Offshore structures under special loads including Fire resistance
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Module – 03
Fire Resistance
Lecture – 39
Fire Safety-Overview

Friends, let us now move on to the set of lectures in module 3, which is the last module in this course title Offshore Structures in the Special Loads Including Fire Resistance. In this module we will focus about Fire Resistance; in lecture number 39, today we will talk about fire safety an overview.

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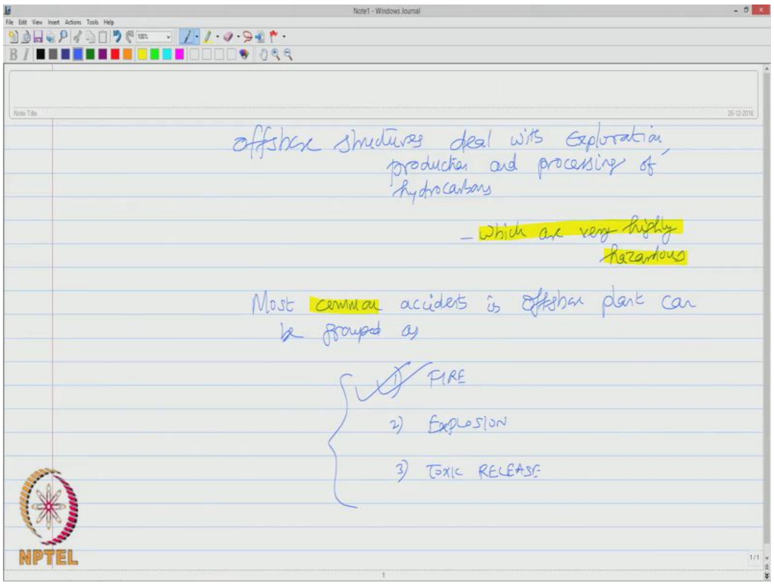

We all know that offshore structures deal with exploration, production and processing of hydrocarbons, which are very highly hazardous that is a very important statement which we must realize that hydrocarbons are very hazardous and most common accidents in offshore plant can be grouped as; one due to fire, two due to explosion and third due to toxic release.

So, friends it is very important to realize and understand at this point, that fire is one of the major group of accidents in offshore plants, though I say a word common, but these accidents are not that common, they occur away now and then whenever such accidents are report in offshore plants, they can be commonly grouped only on these 3 heading and fire place the lead role in the group of accidents, which are generally reported in offshore structures.

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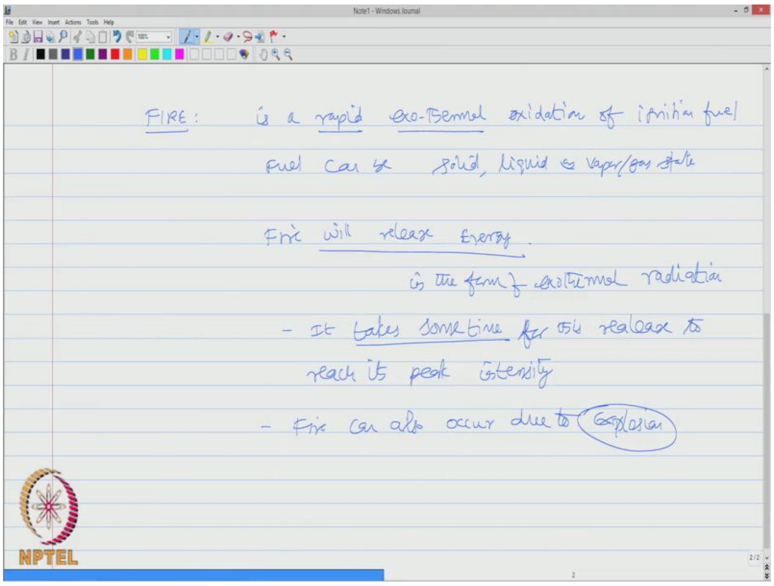

So, let us look into certain definitions and understand basic characteristics of fire. So, the question comes what is fire? Fire actually is a rapid exo-thermal oxidation of ignition fuel. So, the catch word here is here is rapid and exo-thermal. The fuel what we talk about can be solid, liquid or in vapor or gaseous state, fire will release energy, this will be in the form of exo thermal radiation.

