Advances in UHV Transmission and Distribution
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Lecture - 12
HV testing on Composite Insulators

We discussed about the polymer or ceramic insulator which are use for high voltage and extra high voltage transmission systems, we were mentioning about the glass insulator. So, glass insulator are also of are being used for extra high voltage and ultra high voltage transmission, one of the most of the typed are carried out similar to the ceramic or porcelain insulator.

So, one of the experiment which has been carried out in the laboratory is the artificial rain performance of the glass insulators. So, we would like to see a small video clip of the performance of the glass insulator. So, the voltage is a applied in steps and the moisture or the rain through the fog nozzles as per stranded is generated in the fog chamber, then the voltage is increase we find that the discharges from the conductor and towards the ground, scintillations or park partial arcs will be observed initially later on as the voltage increases the stress across the string increases the conductivity on the surface of the glass insulator increases further increase in voltage will have break down or the flash over across the entire insulator shrink.

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So, one such example you can see here, this is the chamber especially made for pollution studies where you can see the having glass insulators in 6 insulator are in service.

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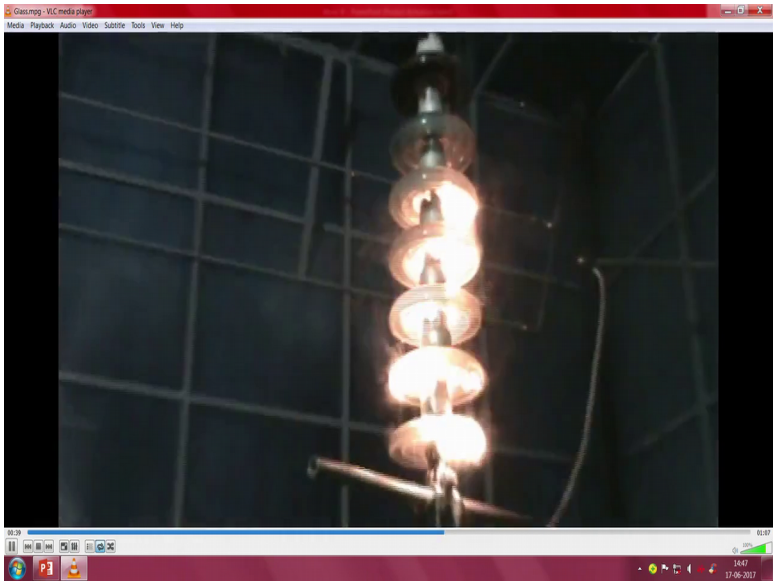

This is the high voltage conductor, where the voltage is taken from 150 k v to amps. So, the voltages applied here you can see the discharges on the surface, the scintillations or partial arcs initially then the depending upon the surface conductivity the scintillations increase further increase in a voltage will lead to complete break down or the flash over.

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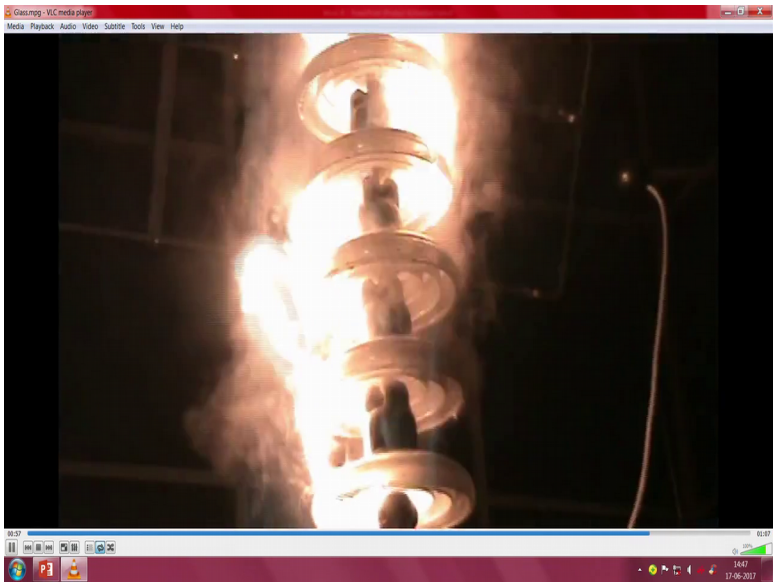

So, this is one of the experimentation for conducting the wet on pollution; this you see the entire flash over across the shrink during the flash over you are also observe the fumes of hot fumes which are like a smoke coming out of the during the flash over process.

