Drilling and Blasting Technology
Prof. Kaushik Dey
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Lecture – 23
Explosives Properties-3

Let me welcome all of you to the 23rd lecture of the Drilling and Blasting Technology course. In last 2 classes we are discussing the Explosive Properties and the different testing procedure of those properties. Still in this class also we will continue those things. So, as every class we do, let us retrospect the previous lectures.

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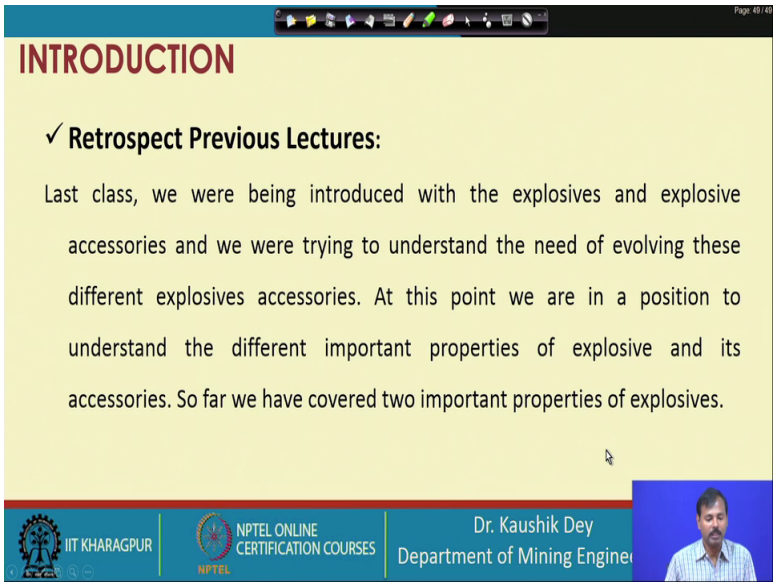

In last classes, 2 classes we are being introduced with the explosives and explosive accessories. And, we are trying to understand their need to need of evolving these different accessories. And, we are in a position to understand the important properties related to explosive. And so far we have already discussed about the 3 important properties that is the BOD, density and the strength of the explosive. And the different testing procedures for those are also discussed.

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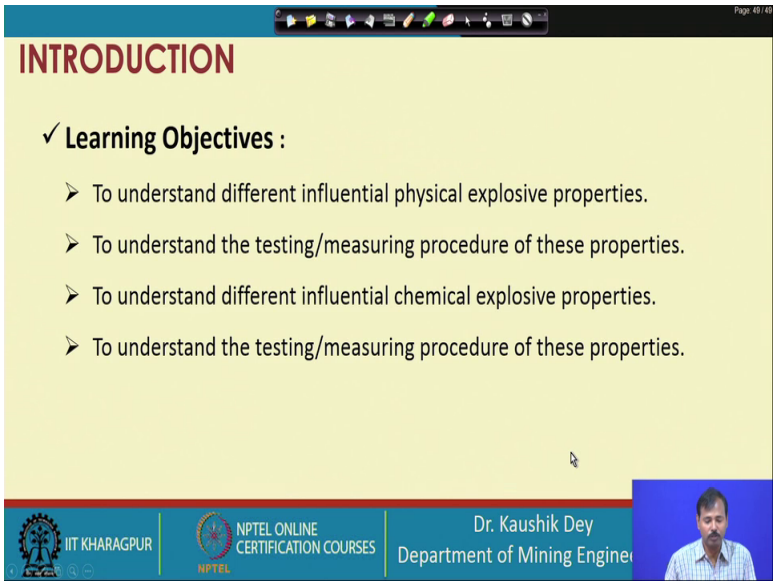

So, our learning objective remains same that we are understanding the different physical and chemical properties of the explosive, which are required for the essentially for required for the designing the blast and their testing or measuring procedures. So, that we are able to understand or measure the property those properties and accordingly we can modify our design.

So, in this class we will try to understand what are the other properties which is having significant impact that of on the performance of the explosive.

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But, prior to that let us observe this demolition blasting video, which is carried out in a Chinese city, where the complete construction is demolished using the explosive simultaneously and this is the view you can observe which is taken from the drone camera from the top and the blasting is carried out simultaneously almost few thousand of houses are demolishes here.

High rise buildings are demolishes with simultaneous blasting. And, you can see if it is carried out manually this may take huge time, but as it is carried out using the blasting technology, the complete structures are demolished within a few seconds and you can see almost all the structures are demolished, except one was unable to blasted, because of some other reasons.

So, blasting is a good tool, which not only can be used for excavation of the rock, but for the demolition also this can be used significantly as you can see from this video, but for all this we should understand the different properties.

