Chemical Process Safety
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Lecture 11 - Material Safety Data Sheet-1

So, welcome to this module of Material Safety Data Sheet, now Material Safety Data Sheet is an integral part of source of information of any chemical which is present at your workplace.

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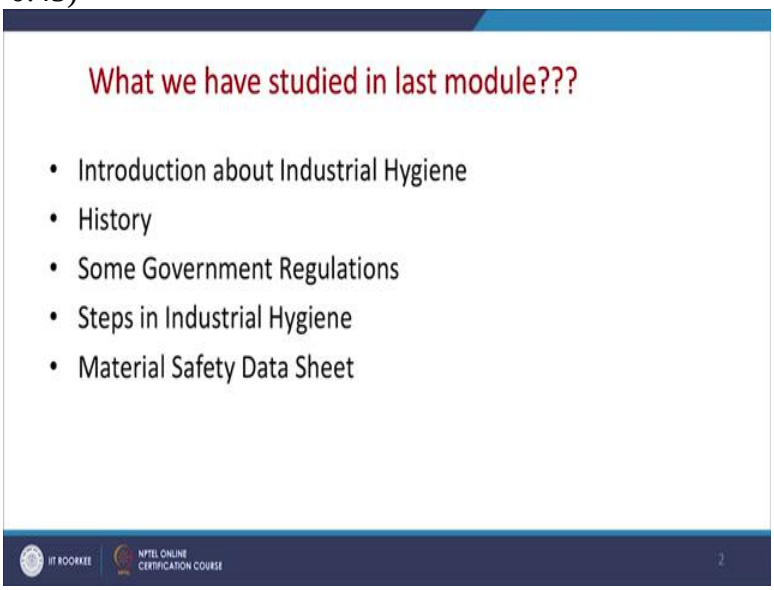

Now in the previous module we have studied about what is industrial hygiene, what is the brief history of industrial hygiene, we have discussed some abbreviation related to the governmental regulation through which we are going to handle in the subsequent modules. What are the various steps involved in industrial hygiene, like in identification, evaluation and controlled methodology and a brief description about material safety data sheet. Now, as I told you that material safety data sheet is an integral part of any chemical because this is the prima facie source through which we can have all information which we can think about for a particular chemical. So in this particular module, we are going to discuss the various steps or various sections involved in material safety data sheet. Remember this is a compendium for a particular chemical.

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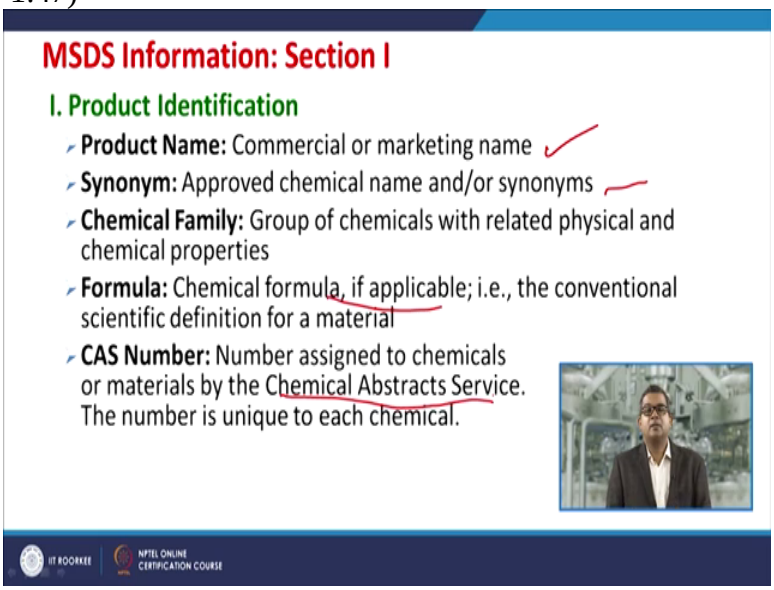

So first section deals with the product identification and a different steps are like product name, commercial or marketing name, this is just like that NaCl, usually we used to purchase the NaCl in the form of common salt, table salt etc. So, commercial or a marketing name, but scientifically it is available in the name of sodium chloride. Different type of synonyms, approved chemical names and different synonyms, in which chemical family it belongs to.

So, chemical family, group of chemical with the related physical and the chemical properties, what is the formula, chemical formula if applicable, that is the conventional scientific definition for a material, that is essential. Then CAS number, CAS number is the identity, it is just like an Aadhaar number, so CAS number, CAS number is the Chemical Abstract Service number. So if you wish to have proper information or all information related to that particular chemical, you can go ahead with this chemical abstract service number so that you will get the proper information which you require for any particular process.

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Now in this particular section, this is the pictorial diagram through which you can assess that whether this particular chemical is having the fire hazard, health hazard and in case of any specific hazards, it is also enlisted. What is the reactivity of that particular chemical? And based on this particular information, there are different numbers being provided. Now, suppose, if this particular component is having a potential health hazard, that means this is this may have a higher number. If it is having the high fire hazard then it may have a higher number. Usually these numbers are designated from 0 to 4.

Now, suppose this particular (chemical) this particular line represents that this particular chemical is not reactive with water. So this particular pictorial diagram, because sometimes it may not be possible for you to go through the entire material safety data sheet because it may contain so many pages, so this particular information gives you a just that how has hazardous this particular chemical is. Like health hazard, this particular chemical which is presented over here is having the extreme danger because based on this information. Now it is having the fire hazard below 200 Fahrenheit, they are having specific hazards related to other aspect like it is reactive, it is unstable if heated, that gives you grading 1 etc.

So this section also deals with the name and address, phone number of the manufacturer. Now this particular information is again useful. Whenever you require any specific information which is not listed in material safety data sheet, then you can always have a liberty to ask the manufacturer,

‘Okay, gentlemen, I am having this particular requirement, I am having this particular information needed for my process, so kindly supply me this one’. The date of MSDS preparation, now this is again very important because every chemical is having its own shelf life.

So when this particular chemical was produced or manufactured, then (they) must you must know that the day the MSDS was written so that you can assess that what is the shelf life and how, what is the half life of that particular chemical. There are certain rating, these all these ratings are attributed to NFP and National Fire Protection Association rating and all these MSDS must possess the storage color code like this, this and this one.

