DC Power Transmission Systems
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Lecture – 66
Reactive power requirement

So, what we have seen in the last few classes is filters that are used on the AC side. So, essentially to minimize the harmonics in the currents drawn from the AC system and we also see saw the design of one type of filter which is a single tune filter ok.

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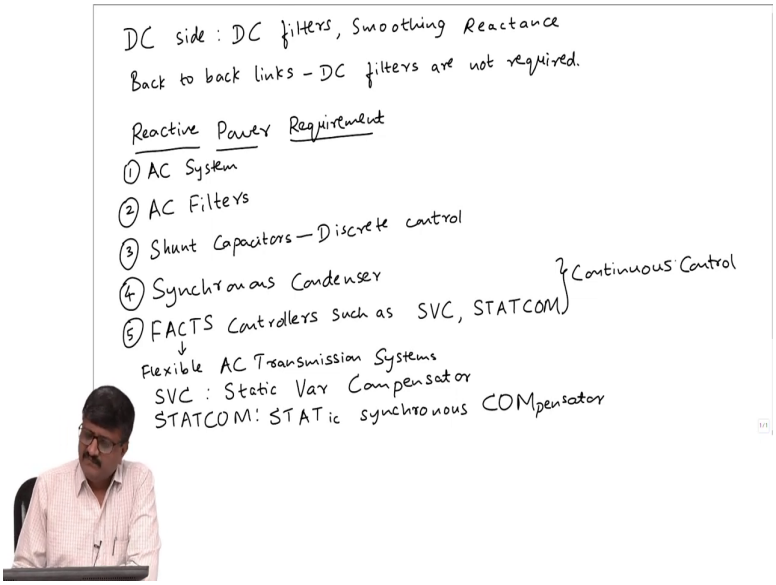

So, there are other filters which are used in a DC transmission system for example, on the DC side. We use DC filters and there is also in addition to that there is a smoothing reactor.

So, there is a large inductance which is connected in series in order to minimize the harmonics in the current on the DC side. Now this is presence of smoothing reactor is one of the reasons for having the model of the DC side as a current source say if you recall one of the models is just a current source a constant current source on the DC side. Now, that is because of the presence of a large inductance which is called smoothing reactance.

So, I will not get into the details of the smoothing reactor or the other DC filter, but one point to notice if I have only back to back connection or back to back links, if I have back to back links. That means, we need to interconnect two systems without having a transmission line; that means, the rectifier and the inverter are in the same building ok. So, there is no transmission line such DC systems are called back to back links.

So, in this does not require DC filter, DC filters are not required ok. So, that is about filter we will briefly look at some one more equipment that is required in a DC transmission system. We saw that the reactive power is actually absorbed by the converter so; that means, from where does this reactive power come?

So, if I want to look at the reactive power requirement of the converter. See, now from where does this reactive power come? See if you do not do any additional, I mean if I do not provide any additional source then the AC system itself supplies the reactive power so that is one option the AC system itself supplies the reactive power. Now invariably there are filters on the AC side to minimize the current harmonics. Now these filters can provide reactive power at the fundamental frequency.

See, if you recall when I, when we decided the rating of the capacitor or inductor we saw that, we took the fundamental current and harmonic current. Now that fundamental current is essentially supplying react power. Now please note what will be the reactive power, I mean of the inductor and capacitor. So, if I compare the reactive power absorb by the inductor of the filter at the fundamental frequency and the reactive power generated by the capacitor of the filter at the fundamental frequency which one is larger?

Say the inductor and capacitor will act in opposite ways ok. So, when it comes to reactive power inductor by convention is absorbing capacitor by convention is generating ok. Now that is the usual convention of reactive power. So, whether generation is more than absorption or it is the other way. Sorry?

Student: Absorption.

Absorption is more? See what is the expression? Take the square of the current and multiply it by reactance, take the square of the fundamental component of a current and multiply it by reactance, so which one is larger is the question? i f 1 square into the reactance at fundamental frequency of the capacitor and i f the same current flows they are in series.

Student: I think capacitor will be the (Refer Time: 05:02).

You think, so you are not sure.

Student: Because capacitator in micro so, from the omega series we will see 10 rise to 6 will come up, so this values of.

