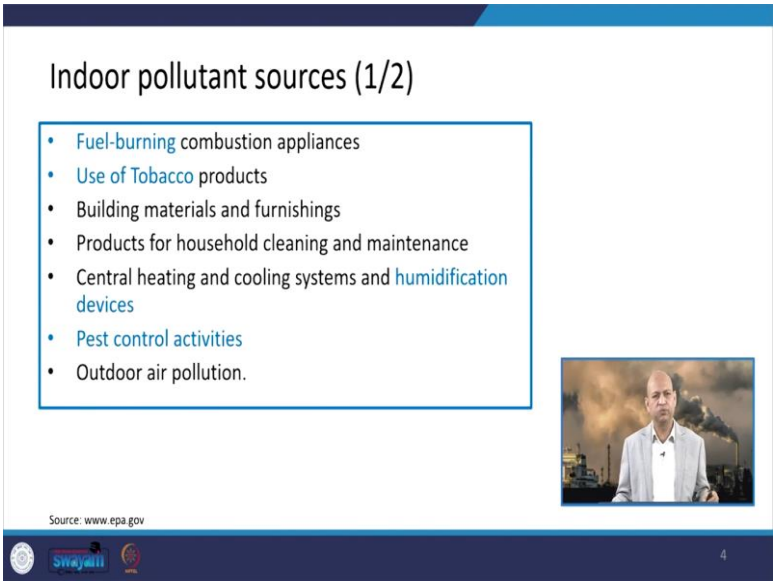

So, the sources are like fuel burning combustion appliances, use of the tobacco products then building materials and furnishes. So, this is the summary kind of thing which I just discussed or products for household cleaning and maintenance, central heating and cooling systems and humidification devices. 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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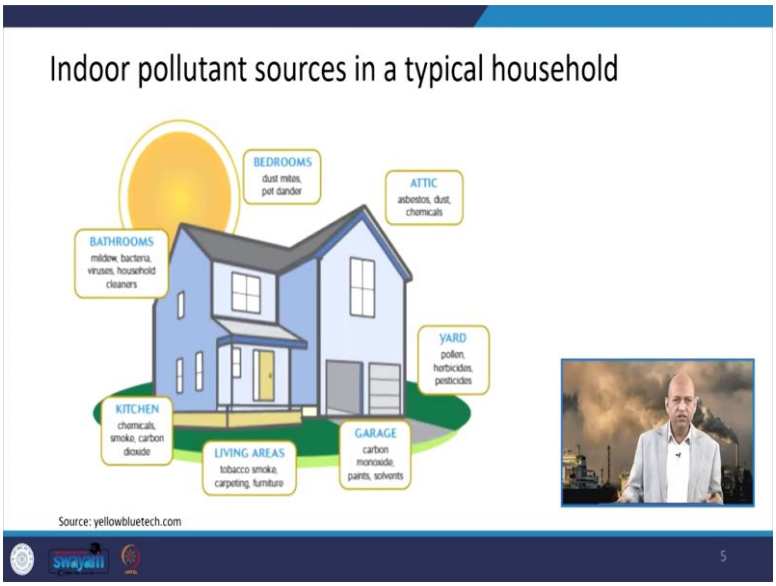

When we try to visualize what is happening inside the building, so if this is a kind of residential building, dust, mites etc from bedrooms that can be one source. And pet, our pet whether it is cat or dog they are roaming around inside the building and they can be source of some sort of

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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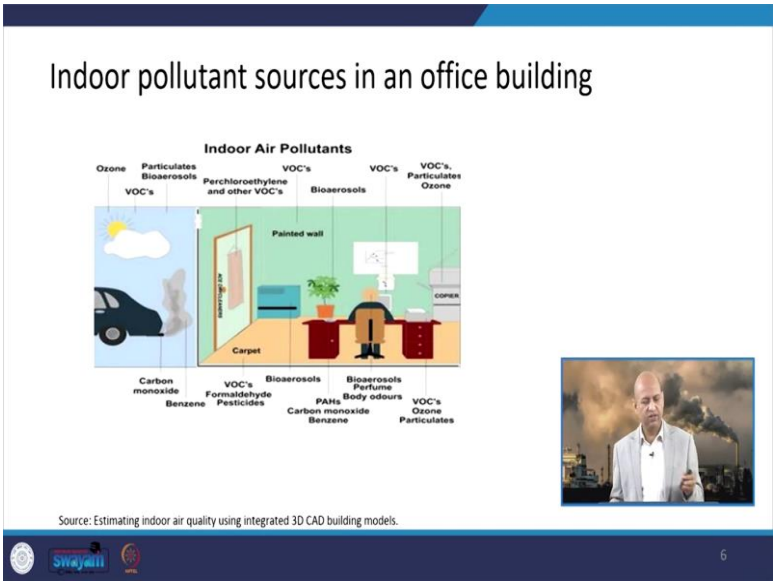

When we talk about business or office setting, then different kind of activities are there to contribute to indoor air pollution like photocopying machine is there so some emissions are there for of VOC's. When you are changing that toner again some aerosols will be in the air. And then again similar 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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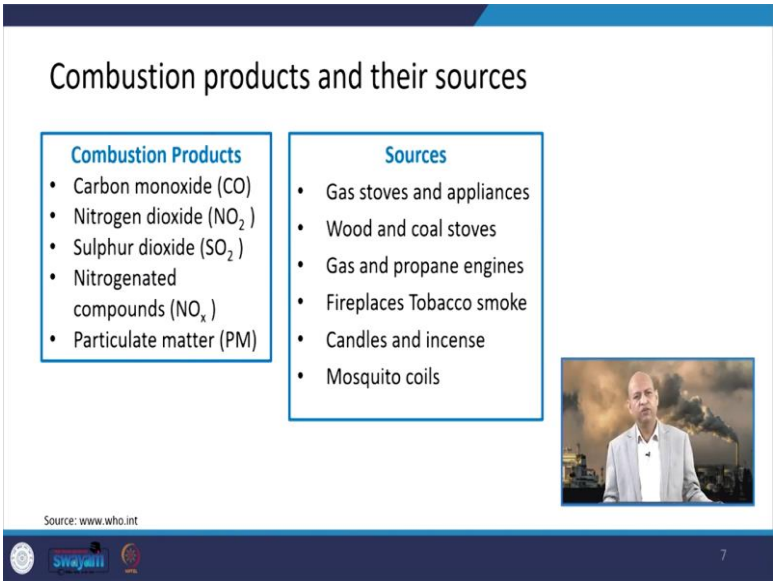

Well, when we relate the combustion products and their sources. This is very very comprehensive list like different kind of pollutants are there combustion products basically like CO, NO_2, SO_2 and NO_x particulate matter and they are emitted from gas stoves or appliances, wood and coal stoves or fireplaces or mosquito coils, candles all those may be the sources inside the house.