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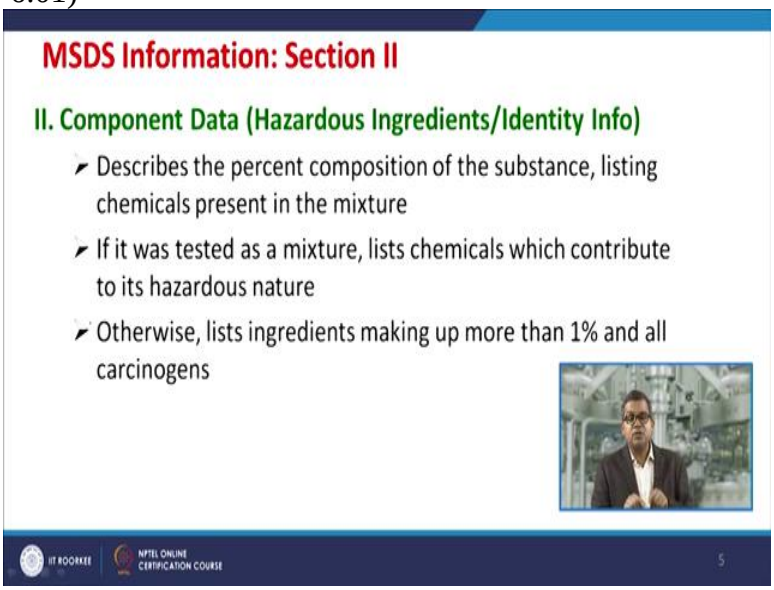

The second section deals usually deals with the component data, that is what kind of hazardous ingredient etc present in it. This describes the percentage composition of the substance, listing chemicals present in the mixture, if it was tested as a mixture lists chemical which contributes to its hazardous nature, otherwise lists ingredient making up to more than 1 percent and all carcinogens.

Now this is extremely essential because suppose your component which you are dealing upon is say 50 percent pure or it is having the minimum assay of say 75 percent, that means rest other are having some other component. This may create a future problem in your reactor or in the reaction kinetics etc. So you must know because sometimes this may lead to some production of undesired

component. So you must know this particular information so that the prima facie you can take certain precautionary measures.

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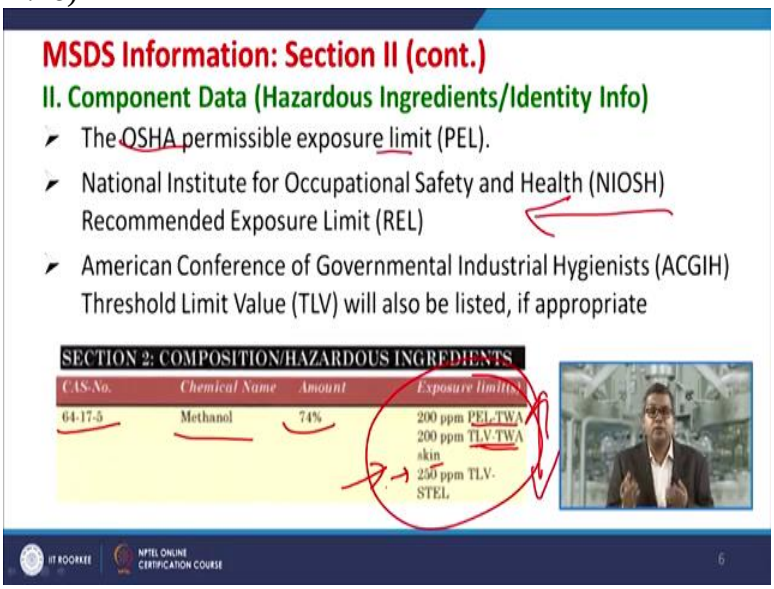

In this particular section, you must have all component data like OSHA permissible exposure limit, National Institute of Occupational Safety and Health Hazard standards, recommended exposure limits, ACGIH standard threshold limit values so that you can adopt the preventive measures like this. If you go through this particular (example) example, the CAS number is enlisted, the chemical name is enlisted, what is the minimum assay is enlisted and what are the exposure limits so that at your workplace your workers may not get over exposed.

So, be aware about this particular limit value. And moreover, it should also be mentioned that what kind of methodology is being used like permissible exposure limit that is attributed to OSHA, like TLV TWA attributed to an NIOSH, like 250 PPM TV STLEL short term exposure limit that is for 15 minutes. So, 250 PPM, it should not go beyond this; otherwise your workers will be overexposed and you need to adopt a certain control methodology.

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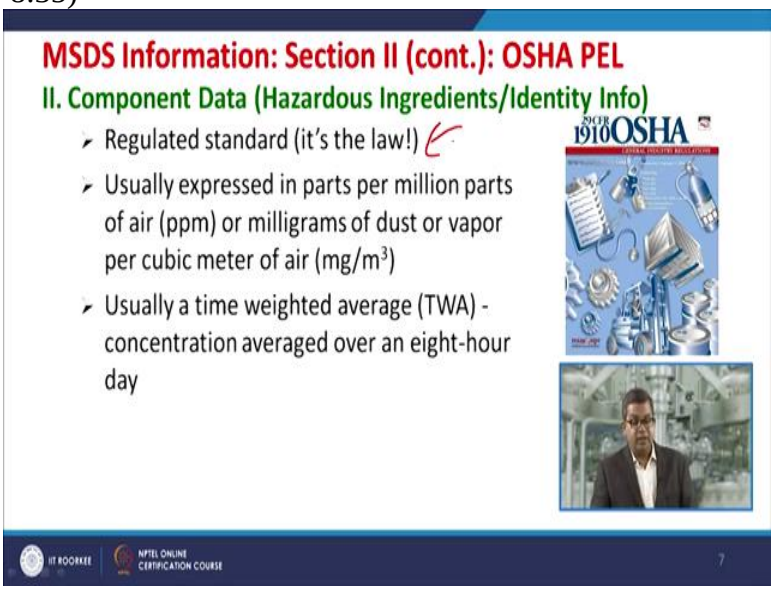

Now, you must, this particular section must also enlist that the regulated standards, that is it is the law, it is the regulatory aspect that you must enlist all the regulated standards and usually these regulated standards are expressed in terms of parts per million or milligram of dust or vapor per cubic meter of air, usually the time weighted average concentration averaged over an eight-hour a day. And in case if the worker shift exceeds this eight-hour a day, then you need to recalibrate the things accordingly.