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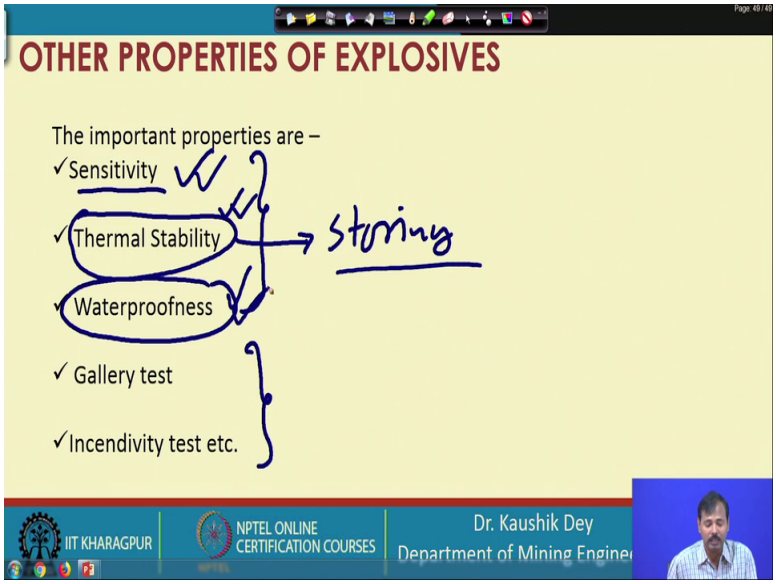

So, the other important properties except the density BOD and strength parameter of the explosive, the important properties are the sensitivity, thermal stability, waterproofness, gallery test and incendivity test.

This last 2 test tests are important for blasting carried out in the explosive medium, but these 3 properties are important in general purpose of the use of the explosive. If you

recall, when we are discussing about the dynamite or the invention of the dynamite by Sir Nobel, we are discussing about the sensitivity that time we have discussed that sensitivity should be such that the explosive should not be too sensitive; that means, there is a chance of premature explosion during the handling of the explosive, neither the explosive should be too less sensitive; that means, we need to have huge amount of shock energy to explode the explosive.

So, that is why the sensitivity is very very important. Simultaneously, if you see the thermal stability, this thermal stability is important for 2 purpose; one is that for the storing of the explosive, second one is the use of the explosive in a hot condition. Because, the climatic conditions may be different from the countries to countries and it may be different from the use of explosive position of the use of explosive that may be different. So, that is why thermal stability of the explosive property explosive chemicals are essentially required.

Waterproofness is required to understand where the explosives are being used in the watery holes. So, that is also another very important parameters. Not only that, this waterproofness is also important, where we are using detonating fuse or similar type of explosive accessories, in a rainy atmospheric rainy condition or the maybe the through which the detonation is being passed, that area is filled with water.

So, that is why these are important factors and that has to be considered during the consideration of the explosive properties. And, for that we should see what are the possible test measures are there available with those things?

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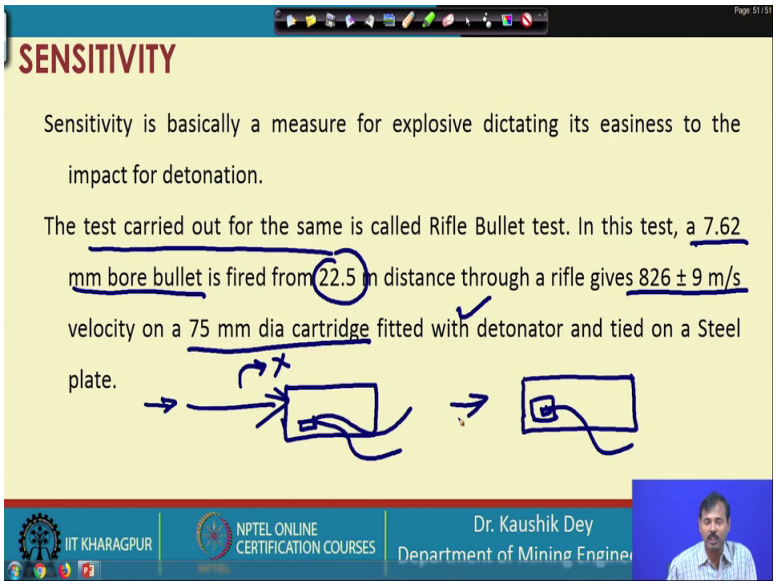

So, sensitivity is basically a measure for explosive dictating it is easiness to the impact for detonation. So that means, sensitivity is basically give us the measure, that how sensitive is the explosive on a given shock? Whether it is being detonated with a small shock or it needs a very high shock for the detonation or it needs some moderate shock for the detonation?

So, for this the test is carried, the test is carried out for the same is called Rifle Bullet test. Where, the shock is given by the bullet which is triggered from a Rifle. So, what is carried out in this test? In this test a 7.62 bore bullet is fired from 22.5 meter distance from a rifle, which gives the bullet a velocity of 826 plus minus 9 meter per second.

So, the rifle is fixed, the bore of the bullet is fixed; that means, the mass etcetera of the bullet is fixed and the distance is also fixed. And, which type of explosive is used? The explosive is also fixed. The explosive should be of 75 mm diameter cartridge and the explosive must be fitted with a detonator, the explosive must be fitted with a detonator, or whichever is required for detonating that explosive. That means if the explosive is not detonator sensitive, it is booster sensitive. In that case also we need to provide a booster fitted, the booster is fitted with the detonator; that means, the complete set of initiation system must be provided.

Suppose, if you see this is the explosive cartridge, which is kept sensitive; that means, detonator sensitive explosive. In that case we must provide a detonator inside the

explosive. And, then we subject the explosive under the rifle bullet test ok. So, that the bullet will hit this explosive and the explosive is on a condition, where it the shock may detonate the total system. So, we will see the shock provided by the rifle bullet is able to initiate the explosive or not with the full initiation system; that means, if this rifle bullet test is giving a X shock pressure, whether the X shock pressure is able to initiate the system or not.

