Recent Advances in Transmission Insulators

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Module No # 03
Lecture No # 11
Introduction of Hybrid Insulators

Good morning, we have discussed about various options of cleaning and coating of the insulators and new technology that is the hybrid insulator technology is being adopted by the utilities. So we will look into the brief introduction part of this hybrid insulators how this hybrid insulators will be of useful to the utilities. Particularly this hybrid insulators are made in a way to overcome the cleaning and the coating aspects which are earlier ceramic insulators used to be done.

So here the technology is the adoption of both ceramic and polymer material for the existing ceramic post particular the post insulators are being manufactured in the hybrid way. And the room temperature vulcanize coatings which were being done for the ceramic post insulators are being tried out with the hybrid the post insulators.

So we will be looking into the basic introduction into the hybrid insulators how the design aspects and how importance is this technology to be adopted. Presently many manufacturers and utilities are trying to adopt this newer technology.

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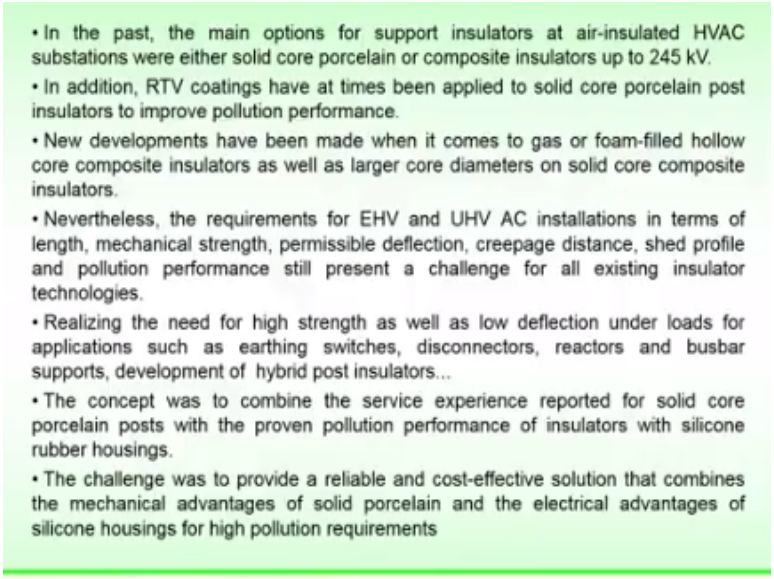

So in the past you know the main options for bus post or a support insulator in substations that is near insulated high voltage AC substations whether either solid core porcelain or composite insulators up to 245 KV. In addition room temperature vulcanized coatings were used at times to the solid core porcelain post insulator mainly to improve the pollution or contamination performance of this over a period of time.

With the new development have been made particular when it comes to the gas or form filled hollow core composite insulators as well as the large diameter or solid core composite insulators. These are generally used in substation and for the equipment and for the distribution component equipment which are (()) (02:59).

So never the less requirement for extra high voltage and dry voltage in installation in terms of length mechanic performance then the creep age distance the shed profile contamination problems performance of this bushings or post insulators still present a challenge for all existing insulator technology either it could be for the porcelain or for polymer technologies. So releasing this need for high strength as well as load reflection under loads for applications such as our things which is disconnections, reactors bus pass support insulators.

So this has given a way for the development of a new type of insulators like the hybrid post insulators and so on which are being used in the high voltage EHP or UHP substations. Here in the hybrid insulator Technology the concept is to combine the service experience which as earlier

reported for solid core for porcelain post with the help of a proven pollution or a contamination performance of insulators with the silicon rubber housings.

So combination of both ceramic post with the Silicon rubber housing could provide newer technology or newer insulator technology where it could be of better help and service performance in the substations. So the challenge was to provide mainly the reliable and also the cost effective solution this combines the mechanical advantages like the solid porcelain and also the electrical advantages of silicon rubber housings or the liquid silicone rubber housings which have planned for high pollution requirements.