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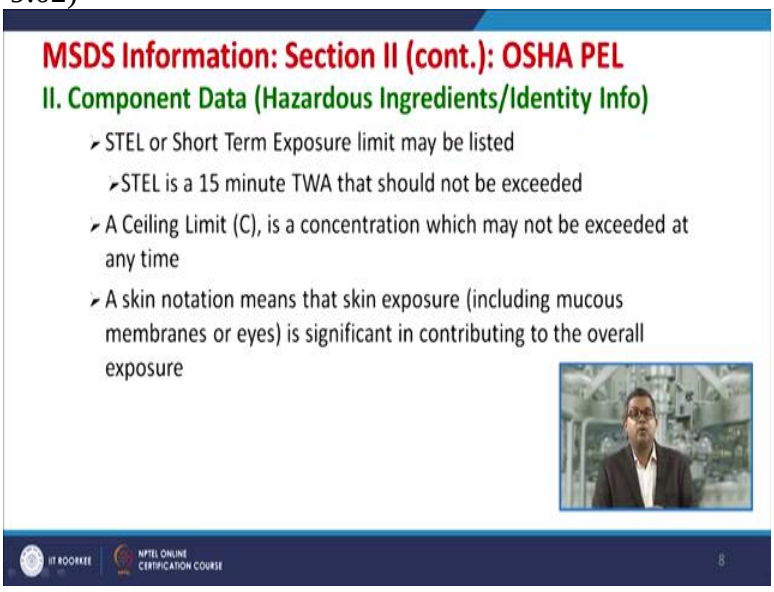

The short term or exposure limit should also be listed so that instantaneously the workers should not be overexposed, the ceiling limit usually a concentration which may not be exceeded at any

time, it should also be there if applicable. A skin notation usually means that skin exposure including the mucous membrane or eyes is significant in contributing to overall exposure.

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The next section that is section three usually deals with the precaution for safe handling because sometimes you aware that concentrated H_2SO_4 you cannot store in metal vessel, so how you can handle the things safely and how you can store the things properly? Like sodium metal, you cannot store in a hydroscopic environment, that is why it is being stored in Kerosene, so usually this section provides the information for handling and storing a product, this information may be sometimes found under the section seventh or under the section of reactivity, because obviously, whenever you are storing a particular component, you will ensure that it should not be reactive with the material of the vessel in which it is stored.

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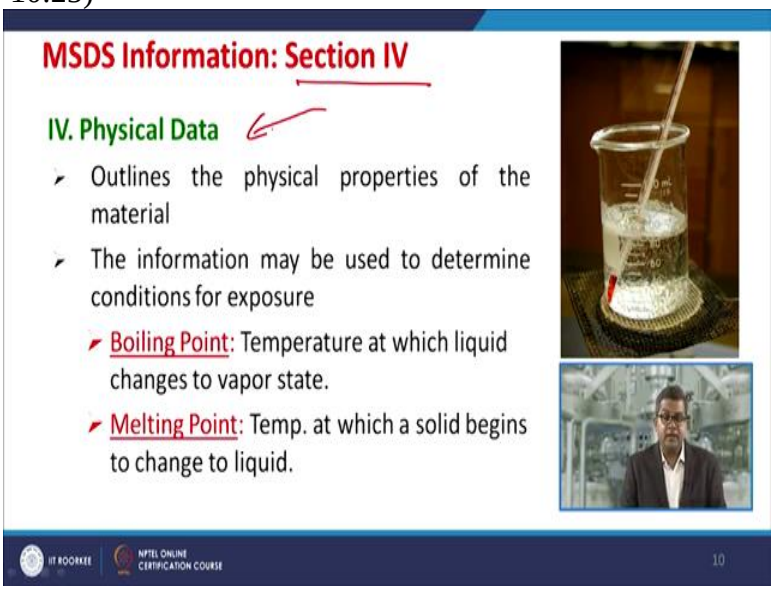

This particular section that is Section Four usually in all MSDS possesses a very useful data, that is the physical data, physical or chemical data. Physical data comprises of outlines of physical properties of the material, this information may be used to determine condition for exposure like boiling point temperature at which liquid changes to vapor state, it must be listed, melting point temperature at which the solid begins to change to liquid. And remember whenever it is being used all kinds of information, then it is also necessary to mention what is the process adopted for calculating or determining these physical parameters.

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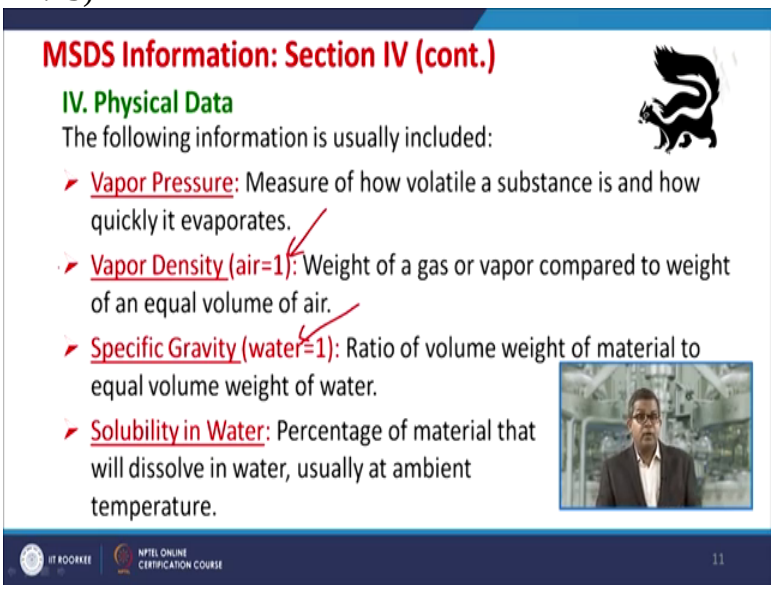

Vapor pressure, that is measure of how volatile a substance is and how quickly it evaporates. Vapor density with a difference of air is equal to 1, weight of a gas or vapor compared to weight of an equal volume of air. Specific gravity with a difference of water equal to 1, ratio of volume weight of material to equal volume weight of water. Solubility in water, percentage of material that will dissolve in water usually at ambient temperature.

Now remember, whenever you are violating these two references, then definitely you must or manufacturer must ensure that he or she or it should give a proper reference on which they have calculated the vapor density or a specific gravity. And moreover, whenever you are using these physical data you must know the proper definition and when it should be used. That is why technical knowledge and technical competency is important.

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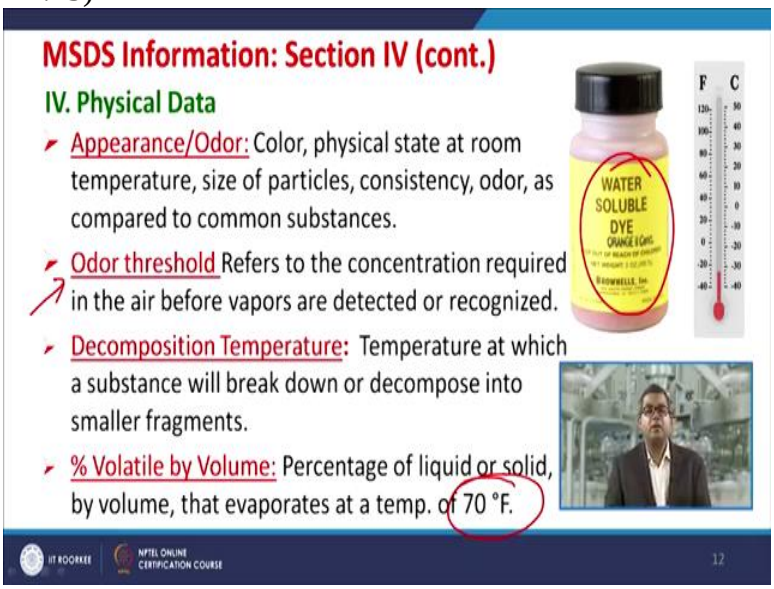

Then in this section, that is the appearance or odour, color, colorless physical state at room temperature, size of particle consistency, odour or odorless as compared to the common substance it should be there like this, here it is mentioned. Then odour threshold referred to the concentration required in air before vapors are detected or recognized. Now this is again a very crucial because you must know or you must experience all these odour thresholds so that you can recognize that this is present at your workplace and this is beyond the threshold limit value.