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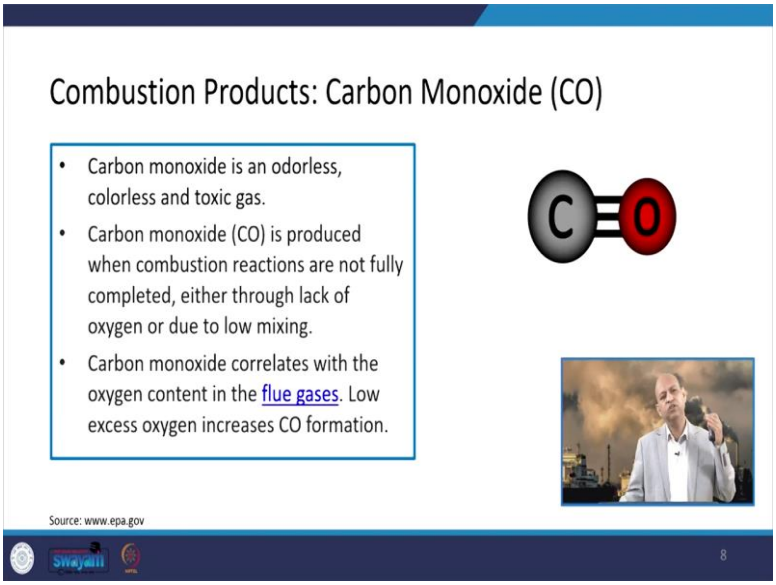

Now, if we talk about one by one for different pollutants. So, they have certain physico chemical properties characteristics and the dominating source also for each pollutant. We will go in detail now like carbon monoxide, this is odourless, colourless but toxic gas. It can go inside our body it can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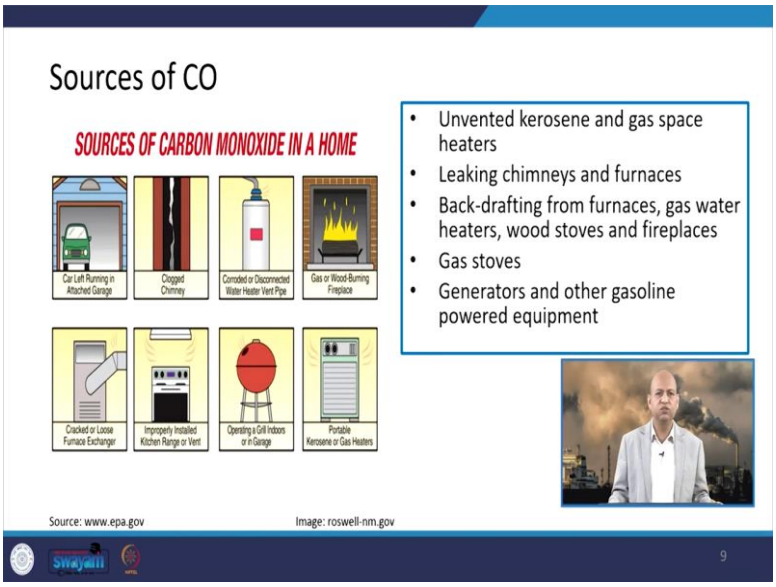

Then there may be certain sources for that, for example you can see here all these kind of sources are there which contribute to the carbon monoxide emissions, whether it is gas or wood burning fireplace or car left running in the test garage so carbon monoxide is there in these exhaust emissions.

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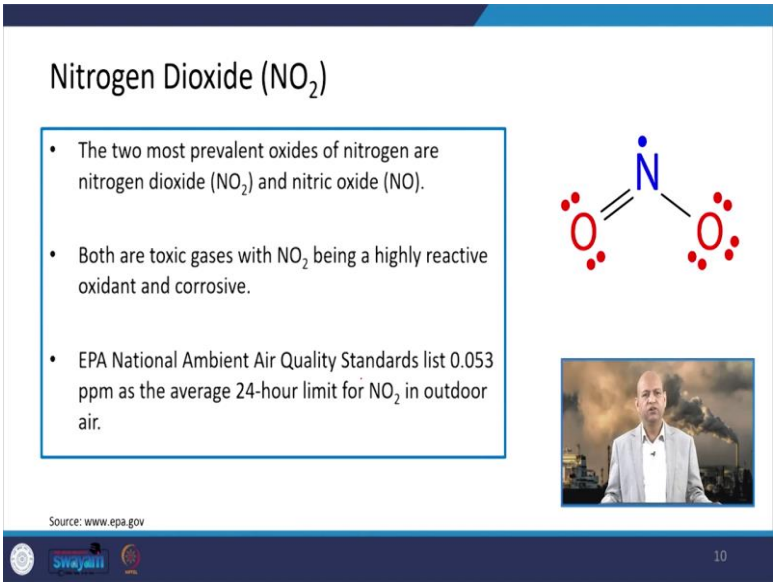

All these activities can contribute to the CO emissions. When we talk about nitrogen dioxide, whether it is NO_2 or NO these are having negative healthy facts. And this EPA National