The interesting part which is slightly beneficial advantageous to offshore engineers is that, it takes some time for this release to reach its peak intensity, this is the buffer time which is given as a preventive measure time where or within which fire accidents or spread of fire should be controlled or mitigate. So friends, fire can also occur due to explosion. So, it has got a link with a next group of common accident, which is explosion.

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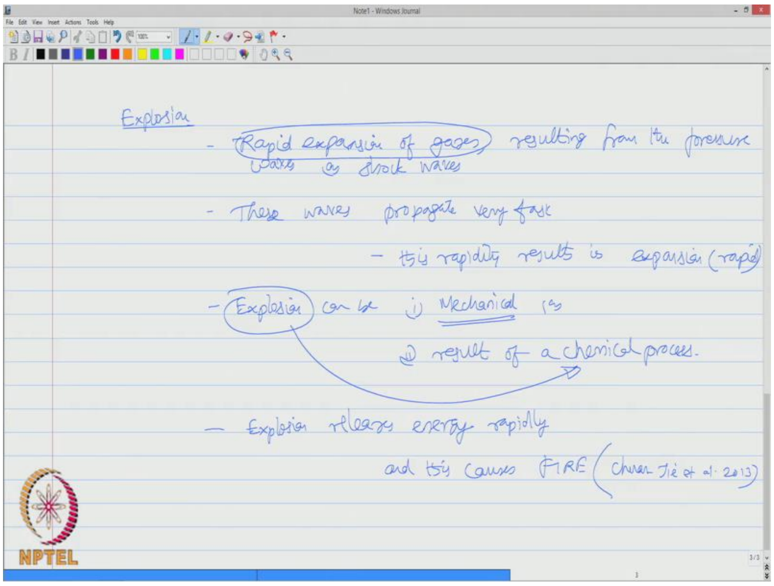

Then let us understand what is explosion? Explosion is rapid expansion of gases resulting from the pressure waves or shock waves. So, the catch word here is it is a rapid expansion, they result in what we called as a pressure wave or a shock wave these waves propagate very fast and this rapidity results in expansion, which is also rapid.

Friends it is important to understand that explosion can be a mechanical process or result of a chemical process. So, this is a common misunderstanding with people the explosion is attached only to chemical process that is a wrong conceivement of idea; explosions can occur because of mechanical reactions as well we will discuss this in detail as we proceed further in different modules in this lectures.

So, again explosions of cross sections with fire, explosion releases energy rapid and this causes fire. So, friends fire and explosion are very strongly coupled each other in terms of their process, you can say this is Chuan Jie et al 2013.

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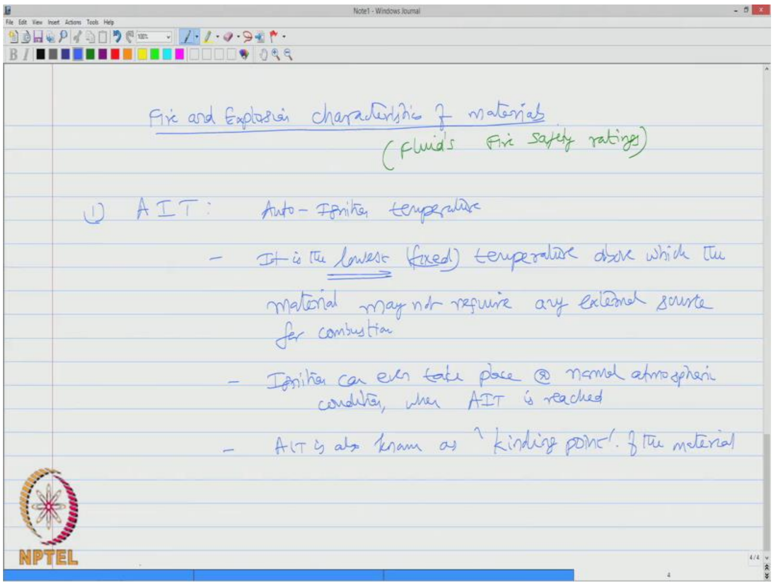

Now, let us commonly look at some characteristics of fire and explosion of materials.

Sometimes they are also called as fluids fire safety ratings, first one is what we call AIT expands for auto ignition temperature of any material, which is flammable. By definition it is the lowest fixed temperature. So, it is the lowest temperature above which the material may not require any external source for combustion, ignition can even take place at normal atmospheric condition when auto ignition temperature is reached.