Then decomposition temperature because sometimes if by change in any temperature or temperature rises by any means, then some component may get decomposed and sometimes they may create a problem at the workplace.

So, you must know that what is my decomposition temperature, temperature at which a substance breaks down or decomposes into small fragments and these small fragments sometimes may be dangerous. Percentage volatile volume, the percentage of a liquid or a solid by volume that evaporates at temperature of 70 degree Fahrenheit. Now, this particular temperature should be mentioned because sometimes that is mentioned in degrees Celsius or sometimes in other units. So, be careful about these units.

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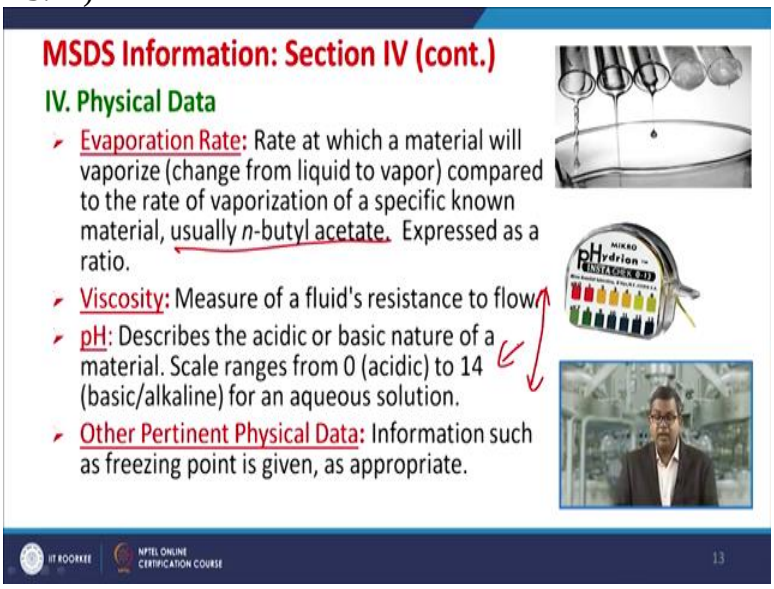

Then the evaporation rate, the rate at which a material will vaporize or changed from liquid to vapor compared to the rate of vaporization of a specific and known material, usually normal butyl acetate expressed as a ratio. Now again whenever you are using this as reference material, you must know that what is my reference material, only then you must represent or you must interpret these data. Viscosity usually a measure of fluid's resistance to flow, pH describes the acidity or basic nature of a particular material, usually scale ranges from 0 to 14 for an aqueous solution, must know because sometimes certain accidents they took place in past that people forget to have a knowledge about this pH. Other pertinent physical data, this information such as freezing point, etc; it should be given as appropriate.

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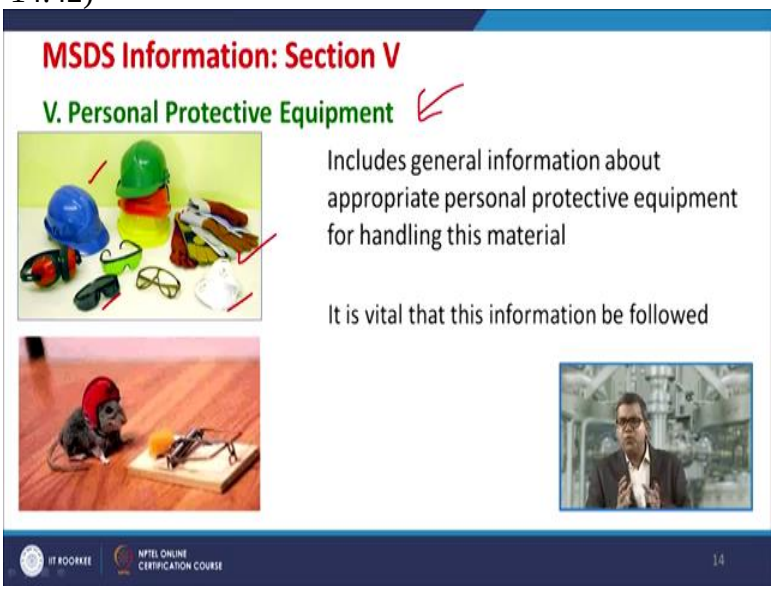

Now, next section, it deals with the personal protective equipment, this includes the general information about appropriate personal protective equipment for handling these materials. Now this particular information is vital because you got that this particular information, that this particular component is having fire hazard or it is prone towards the health hazards etc. Then you know that what are the threshold limit values.

So if they are below the threshold limit values, then there is no harm. But if they exceeds then definitely you need to adopt certain protective measures. So what kind of protective measures you need to adopt both for the process as well as for the person those who are working in and around that particular arena. So, this section deals to provide the information about the personal protective equipment, you can see that there are headgears, goggles, gloves, mask, etc. So you must aware all those that at what point of time and at what scenario you need what kind of personal protective equipment. This is by the technical competency.

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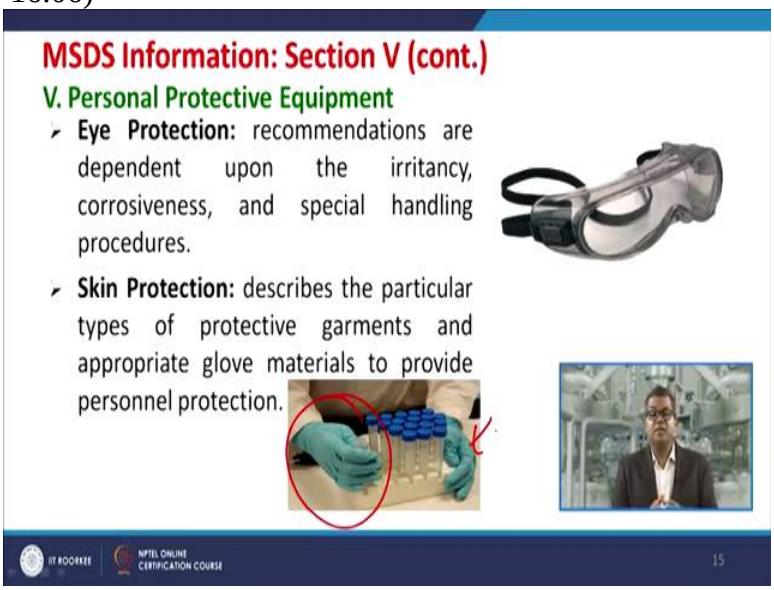

These are the various personal protective equipment like eye protection, eye gears. Recommendations are depend on the irritation, corrosiveness and a special handling process. Because remember, your eye and skin these are the prima facie through which you can get information that something at your workplace is wrong, because sometimes if there is a chlorine exposure your eye may get irritated, the skin may become dry. So, if skin becomes dry then you must adopt certain skin protections. So this describes the particular type of protective garments and appropriate glove material to provide the personal protection. Now remember whenever you adopt this gloves etc it should not be reactive with your skin, only thing is that they need to provide a barrier between the toxic substance and yourself.