No, without even taking the value I mean one need not take the value. See look if you look at the expression? What do you can you not infer anything from that?

Student: (Refer Time: 05:23) and that is good.

Which one is?

Student: Generation will be.

Generation is more than consumption.

Student: Without taking value.

No, why do we need values, say we know that the value of inductor and capacitor is such that it is equal 1 by root lc is equal to the.

Student: Some.

Some harmonic.

Student: Yes.

Whether it is 11th harmonic 13th some harmonic ok, which is higher than fundamental.

Student: Yes.

So, what is happening at fundamental is a question? From that can we not say what is happening at the fundamental?

Student: Both should be equal to.

Sorry?

Student: Both should be equal (Refer Time: 05:58).

Both should be equal at?

Student: Harmonic frequency.

Harmonic frequency, harmonic frequency is 11th or 13th or 23rd 25th so on ok. Now what is happening at fundamental is the question?

Student: We know that two curves are intersecting at the harmonic, but.

What is happening at fundamental? Fundamental is less than harmonic, fundamental is always less than harmonic.

Student: Yes.

So, what is happening at fundamental?

Student: (Refer Time: 06:28) we just say (Refer Time: 06:30) with f.

So.

Student: Can we decrease the frequency?

So, there is more generation of reactive power or more than there is net generation of reactive power or net consumption of reactive power?

Student: Net generation.

Net generation, so that is what I am saying. So, AC filter is also a source of reactive power. So, the AC filters. So, without providing any additional equipment these two are anyhow there, there they will provide the some amount of reactive power, but if it is not sufficient. Say I mean AC filter is not actually for the purpose of providing reactive power, it is for the purposes of reducing the harmonic content in the currents on the AC side, but it also provides reactive power.

So, if that is not sufficient then the system has to provide, but it will be always at some point where the system may be overloaded so it reactive power is supposed to be ideally generated at the place where it is required ok. So, that is why I mean we are we are familiar with this, we say power factor correction. So, all our loads are almost inductive loads so we do reactive power correction locally by having a reactive power generation. So, I say in the form of capacitor ok. So, shunt capacitors is another option. Any other source of reactive power?

Student: Condenser.

Condenser synchronous condenser, synchronous condenser. Any other source, you have heard of reactive power source? Any other reactive power source?

Student: FACTS.

Sorry?

Student: FACTS.

So if you have studied flexible AC transmission system controllers FACTS stands for flexible AC transmission systems. So, there are some FACTS controllers such as SVC STATCOM. SVC in fact, is an abbreviation SVC stands for Static Var Compensator. STATCOM is also an abbreviation STATCOM stands for static synchronous compensator.

So, these are the different sources you will not get into the details of these two FACTS controllers of course, or in general what is FACTS controllers, this is part of an other course if one is interested so, just for the sake of completeness I am listing them. Now there is one major difference between the last two sources and the 3rd one of course, the first two are any how there ok. Now 3 4 and 5 are something which are additions. Now what is the major difference between 3 and the other two 4 and 5.

Student: Passive.

Sorry?

Student: (Refer Time: 10:20) passive (Refer Time: 10:21).

Passive, I mean then you have to define passive active so I did not want to get into those definitions even in the context of filters I did not say what is, I just because somebody is said active I said passive without even defining what is passive? No, much more simpler terms that we are familiar.

Student: Uncontrol.

Ah?

Student: Uncontrol.

Uncontrol, actually there are mechanical switches so discrete control there is no continuous control for shunt capacitor it is it provides only discrete control. One can have many capacitors in parallel with switches so depending on how many switches you close or how many switches you open the amount of capacitance can change, but it takes only discreet vales that is all. If you have only one capacitor it takes only two values either there is capacitance or no capacitance.

When, when it comes to synchronous condenser and FACTS controllers you have continuous control. But one should know that there are some problems with synchronous condenser.