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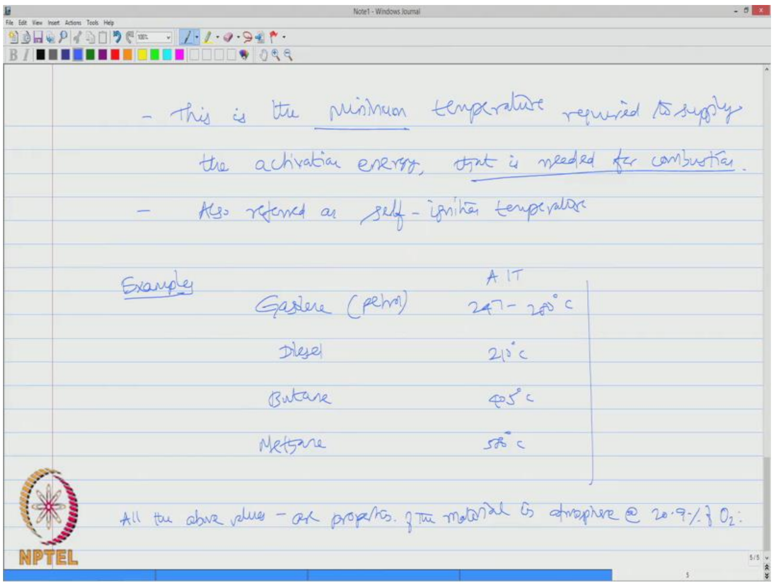

Literature also refers this as kindling point; AIT is also known as kindling point of the material. So, one can say that this is the minimum temperature required to supply the activation energy that is needed for combustion, sometimes it is also referred as self ignition temperature, we can give some examples of different chemicals or material whose AIT is known in the literature. Let us talk about gasoline the commercial name what we call as referred as petrol, AIT it is auto ignition temperature of petrol varies from 247 degree to 280 degree Celsius. Diesel is 2010 degree Celsius, butane is 405 degree Celsius and methane is 580 degree Celsius.

Please note that all the above values or properties of the material, one you can say even combustion material in atmosphere at 20.9 percent of oxygen.

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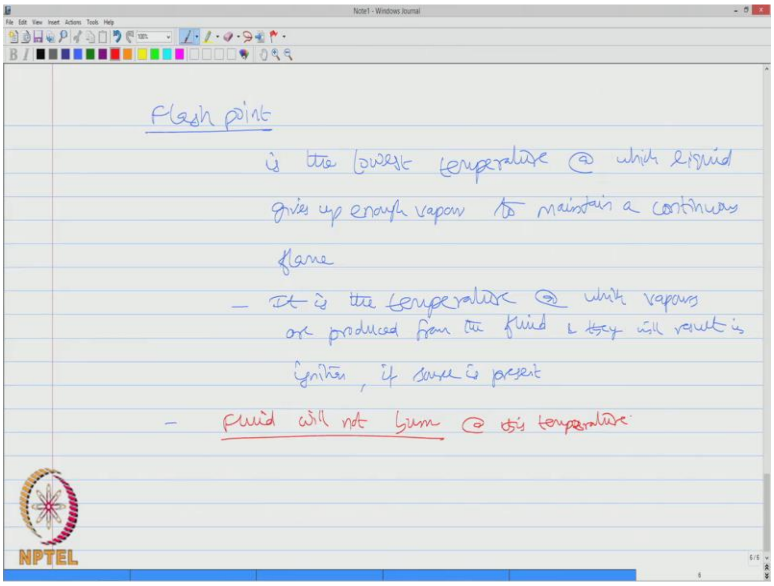

Let us talk about flash point. Flash point is the lowest temperature at which liquid gives up enough vapor to maintain a continuous flame, it is a temperature at which vapors are produced from the fluid and they will result in ignition if source is available. It is very important to make a statement fluid will not burn at this temperature, it only AITs ignition that is important