So the intention is to see that the adoption of both the technologies porcelain ceramic or the polymer housing for better performance.

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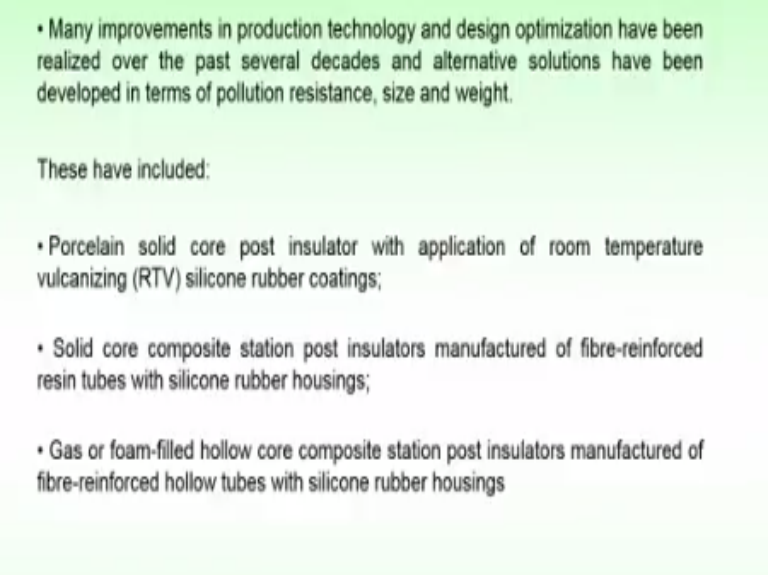

So many efforts were made towards this technology improvement in this technology and also in the production part and design optimization realized over the past several decades and alternative solutions have been tried or have been developed in terms of pollutions resistance the size of the bushings and weight and so on. Here the main technology improvement aspect which have been under gone include the porcelain solid core post insulator with application of room temperature vulcanized silicon rubber coatings for the porcelain post insulators.

The second is solid core composite state insulators manufactured with fiber rein force raise in tubes with silicone rubber housings the first one being the porcelain solid core post insulator. Application of room temperature vulcanized silicon rubber coating the second is solid core composite station post insulator manufactured with the help of fiber train force arising tubes with Silicon housings.

So there is material which is being used to replace the porcelain the third is the gas or foam filled hollow composite station post insulators mainly manufactured of a fiber reinforced hollow tubes with again a silicon rubber housing. So these have been improved on the technology is being tested and it is being used for sometimes.

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- Various developments for larger core diameters on solid core composite support insulators have been made but are limited by the rod production process.
- In practice, solid core composite insulators are applied mainly at system voltages up to 220 kV since they cannot achieve the required cantilever strength and low deflection of porcelain solid core posts.
- Another approach has been hollow core composite posts, with gas or foam filling.
- Besides the complex issues of the behaviour of the filler, this solution also demands very large core diameters to reach a deflection under bending load similar to that provided by a solid core porcelain insulator.
- Hybrid outdoor post insulators offer a solution that combines the advantages of porcelain post insulators and polymeric post insulators, but without their respective disadvantages.
- Such insulators were first developed in the 1970s for application on 25 kV railway catenaries. By definition, these hybrids are insulators made of a ceramic or glass core with a polymeric housing and equipped with one or more metal fittings.
- Therefore, this technology could be applied for post insulators as well as for hollow core and overhead line insulators.

Apart from this various other development for larger core diameter in particular to solid core composite support insulators have also been made. But there are limited but the production by the rod of the rod production process. So in practice or partially solid core composite insulators are mainly applied for a system voltage of 220 kilovolts since they cannot achieve the required cantilever strength.

