CAPITAL UNIVERSITY - KODERMA

ELECTRICAL ENGINEERING MATERIAL ASSIGNMENT

Name : Arshad Nazir

Electrical and Electronics Engineering

Signature:

Date :

Q1:

Working Principle of HRC Fuse

In normal conditions, the flow of current through the fuse doesn’t provide sufficient energy to soften the element. If the huge current flows through the fuse then it melts the element of the fuse before the fault current achieves the climax.

When the fuse is in an overload condition, then the element of the fuse will not blow-off however if this condition exists for an extended period, then the material like Eutectic will dissolve & break the element of the fuse. When the fuse is in short circuit condition, then the thin parts of the fuse element is less area will dissolve quickly & will smash before the eutectic material. So this is the reason to provide the limitations within the element of HRC Fuse.

Construction of HRC fuse

The construction of HRC fuse includes a material that has high heat resistant body like ceramic. This ceramic body includes metal-end caps that are welded through an element that carries silver-current.

The internal space of the fuse body is filled by a filling powder material. Here the material used in this is quartz, plaster of Paris, dust, marble, chalk, etc. So this is the reason the flow of current cannot overheat. The generated heat vaporizes the melted element. The chemical reaction will occur between filling power and silver vapor to result in high resistance material to help in reducing the arc within the fuse.

Generally, copper or silver is used as the fuse element because of its low specific resistance. This element has normally two or more sections. The fuse element normally has two or more sections that are connected through tin joints. The melting point of tin is 2400 degree C that is lesser than silver’s melting point of 980 degree C. Thus the melting point of tin joints stops the fuse from getting high temperatures in the short circuit and overload conditions.

Q2:

i) The commutator is made of copper segments insulated from each other by mica sheets and mounted on the shaft of the machine.

ii) In most types of transformer construction, the central iron core is constructed from of a highly permeable material commonly made from thin silicon steel laminations. These thin laminations are assembled together to provide the required magnetic path with the minimum of magnetic losses.

iii) The outer frame of a dc machine is called a yoke. It is made up of cast iron or steel. In small DC machines, it is made up of cast iron and in the case of large DC machines, it is made up of cast steel.

iv) Armature wiring is made from copper or aluminum. Copper armature wiring enhances electrical efficiencies due to its higher electrical conductivity. Whenever current is supplied through field winding than it electromagnetics the poles which generate required flux. The material used for field windings is copper.

Q4:

Properties of steel

The density of steel varies based on the alloying constituents but usually ranges between 7,750 and 8,050 kg/m3 (484 and 503 lb/cu ft), or 7.75 and 8.05 g/cm3 (4.48 and 4.65 oz/cu in).

Even in a narrow range of concentrations of mixtures of carbon and iron that make steel, several different metallurgical structures, with very different properties can form. Understanding such properties is essential to making quality steel. At room temperature, the most stable form of pure iron is the body-centered cubic (BCC) structure called alpha iron or α-iron. It is a fairly soft metal that can dissolve only a small concentration of carbon, no more than 0.005% at 0 °C (32 °F) and 0.021 wt% at 723 °C (1,333 °F). The inclusion of carbon in alpha iron is called ferrite. At 910 °C, pure iron transforms into a face-centered cubic (FCC) structure, called gamma iron or γ-iron. The inclusion of carbon in gamma iron is called austenite. The more open FCC structure of austenite can dissolve considerably more carbon, as much as 2.1% (38 times that of ferrite) carbon at 1,148 °C (2,098 °F), which reflects the upper carbon content of steel, beyond which is cast iron. When carbon moves out of solution with iron, it forms a very hard, but brittle material called cementite (Fe_3C).