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

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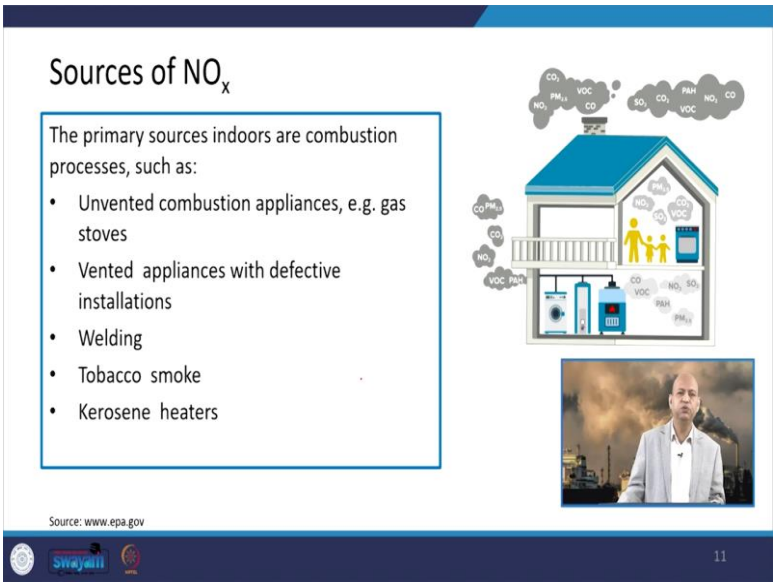

And the sources could be many again as like unvented combustion appliances, gas stoves etc. They emit lot of NO_x because NO_x emission is always there like CO and CO_2 is there whenever you are burning something because NO_x has to be there when burning activity is nothing but oxidation and oxygen is 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.

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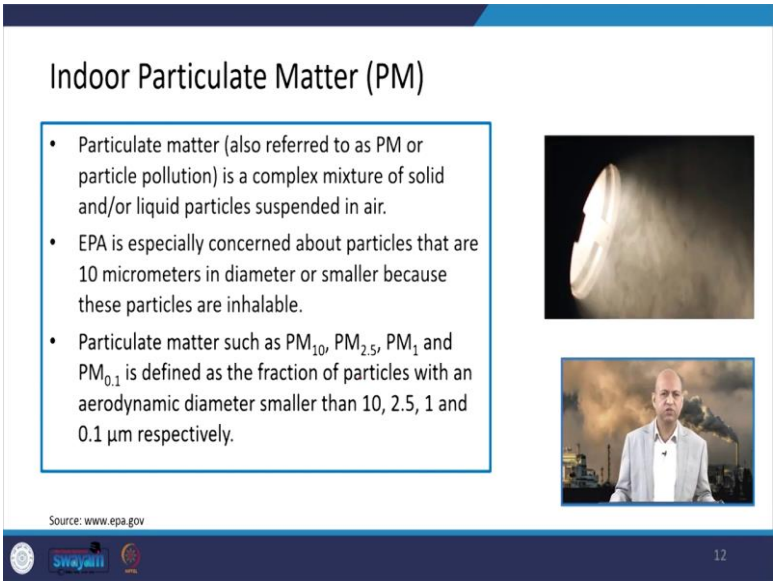

When we talk about the particulate matter, so they also come from different sources and you can see like when sunlight is coming in a dark place you can see different small particles which are detectable by naked eye but they may be very small particles, ultra-fine particles which are not visible, very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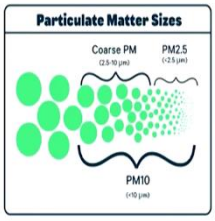
Indoor PM sources

- 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

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

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 PM10.
- 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

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 PM_{10} 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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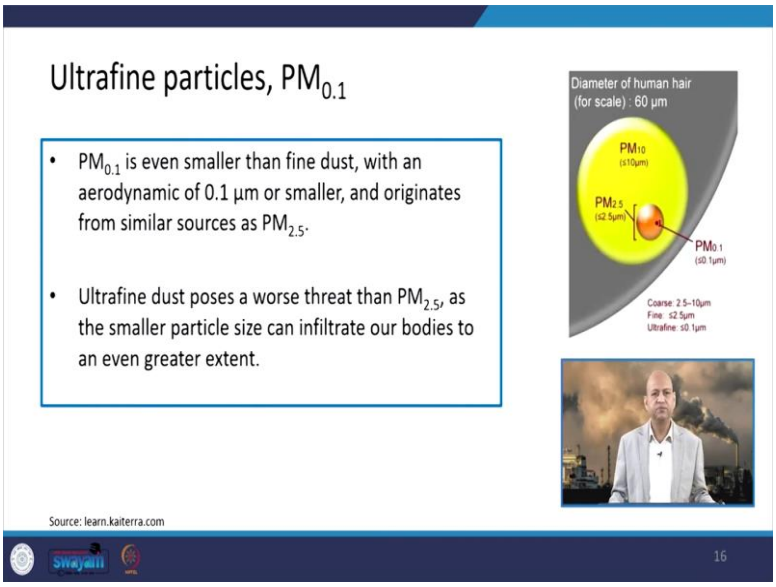

While ultra fine particles like 0.1, $PM_{0.1}$ they are very smaller and they can originate from similar sources like $PM_{2.5}$ and they can pose very threatening like more than $PM_{2.5}$ and as it is very small particles and can infiltrate in our bodies to the greater extent. So, we have to be careful 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.

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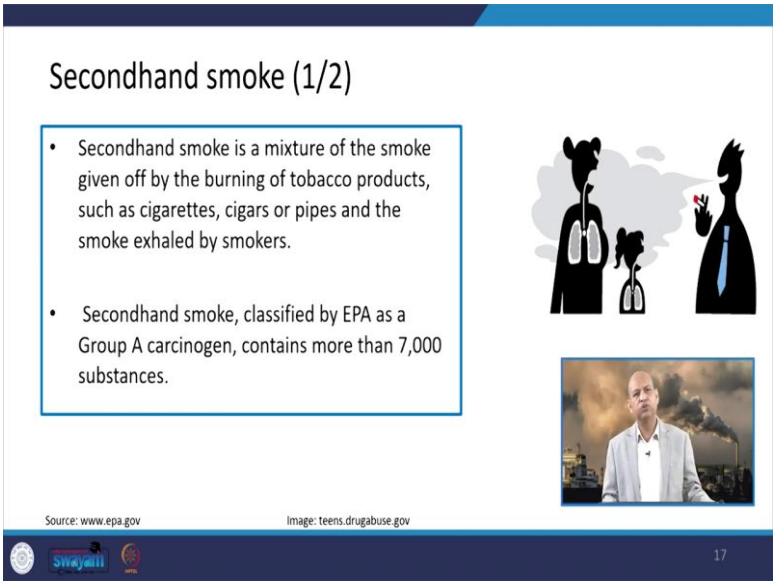