So this mechanical strength would place a role and also the load reflection of a porcelain solid core post so that is the reason in practice solid core composite insulator are mainly used for 220 Kilovolts. So another approach has been using the hallow core composite or post with gas or foam filling besides the complex issues of the behavior of filler this solutions also demand so

very large core diameters to reach ta deflection under bending load similar to that provided by the solid core porcelain insulators. So mechanical strength is are of most importance of are the long performance so hybrid outdoor post insulators offer a solution that combines the advantages of both porcelain insulators and polymeric or silicon arubber post insulator but without their respective disadvantages.

This is how the hybrid post insulators came into the usage so these insulators here first developed in 70's. So almost 50 years for a application of 25 KV application for 25 KV Railway catenaries so this hybrid technology was tried out for Railways for attraction definition this hybrids or hybrid insulators are made up of ceramic or glass core in the middle with a polymer housing and equip with one or more metal fittings so this for 25KV were developed this were tried for the post insulators and equipment mounting insulators for mounting the equipment in substation.

Therefore this technology is being developed in 1970's could also be applied for post insulators have been minted. This post insulators or as well as the hollow insulators or hallow core insulators and for overhead line insulators are being normally call as long rod insulators. So this has been extended for substation and transmission and also for equipment housing in substations.

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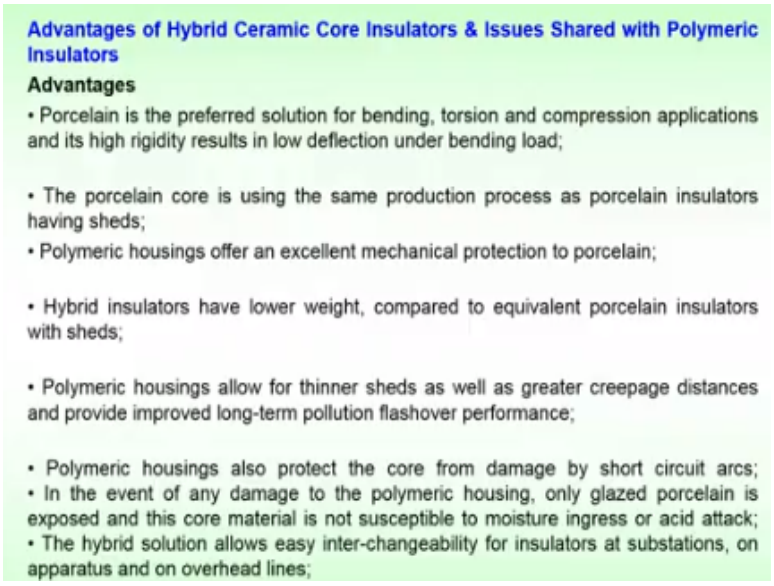

So there are advantages of going in for the hybrid technologies so advantages of this hybrid ceramic core insulators and some issues shared with the polymeric insulators have to be known. So if you are presented here so when you see the advantages porcelain is the prepared solutions

for mechanical bending torsion and compression applications and it is high rigidly results in load deflection and bending load.

A porcelain core is using the same production process as the porcelain insulators having shed then porcelain housings of excellent mechanical production for porcelain polymeric housing sorry. The polymeric housing for excellent mechanical protection to porcelain hybrid insulators because of the combination of both the porcelain and the polymer have lower weight in comparison to equivalent through equivalent porcelain isolators with petticoats or sheds for the crepe age part.

So here again the polymer housings allow for thinner shed as well as greater crepe age distances and provide improved long term pollution and contamination flash over performance. That is one of the reason where even the transmission line insulators that is a ceramic or glass insulators are being replaced by the utilities in the areas where contamination or a pollution blash over is an series issue.

So here also polymer housings have better perform better thinner sheds as compare to porcelain insulators so polymer housings also protect the core from damage by short circuit arcs this is one of the important aspect of polymer housing in case of any even or any damage to the polymer housing only glazed porcelain is exposed and this core material is not susceptible to moisture ingress or acid attack.

