Drilling and Blasting Technology
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Lecture – 17
Explosives-2

Let me welcome all of you to the 17th lecture of Drilling and Blasting Technology. I hope before attending this lecture you have already attended the lecture number 16, if not attended, this is my sincere advice to you that you must attend lecture number 16, otherwise lecture number 17 is basically the continuation of the lecture number 16. So, it will not be helpful to you if you are not observing the lecture number 16.

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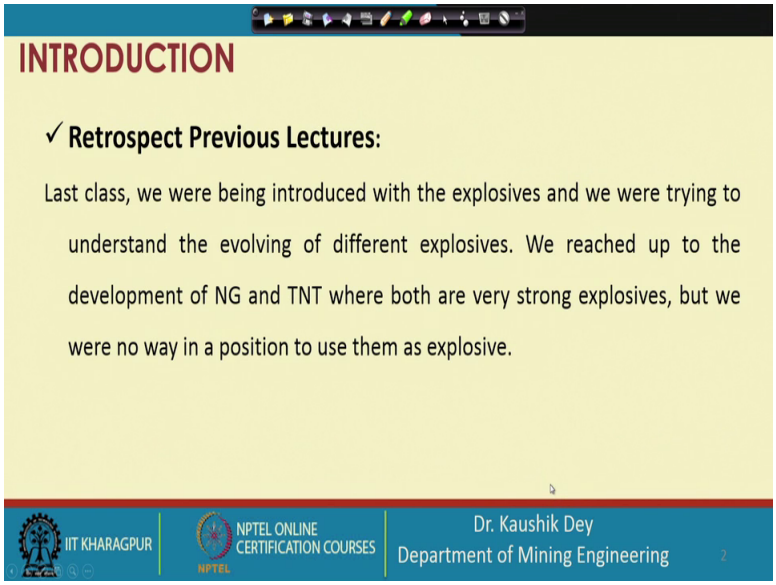

So, let me have one just retrospect one slide retrospect of the previous lecture. In the lecture number 16 we were being introduced with the explosive, we understand what is explosive, we were trying to understand the evolving of different explosive; so we have started how the different explosives are started evaluating. And, we reached up to the development of nitroglycerin and TNT, where both are very strong explosive. But, we were no way in a position to use them as a explosive, because these are the dangerous explosive and these are not flame sensitive explosive, so that we cannot initiate this a blast explosive or explosion you by providing a flame. And, their sensitivity is very high, their transportations are problematic, their controlled explosions are problematic.

So now, we are in a position we understand that gunpowder which is a low explosive cannot serve our requirement where the explosion is essentially required high strength to fragment the rock, gunpowder is not suitable for that, but our accepted technology is there which can explode the gunpowder. We are having the knowledge of nitroglycerin, trinitrotoluene, fulminating gold which we know as the explosive very dangerous, strong, high energy explosive, but we do not have the knowledge to explore those explosive as controlled manner as we wish.

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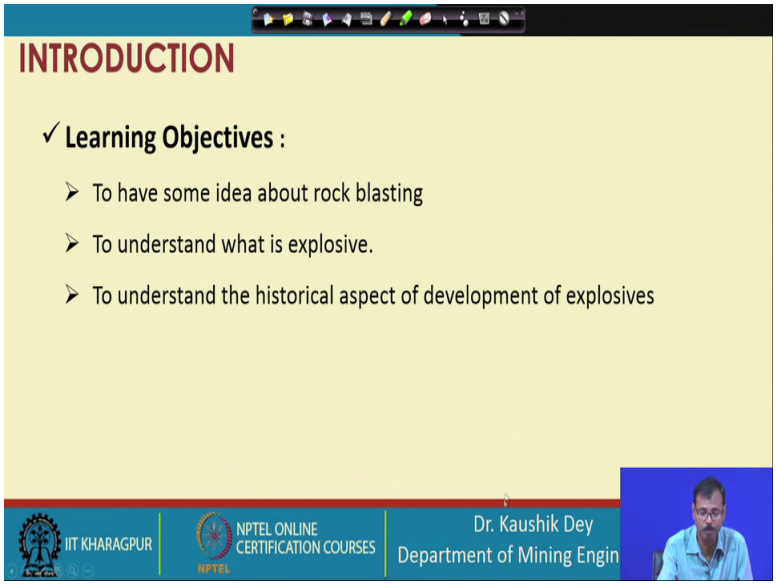

So, basically at this point let us again retrospect the learning objectives which we have discussed in the last class. Our objective is to have some knowledge about rock blasting we will see a one video here also understanding the explosive and historical perspective of the explosive.