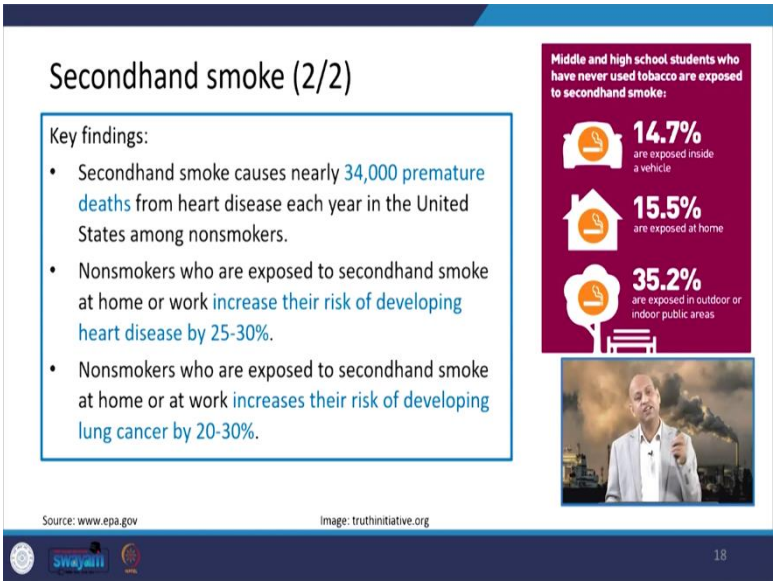

When we talk about this second hand smoke which is coming from like smoking activities so the passive smoking is there because even if you are non-smoker, somebody is smoking and in the air those particles, those gaseous components are there you are inhaling and that way again you are exposed to those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

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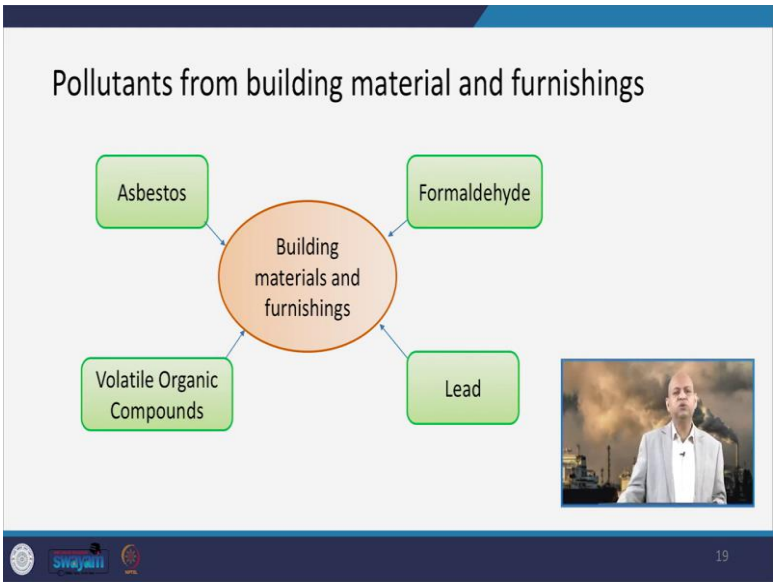

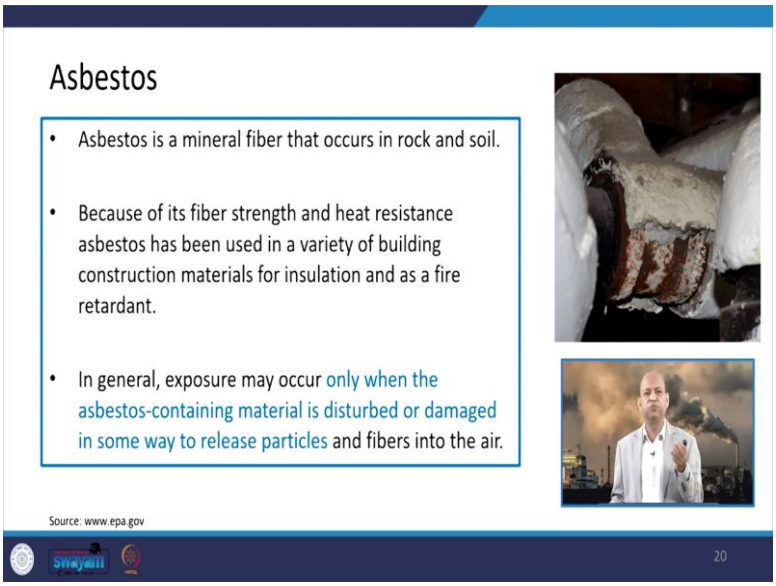

So, in totality if we talk about like pollutants from building material and furnishing, then different kind of pollutants may be there like asbestos, formaldehyde, volatile organic compounds or lead those kind of things. So, these are the different pollutants and if we go one by one again so the asbestos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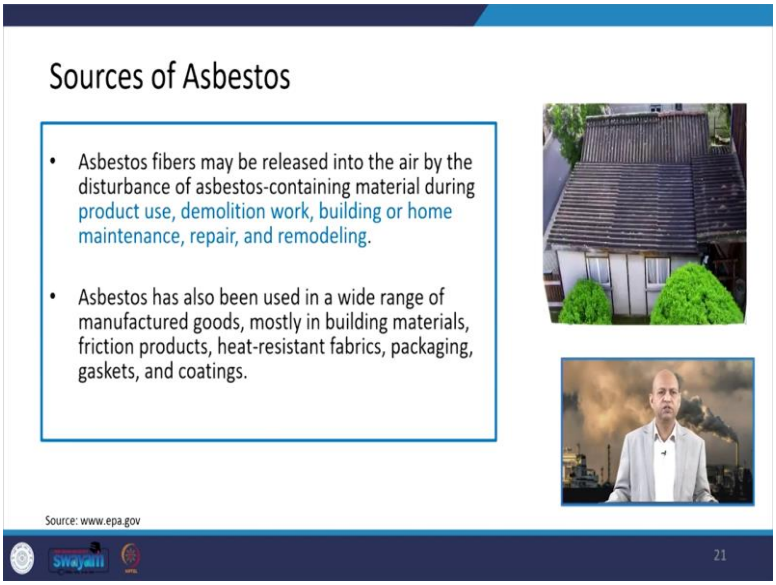