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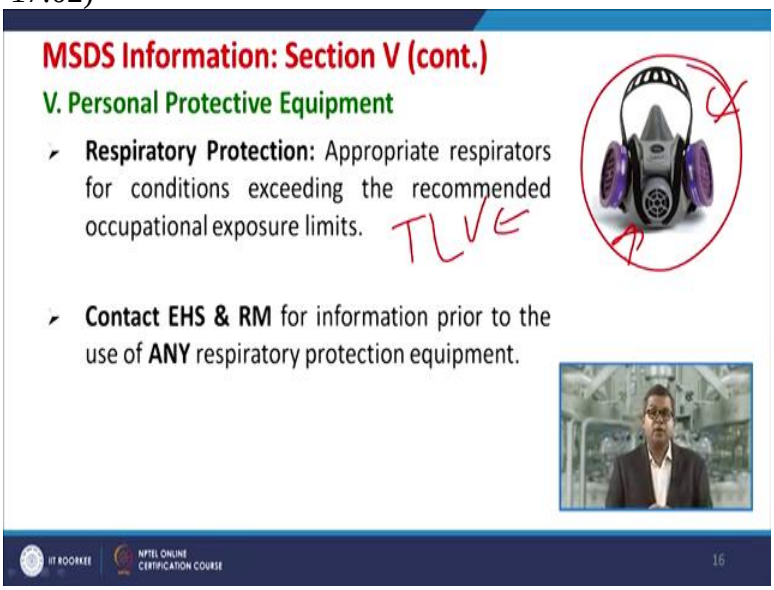

There are certain respiratory protectors, they are appropriate because if your working environment is overexposed, not only you are controlling the inherent things of your process, but sometimes the things are overexposed or if you are gradually exposed to the toxic environment when the concentration is no doubt is below TLV, but the repeated exposure may create the future health problem. To overcome such type of thing, use the respiratory protection, this is the appropriate respirators for condition exceeding the recommended occupational exposure limit. So if it increased, if the workers are exposed by having the higher TLV then it is always recommended to use this personal protective equipment.

Now contact EHS or relative measures for information prior to use of any respiratory protection equipment. Because whenever you are using this kind of the respiratory production equipment, definitely your efficiency is challenged, definitely you are compromising with your efficiency. So before adopting any kind of respiratory technique, you must consult the environment health hazard safety person so that they can give you that what kind of respirator is essential for you. Because the respirator is of N number of time, they may have a certain cartridges, they may have a certain canister through which the toxic substance may get neutralized over the period of time. Sometimes they may have some filters or absorbent materials so that you can have a proper or purified air into your for your breathing.

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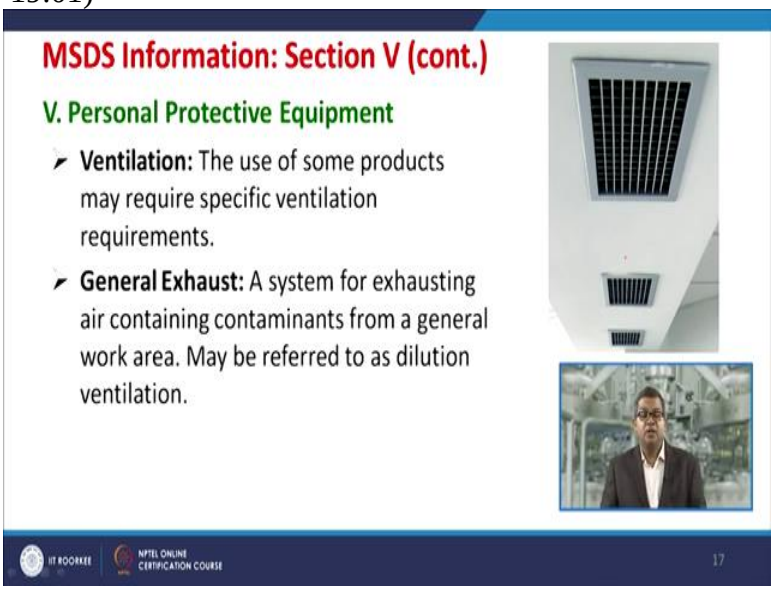

Other personal protective equipment comprises of ventilation, the use of some product may require the specific ventilation. Now ventilation is usually of two types, one is the local ventilation so that you can remove the toxic substance from your workplace and some processes uses the dilution ventilation through which you can reduce the concentration of toxic substance at your workplace by either some inert gases or air so that it can go below the TLVs, threshold limit values. General exhaust, usually a system of exhausting air containing contaminants from a general work area, this may be referred as a dilution ventilation.

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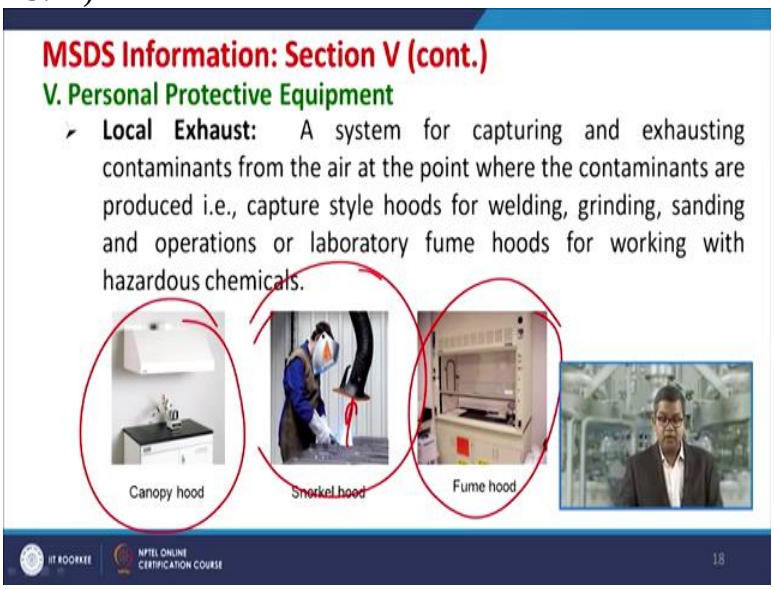

The local exhaust, a system of capturing and exhausting contaminants from air at the point where the contaminants are produced, capture style hoods like this, canopy type of hoods for welding, grinding, sanding and operation of laboratory fume, fume hoods for working with the hazardous chemicals. This is again a general type of local exhaust through which it can, the hazardous substance may be sucked away from the workplace.