So several advantages are being shown here the hybrid solution allow easy interchangeability of insulators and substations on operators and also on forehead lines. So the advantages going in for hybrid solution allows easy interchangeability source replacement of the insulators bushings post insulators hollow core insulators and also on the overhead transmission lines is comparatively easier comparison to the ceramic or a or a glass type of technology that is one of the major advantages going in for hybrid technology ahh.

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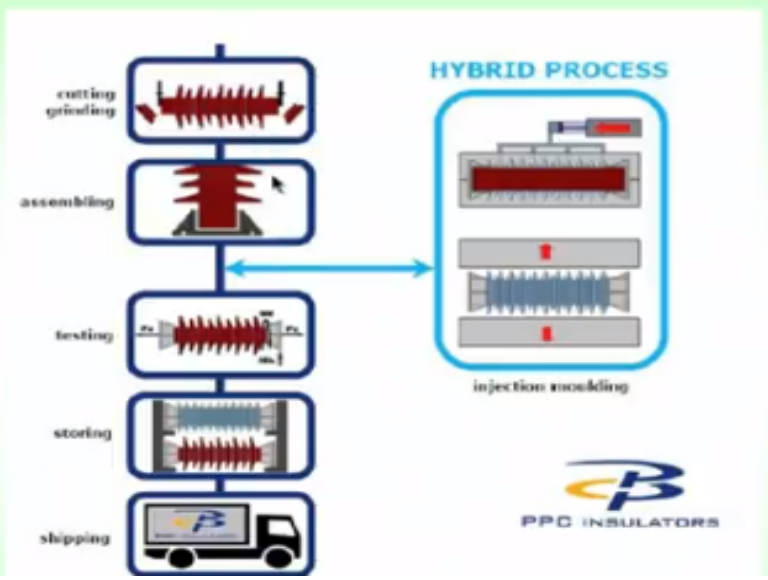

This figure shows the process of manufacturing for a regular post insulators and they the hybrid process here as earlier explained in the ceramic manufacturing ceramic insulator ceramic manufacturing we have discussed about the production aspects the manufacturing aspects of both the disk insulators as well as the post insulators here we briefly look into the process of comparison between the ceramic bushings or ceramic or post insulators mainly and the hybrid process which is involved.

So you can see that for the ceramic process cutting and gridding of this size done for the insulators. We have an assembly for fixing the metal in gaps this is after the initial process of materials making the moulding aspect then again after the firing and several process. So the cutting of the several portion of the insulators is done the metal fixtures are done here with the assembly as shown here then you have the testing of this finished insulators post insulators you can see the metal end fitting both the sides.

So here again the testing electrical testing, mechanical testing as described by the standard or being carried out. Once the equipment undergoes certain prescribed standards which are again routine or acceptance or type testing involving both mechanical electrical test as prescribed for particular voltage level this tested insulators are the lot of insulators to which it is undergone the testing are again stored in a respective crags and these are ship to the required sub stations or the place where is to be installed.

So this is again recap of the porcelain housing or a housing post insulator manufacturing process. So you see the hybrid process it is mainly done with the injection modeling similar to the molding of a polymer insulator and once the injection molding is done the insulators polymer sheds which are being kept from the assembly part the polymer sheds are assembled on the ceramic bushings.

And this under goes the injection up to the injection molding the materials are again tested for various electrical and mechanical aspects and their ship to the necessary place where it is to be installed so after the testing. So this is process for both hybrid as well as porcelain technology where it is being used for hallow core or porcelain insulators.