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So, to boost you let us see one blasting again. This is explosion of explosive which we are observing in a slow motion; that means, this explosion is occurred in millisecond duration maybe 2 – 3 millisecond duration maybe 40 – 50 millisecond duration but we are observing this in few second duration. So, that means, this is being observed at a very very slower pace, so that you can look into the blasting process it at a at a slower pace and you can understand how the blasting is being processed.

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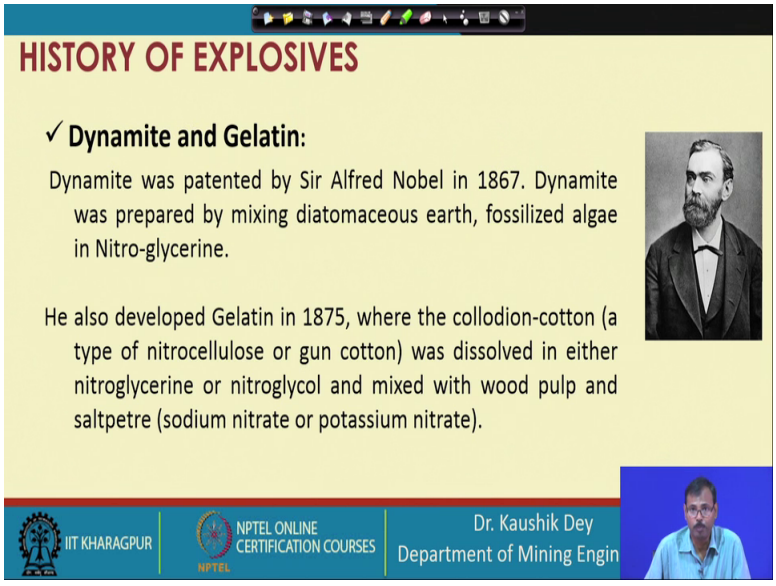

Now, I want that whether you know this person or not? I expect most of you know this person because he is very very famous person Sir Alfred Nobel. He is the person who basically invented the dynamite and he is the person who controlled the explosibility of the nitroglycerin and that allow the use of nitroglycerin as the commercial explosive. So, Sir Alfred Nobel earned from this dynamite donate all his money to the Nobel Trust. So, that we are getting the Nobel Prize.

In fact, I am being tempted that I should tell more in this juncture about the process of developing this dynamite. In fact, professor in fact, Sir Alfred Nobel, he was experimenting with nitroglycerin; that time it was the urge of the industry that everyone should know how to get rid of the sensitivity of the nitroglycerin, so that it can be used commercially it can be exploded as per the wish of the user.

So, Sir Alfred Nobel is the person who first for invented the detonator which is the device to explore the explosive like dynamite TNT which are a high explosive, but need a sock not a flame for the explosion. So, basically what Sir Nobel did, he used mercury fulminate or gold fulminate which along with mixing with some azides can be used as the device which will receive the flame and deliver the shock.

So, first he has invented a detonator which can initiate this nitroglycerin and TNT types of high explosive. So, that was his first invention he invented in 1863 and now, in 18 if you are standing at 1863 you are having you are having now some device which can explode this explosive, but still some problems are there. One problem is that transportation of the nitroglycerin because it is very very dangerous, it is highly sensitive during transportation it can explode and kill the people.

And second was is the TNT; TNT is in powdery form, but TNT use of TNT as a mixture of explosive is very very difficult that time and you using the detonator to do that and TNT blasting is very very fast. So, use of these two was very very difficult and you are standing at 1863 and all the Europe is trying to find out a way, so that nitroglycerin can be used as the commercial explosive.

So, different people are trying to use different thing. They are trying to use mix different woods, charcoals like that pulps everything they are trying to mix with nitroglycerin, so that it can be used commercially as the explosive and in doing so Sir Alfred Nobel also

met a number of accidents. He lost his brother and 5 fellow scientist in one explosion in search of reducing the sensitivity of the nitroglycerin.