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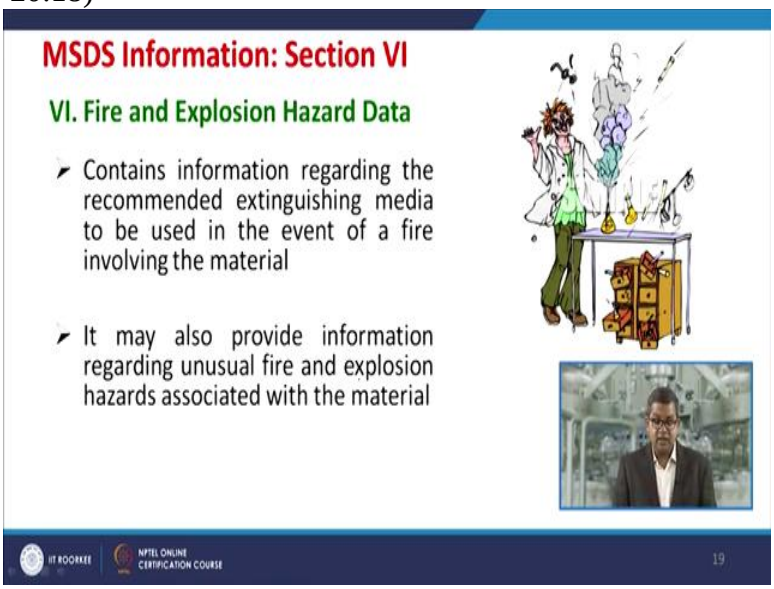

The next section deals with the fire and explosion hazard data because this creates another problem. Suppose like hexane, like LPG etc, everything is which is flammable nature may create a future problem, so you must know that how hazardous that particular substance is in terms of fire. This contains the information regarding the recommended extinguishing media to be used in the event of a fire involving the material. Because you cannot use water based (extinct) fire extinguisher in place of electrical fire or if by any means the cooking oil catches fire, then you cannot use water as an extinguishing media.

So, you must know that which kind of fire extinguisher is used for in case of any fire. It may also provide this particular section may also provide the information regarding unusual fire and explosion hazards associated with the material.

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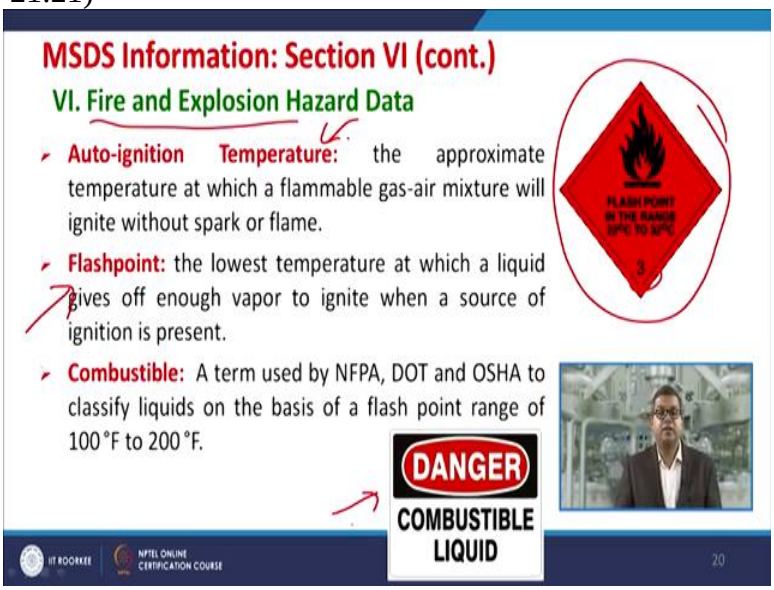

Now under this section, the auto-ignition temperature must be listed, the approximate temperature at which a flammable gas air mixture will ignite without a spark or flame, the Flashpoint must be listed, the lowest temperature at which a liquid gives off enough vapor to ignite when a source of ignition is present.

The combustible, the term used by NFPA and Department of Transportation and OSHA to classify liquid on the basis of a flashpoint ranges of 100 Fahrenheit to 200 degree Fahrenheit, so this information is essential because when we talk about, when we discuss the Jaipur accident, then this AIT and Flashpoint played a vital role because the fire at the Jaipur terminal propagated because of the auto ignition temperature of petroleum product and a flashpoint right. So, whenever this particular section is dealing with this or particular chemical is having this kind of hazard, then this type of labeling must be there, that the Flashpoint in the range of 22 degrees Celsius to 32 degrees Celsius. And it is the level three type, that means extremely inflammable.

Or sometimes you may see that this type of label spaced for the various kind of time cards etc, in which it is the mentioned that danger, away from that time card because it is carrying the combustible liquid.

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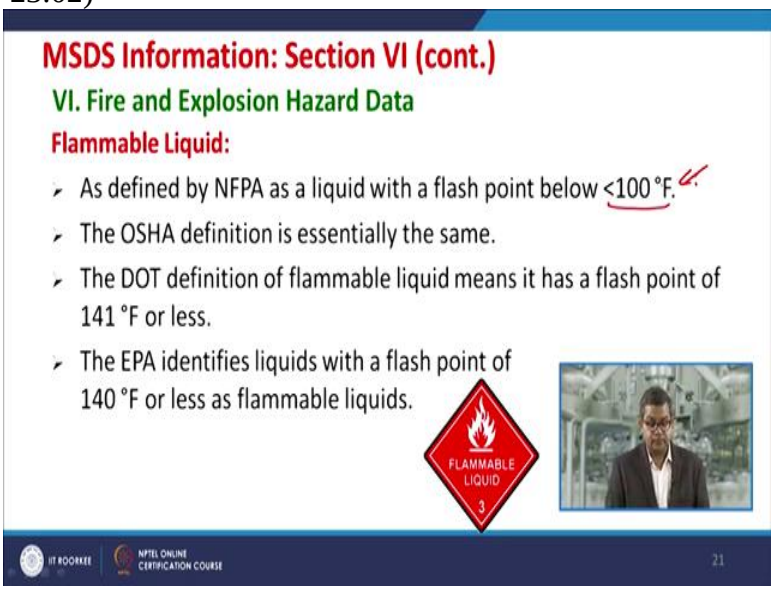

Now flammable liquid, what kind of definition it possesses? Now usually as defined by NFPA, this is a liquid with the Flashpoint below 100 degrees Fahrenheit. I am repeating it again that whenever you use this, you carefully use this particular data because 100 degree Fahrenheit is bit different from 100 degree Celsius. The OSHA definition is essentially same and in the close proximity of NFPA, the Department of Transportation because sometimes you need to transport these petroleum products or a flammable material from one place to another place, so they gave their own specification.