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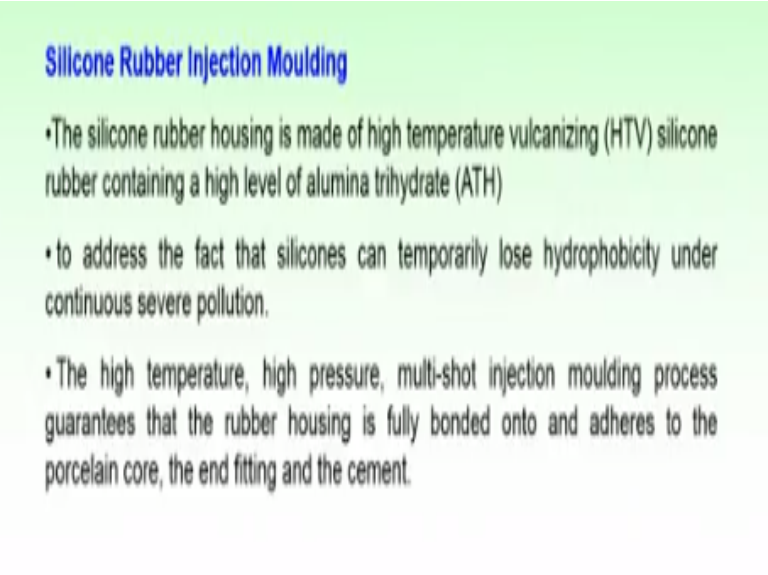

So how this is done silicon rubber injection molding which we have discussed during the manufacturing of polymer insulators here the silicone rubber housing is made of high temperature organized silicon rubber containing level high level of aluminum trihydrate ATH is the filler and silicon rubber. So the ratio of prescribed 50 and 50 + with filler additive filler this housing is made of high temperature vulcanized silicon rubber.

So address the fact that the silicon can temporally use hydro focus under continuous several severe collusions or contamination environment. So the temperature high temperature high pressure multi shot injection molding process which is being done this guarantees that the rubber housing is fully bonded onto the adhere the porcelain course. So as mentioned earlier the core of

the insulators assembly is the porcelain so this core of the insulator inside is the porcelain on that is the polymer is the silicon rubber shed which are embedded on that.

So this high temperature high pressure short injection molding process guarantees rubber housing in full bonded end to end the full porcelain and the end fittings and the cement. Cement again is used for bonding this insulators. Here you can see this cement which is bonding the metal and the housing portion here that is the ceramic housing on both the sides. So it has to bond at the end fitting and see that mechanically it is stable.

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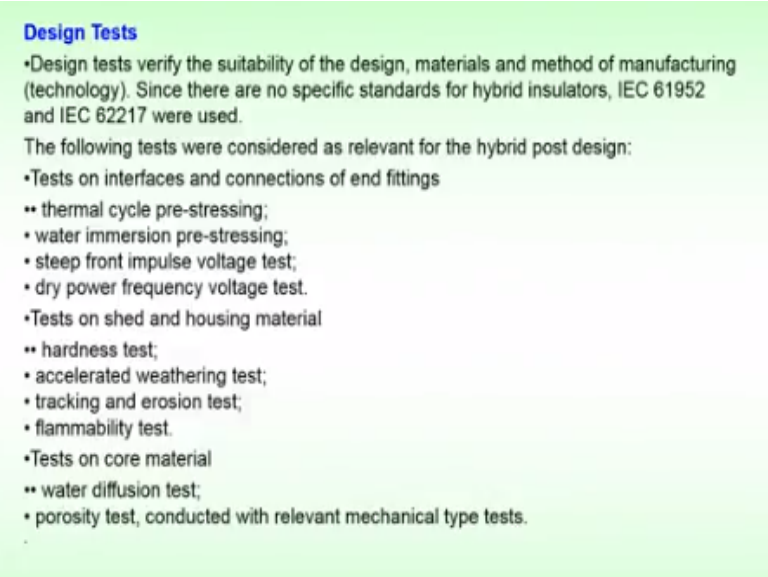

Again here I we will not go into the various test or the design aspects or the testing aspects again this technology being the newer one designed test or basically to verify the suitability of design material and the method of manufacturing. So as mentioned since there are no specific standards for hybrid insulators presently so the I is T61952 and IC62217 are generally followed where the test recommended by this two standard are being used for the hybrid post design.