When steels with exactly 0.8% carbon (known as a eutectoid steel), are cooled, the austenitic phase (FCC) of the mixture attempts to revert to the ferrite phase (BCC). The carbon no longer fits within the FCC austenite structure, resulting in an excess of carbon. One way for carbon to leave the austenite is for it to precipitate out of solution as cementite, leaving behind a surrounding phase of BCC iron called ferrite with a small percentage of carbon in solution. The two, ferrite and cementite, precipitate simultaneously producing a layered structure called pearlite, named for its resemblance to mother of pearl. In a hypereutectoid composition (greater than 0.8% carbon), the carbon will first precipitate out as large inclusions of cementite at the austenite grain boundaries until the percentage of carbon in the grains has decreased to the eutectoid composition (0.8% carbon), at which point the pearlite structure forms. For steels that have less than 0.8% carbon (hypoeutectoid), ferrite will first form within the grains until the remaining composition rises to 0.8% of carbon, at which point the pearlite structure will form. No large inclusions of cementite will form at the boundaries in hypoeuctoid steel. The above assumes that the cooling process is very slow, allowing enough time for the carbon to migrate.

As the rate of cooling is increased the carbon will have less time to migrate to form carbide at the grain boundaries but will have increasingly large amounts of pearlite of a finer and finer structure within the grains; hence the carbide is more widely dispersed and acts to prevent slip of defects within those grains, resulting in hardening of the steel. At the very high cooling rates produced by quenching, the carbon has no time to migrate but is locked within the face-centered austenite and forms martensite. Martensite is a highly strained and stressed, supersaturated form of carbon and iron and is exceedingly hard but brittle. Depending on the carbon content, the martensitic phase takes different forms. Below 0.2% carbon, it takes on a ferrite BCC crystal form, but at higher carbon content it takes a body-centered tetragonal(BCT) structure. There is no thermal activation energy for the transformation from austenite to martensite. Moreover, there is no compositional change so the atoms generally retain their same neighbors.Marten site has a lower density than does austenite, so that the transformation between them results in a change of volume. In this case, expansion occurs. Internal stresses from this expansion generally take the form of compression on the crystals of marten site and tension on the remaining ferrite, with a fair amount of shear on both constituents. If quenching is done improperly, the internal stresses can cause a part to shatter as it cools. At the very least, they cause internal work hardening and other microscopic imperfections. It is common for quench cracks to form when steel is water quenched, although they may not always be visible.

Applications of steel

Iron and steel are used widely in the construction of roads, railways, other infrastructure, appliances, and buildings. Most large modern structures, such as stadiums and skyscrapers, bridges, and airports, are supported by a steel skeleton. Even those with a concrete structure employ steel for reinforcing. In addition, it sees widespread use in major appliances and cars. Despite the growth in usage of aluminium, it is still the main material for car bodies. Steel is used in a variety of other construction materials, such as bolts, nails and screws and other household products and cooking utensils.

Properties of PVC

PVC is a thermoplastic polymer. Its properties are usually categorized based on rigid and flexible PVCs.

Mechanical

PVC has high hardness and mechanical properties. The mechanical properties enhance with the molecular weight increasing but decrease with the temperature increasing. The mechanical properties of rigid PVC (uPVC) are very good; the elastic modulus can reach 1500–3,000 MPa. The soft PVC (flexible PVC) elastic limit is 1.5–15 MPa.

Thermal and fire

The heat stability of raw PVC is very poor, so the addition of a heat stabilizer during the process is necessary in order to ensure the product's properties. Traditional product PVC has a maximum operating temperature around 60 °C (140 °F) when heat distortion begins to occur. Melting temperatures range from 100 °C (212 °F) to 260 °C (500 °F) depending upon manufacture additives to the PVC. The linear expansion coefficient of rigid PVC is small and has good flame retardancy, the limiting oxygen index (LOI) being up to 45 or more. The LOI is the minimum concentration of oxygen, expressed as a percentage, that will support combustion of a polymer and noting that air has 20% content of oxygen.

As a thermoplastic, PVC has an inherent insulation that aids in reducing condensation formation and resisting internal temperature changes for hot and cold liquids.

Electrical

PVC is a polymer with good insulation properties, but because of its higher polar nature the electrical insulating property is inferior to non-polar polymers such as polyethylene and polypropylene.

Since the dielectric constant, dielectric loss tangent value, and volume resistivity are high, the corona resistance is not very good, and it is generally suitable for medium or low voltage and low frequency insulation materials.