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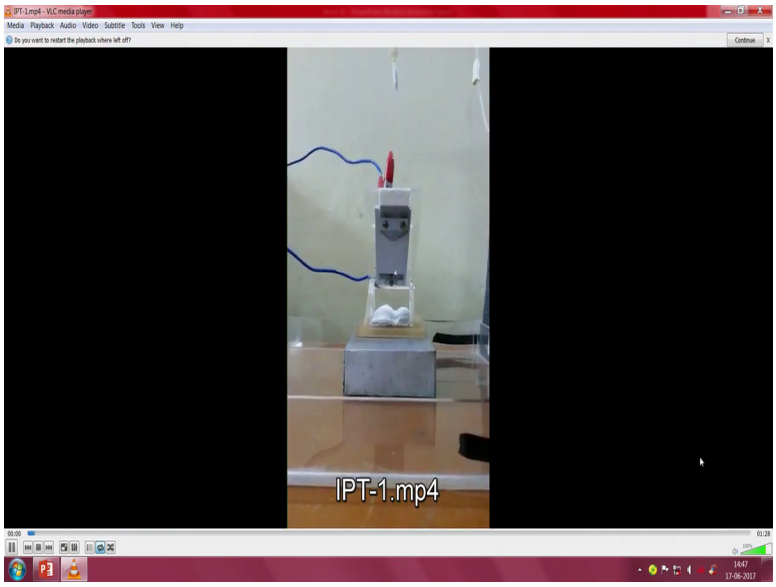

Now we have discussed about the ceramic and the glass insulators; the reliability of the testing aspect have been discussed.

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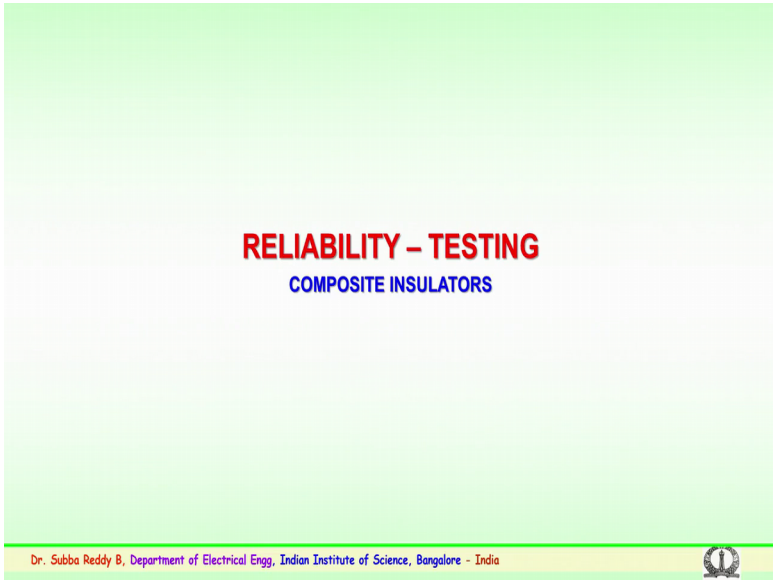

As we know that presently more advance type of material that is the silicon rubber or a composite or a polymeric material is being employed for the transmission systems and distribution systems also. So, reliability of the composite insulators are polymer insulators these being organic in nature are very important not only carrying out the regulator testing aspects, these being organic material have to be tested for more reliable for the long run in the field to give us a good service in the field.