So, basically this is very very difficult situation where he was unable to get rid of nitroglycerin. But finally, in 1867 finally, in 1867 he mix he mix nitroglycerin with diatomaceous earth, fossilized algae and found now the sensitivity of the nitroglycerin is very much within the control it is no more that much sensitive, so that it will explode on explosion, but simultaneously it can be initiated with the invented detonator by the Nobel.

Now the nitroglycerin can be controlled, can be exploded in a controlled manner by the user and also to be transported by the user; so this mixed a diatomaceous earth algae and nitroglycerin has been termed as dynamite by Sir Nobel and this invention open up huge phase of the rock blasting. Now, huge blasting can be carried out, the production rate has increased huge and that demand that time it was in the industrial age, the demands of irons, the demands of the metals, the demands of the limestones; that means, cements etcetera has been increased a lot and this invention addressed the need of that much that huge quantity of excavation requirement. So, this is the achievement carried out by Sir Nobel and he has earned a lot of money from that.

But, still if you are looking at 1867, still there were some problem. The problem was that dynamite has been invented, but dynamite has some problem. The problem is that dynamite was in little bit critical property levels. It starts sweating, it absorbed moistures; so, the handling it becoming little bit problematic, it is not fully a solid, it is having some semi liquid state.

So, like that way handling was problematic the characteristics offered by the dynamite with depends highly with that mixing elements that is the algae and the diatomaceous earth. So, every time some dynamite is produced offering some different types of properties. So, it is not providing us the consistent properties consistent results and that is why the planning of excavation with dynamite was little bit problematic.

So, to control over this and also to have better control on the sensitivity of the nitroglycerin Sir Alfred Nobel developed gelatin. In fact, this is again another accidental discoveries, where he has found that the nitrocellulose or gun cotton which is also called collodion cotton is a very good absorber of the nitroglycerin. This cotton absorbed the

nitroglycerin and reduce the sensitivity of the nitroglycerin, it forms a gelatinous material while it is mixed with the wood pulp and saltpeter.

So, mixing the nitrocellulose with the nitroglycerin and along with the wood pulp and the sodium or potassium nitrate can be called as the gelatin which is developed by the Sir Nobel in 1875, he has patented this. Now, this invention of gelatin became more popular because the sweating problem is not there. It is very easy to handle it is provide as the consistent property because the mixing elements like nitrocellulose potassium nitrate etcetera wood pulp is basically the source of the carbon. So, these are having basically the consistent properties. So, the properties of the gelatin is also very consistent.

So, that is why this gelatin become very very popular in the excavation industry and it is started very very well popular use in the mining sector also.

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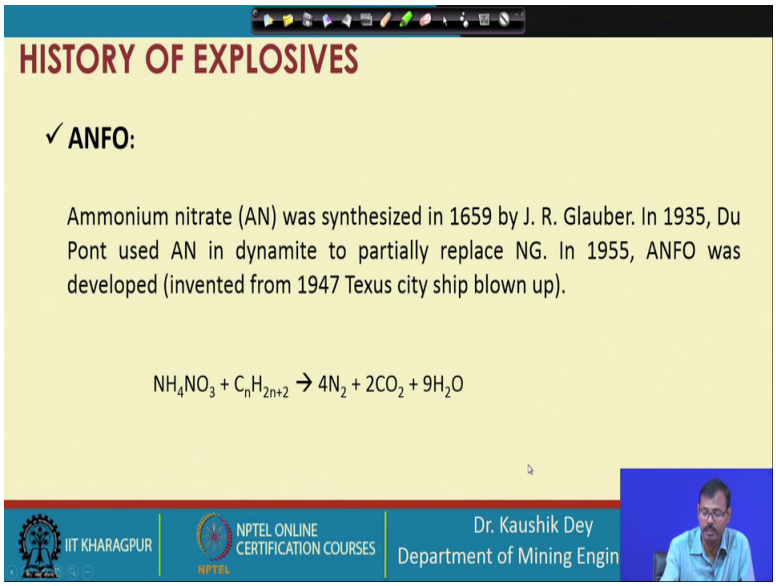

So, basically this these are the enormous achievements in the explosive, but still people found that we need some more explosive inventions, but unfortunately most of the explosives are invented from the unwanted explosion and the inquiry of those explosions revealed the explosive properties of a number of mettles; like this one you say ammonium nitrate.