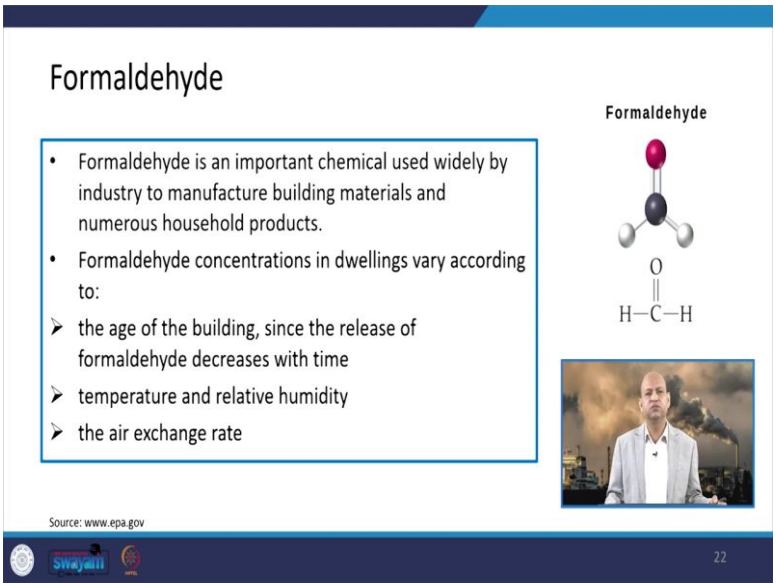

Sources of asbestos can be different sheets whatever building material which they are using the asbestos, so those kind of tiles or sheets they may be there for these releasing asbestos. These heat resistant fabrics or packaging, gaskets, coatings all these they are using the asbestos. So, it is present 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.

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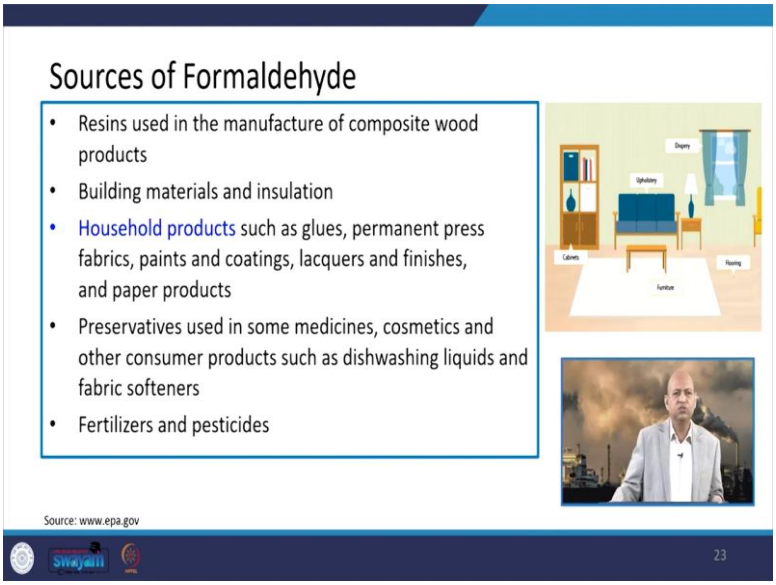

And the sources can be all those kind of household products like glues, permanent price fabrics, paints, coatings all these finishes, paper products they are using all those kind of things where this formaldehyde may be present and they can come out depending upon the temperature etc.

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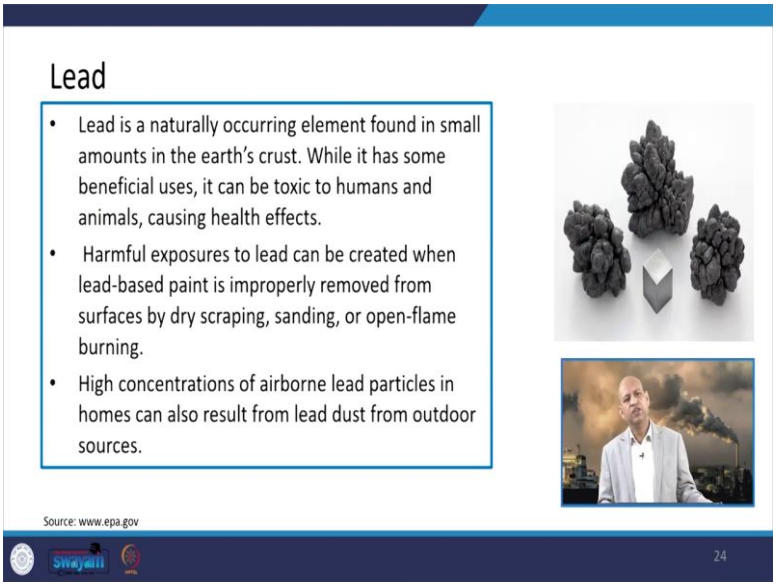

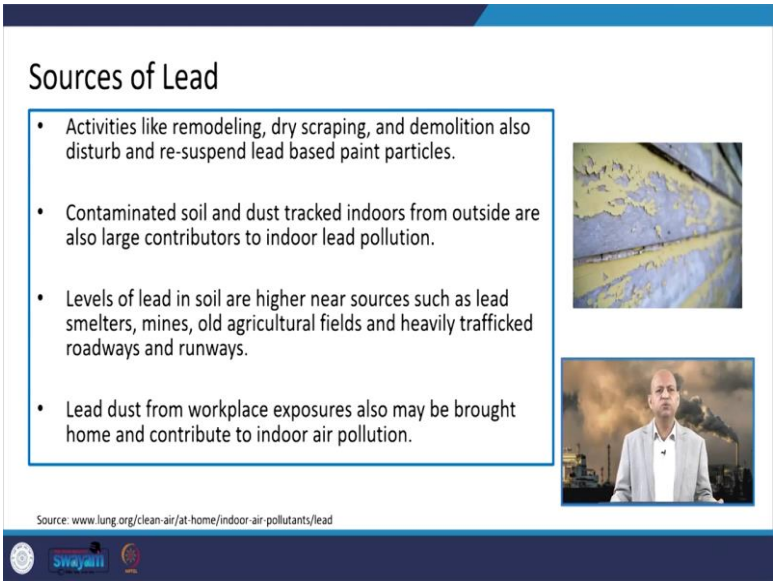

Similarly, lead is present in different kind of things like paints etc. That is why, now a days unleaded paint is becoming popular, like unleaded petrol or unleaded gasoline. It used to have lot of lead content but there this new policy came into existence because lead is very harmful for this memory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