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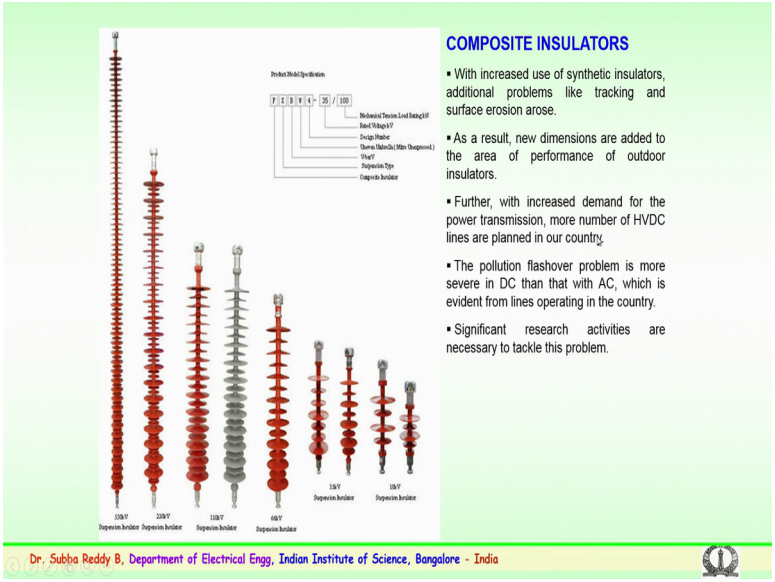

So, the composite insulators increased over the period particular in the country; for a decade also we are being using it for distribution voltage levels to the ultra high voltage a levels both for AC and DC applications; with increased use of synthetic or a composite type of insulators the utilities are facing additional problems particularly like tracking and surface erosion.

So, as a result a new entire new dimension is being added to the area particularly pertain to the performance of these composite or polymeric insulators which are being used as outdoor insulator transmission system. Further with increased a demand for the power transmission in the country many or more number of high voltage DC transmission lines are being executed and are being planned in our county.

So, here again as the voltage level goes up above 400 kilo volts as mentioned the pollution or a contamination phenomena is a very important aspect to be considered for

the design of line insulation. So, the pollution flash over problem is much more absorbed to be much more sever in case of DC then with alternating voltage.

So, which is evident? Because of the practical lines which are operating in the country. So, there is a requirement a significant activity pertain into the performance have to be carried out further in the laboratories, research laboratories and to see that how the problem could be tackled particularly pertain in to the performance, the degradation of the surface of rubber insulator and so on. So, these are various types of insulators which are being used for a distribution class to a very high a voltage levels, both for AC and DC transmission system.

So, it consist basically as mentioned earlier and fittings with a polymer 5 class rod and polymer sheds or silicon rubber sheds.

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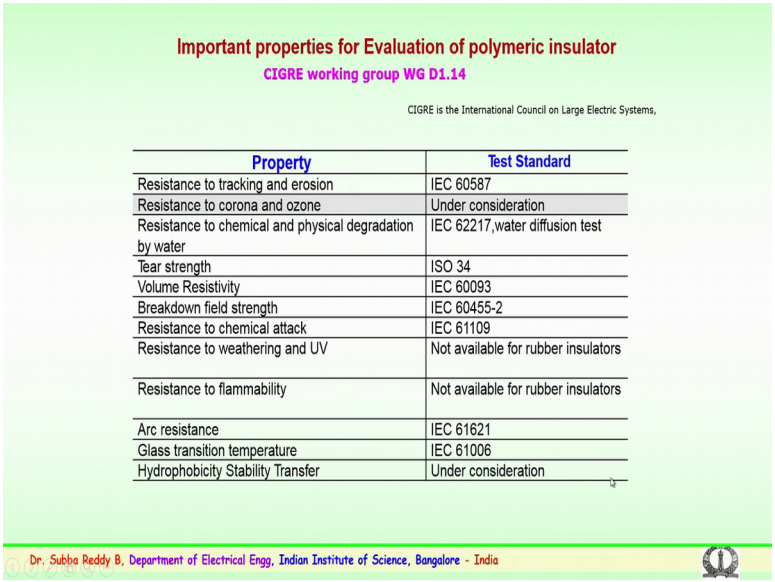

So, an important property for evaluation like checking the reliability is very important. So, not only the regular testing standards which have been prescribed not only following the testing standards as these insulators are of recent origin. So, the important properties for evaluation are being categorized a particularly the CIGRE working group, the CIGRE is on international council on large electric systems.