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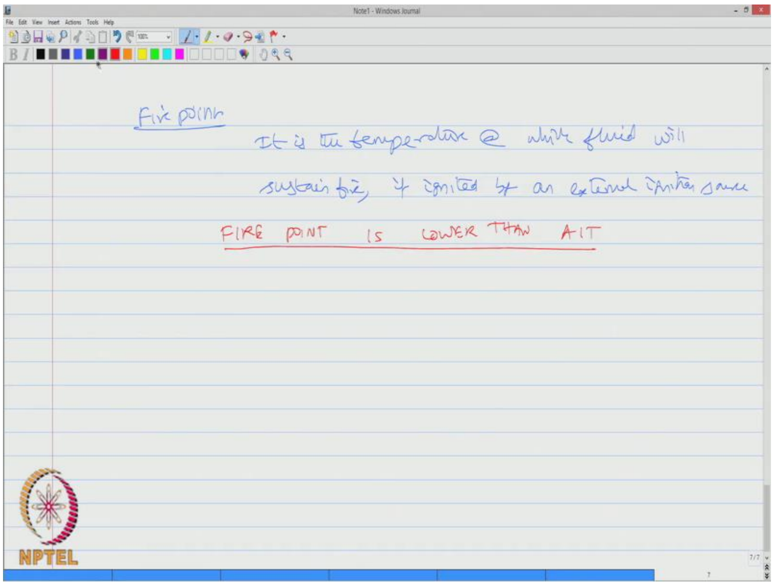

The next one is fire point; it is the temperature at which fluid will sustain fire, if ignited by an external ignition source. Please understand that fire point of any material is lower than flash point sorry auto ignition temperature.

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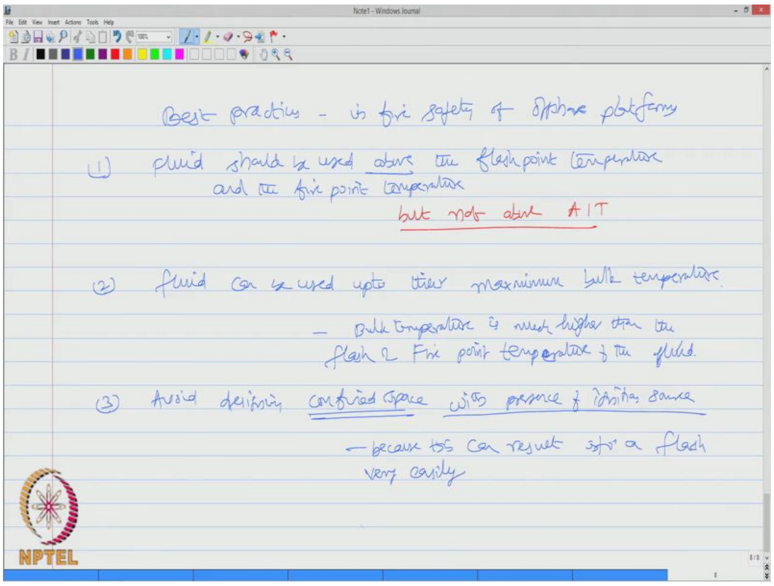

Now, let us talk about some of the best practices being followed in fire safety of offshore platforms, these practices are either followed or recommended to be followed by international course. The first one could be that fluid should be used above the flash point temperature and the fire point temperature, but not above auto ignition temperature.

So, that is the first practice which should be strongly followed in any process industry, but of course, very particular in offshore platforms. A second could be fluid can be used up to their maximum bulk temperature, because the advantage is bulk temperature is much higher than the flash and fire point temperature of the fluid, it is a very common phenomena. The third could be we must avoid design of or designing confined space with presence of ignition source.

If there is a potential presence of ignition source that should not be designed as a confined space, because this can result into a flash very easy easily.

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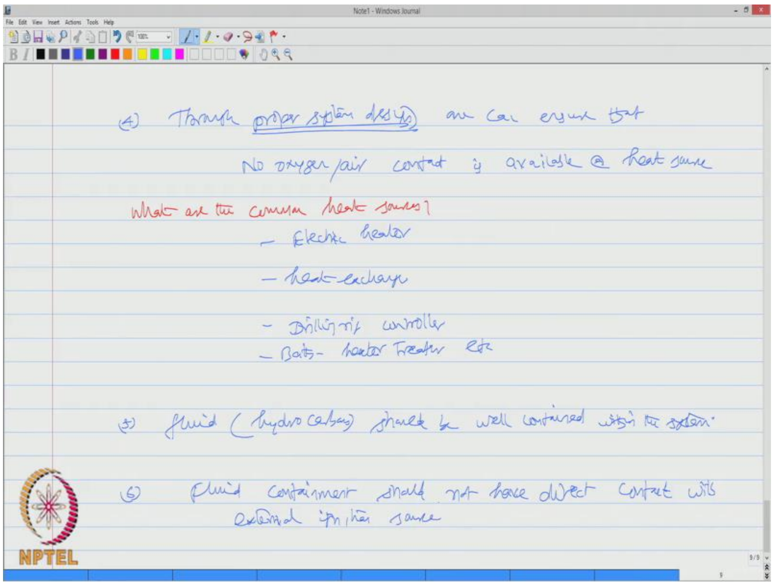