Similarly, if the explosive is non-cap sensitive, in that case the explosive must be fitted with a booster or cap sensitive explosive, which must be fitted with a detonator and the total system will be subjected to the rifle bullet test. So, this is the principle of this test and this principle is very very good to understand the sensitivity of the total explosive system or the charged system, whether it can be prematurely blast or not.

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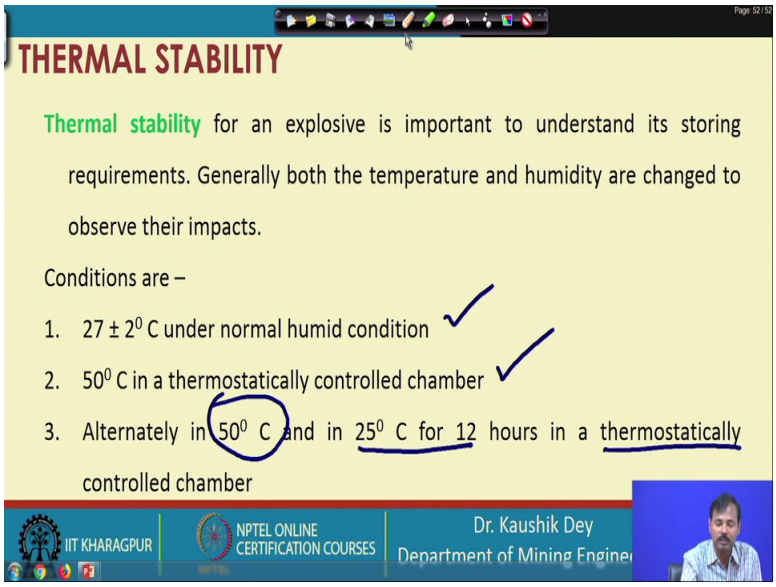

So, we should understand the second property which is thermal stability. Thermal stability for an explosive is important to understand it is storing requirements. So, basically it is carried out for the storing requirement. Generally both the temperature and humidity are changed to observe their impact on the stored explosive ok.

So, in this case we change the temperature and the humidity and see their impact on the stored explosive on different conditions. The first condition is that 27 degree plus minus 2 degree centigrade temperature and under the normal atmospheric humid condition.

The second storing is the 50 degree centigrade that is the high temperature, which is provided thermostatically controlled chamber and we see the impact of that high temperature on the stored explosive. Third one is that alternately 50 degree centigrade and 25 degree centigrade for 12 hours in each condition and both the chambers are thermostatically controlled and we see if there is any changes in the chemical compositions of the explosive or not.

So that means, if the temperatures are being varied 12 hours 25 degree centigrade and 12 hours 50 degree centigrade. And the explosive chemical is subjected to these thermostatic changes and we see if the impact of the temperature is there on the explosive chemical is there or not.

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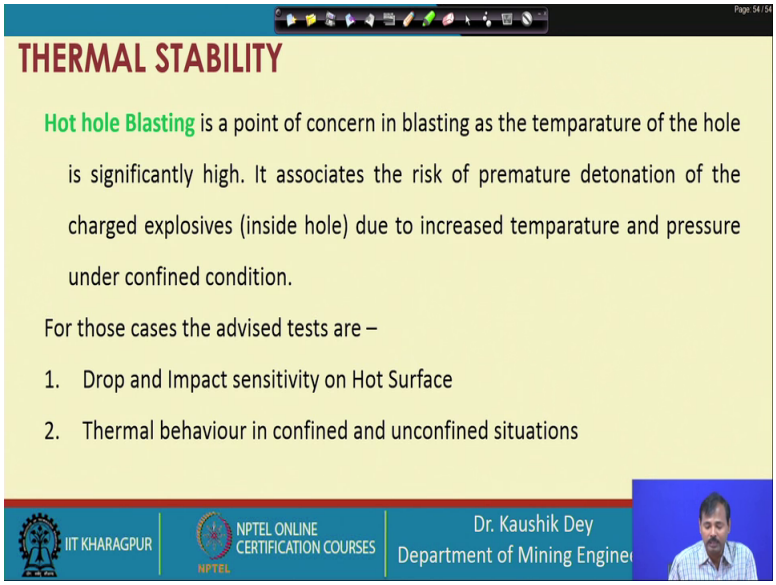

So, using this we try to check the thermal stability of the explosive. But there is another these is of the stored test explosive, but there is a another point of concern about the thermal stability of the explosive, where the hot hole blasting is being carried out. So, first we should understand what is called hot hole blasting; hot hole blasting basically a type of blasting where the temperature of the blast hole is very high. Normally, we consider any blast hole having a temperature more than 70 degree should be considered as the hot hole.

So, hot hole blasting is a point of concern in blasting as the temperature of the hole is significantly high. And, as the temperature of the hole is high, if we place our normal

explosive inside that hole; that means, the whole is charged with the normal explosive, there is a chance that the explosive maybe prematurely detonated because of the heat, which generates the gas from the chemicals of the explosive. And, under confined condition the pressure will build up if the pressure will reach to the detonating pressure, the explosive will be initiated.

