DC Power Transmission Systems
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Lecture – 57
MTDC systems: Applications

We have studied so far has 1 rectifier and 1 inverter. So, there are 2 converters.

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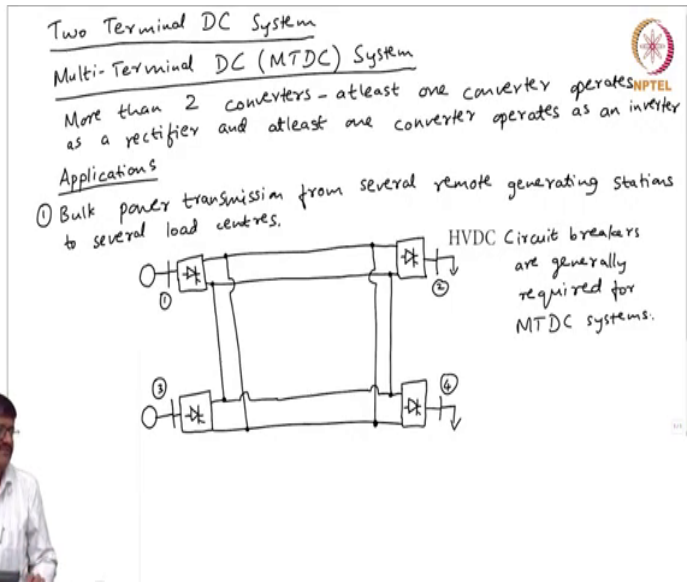

So, these are known as two terminal DC systems. That is a system with 2 converters; one acting as a rectifier another acting as an inverter ok. Now, there are some situations where having more than 2 will be advantageous. So, such systems are known as multi-terminal DC systems, this abbreviated as MTDC.

So, in multi terminal DC systems there are more than 2 converters; more than 2 converters and at least one of them operates as a rectifier and at least one of them operates as an inverter. At least, one converter operates as rectifier and at least one converter operates as an inverter.

So, what are these multi terminal DC systems and where do they find applications? So, it is better to start with applications. So, that one can get an idea of the arrangement that is used in a MTDC system. Now, if you recall the applications of two terminal systems we have already seen some applications say if there is a bulk power that needs to be transmitted across a long distance then DC is an option for economical reasons.

And there are some other reasons for example, if there are two systems operating at different frequency and you want to interconnect them then HVDC is an option. Or though they are operating at the same nominal frequency the frequency control has to be independent, means that they can be connected using DC and there are a few other applications for example, under water or underground transmission you use DC.

Now, the similarly there are applications for multi terminal DC systems. So, first let us see the applications then it becomes clear. Why we need this and what exactly is simply DC systems? Ok. The first application is bulk power transmission from several remote generating stations to several load centres. Now, this application is similar to the applications for the two terminal system. See in two terminal system, if I have one generating station which is far away from the load centre then HVDC is an option ok. Now, here instead of one generating station and one load centre there are several generating stations and several load centres.

So, for example, I have at some location a generator all of you are familiar with single line diagram. So, if I have a generator. So,. So, I will not show several say two more than one more than one ok. So, suppose there are two generating stations and say two load centres. Now, what one can do is use a MTDC system, see suppose I wanted let me, first try to say how different is MTDC system from two terminal DC system.

Suppose, I had two terminal DC systems then I can have a two terminal DC system between say I let me call this bus one, bus two, bus three, bus four ok. So, I can have a two terminals DC system from between one and two; between three and four. But the point is we need some interconnection because of reliability and it is not that the load at two is exactly matching the generation at one and the load at four may not be exactly matching there.

So, some of the loads are two and four are met by one and three generates at one and three so, we do an interconnection. Now, for the sake of reliability we may have a mesh connection. So, when I say mesh connection what I mean is I may have a connection between one and two, three and four and also between one and three and I may also do between two and four for reliability.

Suppose there is loss of one line I can still. Now, if I have four such two terminal systems how many converters are required? See, I want to connect one and two, three and four, one and three and two and four. All these buses are connected by two terminal DC systems. Huh???

Student: 8.

8. I need 8 converters I need 8 converters. Now what we do in MTDC system is we do not use eight converters for the same connection between their buses we will need less number of converters. Let us see how it is done. So, these are schematic diagrams for the converter. So, since I have shown the generators at 1 and 3; it means that, if I just connect 1 and 2 and 3 and 4. It means the converter at 1 is operating as a rectifier converter 2 at bus 2 is operating as.