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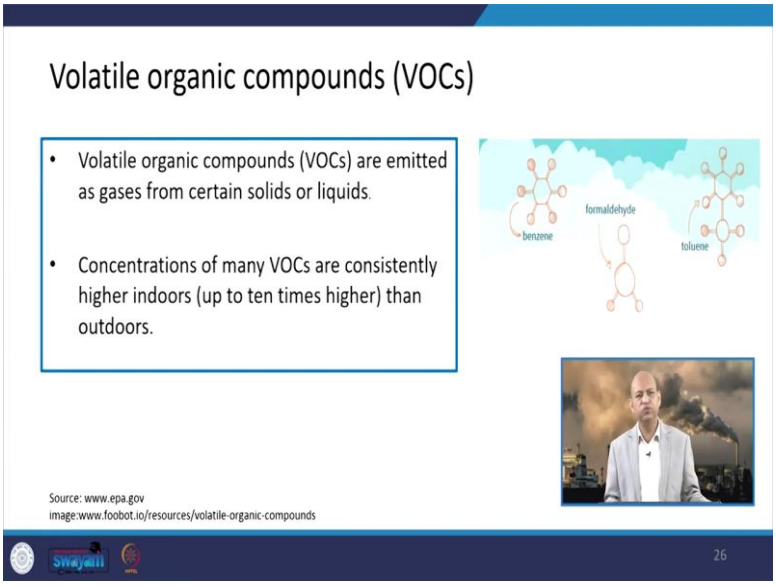

Common VOCs found in indoor environment (1/3)

- **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

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

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

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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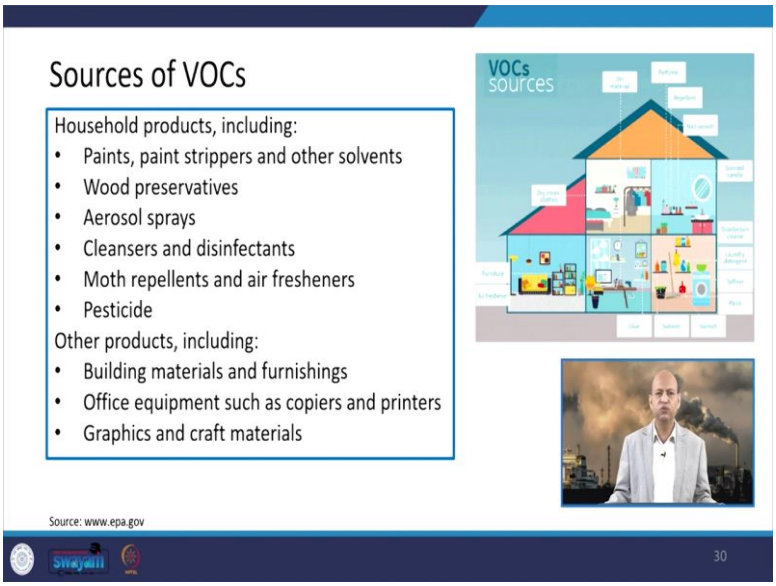

And household products which include these VOC's are like paints or wood preservatives, aerosol sprays. So, whenever you are going to have like good spray which smells good, in the indoor environment but it is not good for the health because it is having these toxic view VOC's. And then these cleanliness 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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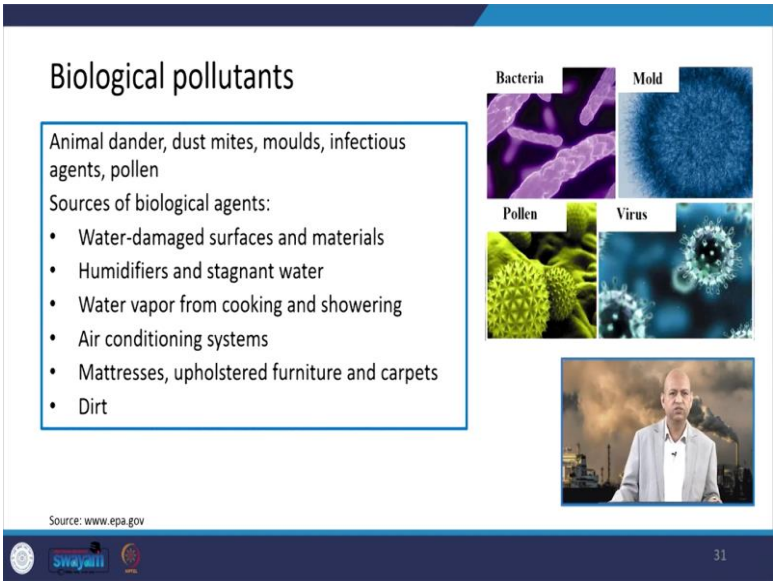