Chemical

PVC is chemically resistant to acids, salts, bases, fats, and alcohols, making it resistant to the corrosive effects of sewage, which is why it is so extensively utilized in sewer piping systems. It is also resistant to some solvents, this, however, is reserved mainly for uPVC (unplasticized PVC). Plasticized PVC, also known as PVC-P, is in some cases less resistant to solvents.

Applications of PVC

Pipes

Roughly half of the world’s PVC resin manufactured annually is used for producing pipes for municipal and industrial applications.

Electric cables

PVC is commonly used as the insulation on electrical cables such as teck; PVC used for this purpose needs to be plasticized.

PVC fabric is water-resistant, used for its weather-resistant qualities in coats, skiing equipment, shoes, jackets, aprons, patches and sports bags.

PVC fabric has a niche role in speciality clothing, either to create an artificial leather material or at times simply for its effect. PVC clothing is common in Goth, Punk, clothing fetish and alternative fashions. PVC is less expensive than rubber, leather or latex, which it is used to simulate.

Q6:

i) N type semiconductor

N-type semiconductors are created by doping an intrinsic semiconductor with an electron donor element during manufacture. The term n-type comes from the negative charge of the electron. In n-type semiconductors, electrons are the majority carriers and holes are the minority carriers. A common dopant for n-type silicon is phosphorus or arsenic. In an n-type semiconductor, the Fermi level is greater than that of the intrinsic semiconductor and lies closer to the conduction band than the valence band.

ii) P type Semiconductor

P-type semiconductors are created by doping an intrinsic semiconductor with an electron acceptor element during manufacture. The term p-type refers to the positive charge of a hole. As opposed to n-type semiconductors, p-type semiconductors have a larger hole concentration than electron concentration. In p-type semiconductors, holes are the majority carriers and electrons are the minority carriers. A common p-type dopant for silicon is boron or gallium. For p-type semiconductors the Fermi level is below the intrinsic semiconductor and lies closer to the valence band than the conduction band.

Q7:

i)The properties of the glass insulator are

- Dielectric Strength: The approximate value of dielectric strength is 140 kV/cm.
- Compressive Strength: The approximate value of compressive strength is 10,000 Kg/cm^2.

- Tensile Strength: The approximate value of tensile strength is 35,000 Kg/cm^2.

Applications

Glass is a thermal insulation material consisting of intertwined and flexible glass fibers, which causes it to "package" air, resulting in a low density that can be varied through compression and binder content (as noted above, these air cells are the actual insulators.glass wool can be a loose-fill material, blown into attics, or together with an active binder, sprayed on the underside of structures, sheets, and panels that can be used to insulate flat surfaces such as cavity wall insulation, ceiling tiles, curtain walls, and ducting. It is also used to insulate piping and for sound proofing.

ii)Properties of ceramics

High hardness

High melting point

Good Thermal insulator

Highly electricity resistance

Low mass density

Generally, chemically inert

Brittle in nature

Zero ductility

Low tensile strength

Applications of ceramics

They are used in space industry because of their low weight.

They are used as cutting tools.

They are used as refractory materials.

They are used as thermal insulator.

They are used as electrical insulator.

iii) Properties of Mica

These sheets are chemically inert, dielectric, elastic, flexible, hydrophilic, insulating, lightweight, platy, reflective, refractive, resilient, and range in opacity from transparent to opaque. Mica is stable when exposed to electricity, light, moisture, and extreme temperatures. It has superior electrical properties as an insulator and as a dielectric, and can support an electrostatic field while dissipating minimal energy in the form of heat; it can be split very thin (0.025 to 0.125 millimeters or thinner) while maintaining its electrical properties, has a high dielectric breakdown, is thermally stable to 500 °C (932 °F), and is resistant to corona discharge. Muscovite, the principal mica used by the electrical industry, is used in capacitors that are ideal for high frequency and radio frequency. Phlogopite mica remains stable at higher temperatures (to 900 °C (1,650 °F)) and is used in applications in which a combination of high-heat stability and electrical properties is required. Muscovite and phlogopite are used in sheet and ground forms.