So, this international group mainly focuses on the standardization of some of the properties pertaining to the insulator. So, this CIGRE a working grow D1 14 has

recommended or has been recommending the properties which are to be evaluated for a polymer or a composite or silicon rubber insulators, before actually the standards have been evolved. Some of the standards have been already evolved, but still some are in the stage of evolution. So, you can see here resistance example resistance to tracking and erosion the standard is IEC 60587 which is already evolved and where the methods for conducting of the experiment is being given in the standard. For h v DC resistance to tracking and erosion has to be evolved for AC it is already been established.

In case of resistance to corona and ozone; so corona and ozone will degrade the surface of the polymer insulator. So, this particular standard it is still work is under progress, it is not at standardized. So, the standard has to come up. So, CIGRE working group working towards standardize of this procedure. Similarly resistance to chemical and physical degradation by water it is standardize were IEC 62217 clearly explains about the water division test for the polymer materials; likewise the mechanical strength, that is a tear strength, the volume resistivity, the breakdown of filed strength, resistance to chemical attack then this parameters or properties or also been standardize like which are given here various I international electro technical commission standards have been evolved for evolution of this properties.

So, similarly resistance to flammability, resistance to weathering and UV that is climatic aging or a climatic conditions performance of these insulators still the standards are not at available. So, the CIGRE and many researcher across the globe are working towards the area suggesting many methods to be followed before the process is been standardized. The arc resistance for during the surface discharge arcs is again specified for low and medium and high voltage are king which is specified in the IEC 61621. Similarly glass transition temperature it is mentioned in 61006 IEC, and hydrophobicity this is very important property of the polymer insulator where the material water repellent property on the surface of polymer insulator has to be verified.

So, this is a important property where hydrophobicity stability this is still under concentrations. So, the standard is not at evolved for hydrophobicity so many researcher are working. So, when a look into the twelve mentioned a property is here by the CIGRE working group, out of this twelve there are four which are not yet standardize that is one is resistance to corona and ozone, resistance to weathering and UV that is a climatic effect of ultra violet then weathering conditions then resistance to flammability then

hydrophobicity; these are four important parameters which the standards have not been evolved and this hard to be considered add laboratory level before the performance have to be tested in the long run of the polymer a materials in service.

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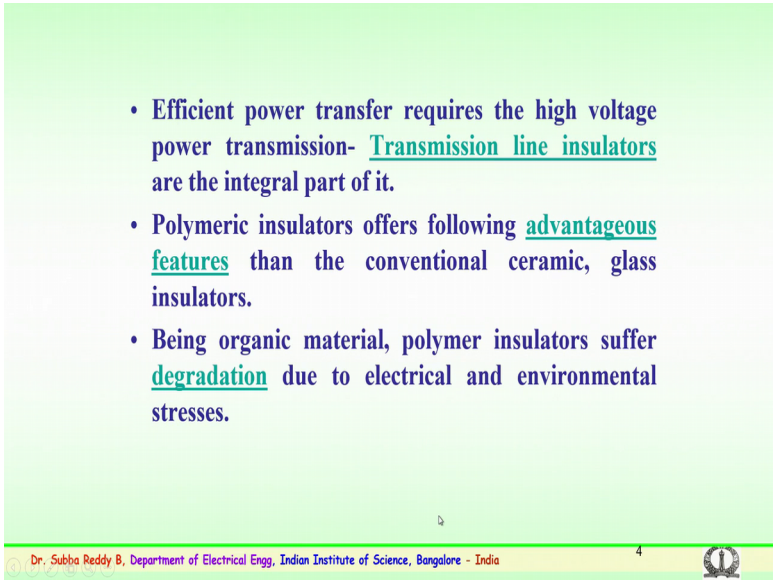

So, you know that for efficient power transmission require the high voltage and transmission insulators are which found the integral part are very important components either it is a ceramic glass or a polymer. So, polymer insulator offers many advantages then the conventional ceramic or a glass. So, being organic they suffer degradation this is a very important point to be noted, this is due to electrical and also environmental stresses.