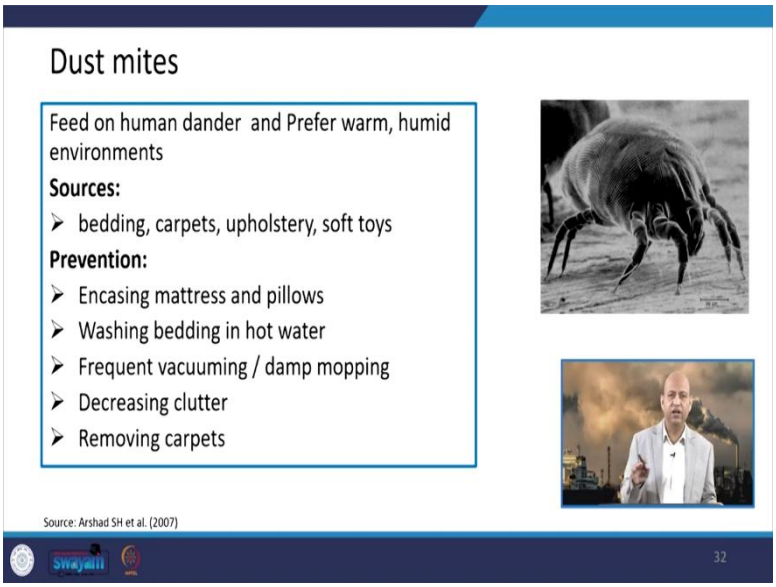

Now, if you talk about biological pollutants which can come from humid corners or moisture or leakage seepage etc that kind of if thing is available or present in the building that is not a healthy sign of the building. So, the water damage surfaces, materials, humidifiers stagnant water they can be 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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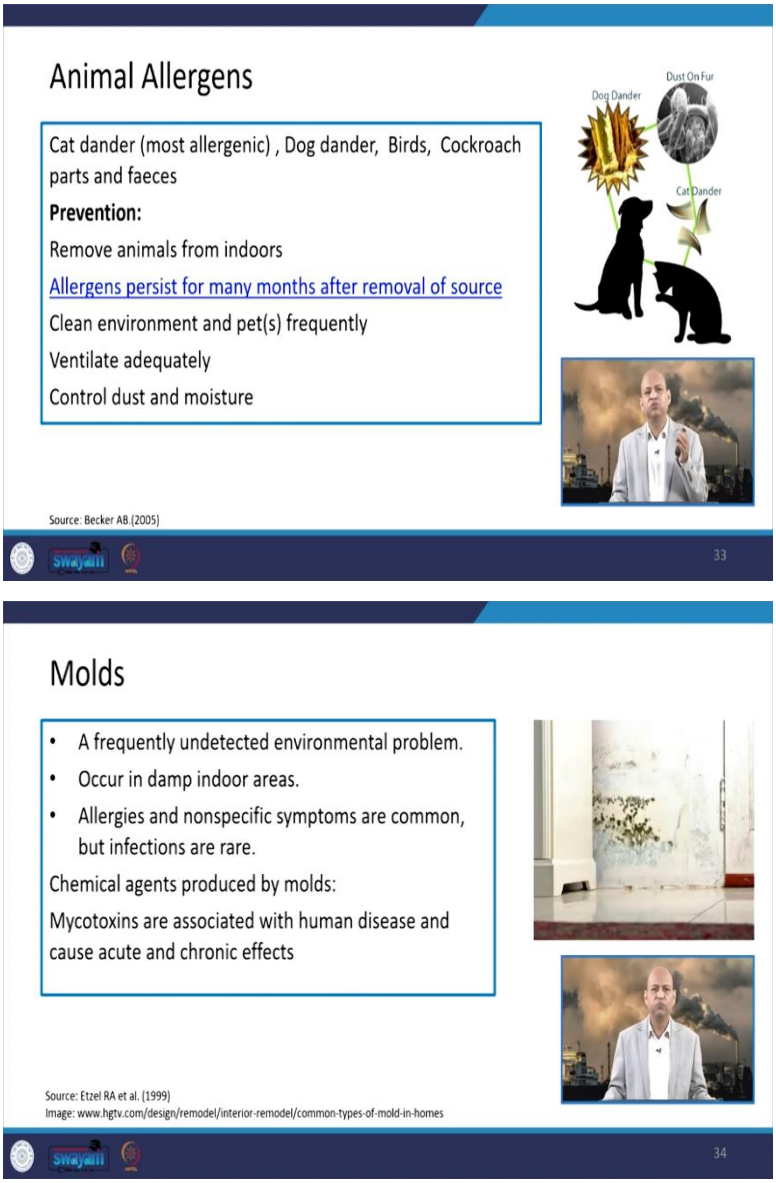

When we talk about like animal allergens so from like cats or dogs, from waste or their hair fall all those can contribute even cockroach etc birds many people have birds also. So, if they are in the indoor environment they can contribute these kind of allergens which come from the their hair fall etc.

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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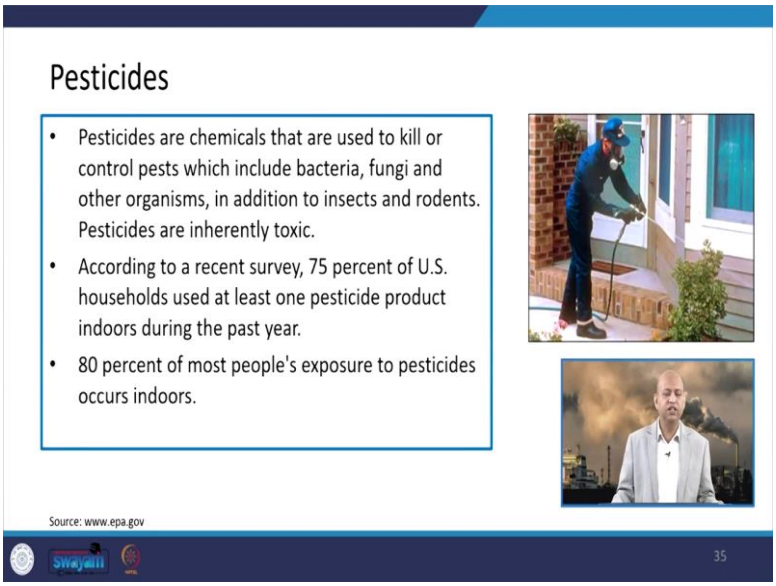

