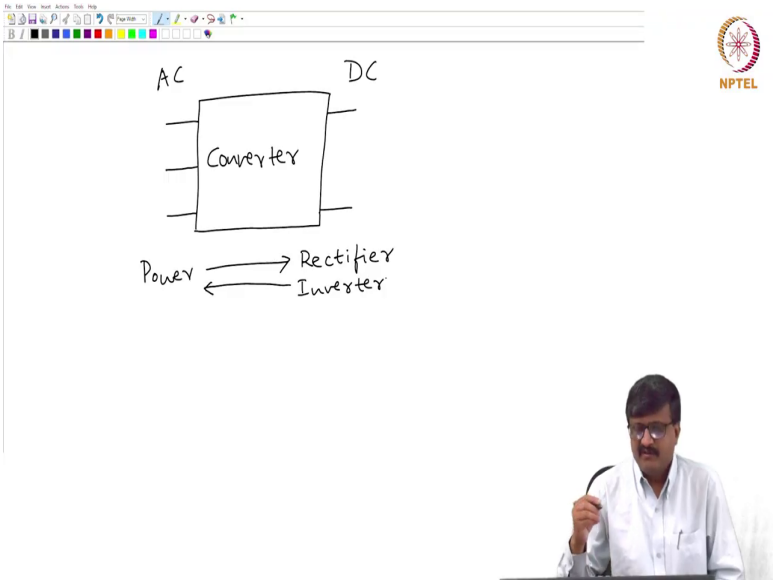
DC Power Transmission Systems
Prof. Krishna S
Department of Electrical Engineering
Indian Institute of Technology, Madras

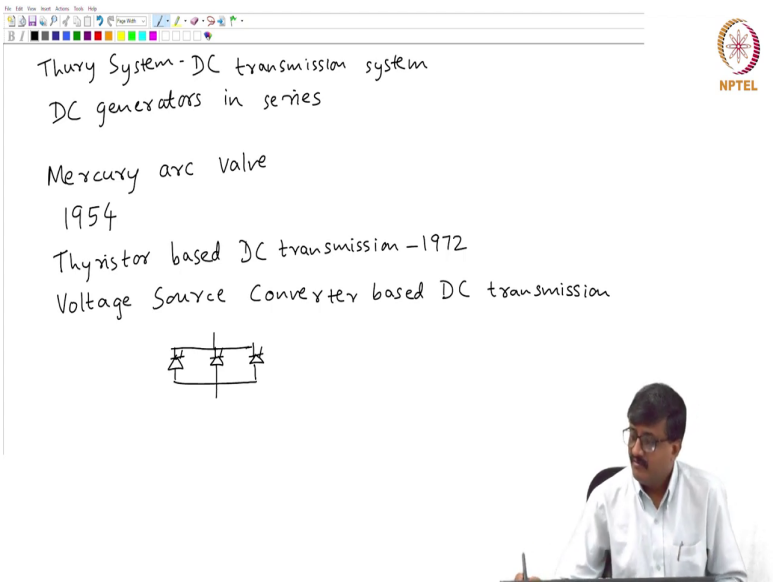
Lecture - 03
Historical developments

(Refer Slide Time: 00:16).



So, all of you know that the history of power systems goes back to late 19 century, it was the end of the 19 century itself there were many power systems. So, not that the D C system or the D C transmission using power electronic circuits was, I mean I was not there of course, at that time because power electronics came much later, but there was D C and A C at that time ok. So, there were many instances of use of D C for transmission even the even if the system was predominantly A C.

(Refer Slide Time: 00:57).



There was a system by name Thury system. Now this is actually a DC transmission system which was used in Europe in the early 20th century. So, it was actually designed by a French engineer by name Thury, Thury is the name of the French engineer who designed this. So, what does this system contain? Actually this system had DC generators which generate power in series, DC generators connected in series.

So, all the armatures of many DC generators are connected in series, now the purpose is to get a high voltage. See for transmission you need high voltage. See the main limitation of DC of course, why we went to AC is, I mean AC provided a means to transform the voltage from a lower value to higher values in transformers that was the reason we went from DC to A C. So, there were some parallel developments in DC also in Europe especially.

So, if I am connect many DC generators in series then I get a high voltage. Then at the consumption end also I have many DC motors which are connected in series and then these DC motors actually drive generators which can be used for consumption. So, this was one system which was popular in Europe for some time, but this did not last long because DC machines have some limitations; of course, there are always limitations with DC machines whether it is motor or generator.