So the DOT in definition of flammable liquid means it has a flashpoint of 141 Fahrenheit or less, the EPA identifies the liquid with the Flashpoint of 144 Fahrenheit or less as a flammable liquid.

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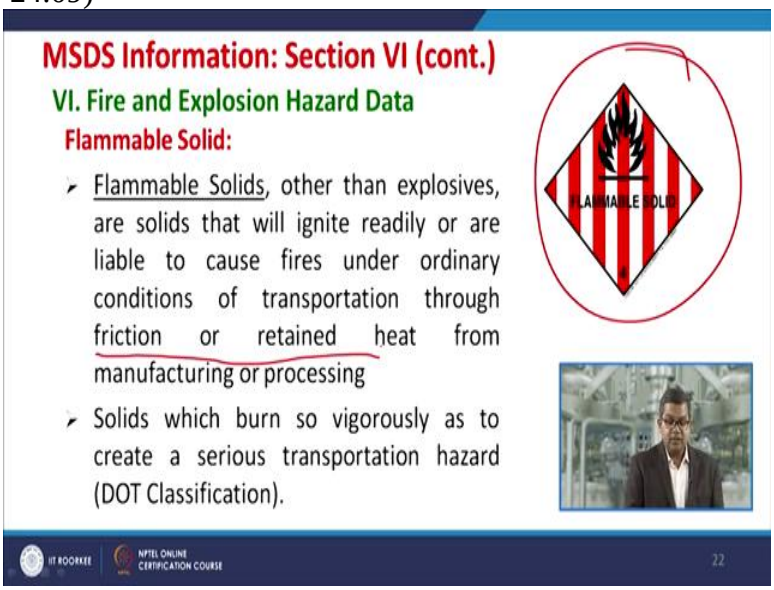

There are certain flammable solids and usually depicted by this particular label, now the flammable solids other than explosives are solid that will ignite readily or are liable to cause fire under the ordinary condition of transportation through friction or retained heat from manufacturing or processing. So, do not forget that friction has also played a vital role while causing the fire, solid which burns so vigorously as to create the serious transportation hazard that is the DOT classification.

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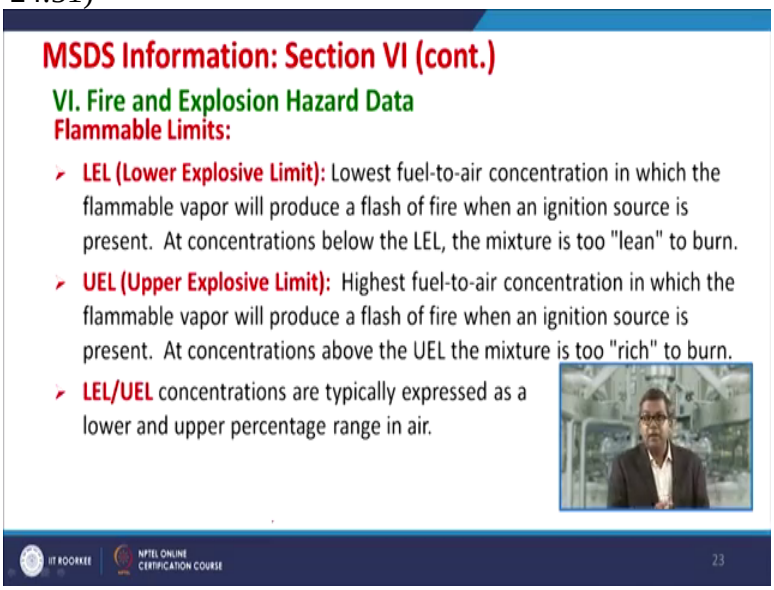

Now, once we talk about the fire and explosion hazard data, we must specify there are certain limits, like while we are handling the vapors or while we are handling the liquids, so we must

specify that what are the safe limit under which we can work upon like in the toxic substance. So, different agencies they give that, the two limits, LEL, the lower explosive limit, lowest fuel to air concentration, in which the flammable vapor will produce a flash of fire when an ignition source is present. At concentration below LEL the mixture is too lean to burn. Remember these two things, LEL or sometimes it is called lower flammability limit or upper flammability limit or UEL upper explosive limit, these are usually governed by the stoichiometric ratios.

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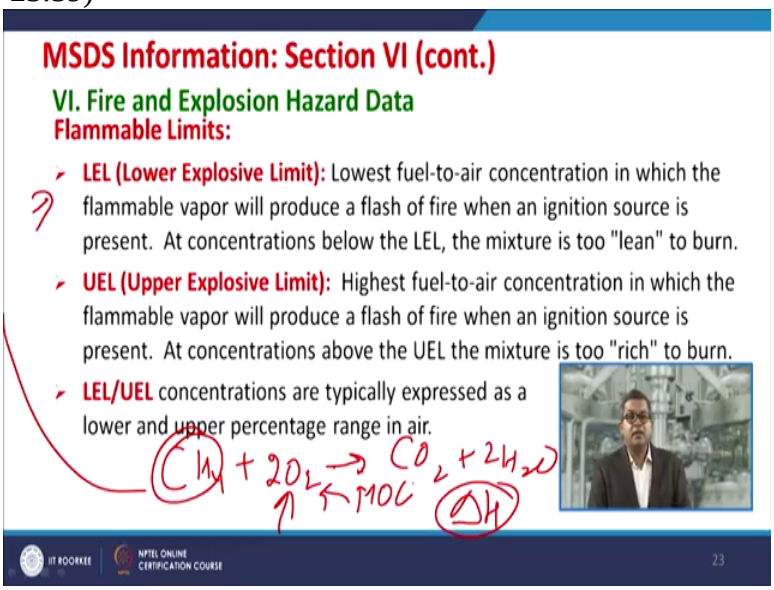

It is just like that if you wish to burn one mole of a methane that is

$$CH_4 + 2O_2 \rightarrow 2CO_2 + 2H_2O$$

Now remember, this is the chemistry of combustion that one mole of CH4 requires two moles of oxygen.