So test include test on interface and connections of end fitting here again similar to the standards prescribed the thermal a cycle pre-stressing test. Water emersion pre-stressing, steep front impulse voltage test is an electrical test dry power frequency voltage test again it is a with stand test at 50 or 60 hertz. At test on shed and housing materials here are again being the polymer material it has to be tested for hardness accelerated weathering test.

Tracking and erosion of silicon rubber material flammability test and for the core test on the core includes the water diffusion test porosity conducted with relevant mechanical test. So these are some of the design test which with reference to AC61952 and 6227 are generally followed for the hybrid type of insulators.

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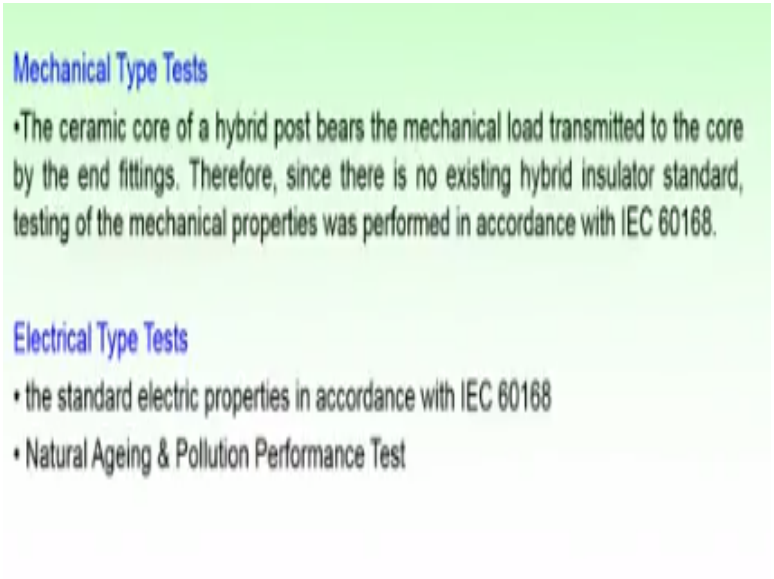

The mechanical test again here the ceramic core of hybrid post bares the mechanical load this is transmitted to the core by the end fittings. So therefore since has been mentioned earlier no existing hybrid insulator standard is available for testing the mechanical properties also. So again here the reference is to IEC 60168 standard which is being used. Similar for electrical type test the standard electrical properties in accordance to the IC60168 are being followed for all the electrical type test on the hybrid insulators.

Likewise natural aging and pollution performance or contamination test as per the standard is referred and for polymer material and for ceramic this test been conducted where rest standard reference to 60168 for both mechanical and electrical test.

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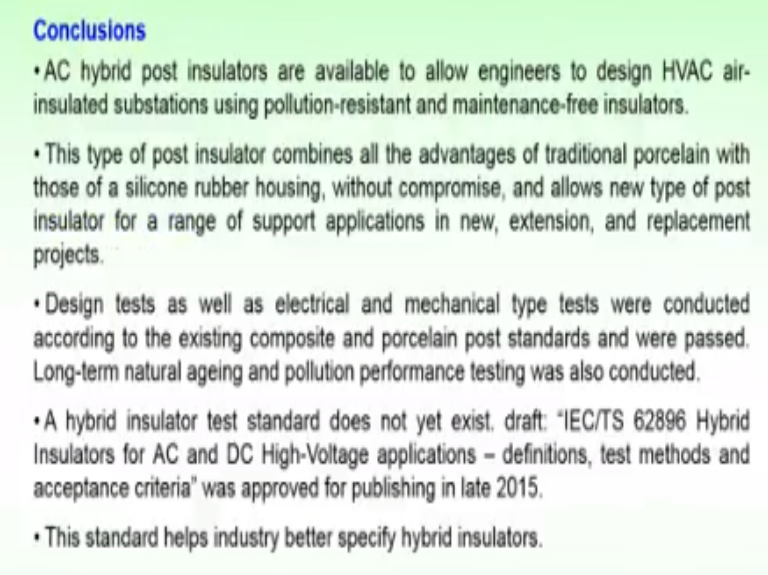