The fourth point could be through proper system design; one can ensure that no oxygen or air contact is available at heat source. So, this should be ensured through a proper system design, it means the question comes what are the common heat sources, electric heater, heat exchanger, drilling rig controller, bath heater tether etcetera.

The next point could be the fluid in our case it can be hydrocarbons also should be well contained within the system. In a six point could be fluid containment should not have direct contact with external ignition source, otherwise it become very highly (Refer Time: 22:52).

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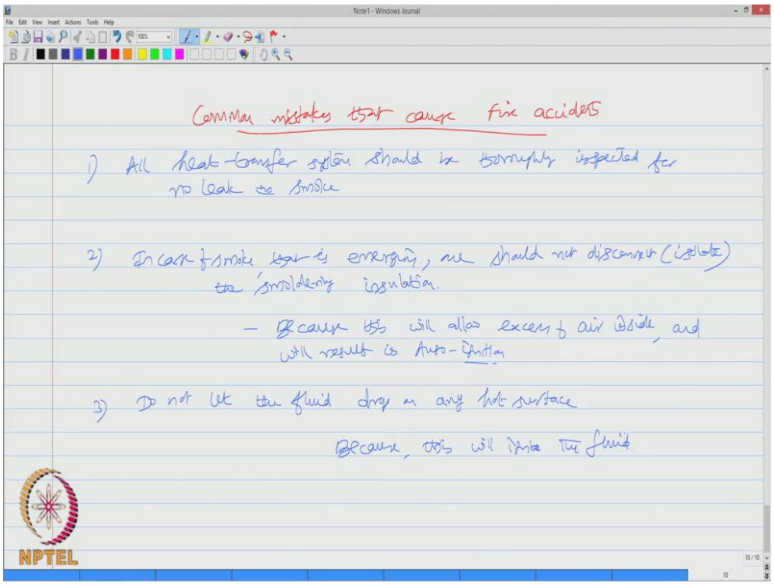

Let us ask a question; what are common mistakes people make that can cause fire accidents? 1. All heat transfer system should be thoroughly inspected for no leak or smoke that is a first practice which we would adopt, if violated can be one of the common mistake to cause fire accidents.

In case of smoke that is emerging one should not disconnect or I should say isolate the smoldering insulation because that can result in serious spectroscopy, because this will allow excess of air inside and will result in auto ignition. The third point could be, do not let the fluid drop on the hot surface on the hand any hot surface because this will ignite fluid.

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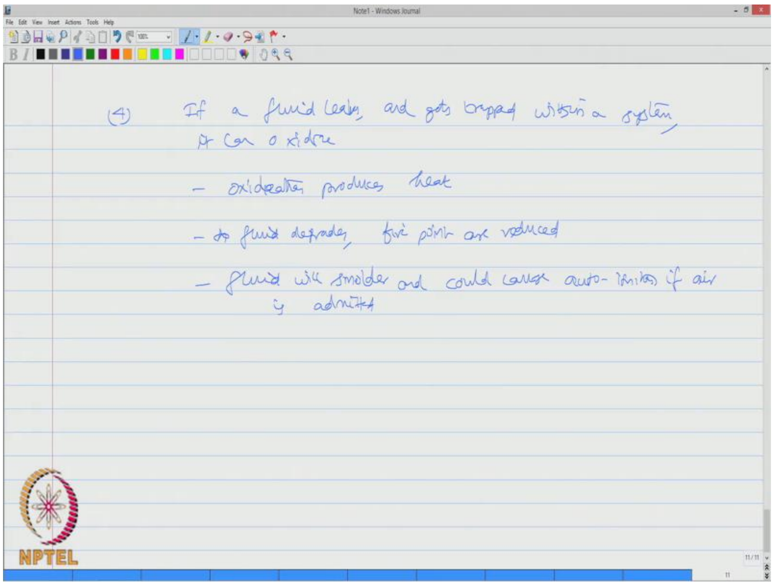

Fourth point if a fluid leaks and gets trapped within a system, lets imagine it is a case which happened; it can oxidize and oxidization produces heat as fluid degrades because of admittance of oxygen, the fire points temperature or reduced in that situation fluid will smolder and could cause auto ignition if air is admitted.