So, that may be a premature detonation condition and everyone which are carrying out hot hole blasting must be careful about this. So, in this case the advised tests are drop and impact sensitivity of the hot surface and the thermal behaviour in confined and unconfined situation of the explosive. So, these 2 tests are important for analyzing the thermal stability of the explosive. I am not going into the details of this test, anyone who are interested to have a look on this test, anyone who are interested to have a look on this test, they can see the reference in the reference the book name is given is the explosive and blasting technology written by G K Pradhan. The details of this tests are available there, the similar test setups are also available in the internet sources. So, the detail knowledge can be acquired from this because of the time constant we are not going into the detail details of those tests.

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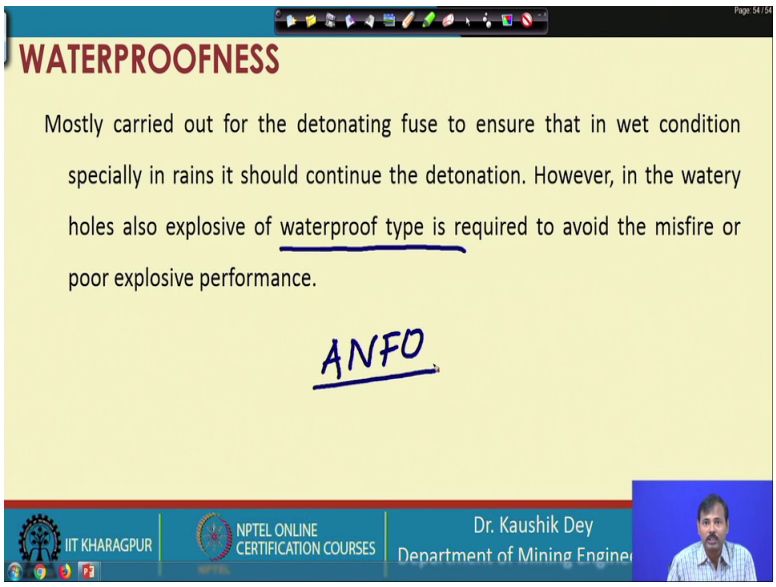

So, next one is the waterproofness. The mostly waterproofness is carried out for the detonating fuse and to ensure that in wet condition also specially in rain, it should continue the detonation. So, there is no chance of cutoff the of the detonation in between

because of the presence of the water. However, in the watery holes explosives of water waterproof types is required to avoid the misfire or poor explosive performance.

And in this contest, I must remind you that we consider this similar one while we are discussing about the density, any explosive which does not have the density more than one cannot be used in the watery holes. And anyone which is of some hygroscopic nature should not be used in the watery holes. So, similarly what we do? We do not use ammonium nitrate fuel oil, as an explosive to the watery holes. Because ammonium nitrate is hygroscopic, it dissolves in water. And what will happen? The explosiveness of the ammonium nitrate will be lost, if we place the ammonium nitrate in the watery holes.

However in some cases ammonium nitrate based emulsion or slurry explosive may be used, because those are in those cases ammonium nitrate the field contains or be surrounded by the oil fields and that is why they behave like they like a waterproof explosive. So, waterproofness of the explosive inside the hole is required when the holes are watery may be due to the rain water or may be due to the underground water groundwater. In those cases waterproof explosives are required. Otherwise, waterproofness of the detonating fuse is very important for understanding the continuation of the detonation pressure from one point to the another point.

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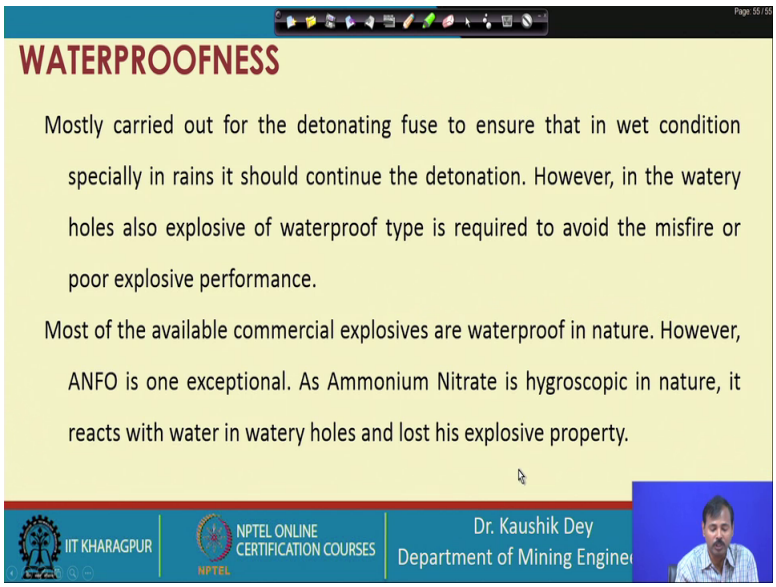