Ammonium nitrate was developed in 1659. Ammonium nitrate was synthesized in 1659 and very common use in the agriculture purpose ammonium nitrate this was commonly

give given as the fertilizer to the plants in the agriculture sector, but no one knows its use as the explosive, unless, in 1947, at Texas port a ship which is carrying the ammonium nitrate face faced the explosion.

So, this is famous as the Texas City accident, Texas City explosion. This is the ammonium nitrate if it is mixed with fuel oil and on reaction it gives nitrogen, carbon dioxide and water.

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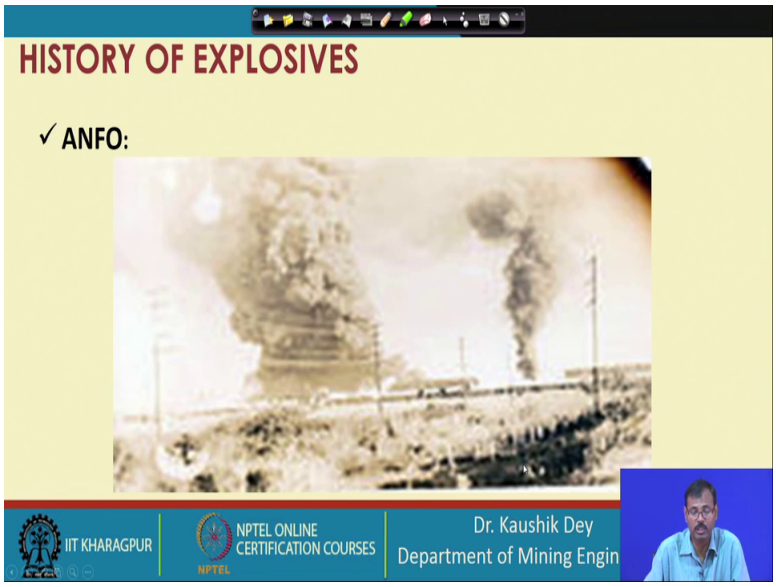

Now, let us look into the Texas city accident, what was happened? A ship which was carrying the ammonium nitrate; ammonium nitrate was placed in the deck lower deck of the ship accidentally caught fire and people are trying to fighting with that fire for two days. This is the photograph where people who are trying to fight with the fire for two days. Ammonium nitrate was in the lower deck the propelling diesel oil which is kept for propelling of the ship was also in the lower deck. And those are there people are trying to fight with the fire, and fire finally reached into the lower deck where ammonium nitrate become mix with the diesel oil and become explosive in the confined environment.

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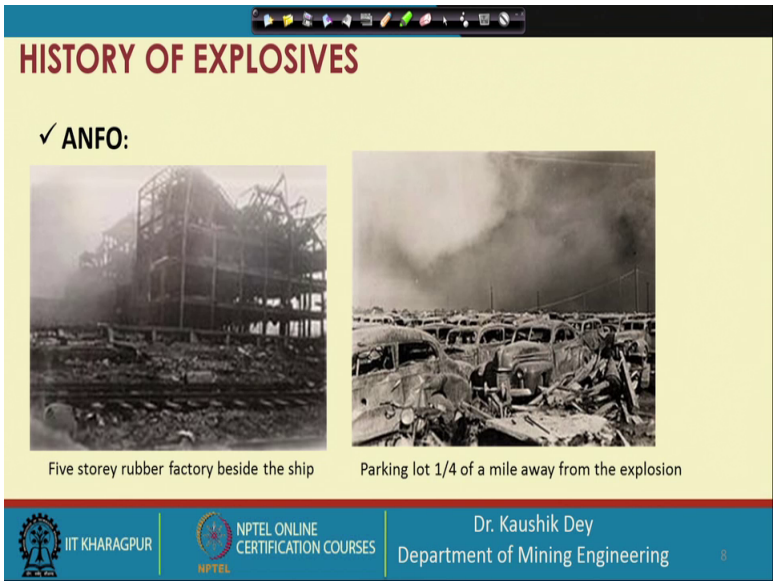

And, suddenly after two and half days explosion occurs and you can see these photographs this is a five storey rubber factory beside that port and this is the status of that after explosion. This is one fourth mile away parking lot where you can see the situation of the cars parked at that parking place after the explosion what happened.