So, the main point of the performance of these polymer insulators for long period of time is one of the quantification to be done particularly for the surface degradation and the insulation properties over a period of time in service.

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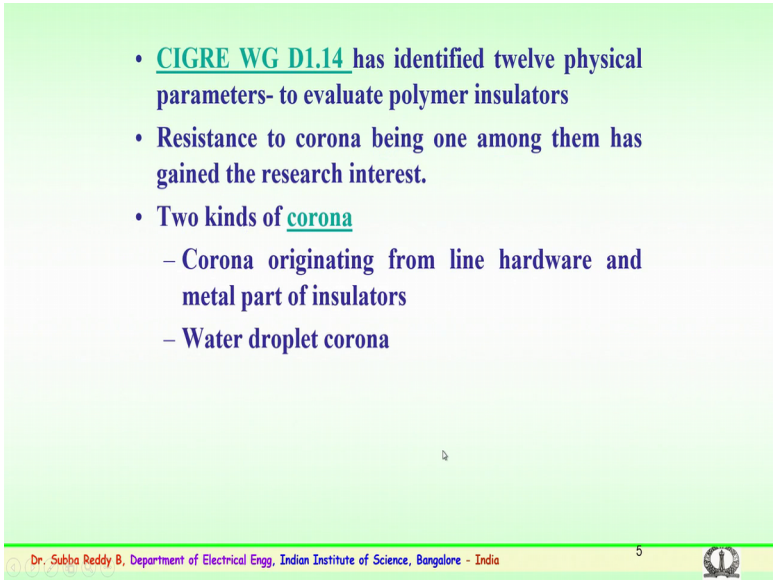

So, CIGRE working group which I mentioned earlier, which is an international body or a council for large high voltage systems working group D1 14 has mentioned as identified 12 physical parameters to evaluate polymer insulator. So, resistance to corona is one among the important which has gained the research interest. So, many people are a focused towards this subject and are being working towards the remedial or trying to see how improve mental aspect could be done.

So, in the field BC 2 kinds of corona, corona which is normally originating from the line hardware like the corona control rings or the yoke plate or any of the hardware material, and sometimes metal part of the insulator; so the inception of corona could be from one of this aspects which the discharges are continuously bombard the surface of polymer insulator and over a period surface degrades because of the corona discharges. The second is the water droplet corona which in case the hydrophobicity of the polymer insulator if it loses the water repellent property, the droplet settles on the surface and there will be tripled junction which is formed on the surface near the conductor junction where continuously the corona due to water droplet may also degrade or the insulator over a period of time, and the surface loses its further hydrophobicity and could degrade the insulator in the long run.

So, these two types of corona could be simulated in the laboratory and has to be evaluated for the performance of the insulators which would be put in service.