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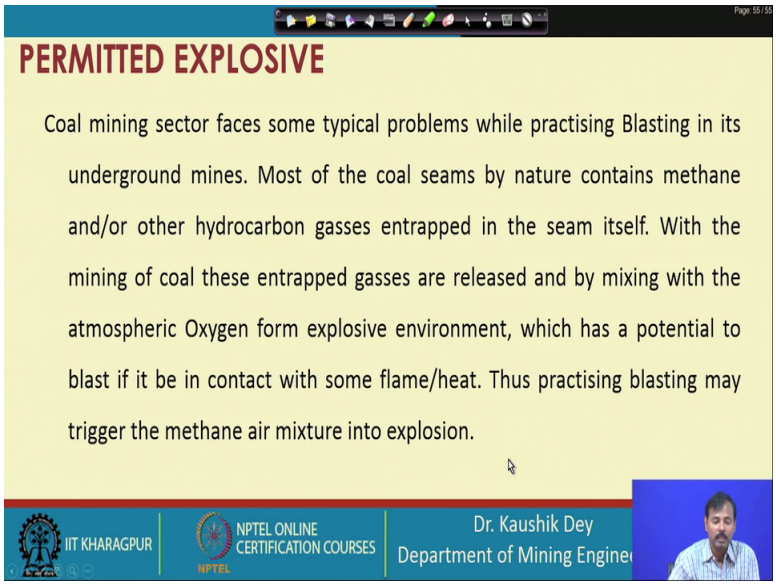

Next, we should understand something about the next 2 test, which are essentially required for the explosive environment. So, in this context let us have some knowledge about the explosive special explosives are required to carrying out blasting in the explosive environment. So, what will happen when we carry out blasting in the coal mining sector etcetera. There some typical problems arises, what will happen most of the coal seams by nature contains methane or other hydrocarbon is as gases entrapped into the seam itself.

With the mining of the coal this entrapped gas gasses are released and by mixing with the Oxygen of the atmospheric oxygen in the air, I forms an explosive environment. So, particular percentage of methane particular percentages of oxygen's are mixed they create an explosive environment and if a naked flame or some heat is injected into that environment, it will blast.

So, this type of blasting is called fire dump explosion or methane air explosion, that is why for practicing blasting may trigger the methane air mixture and convert that into the fire dump explosion. So, while blasting is carried out in the underground coal mines or blasting is carried out in a place, where there is a chance of entrapped methane occurrence of entrapped methane is there, that time all should be cautious enough, because that basically depicts the explosive environment.

So, a blasting carried out in the explosive environment is very dangerous and precaution must be taken for that, what is the first precaution?

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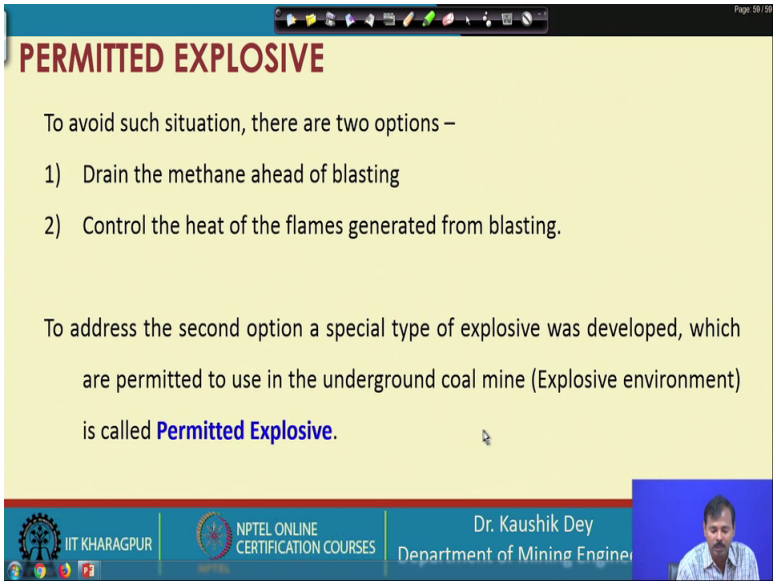

The first precaution is that to avoid that situation we have to control 2 things. First is that one is to we have to drain the methane ahead of the blasting. We have to drain the methane ahead of the blasting, the second one is the controlling the heat controlling the heat. So, that heat and flame cannot be generated from the blasting to arises such situation that it will explode.

So, first one is very difficult and maybe time taking. So, to carry out the blasting, the second option is mostly carried out and to address the second option a special type of a special type of explosive was developed, which is called permitted explosive. What is this permitted explosive? These permitted explosives are the explosives, which are allowed to use in the underground coal mines that is in the explosive environment, but the problem is how you will define this things as the permitted explosive.

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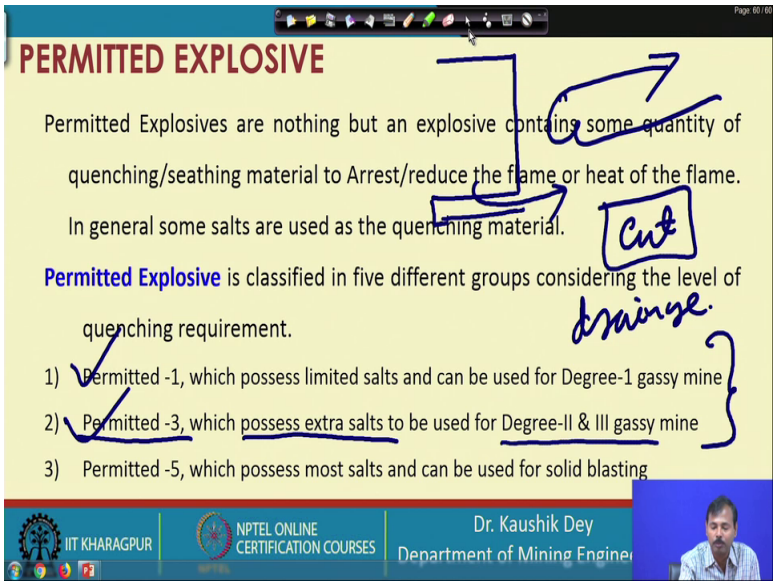