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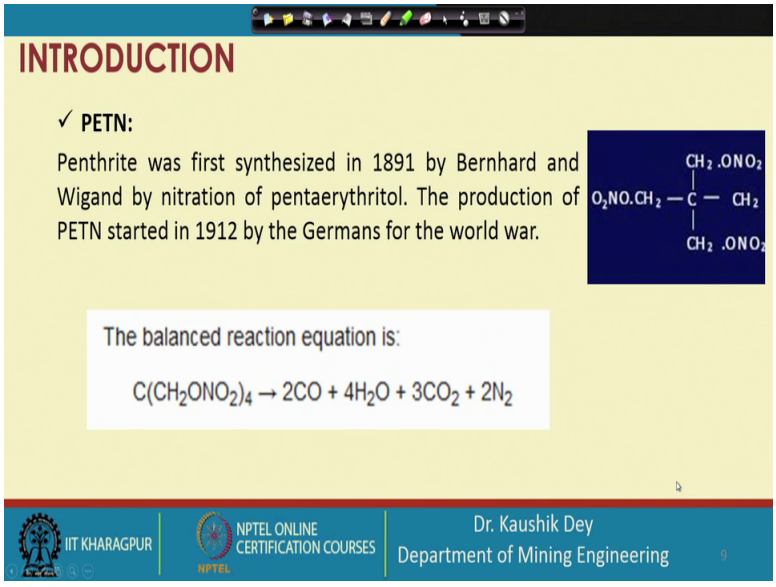

And, on inquiry of that people learnt that the ammonium nitrate may be a very very suitable explosive if it is used as the explosive material. So, from that invention in 1955 onward ammonium nitrate the developed in a prill form and mixing that prilled

ammonium nitrate along with the diesel oil commonly people started using as the explosive.

So, nowadays if you are looking our most of the source of explosive is ammonium nitrate based. We use ammonium nitrate as the major source of explosive and nitroglycerin is now little bit in the back stage. The reasons are there we will discuss those reasons in due course, because ammonium nitrate can be free flowing and it can be placed very easily, it can be pumped inside the a drill hole. So, that is why the handling of the ammonium nitrate based explosives are easier. That is why people are using this type of explosives.

Now, look into the other explosive the next explosive is the pentaerythritol tetra nitrate. So, PETN you can see the PETN which is basically carbon-carbon chain with 4 CH 2 ONO 2 arms and this was synthesized in 1891 and PETN was started as the military explosive in second during the Second World War. Later on PETN was along with TNT was started using mining as it is accessories. PETN is also having the similar property of TNT which we have discussed in the last class and that is also being used in the mining for the purpose.

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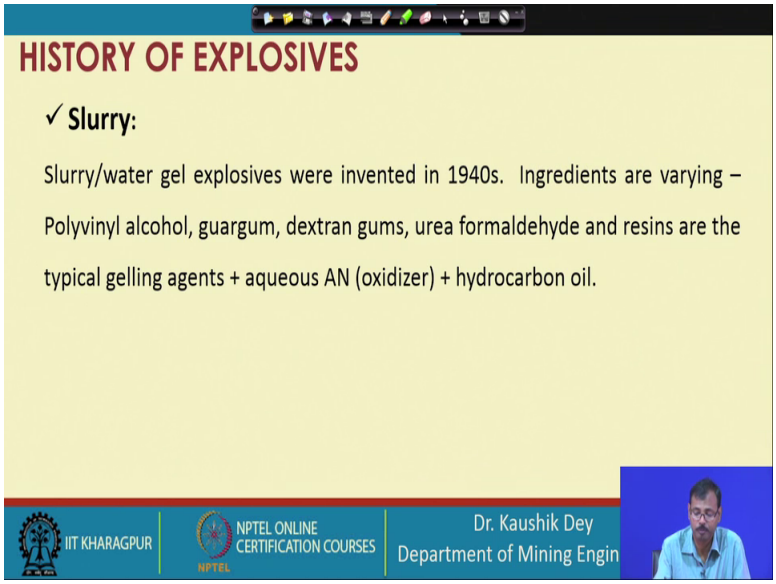