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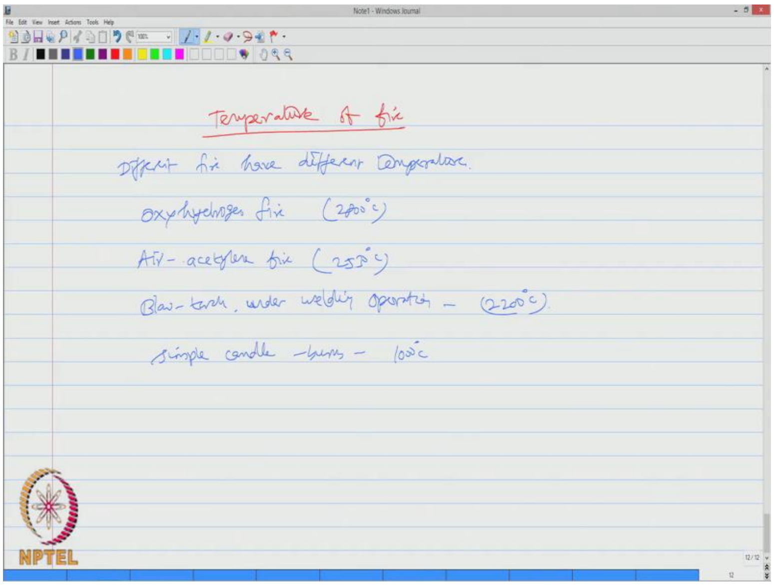

Let us talk about what is the temperature of fire? Different fire have different temperature for instance, oxy hydrogen fire the temperature about 2800 degree Celsius, air acetylene fire about 2530 degree Celsius, the fire which happens it is a blow torch under welding operations has fire value 2200 degree Celsius.

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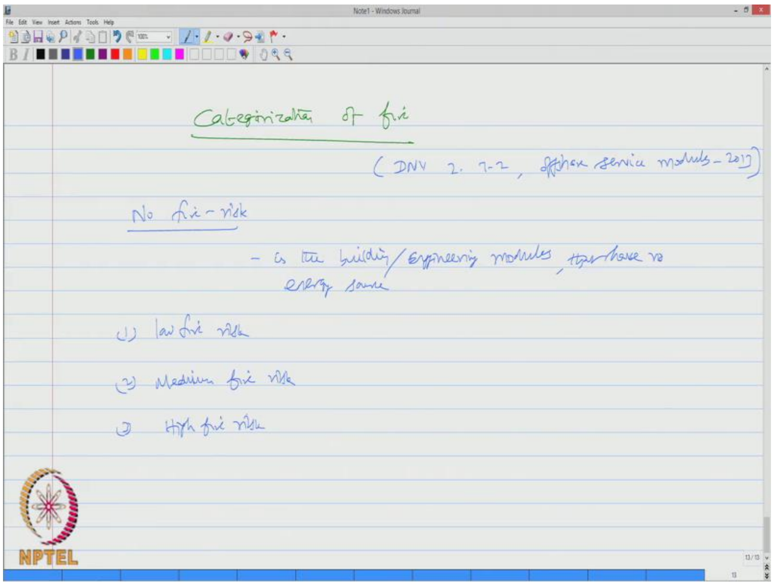

Simple candle which burns will have a temperature of fire at thousand degrees Celsius. Let us move on to the next discussion which is categorization of fire, one can refer international rules DNV 2. 7-2, offshore service module, 2013. According to the court there should be no fire risk in the platform in the building or engineering modules that have no energy source.

So, when you talk about categorization, it is categorized three groups; one low fire risk, medium fire risk, high fire risk.