So, let us see what is there in the permitted explosive? So, permitted explosive is basically nothing, but an explosive contains some quantity of quenching or seathing material to arrest or reduce the flame or heat of the flame. So, there is there are some seathing or quenching material, which basically quench the flame or basically seath, the temperature of the flame or there will be no case that flame will be arises. And that is why heat or flame will not be there, if it is there at all it is not of that much magnitude that will ignite the methane air mixture.

So, basically what we are doing? We are mixing some quenching or seathing material with the normal explosive types so, that we can make it the permitted explosive. And based on this, based on this there is a there are 3 classification there are basically 5 classifications of explosive permitted explosives. First let us discuss permitted 1 3 and 5 we will discuss 2 and 4 later on.

The Permitted-1, which possess limited salts. Basically salts are the common material which is used as a quenching or seathing material and can be used for degree 1 gassy mine. That means, degree 1 gassy mines let us discuss something about the gassy mines here, degree 1 gassy mines basically where the release of methane or hydrocarbons gases is less than 1 meter cube per ton of excavation of the coal is considered as the degree one gassy mine.

If, the release of that gas is between 1 to 10 it is called degree 2. If it is more than 10 it is called degree 3 mines. That means, degree 1 gassy mines is having the less release of methane that is why the potentiality of that to become a showing an explosive environment is less.

So, we need less quenching material and that that can be that is why the permitted 1 explosive is there where the limited salts are used. So, that the quenching can be or quenching or seathing of the flame can be available on that case. Second one is the degree 3 second one is the degree second one is the Permitted-3, which can be used for the degree 2 degree 3 gassy mines.

Where the release of methane is more that is why the possibilities of having an explosive environment is high. And, in that case there will be extra precautions should be taken. So, that no so, so that the flame or heat cannot be arises there, that is why extra quenching or seathing material extra quenching and seathing materials should be used.

But, for these 2 cases these 2 cases, we have used the first technique. The first technique means the release of methane from the atmosphere is carried out before ahead. So, this first 2 cases the release of methane is carried out somewhat, by providing a small cut in the face ahead. So, suppose this is the face where blasting has to be carried out in that case what we do we provide a cut beforehand. So, that the methane can be released on this cut and go to the atmosphere beforehand when we take out this methane from this place to the outer place.

So, the methane content in the coal will become less for this 2 condition. And that is why the salt requirement of these conditions are less because we are taking out most of the methane beforehand.

So, that is why this permitted 1 and permitted 3 explosives are used for the cases, where blasting is carried out after a cut is made, after a cut is made in the face and allowed the drainage of the drainage of the existing methane in the face. In those cases this permitted 1 and permitted 3 explosives are explosives are used permitted 3, permitted 5 explosive is used where there is no cut.

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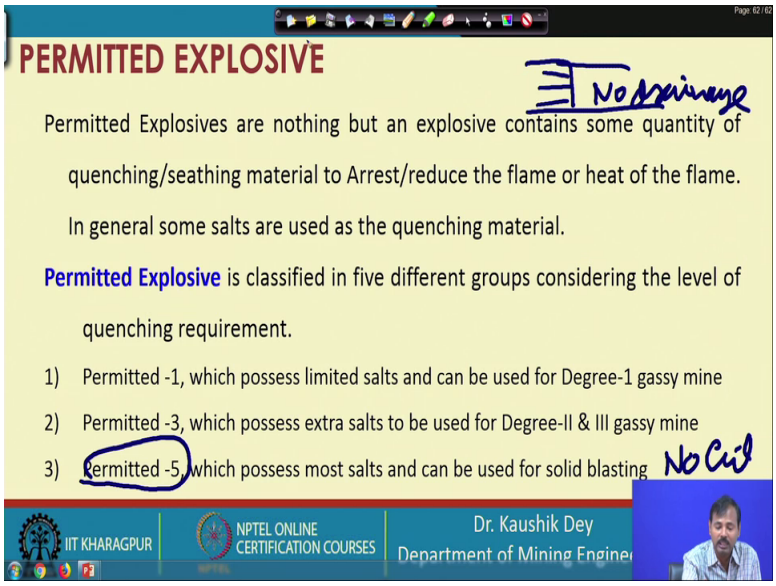

That means full face blasting is being carried out full face blasting is being carried out by drilling and placing the explosive. And there is no drainage of methane beforehand no drainage of methane is there beforehand.

So, that is why basically the blasting is carried out with the full methane content in the coal blasting is carried out, and that is why with the expectation is that the maximum quantity of methane is available in this. And, that is why this type of blasting is called solid blasting and this P 5 explosive must possess. The most quantity of salts and that is why it can be used in the solid blasting.