And, as we have discussed the ammonium nitrate ammonium nitrate is also used as slurry explosive, where ingredients are the polyvinyl alcohol guargum, dextran gums, urea formaldehyde, resins etcetera. These are used mixed each other and it along with the

hydrocarbon oils, ammonium nitrate; ammonium nitrate is essentially required because it is the oxidizer it is the main source of energy.

So, all these slurry agents are mixed with oil and ammonium nitrate oxidizer and mix them create a slurry form, oil is basically the reducer, ammonium nitrate is the oxidizer other used for providing a slurry form, so that it can be pumped inside the drill hole to blast the place the explosive inside the drill holes. So, now, huge quantity of the explosive can be placed very easily using the pumping. So, that is why these slurry explosives are developed.

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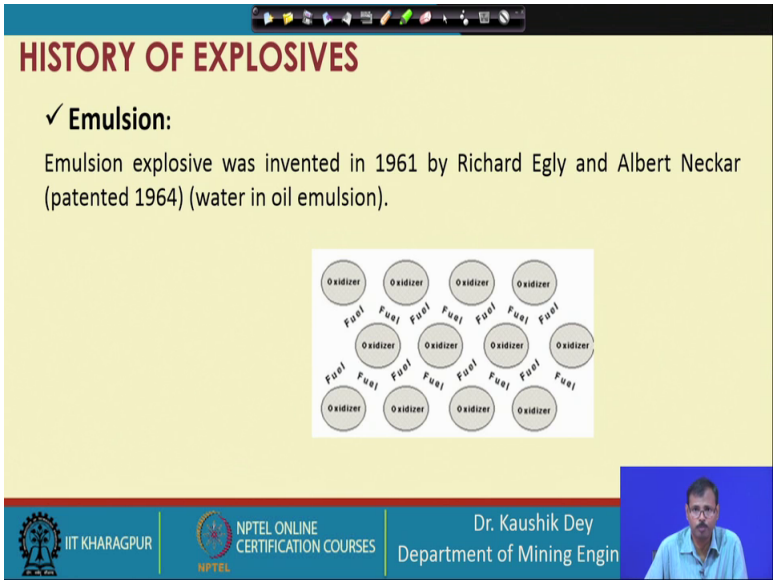

Similarly, the last explosive which we are developed for the commercial purpose is the emulsion, where the slurry explosive is being modified. So, here water in oil emulsification has been carried out in 1960 this has been made and presently the three very popular form of explosive is either emulsion or slurry or ammonium nitrate fuel oil. So, these three explosives are being very very popularly used in present days commercial explosive as commercial explosive and the last explosive developed is 1964 that is the emulsion.

So, this can tell you one thing in last 50 years there is no invention in the explosive, but prior to that there was huge invention is the explosive. But, our present purposes of rock blasting is more or less satisfied with the invention of this ammonium nitrate based explosives. Now, you are able to understand two things by this initially after gunpowder

we have found that gunpowder is no more suitable for our purpose because it is a and we it is a weak explosive and it cannot fragment very strong rock.

So, you are in a search of strong explosive. The moment we search out some strong explosive in terms of fulminating gold, in such terms of TNT, in terms of nitroglycerin, we found that we do not have anything which can control their explosibility. So, their explosibility controlling is very very difficult, not only that these explosives has been found they are not sensitive to flame. So, they cannot be initiated by using the flame.

So, this cannot be initiated. So, we need some initiating device which will give them the shock not the flame. So, the shock has to be given to this explosive which needs the shock for the initiation. So, all the explosives has been invented those are basically shock sensitive and this level of this shocks are different for different explosive. So, for providing the shock and system a an initiator has been developed that is named as detonator.