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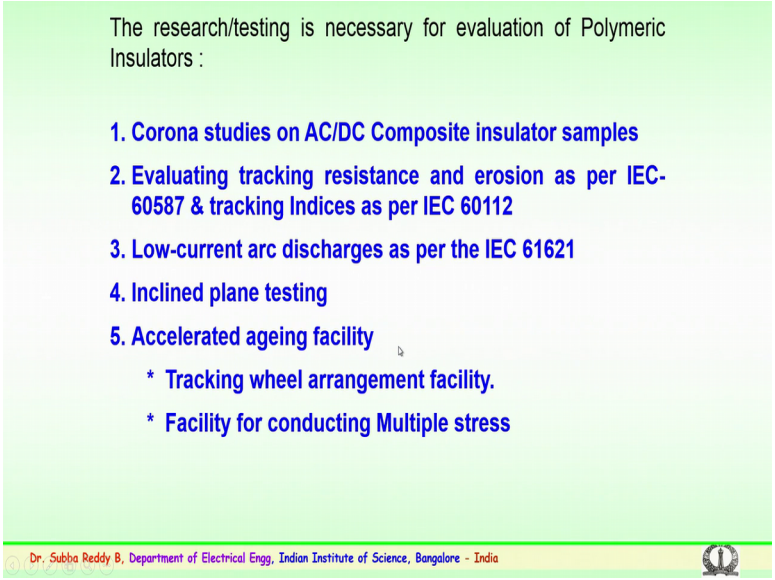

So, the research or the testing for the reliable to testing is important particularly for evaluation of the compositor polymer insulators.

So, it is utmost important to see the corona studies have to be carried out on both that is AC and DC composite insulator samples as this compositor polymer insulator are being used for AC DC transmission distribution systems, AC and DC long distance are transmission systems and also for a distribution in case of AC.

So, evaluating for the corona effect is of utmost importance, there is further the tracking resistance and erosion which is mentioned in the IEC 60587 and IEC 60112 on tacking indices is also important. So, the performance of this material as per these standards will evaluate the material and helps us to know the actual resistance tracking resistance and how depth the erosion happens in case of the insulator in service.

Then there are reliability test prescribed by IEC 61621 particularly low current are discharges; the current of lower current continuous discharges on the sample we should be created where the discharges damage the surface and whether the martial loses at hydrophobicity, this has to be carried out which gives an idea for the reliable working in the field.

So, for these you there is method which has been used the inclined plane testing method; where the inclined arrangement is made at an particular angle and the material or the

sample is fixed on the inclined plane arrangement and either it is AC voltage or the DC voltage is applied for a known period of time for with contamination suitable contamination which is beings mentioned in the standard, the contamination the droplets of contamination is being continuously made to pass on the sample and the voltage is applied between two electrodes. The performance during the flow of contamination the sample degrades itself and there could be erosion; so this helps to see the performance of the sample polymer sample in the field.

The other important aspect or the reliability verification for the polymer full scale insulators or full fledge insulator or approver at type of insulator is the accelerated ageing experimentation, accelerated ageing experimentation again consists of two to three experimentation which normally carried out in the laboratory or basically the experimentation is a salt fog which is not mention here, a salt fog experimentation which could be carried out for thousand hours a period; the second being the tracking wheel arrangement facility where this helps the sample to get itself dipped in the known quantity of solution, then it will have a face where it gets dried and again it comes in contact with the high voltage. So, this facility in how the experimentation is being done we discussed.

Then finally, the facility for conducting multiple stresses; very important this material being organic in nature. So, in the field the insulator is likely to experience multiple stresses; multiple stresses like the temperature effect of temperature, effect of humidity, effect of ultra violet radiations from the sun and also the ultra violet radiations which may come from the corona control rings the corona induced u v i s and due to fog, due to rain, due to pollutions. So, several of this aspects have to be simulated to see whether the insulator with stands over a period of time. These are some of the important experimentation which are necessary to evaluate the composite insulators for a long period of time.

So, we will discuss each and all the important evaluations to be carried out on the composite insulators.