So, just for the sake of completeness I mentioned this, but after this there were other DC systems. See I am talking about there were no semi conductor, there were no Thyristor, diode or IGBT or GTO Thyristor and so on. So, there was a time when we use what is known as mercury arc valve. So, a mercury arc valve is one particular device which can be used to build a circuit which is similar to the rectifier or inverter that we are familiar with now ok

So, there were many HVDC transmission lines using mercury arc valve. So, the very first D C transmission line was in 1954 was using mercury arc valve. Now the Thyristor based transmission started only in 1972. So, from 54 to 72 there were a large number of convertors that were actually commissioned using mercury arc valves. Of course, the there was the mercury arc valve based convertor which was working till 2011

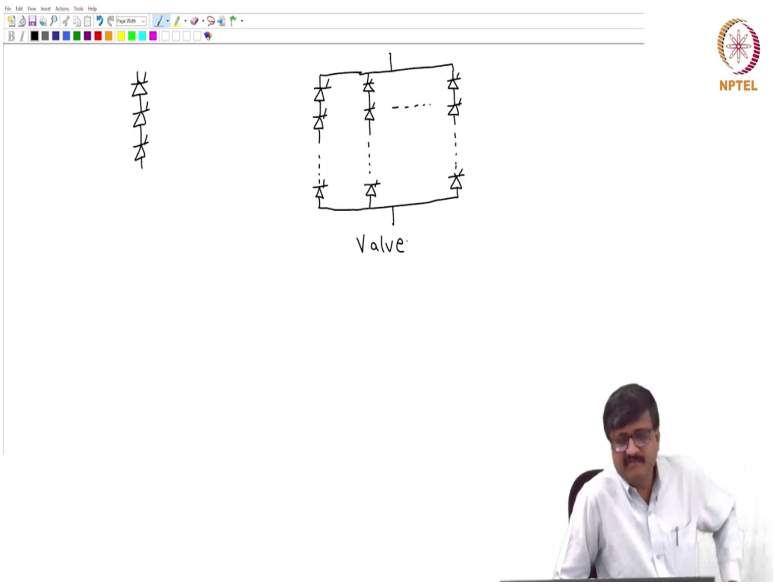
Of course as of today there is no convertor which is using mercury arc valves. So, either we have Thyristor based or the more advanced ones which are actually voltage source converter based. So, the voltage source convertor based DC transmission is more recent and it started with a development of high voltage high current IGBT. So, if you look at the development what started initially as a Thury system which did not have any particular circuit of a convertor, it just used motors and generators then that was followed by a circuit using mercury arc valves

Then we had Thyristors now voltage source convertors, but the point to be noted is the voltage that is required for transmission is of the order of hundreds of kilo volt. Now there is no single device which can which is rated for hundreds of kilovolt. See if you look at a Thyristor; a Thyristor is rated for utmost say 12 KV ok, we have Thyristor rated for 12 KV.

And of course, even the IGBT which is used for building a voltage source convertor does not have a I mean rating which is more than if you 10 percent of KV. So, we have all these are limited to utmost 10 K V voltage rating.

Of course we do have current ratings, current ratings of the order of kilo ohms is available. So, in the early days when Thyristors were used for D C transmission, we use to construct a circuit like this. Suppose you are if you are familiar with the symbol of a Thyristor. Suppose I want a device with a very large current rating. So, what I do is, a single device cannot carry that large current, so we connect many such things in parallel.

(Refer Slide Time: 06:51).



Now, if I do not have the required voltage rating what I do? I connect many such devices in series. Now if you look at the very first Thyristor based D C transmission neither the current rating was available nor the voltage rating was available. So, at that time what was done, we

used both series as well as parallel connections. So, there were many Thyristors connected in series, and many such circuits connected in parallel.

So, this particular circuit having a large number of Thyristors in series and many such series connections in parallel was given a name; the name was valve. So, we use the word valve or to be more precise Thyristor valve to mean a large number of such Thyristors connected in series and such circuits connected in parallel. But now a day we do have the current rating, so we no longer need the parallel connections, but we still need the series connection. So, as I said if I have the maximum rating available as 12 K V if I want say 500 K V. So, the number of minimum number of Thyristors that I need to connect is 500 divided by 12 ok

So, we still do not have a Thyristor device which can with stand the voltage level at a transmission ok. So, at the transmission voltage is hundreds of KV, so 500 V is an example. So, right now we do not need parallel connection we need only series connection as I have shown here.