So, all these modern explosives whether it is dynamite, gelatin, PETN, TNT, slurry, emulsion, ammonium nitrate fuel oil they essentially need some initiator and that initiator the starting name of that initiator is the detonator. So, the detonator is providing the shock that shock level may be different for the different explosive. This may be boost up for some explosive or this may be sufficient for some explosive and this detonator is essentially required to initiate this explosive. That means, present this commercial explosive has one control that if anyone is having this explosive he cannot explode this.

Putting this explosive in a fire is we will not serve anything or it will not destroy anything, because these explosive now are not at all flame sensitive. It will not blushed if it is placed in the flame. In fact, this is the easiest way to destroy the explosive if we are having some explosive which is expired in edge or you need to destroy this explosive, it is essential that you burn that explosive in the open fire, ok. So, basically these explosives are the explosive which are not flame sensitive. So, human being is having a control on the explosive in terms of it initiation.

Simultaneously, these explosive are not that much sensitive, so that it can be immaturely blast; that means, we do not want, but it explodes with our beyond our consciousness and that is called immature blast, it will not immature blast because your say it is sensitivity is not very high. That is why for nitroglycerin we desensitize nitroglycerin to achieve

dynamite, to achieve gelatin, so that we can use it as per our in which we can use it as per as the controlled manner while we are carrying out the blasting.

And, gradually from nitroglycerin to we have shifted towards the ammonium nitrate based explosive. The reason is that ammonium nitrate explosives are the slurry or free flowing compound which can be pumped; that means, the large quantity of explosive can be handled very easily which is not possible for the nitroglycerin based explosives. The sensitivity of these explosives are further poor, it needs a high quantity of shock. So, no one can destroy it, no one can immaturely blast it or no one can wielding or unknowingly willingly mishandle this explosive. So, this is very easy very safe and overall this ammonium nitrate based explosives are very cheaper than the nitroglycerin based explosives.

But, there are some drawbacks of these explosives also because the moment if you are shifting from nitroglycerin to ammonium nitrate based explosive, we will find the strength of the explosives are becoming less. Ammonium nitrate based explosives are not that much stronger than the nitroglycerin based explosives, but anyway the strength is not that much less also. That means, ammonium nitrate based explosives are cheaper, it is compromising something some way to the strength of the explosive.

But, then also for the safety factors for the environmental factors and for the easiness to handle this explosive purpose these are very very suitable explosives. So, that is why most of the explosives which are being used worldwide the major portion of that are being shared by the ammonium nitrate based explosives. Only few quantity of nitroglycerin based explosives are being used.

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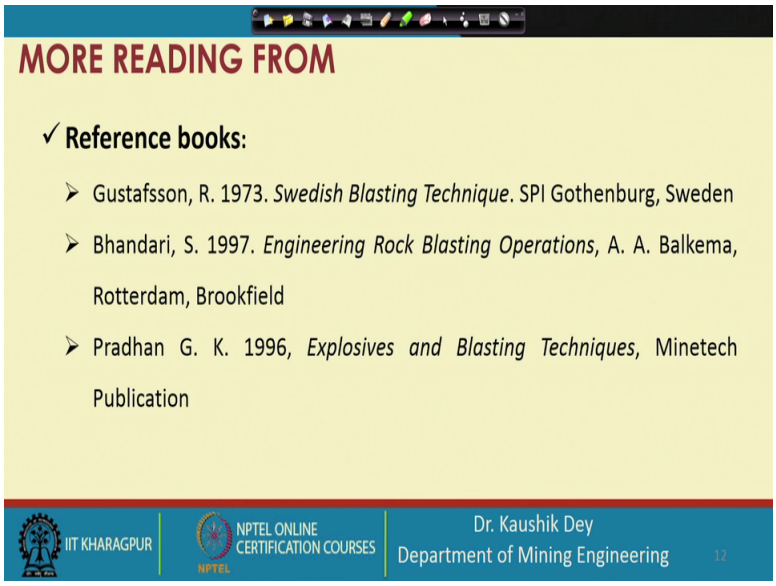

Again, it is strongly wanted that in last class also you have discussed you must read these three a books for having more knowledge about the explosives, because only few explosives are covered here, n number of other explosives are also available. You should know about those explosives, their reactions how they are reacting, their ingredients you should know, you should have a good note on that and you should know the properties of those explosives also.

So, let us stop at this point today.

Thank you.