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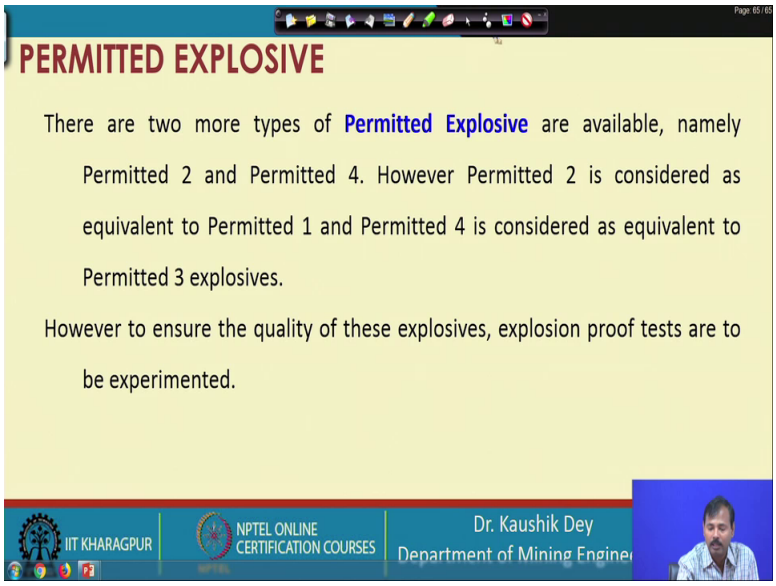

So, permitted explosive 1 3 and 5 is now old 1 to you, permitted 1 is for the degree 1 cut blasting, permitted 3 is for degree 2 degree 3 cut blasting, permitted 5 is for cut blasting for all degree 1 degree 2 degree 3 mines.

But, you can you may ask where is the permitted 2 and permitted 4 explosive. The permitted 2 or permitted 4 explosives are basically developed for avoiding the patent problem. Permitted 2 is basically equivalent to permitted 1 explosives. So, it is developed to avoid the patent, permitted 4 is equivalent to the permitted 3 explosive it is avoided to it is developed to avoid the patent for the degree 3 permitted explosive permitted 3 explosive.

So, that is why this permitted 2 and permitted 4 are not commonly available in India, permitted 1, permitted 3 are replacing this permitted 2 and permitted 4. And this permitted 1 3 and 5 are sufficient for any place to use these things, but the problem is that how this permitted explosive can be certified? That this explosives are of qual[ity]- desired quality or having the desired quantity of quenching material and those quenching materials are performing well.

So, for this it is required to have explosion proof test. And, these explosion proof tests are described as the gallery test and incendivity test.

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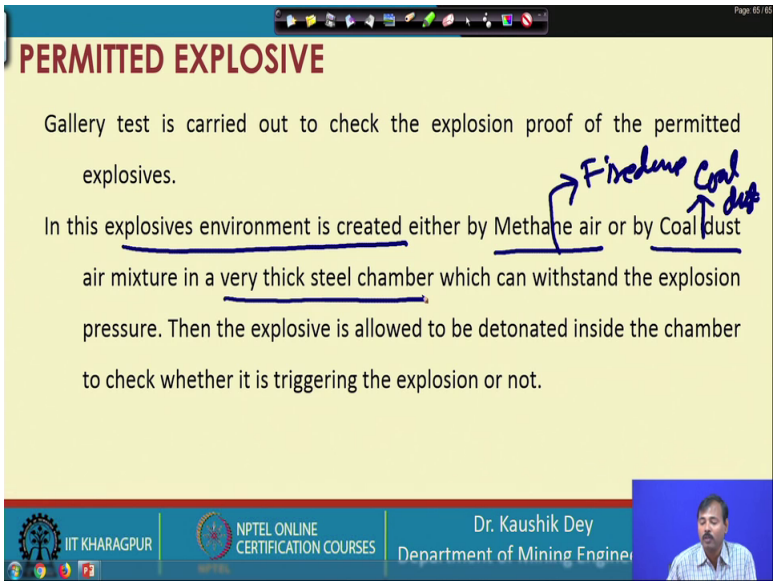

So, gallery test is carried out to check the explosion proof of the permitted explosive. In this explosive in this case explosive environment is created either by methane air or by coal dust air mixture in a very thick steel chamber.

Explosive environment is created by methane airs. So, that we can talk about the fire dump explosion or coal dust air mixture which can be considered as the coal dust explosion. And that explosive environments are created in a thick steel chamber, then we initiate the explosive, which is subjected to that explosive environment. And, see whether the quenching material is sufficiently able to quench the heat of the flame of the explosive. So, that no explosion to the environment occurred; that means no explosion, no fire dump explosion, no coal dust explosion is occurred.

So, this is basically the gallery test carried out to give the certification to the permitted 1, permitted 2, permitted 3 and permitted 5 explosives.