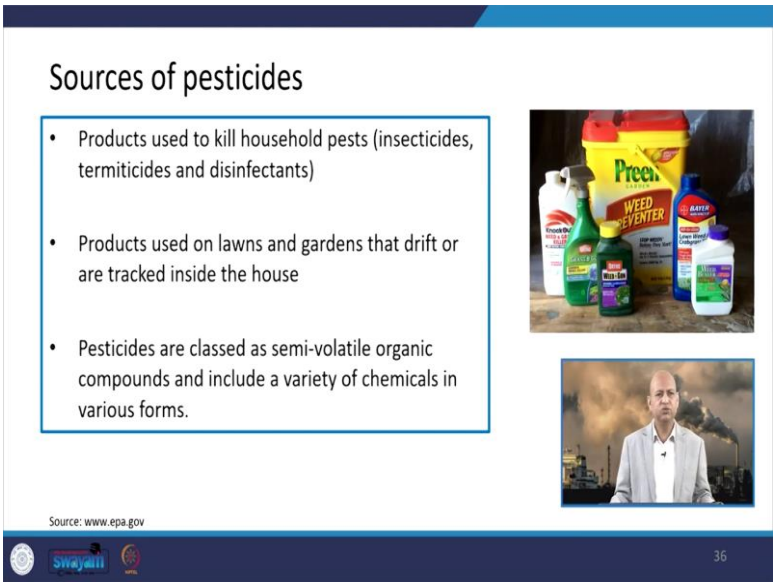

Then pesticides may be there when you are using for gardening etc. So, that can also go inside the building because we have indoor plants also and sometimes we use pesticides etc. So, the sources of the pesticides can be all these kind of chemicals which we are using to protect the plants and to repel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

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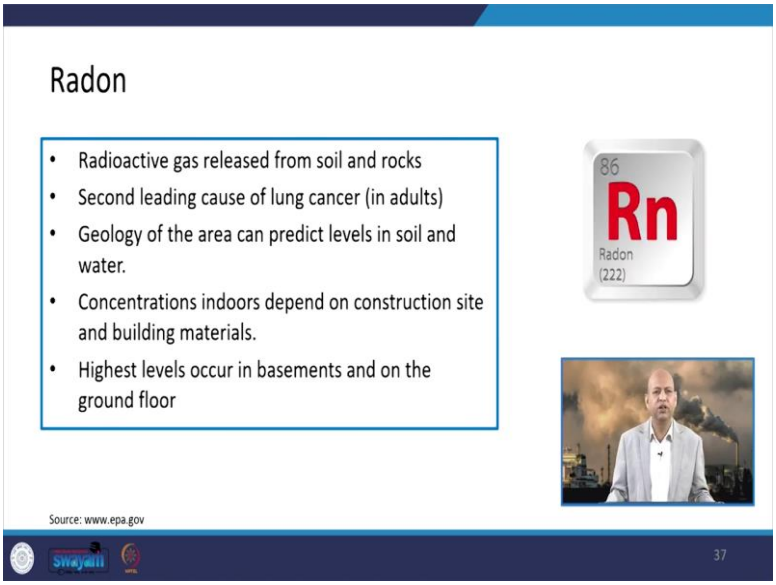

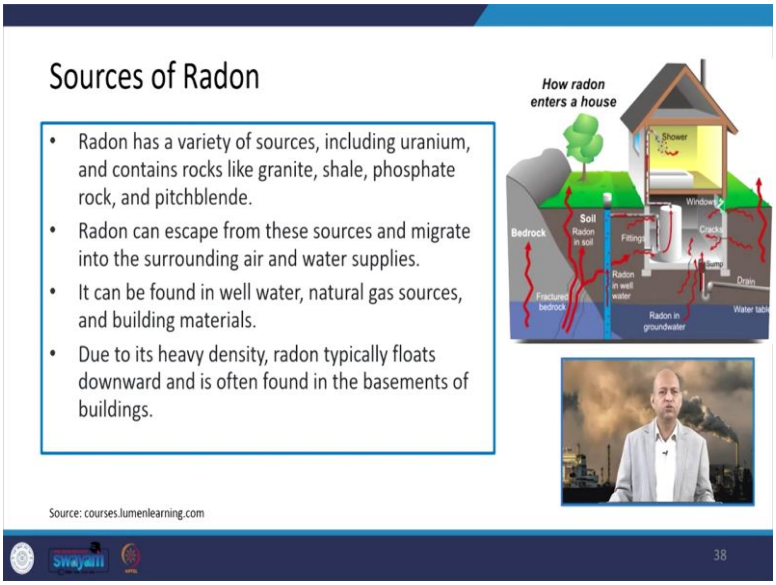

Radon radioactive gas can be released from the soil and rocks and this is the second leading cause of the lung cancer in adults. So, the geological formations of that particular area can influence this radon presence in particular localities. So, if it is present then one should take care otherwise it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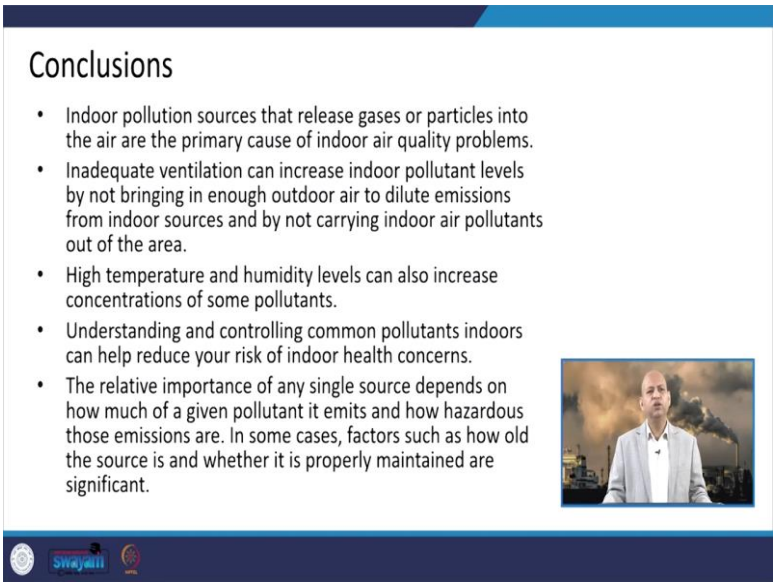

So, all in all we can say that indoor air pollution is a big problem and there are specific sources for some specific air pollutants which are significant in indoor environment and it can vary from household to the office kind of setting and accordingly we have to be careful about their monitoring and 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.