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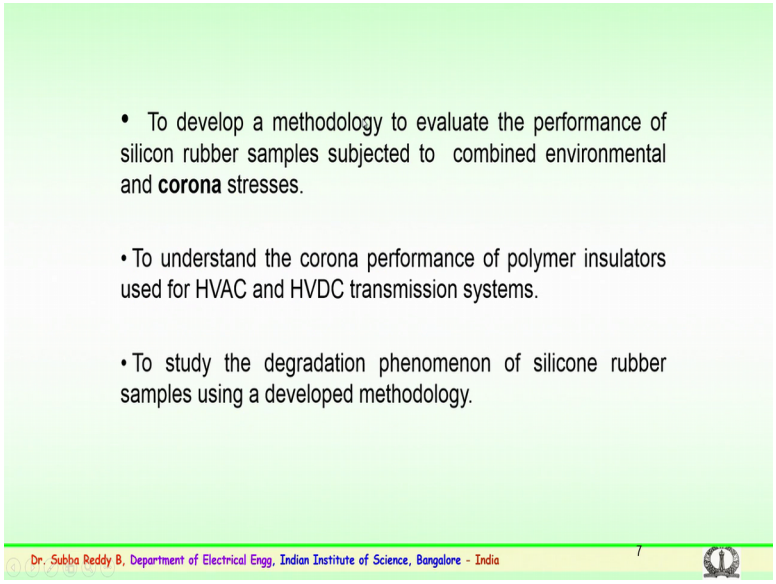

So, for these to carry out the facility it is necessary to develop a methodology how to evaluate that is very important to check the performance of these composite insulators when subjected to combined environmental and also corona stresses. So, this is very important point to be noted.

So, corona is not only happening in dry conditions. So, corona also happens in fall weather conditions are in during the moister condition which could aggravate situation and it could degrade the insulator in a faster process, so to understand the corona performance on composite insulators, which are used for high voltage AC and high voltage DC transmissions systems. So, to study the degradation surface degradation phenomena on samples using methodology, which is normally developed in the research laboratory or as per standards which have been specified?

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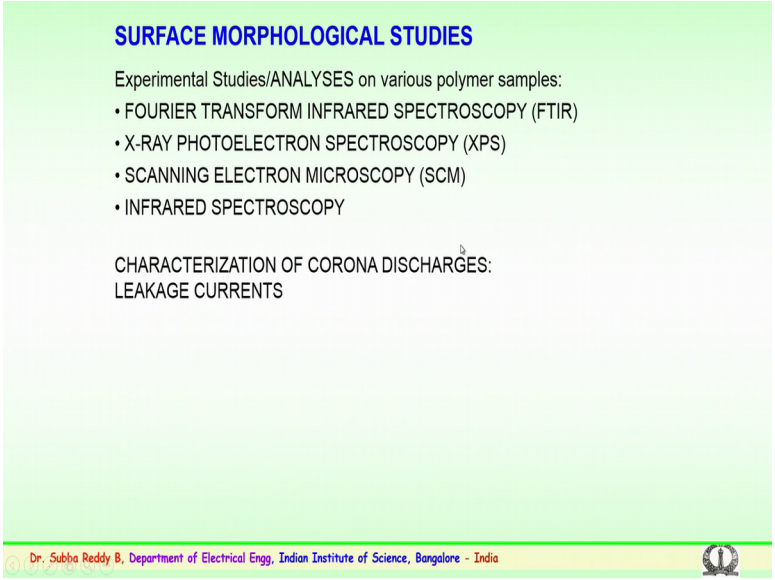

So, for the analysis after the experimentation either going in for the surface erosion studies corona or going in for ageing analysis ageing studies. So, later on the interpretation of the results is an important factor. So, the interpretation of the results pertaining to the surface morphological changes which happen on the insulator samples various methods are being adopted after the experimentation, this are some of the following which are shown are some of the methods apart from the there are several other methods which are being used for the interpretation of the performance of this samples.

So, few of them are the Fourier transformer transform infrared spectroscopy, where this gives an idea about the surface degradation on the polymer samples. The X ray photo electron spectroscopy, the XPS again it gives an idea then scanning electron microscopy it gives the surface changes which have happened on the surface after the experimentation, then they use infrared spectroscopy apart from that t g a thermo gravity gravimetric analysis and other mechanical analysis to find the properties of this insulators. So, electrically the leakage currents which are being used during the which are being measured during the experimentation could be help in categorization of the corona dischargers on the sample they effect on the sample and gives an idea about the changes of the leakage current the magnitude over a period of time during the ageing process.

So, these are some of the methods which are being employed for the interpretation of the surface changes on this polymer insulator samples.