Sorry, converter 1 is operating as a rectifier converter 2 is operating as inverter ok. The loads are again AC please note loads are the usual AC loads. Now, let us see how to do an interconnection, such that the number of converters that is required is shown to be just 4 and this is less than 8 which was required for making the same amount of connections using two terminal DC systems.

So, the DC side will have two wires, I show the two wires; positive and negative. Now, this is the arrangement. So, you see that these are all there are 4 transmission lines. Assuming that all these buses 1, 2, 3, 4 are far away ok. Suppose the distance between any two buses among is 1, 2, 3, 4 are a few hundred kilometres. Now, one can see that there are only 4 converters, and 4 DC transmission lines ok.

Now, if you had two terminal systems you will still have 4; I mean for the same amount for the same connections you will still have four transmission lines DC transmission lines, but 8 converters. Are you getting the point or not? See what I am trying to say is if you look at the converter connected to bus 1. The DC side has connections to 2 converters. One is connected to converter at bus 2 other is converted to converter bus 3 ok.

There are two wires going from the DC side of the converter at bus 1 ok. So, in the case of two terminal systems on the DC side you will have only I mean one connection; you will have only one connection. So, each converter on the DC side is connected to just one more converter on the other end of the transmission line. Whereas, here there can be multiple transmission lines connected on the DC side.

So, in this case we need what is known as I mean in general when it comes to empty DC systems, breakers are generally required; circuit breakers. Circuit breakers are generally required. Now, that raises another question whether it was required for two terminal systems? See, what I am trying to say is circuit breakers are generally required for multi terminal DC systems. Yeah, see when do we need circuit breaker???

Student: Protection.

Protection. If there is a fault somewhere we want to isolate only the faulty component. Suppose, the fault occurs on one of the 4 transmission lines, there are 4 DC transmission lines. Suppose, there is a fault to isolate you have to just rise I mean to isolate the fault you have to isolate the entire transmission line without affecting the rest of the system that is what you do in a normal AC system.

Now, if you have only two terminal lines can I do away with the circuit breakers?

Student: Two terminals.

Yeah, see I do not have multi terminal suppose I have just a two terminal.

Student: Two terminal.

Yes.

Student: Two terminal.

Or in this case 4 2 terminal systems, instead of one MTDC system I can still have the see for the same connection required four two terminal systems. So, wherever I mean if at all there is a fault somewhere in the system on the transmission line can I avoid circuit breakers?

Student: (Refer Time: 12:35).

See the point is you have control over the thyristors. So, you can always have control over the thyristors and see that there is no current. We can completely block the current ok. Now, that is if you do like that here what happens? You are not actually isolating only the faulty component; you are actually affecting the other parts of the system. So, when you have a MTDC system breaker is a must ok. So, breakers are generally required for MTDC systems, but it is ok to not have a breaker for a two terminal DC system. So, this is one application.

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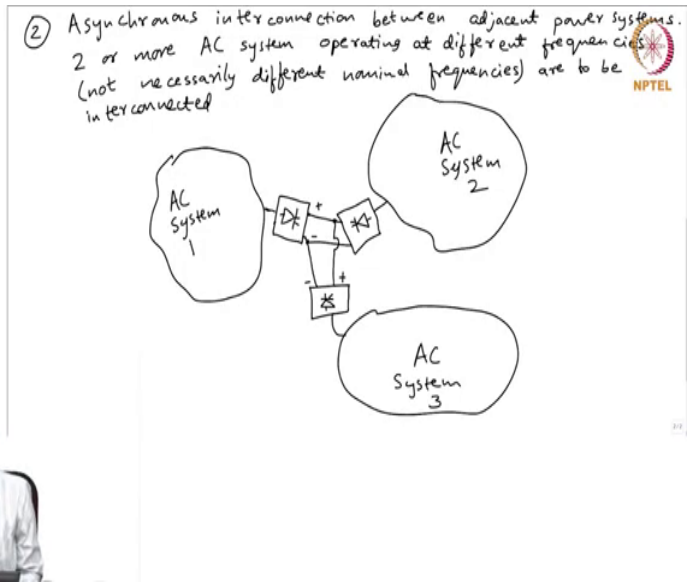

Let us look at some more applications the second application is asynchronous interconnection between adjacent power systems. Now, we say there is an asynchronous interconnection if there are two or more systems operating at different frequencies not necessarily different nominal frequencies, the nominal frequencies can still be same. Now, this comes into picture that is when two or more AC systems operating at different frequencies.