So looking into the hybrid technology the importance of this technology we can have the brief information or difference from the technology which is available here it is understood that for the AC applications AC voltage applications hybrid post insulators are available by which are being manufactured and it allows the engineers to design high voltage AC here insulated sub stations using pollution resistance or contaminated resistance and maintenance free insulators.

This type of post insulators generally combines all the advantages of traditionally ceramic or porcelain insulators with those of silicon rubber housing without any compromise and this technology allows new type of post insulators for a variety of range to support applications in a new extension and inter placement project. So wherever the existing equipment's are this can be placed with the hybrid technology so it allows or it helps in the support of application for the change in replacement projects also.

So the design test has well as the electrical mechanical type test which were conducted according the existing composite and porcelain the ceramic post insulator standards where being used for the present hybrid technology. And for the long term natural aging the contamination performance insulators are also being used with the available standards.

So a hybrid insulator test standard presently does not exist it is in the draft stage where the draft circulation that is IECS 62896 on hybrid insulators both AC and DC high voltage applications which define the definition test methods and acceptance creation etc is being approved for

publishing a soon or this will be used once it is standardized for the hybrid insulators and will be adopted for the testing of hybrid insulators and there is a post insulators which are used in substations and for the equipment's.

So this standards helps industry or to specify the products or the hybrid insulators which are being manufactured both in the country as well as internationally and will be very helpful for the utilities for the reference to this is a general information about the hybrid insulator technology which is being presently coming up using the both ceramic as well as polymer technology which could in future also be extended to many other applications presently it is being used for the substation equipment mountings post insulator and so on.

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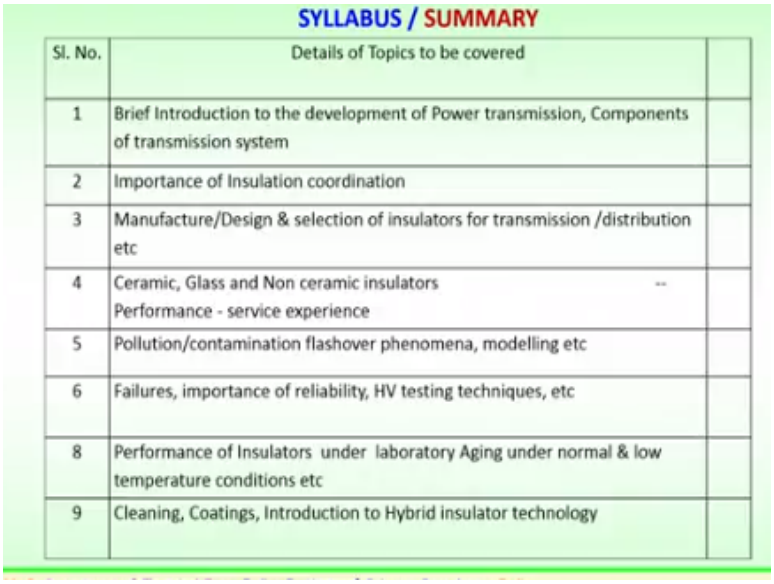

With this the information about basic introducing to hybrid and technology concludes we look into the summary of the entire course contains which have been discussed for this course that is advances in transmission insulators some of the topics covered are being given here.

So we had started the subject with brief introduction or to the development of power transmission which is an important component this gives the information about the present scenario of the power transmission that is both AC and DC transmission what is a present in the country what is the future target which the country is progressing over the power transmission for extra high voltage and ultrahigh voltage transmission.