So if oxygen is present lesser than this required limit, then definitely there will be no fire. So, this particular information must be known those who are working in that particular arena. Similarly UEL or upper explosive limit, this is the highest fuel to air concentration in which the flammable vapor will produce a flash of fire when an ignition source is present. At concentration above UEL the mixture is too rich to burn, that means this concentration is on the higher side and this one is having low and sometimes this particular concentration is referred as MOC, minimum oxygen concentration.

So, this much minimum oxygen concentration is required to burn that particular thing. So in the module of fire, we will discuss this fire anatomy in detail. The LEL, UEL concentration usually expressed as a lower and upper percentage range in air, so if a mixture is in between LEL and UFL only then it will catch fire. If the mixture is too lean or mixture is too rich, then definitely the fire will not be there. So you must know so that in case if you are working in hazardous environment or just take an example of hexane, if the continuous hexane vapors are evolved, then your attempt should be like this, that to reduce the concentration of hexane at the workplace or to reduce the concentration of oxygen at workplace so that these (formed) formed mixture should not lie between the LFL and UFL.

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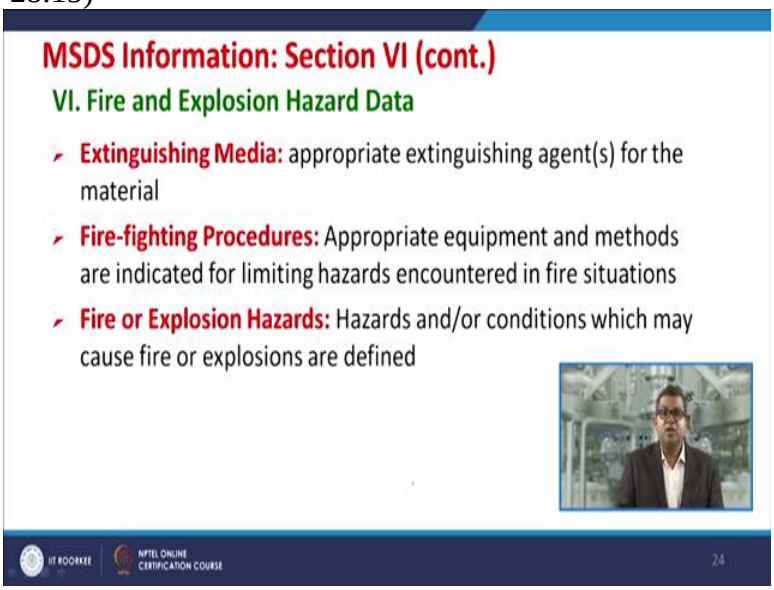

Now in case of fire, you must know that what kind of extinguishing media we should use, so extinguishing media that is the appropriate extinguishment agent for the material so that the fire can be extinguished. The proper firefighting procedure must be enlisted that is the appropriate equipment and methods usually to be indicated for limiting hazard encountered in the fire situation. So, all kind of procedures must be enlisted in MSDS.

The fire and explosion hazard, hazards and or conditions which may cause fire or explosion should be defined and sometimes because of any accident or sometimes if you are handling particular reaction which is exothermic in nature and if by any means the temperature rises and sometimes

the particular substance because of the auto ignition ability it may catches fire and the things may be dangerous. So, all kind of scenario must be enlisted in MSDS.

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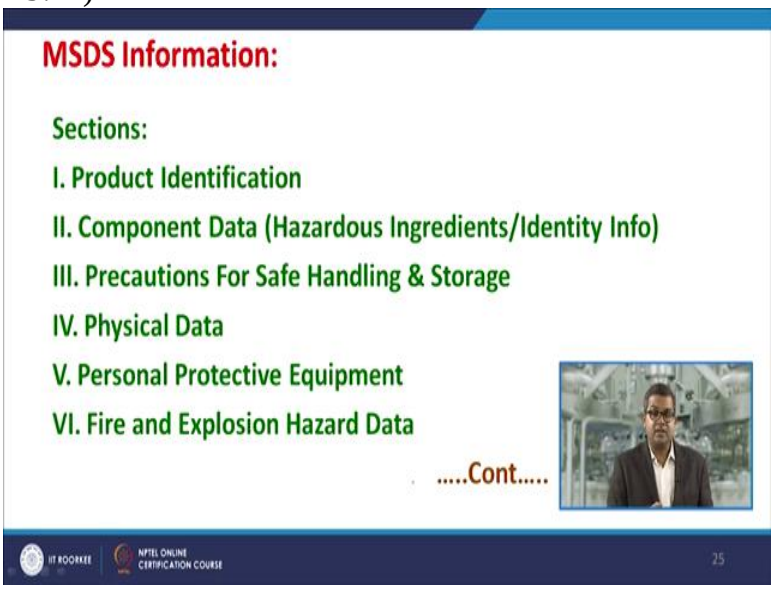

In this particular module, we have discussed the information, MSDS information related to the product identification, how we can identify the product, how we can distinguish the product from the chemical name to the family to the commercially available name, what kind of component data related to the hazardous ingredients etc. We have taken the precautions how we can store it safely, how we can handle that particular substance safely. How important and what kind of the physical data should be there in the MSDS, in the section 4, what kind of based on the information available what kind of personal protective gear should be used and how what are the different fire and explosion hazards data and how we can deal it upon. In the subsequent lecture we will go ahead with MSDS in detail with the remaining parts.

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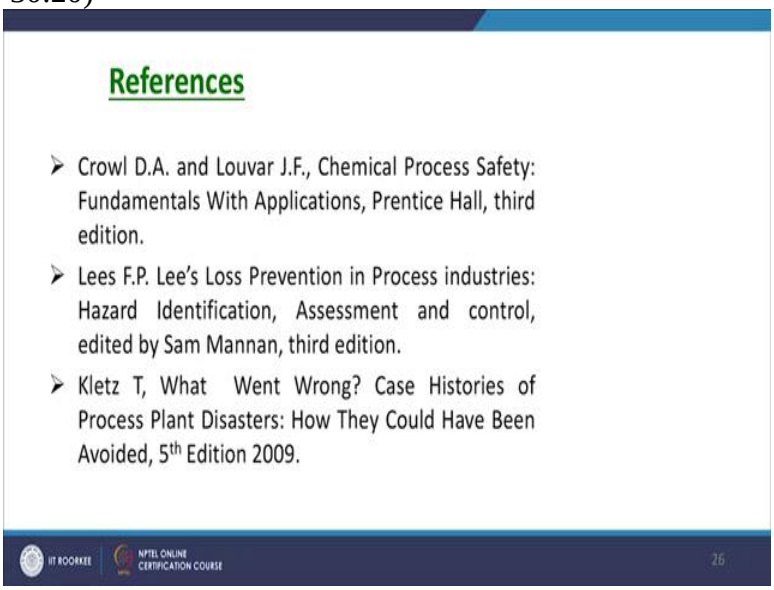

Again, you can utilize these references for future studies. So thank you very much for this module.