So, when I say different frequencies it means not necessarily different nominal frequencies. It can be same nominal frequency. So, such systems are to be interconnected. So, this application is again similar to the application of a two terminal system, but only difference is in the case of two terminal, it was just two systems. Now we have in general any number of systems. So, let me take an example.

Suppose I have three systems ok. So, these are 3 AC systems; AC system 1, AC system 2, AC system 3. So, what one can do is do an asynchronous interconnection. So, have a converter connected to each of these 3 systems. Compare this with interconnecting system 1 and 2 using two terminal system; two terminal system. Similarly, interconnection between 2 and 3 AC system 2 and AC system 3 by two terminal, again between 1 and 3 you see two terminal.

So, this is another example as well as applications. So, we are I mean I am not trying to give a definition or a general definition of MTDC system. I am trying to convey what is MTDC system by means of applications. So, this is one application. So, similarly there are a few more there is one more application.

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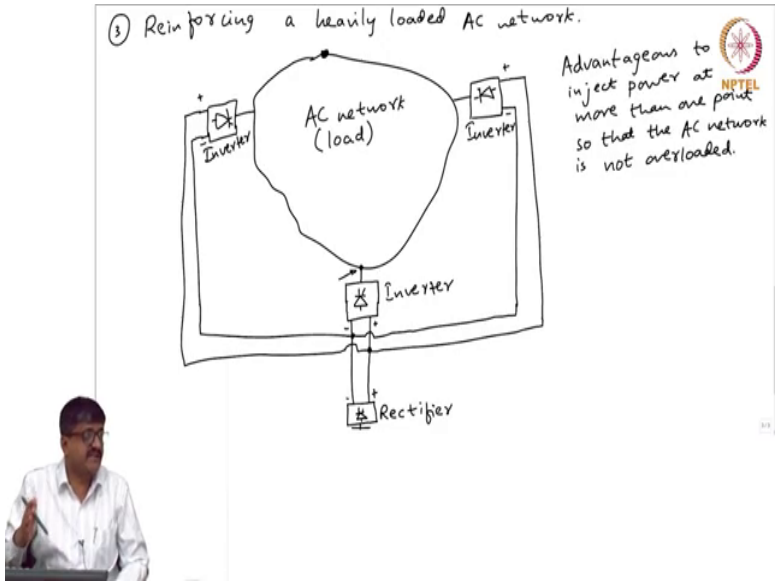

Reinforcing a heavily loaded AC network ok.

So, let me first say what I mean. Suppose, I have a large AC network; large means it occupies a large geographical area AC network, essentially it contains load. Now there is a generator somewhere which is say remote. Now, I use an arrangement like this I have one converter here. Now in the AC network I use more than one converter as inverters ok. Let me first complete the diagram and try to convey what I mean.

So, I have 1 AC bus to which a rectifier is connected. So, this converter operates as a rectifier and the remaining 3 converters operate as inverter. This is inverter; this an inverter this also an inverter. So, whenever we have an AC network which is distributed over a large geographical area. Now, we that is a very common suppose I have a big city; that means, a large urban area; that means, it is distributed the [vocalised-noise] the I mean the network is distributed over a very large geographical area.

Now, in that case if I inject power at one point what will happen? See, suppose the network is huge in area huge in area ok. So, if I net inject power at one point. Now, suppose I inject power at this point ok. Now, if that power [vocalised-noise] same power which is injected has to get distributed over the entire AC network. So, if it has to go to the other end say at this point. It has to pass through all the wires that are interconnecting this end and the other end to which the inverter is connected.

So, just for I mean [vocalised-noise] transferring the power here the these wires have to carry a large amount of current. So, it is actually loading the AC network. Now, many times it is advantageous to have I mean spend on the converters; additional converters which act as inverters instead of spending on the wires. So, it is actually ensuring that the AC network is not loaded to carry unnecessarily power from one end to the other end instead of that inject power at many points ok.

Many a many a times this is less expensive. So, it would be advantageous to inject power at more than one point. So, that the AC network is not overloaded. So, these arrangement requires one rectifier and many inverters; only one rectifier and many inverters. Now, these are some applications in the process we saw examples as well ok.

Now, still now I have not given a very proper definition of MTDC system. So, one can say that a MTDC system consists of more than 2 converters and there is an interconnection on the DC side that is the definition ok. So, there is an interconnection on the DC side.