We looked into the important component of the transmission system which play a vital role and advancement of this component for the extra high voltage and ultrahigh voltage systems. We also discussed about the important of insulation coordination this particularly at extra and ultrahigh voltage conditions. So installation coordination is a important criteria for the designing of lining insulation for the voltages above AHP.

So the important parameter which come into existence the protection and a the safety aspects has been discussed. We also looked and discussed about the manufacturing design or a selection of insulators for transmission and distribution system so when what are the type of insulators are to be used at a location or depending upon the crepe age depending upon the number of insulators and for lightening aspects considering lightning switching and pollution aspects.

How the selection of insulators have to be made for various environment conditions where is polluted locations so this we have tried to discussed we further discussed the importance of ceramic glass polymer insulator in detail where we stressed upon the manufacturing aspects of ceramic glass and porcelain insulators there performance their service experiences how the technology to be adopted and which is the technology to be looked into which is the better technology.

Then we looked into the importance of the problem like contamination or a pollutions this contamination problem which is a very serious threat at working voltages there are point to be noted. So at working voltages above kilo volts the contamination problem plays a major role the design consideration have to be made on the basis of pollution or contamination so at EHO and above 400 that is ultrahigh voltage range 765 KV 800 KV how the contamination flash over happens the basic phenomena of pollution flash over.

How to happens so what are the methods which are being used to tackle this problem the utilities which have been using these methods so various technics which have been evolved over the period and what is the techniques which try to develop at the laboratory level also been discussed we also into the failure in the field importance of reliability of the insulators that is the three technologies and also we looked into importance of high voltage testing's.

And what are the type of test acceptance or routine testing's which are carried out for the insulators the important of this testing of various test methods are to be followed apart from that there are never insulators like polymer insulators where still standard are being evolved. So we also looked and discussed about the probable research activity or the standard which are to be evolved some activity into this aspects and the focus on this has been attempted in the laboratory also been discussed.

Then performance of insulators and your type of test methods and particularly for long performance and again conditions how the insulator perform in the lab laboratory aspects this also have tried to see the again of polymer insulators in the laboratory for the over long period of time both for different condition that is electrical thermal electrical then also multi stress arrangements which are been made like the effect of UV, humidity temperature electrical stress.

So we have tried to look into the effects of this parameters how the insulator perform in the multi stress arrangement or the environment based on some standard criteria how it has been done this also we have tried to look into this aspect both under normal conditions and abnormal conditions like low temperature and so on. Then we discussed the importance of cleaning methods for the insulators for the porcelain ceramic and also glass insulators.

And we discussed about the coatings special coatings for the three technologies ceramic glass and porcelain polymer insulators how the coatings help in the better performance of these insulators in the field. So lot of methods and technic and procedures and various solvents or solutions which are available try to discuss and the importance of this coatings have been listed in the lectures.

Apart from we also discussed about brief introduction about the hybrid technology that is the combination of ceramic and the polymer technology in particular to the substation bushings or the equipment where this housing earlier used to be used. So with the help of the polymer or silicon rubber technology the sheds whether sheds of silicon rubber or polymer material and the core of the material being the ceramic bushings.

So this again one more the improvement like using the liquid silicon rubber is also being done for a high voltage bushing or a post insulator or the follow core insulators at a very high voltage

level so that also be tried to use the silicon rubber material on the ceramic bushing so or on the composite material.

So several of this things have been discussed in this subject hope this lecture will be very useful for the practicing engineers as the students as this technology in the country is being evolved and the important of insulation of a prime importance and design criteria for the insulation is at most importance as the technology even it is evolved for last hundred years the ceramic porcelain the polymer insulated which is being adopted for last say decade or more.

Lot of information lot of studies have to be conducted has this are of your technology and being an organic in nature the polymer insulator or silicon rubber insulators have aster degradation compare to the ceramic or glass. So this lecture feel that some important and useful discussions have been done so finally I thank you all and god bless you thank you.