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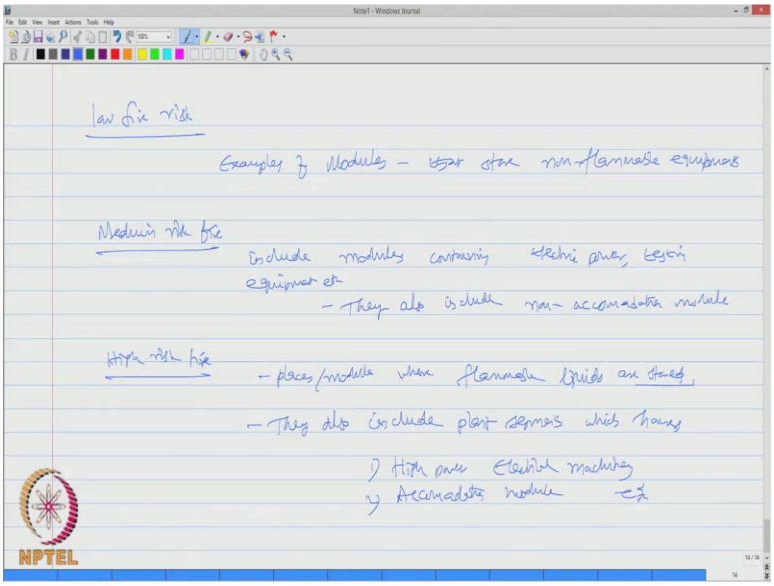

So, let us discuss what is low fire risk? We need to understand that fire is always associated with risk estimates in offshore platforms, low fire risk are actually examples of module structures, that store non flammable equipments whereas, medium risk fire include modules containing electric power, testing equipment etcetera. They also include non accommodation module, high risk fire these are the places where flammable liquids are stored they also include plant segments which houses high power electrical machineries, accommodation module etcetera.

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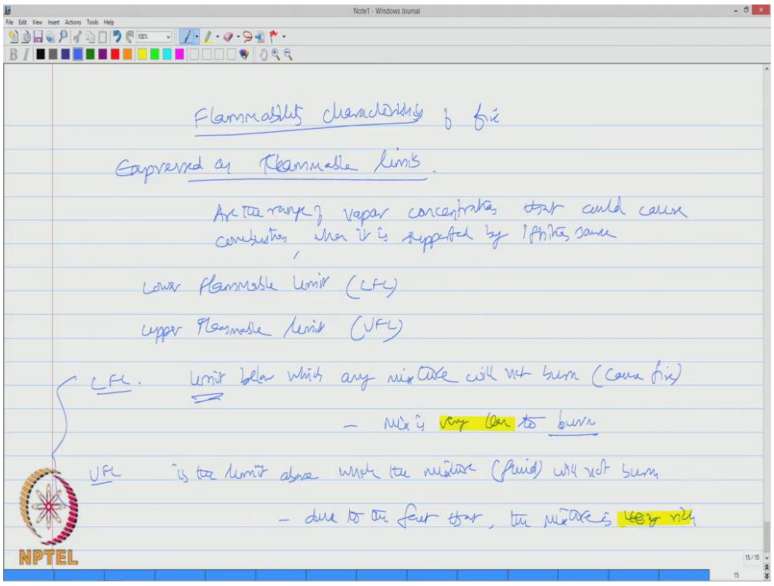

Let us talk about the flammability characteristics of fire; they can be expressed as flammable limits, flammable limits are the range of vapor concentration that could cause combustion when it is supported by ignition source.

There are two limits which are very important in the literature to explain the flammable characteristics of fire, what we call as lower flammable limit as LFL; upper flammable limit as UFL; this is LFL, UFL.

Let us see what is LFL; LFL is the limit below which any mixture will not burn or will not result in fire, the main reason is the mix is very lean to burn. It needs some hydrocarbon concentration which may not be present in specific limit level below which it will not burn. Upper flammable limit is the limit above which the mixture or the fluid again will not burn; this may be due to the fact that the mixture is very rich. So, if you have a mixture which is very lean, it can result in lower ground limit; if have a mixture which is very rich in concentration it can be land up in upper flammable limits; see it is between these two limits mixtures or fluid will catch fire.