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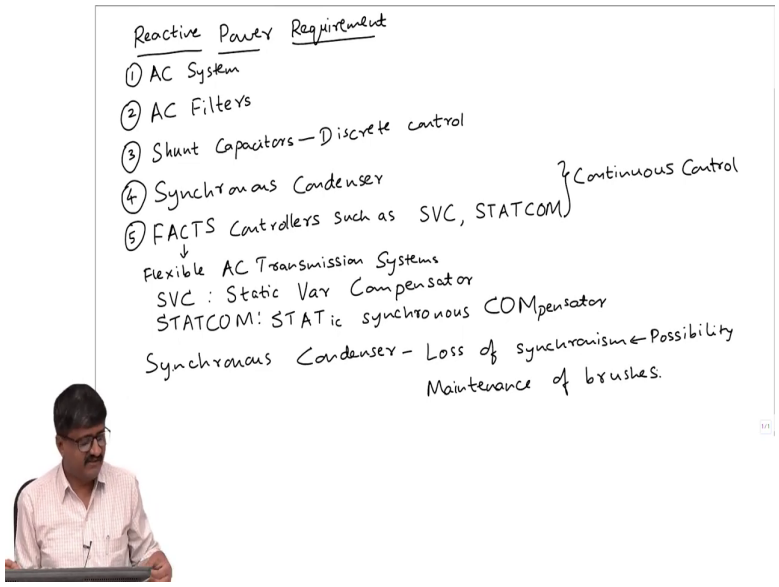

So, when you take a synchronous condenser always there is a disadvantage attached with that synchronous condenser. First of all what is a synchronous condenser?

Student: It is a motor.

Motor?

Student: If synchronous motor without low operating at it is (Refer Time: 12:01) for.

So it is a synchronous machine, if I ignore losses it is neither a motor nor a generator, if I ignore the losses it is neither a generator nor a motor it is just a synchronous machine which is connected to the AC grid and on the shaft there is nothing connected neither a load nor a

prime over ok. So, it is just a synchronous machine, but if you just take the losses into account it one can say it is a motor.

But there is no motor means normally you connect a mechanical load to the shaft, there is no such mechanical load there is no prime over also ok. Now what are the problems I mean there are some disadvantages due to use of synchronous condenser. Now this disadvantages is common to all synchronous machines, see when you whenever you have synchronous machine there is a problem of loss of synchronism.

Say though there is no generation of active power from this there can be a loss of a synchronism which can happen with any synchronous machine. So, one disadvantage is loss of synchronism. That is an issue, then I mean this just a possibility loss of synchronism is just a possibility you know. Another disadvantage compared with the FACTS controller.

See FACTS controllers are essentially power electronic circuits that is all, they are only power electronics circuits, FACTS controls are power electronics circuits. Now if you compare a synchronous condenser or FACTS controller I mean by definition I mean synchronous condenser has a stator rotor there is a rotating element FACTS controllers are just I mean stationary circuits. Now there is whenever you have a rotating element there is a possibility of slippering brushes, which you do have why? Why do you need slippering brushes in synchronous condenser?

Student: Because we use.

Filed has to be supplied some current or voltage a DC voltage, field is actually rotating armature is stationary. Now how do you connect a source, DC source to this filed? So, the external DC source is just some stationary equipment and the field winding is rotating so to connect them you need a slippering brushes. So, whenever there is a contact between the rotating slipperings and the stationary brushes I mean they will be wear and tear.

So, whenever that happens you need to keep replacing this I mean periodical, of course even otherwise I mean there are there is another location where there is a contact between

stationary part and the rotating part, where is that? Any rotating machine has a contact between stationary part and a rotating part right, where is that?

Student: In the (Refer Time: 14:40).

Where do you see that contact? Or there is no contact it is just rotating in air, that is also possible.

Student: Bearings.

Bearings, it is bearings. See if you look at any rotating machine a cylindrical structure that two end plates there are two bearings on both sides ok. So, that is a contact of course, there are some developments I mean if one uses a magnetic bearings you can avoid that also ok. So, one can use a magnetic bearing to see that I mean it just rotates in air without any contact ok.

But, this is a something which requires frequent maintenance maintenance of, maintenance due to brushes maintenance ok, I would say maintenance of brushes, the carbon brushes that keeps bearing out so you need to replace that periodically. So, I presume we are all familiar with synchronous condenser, its see just as I said a synchronous machine without a prime over without a mechanical load and it is connected to the grid.

So, I can generate reactive power by controlling the field current, in fact I can even absorb I can generate or absorb, by varying the field current ok. So, the that is the advantage of a I mean synchronous condenser it has a continuous control.

So, that is about the reactive power requirement.