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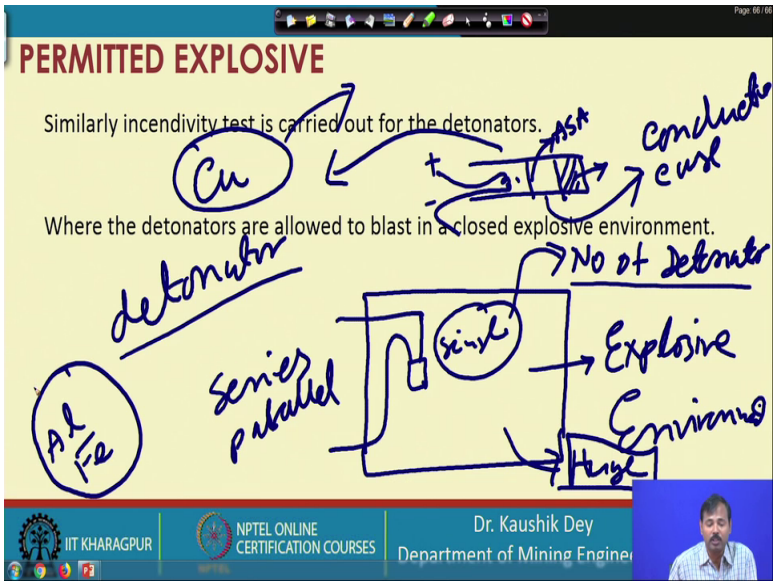

Similarly, incendivity test is carried out; incendivity test is carried out for the detonator, where the detonators are allowed to blast in a closed explosive environment.

So, what carried out here? The explosive environment is created in a chamber. So, in this chamber explosive environment is created. Similarly like coal dust or methane air mixture then the detonators are detonators are provided very often not a single detonator often, we can change from a single detonator to a number of detonator.

That is in either in series connection or in parallel connection series or parallel connection a number of detonators are fitted in this chamber and that is allowed to be detonated. And, if the if it ignites the explosive environment, then the huge blast will occur this magnitude of this blast will become very huge. And, if huge blast occur then we consider the detonator is detonator is failed in the incendivity test; that means, the detonator is not sufficient to be used for the underground explosive environment.

Generally, what is happened? In detonator the base charge the base charge is petn and this electrical flux is given a flame to the primary charge which is nothing, but the ascites and stiffness. So, this base charged which is initiated may ignite the explosive environment that the methane air mixture or something mixture or something like that. And, here to reduce the heat of that a conductive a conductive material or case is used as the out outer part of the detonator.

Normally, what is used here? It is the copper tubes are used; these copper tubes are used as the conductive material. So, that the heat generated by the initiation of the petn or the initiation of the asa the heat generated from there are taken by the copper casing. And that is why the heat coming to the flame has to be reduced enough, but as the copper is very costly often, there is a tendency of the manufacturer that they use aluminium or iron tubes. And, it has been found in a number of test that these tubes failed to pass this incendivity test. And, that is why in most of the cases the copper tube detonators are only allowed those which are passed in the incendivity test.

So, that is why especially those thickness of the copper casing etcetera and their purity. So, that the thermal conductivity can be accepted can be observed as the accepted level. So, those are very important in this case. So, incendivity test is required to identify whether the detonators can be allowed to use in the explosive environment or not.

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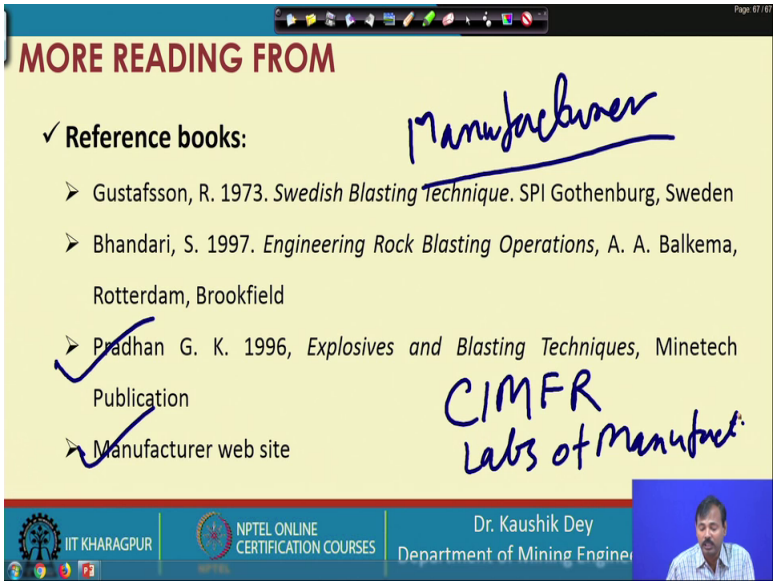

So, there are n number of other tests are also there, which is essentially required for the understanding of the explosive and their accessories as the acceptance. And their acceptability in the different condition, but because of the time constant it may not be possible to address all those test all those properties to be discussed in this lecture. I request you please go through the different manufacturer website, manufacturer website; where those tests specification of this tests are given, you will get a good description of

this specific specification of those tests and properties in this book also is the manufacturer website.

Apart from that some of these tests are available with the CIMFR with the manufacturers, labs of the manufacturers, specially Nitro Nobel etcetera those reputed manufactures (Refer Time: 33:52) you can find out this test facilities are available. So, you must go through those facilities you can you must go through those properties importance of those properties by yourself. So, this is all from this lecture. In next lecture, we will lecture discussed about the explosive thermochemistry of the explosive and the explosive rock interaction.

Thank you.