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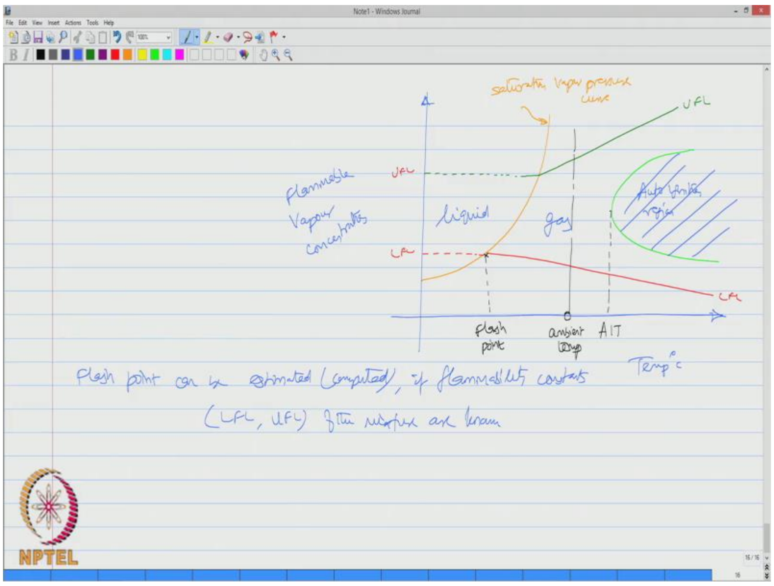

Let us try to plot this graphically and explain how do they vary; we have temperature in degree Celsius in y axis we are going to plot flammable vapor concentration, let say one part of the curve which is saturation vapor pressure curve, you have the upper limit which increase this is upper flammable limit and you have lower limit this is lower flammable limit, this is upper flammable limit and the lower flammable limit will you keep on expanding.

In between there is an auto ignition region; region is auto ignition region therefore, the apex of this we call as auto ignition temperature wherever the LFL intersects the saturation vapor pressure line, that is called as flash point and your ambient temperature lies somewhere in between.

So, one can easily group them now as this is going to be liquid and this is going to be gas. Looking at this figures and different curves guiding the UFL and LFL lines, one can easily see flash points becomes an important definition of any material or any combustion material, flash point of any combustive material can be estimated rather computed, if the flammability constants that is LFL and UFL of the mixture are known.

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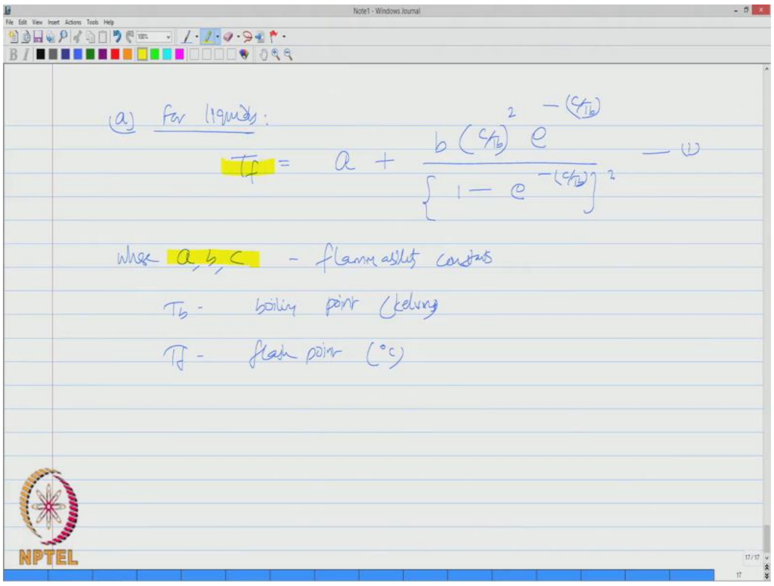

So, for liquids the flash point is given by an empirical relationship as I am writing now; b c by T b square e power minus e power minus c by T b, 1 minus e, minus c by T b, the whole square on equation number 1. Where a comma b comma c these are called flammability constants, T b is called boiling point in Kelvin's and Ti is called flash point in degree Celsius.

So, if you know the values of the constants a, b, c, which are called flammable constants for a given hydrocarbon mixture and always find the flash point in degree Celsius using this empirical relationship of course these constants a, b, c can be computed experimentally using open cup method.

So, friends in this lecture we are slowly understanding different characteristics and flammability behavior of different material, their properties we need to understand them in detail before we talk about fire resistance where designed, fire resistance by choice of material etcetera.

Thank you very much.