Applications of mica

It is used in paints as a pigment extender and also helps to brighten the tone of colored pigments.

In the electrical industry the same as thermal insulation, and electrical insulators in electronic equipment.

Its shiny and glittery appearance makes it ultimate for toothpaste and cosmetics.

iv) Properties of Asbestos

Asbestos fibres tend to possess good strength properties (e.g. high tensile strength, wear and friction characteristics); flexibility (e.g. the ability to be woven); excellent thermal properties (e.g. heat stability; thermal, electrical and acoustic insulation); adsorption capacity; and, resistance to chemical, thermal.

Applications of Asbestos

Asbestos has been used in roofing, thermal and electrical insulation, cement pipe and sheets, flooring, gaskets, friction materials, coatings, plastics, textiles, paper, and other products.

Q8 :

Materials having high resistivity or low conductivity are very useful for some electrical engineering products and applications. These material are used to manufacture the filaments for incandescent lamp, heating elements for electric heaters and furnaces, space heaters and electric irons etc.

Some of Materials having High Resistivity or Low Conductivity are listed below.

Tungsten

Carbon

Nichrome or Brightray B

Nichrome V or Brightray C

Manganin

Tungsten

Tungsten is produced by very complicated processes from rare ores or from tungstic acids. Some facts about tungsten are listed below-

Very hard.

Resistivity is twice to aluminum.

High tensile strength.

Can be drawn in the form of very thin wire.

Oxidize very quickly in the presence of oxygen.

Can be used up to 2000oC in the atmosphere of inert gases (Nitrogen, Argon etc.) without oxidation.

Properties of Tungsten

Properties of tungsten are listed below

Specific weight : 20 gm/cm3

Resistivity : 5.28 μΩ -cm

Temperature coefficient of resistance : 0.005 / oC

Melting point : 3410oC

Boiling point : 5900oC

Thermal coefficient of expansion: 4.44 × 10-9 / oC

Uses of Tungsten

- Used as filament for incandescent lamp.
- As electrode in X- ray tubes.
- The great hardness, high melting and boiling points make it suitable for use as electrical contact material in certain applications. It is having high resistance for destructive forces produces during operation of electrical contacts.

Q9 :

Dielectric loss quantifies a dielectric material's inherent dissipation of electromagnetic energy (e.g. heat). It can be parameterized in terms of either the loss angle δ or the corresponding loss tangent tan δ. Both refer to the phasor in the complex plane whose real and imaginary parts are the resistive (lossy) component of an electromagnetic field and its reactive (lossless) counterpart.

Dielectric Loss Angle

The phase difference between the electric field vector and the electric displacement in a dielectric material. This phase difference is caused by energy losses in the dielectric.

Q10 :

Curie point, also called Curie Temperature, temperature at which certain magnetic materials undergo a sharp change in their magnetic properties. In the case of rocks and minerals, remanent magnetism appears below the Curie point—about 570 °C (1,060 °F) for the common magnetic mineral magnetite.

Retentivity: A measure of the residual flux density corresponding to the saturation induction of a magnetic material. In other words, it is a material’s ability to retain a certain amount of magnetization when the magnetizing field is removed after achieving saturation.

Q11 :

Resistance is defined as the opposition to the flow of electrical current through a conductor. The resistance of an electric circuit can be measured numerically.

The resistance of a conductor depends on the cross sectional area of the conductor, the length of the conductor, and its resistivity. It is important to note that electrical conductivity and resistivity are inversely proportional, meaning that the more conductive something is the less resistive it is.

The effect of temperature on the resistance of the conductor is directly proportional to each other. The increase in temperature of the conductor increases its resistance and makes it difficult to flow current through it.Hence the increase in the temperature of the conductor increases resistance in the conductor.

Q12 :

12a)

The induction motor consists stator frame stator core rotor

The stator frame consists of Lamination of silicon steel, usually with a thickness of about 0.5 millimetre. Lamination is necessary since a voltage is induced along the axial length of the steel as well as in the stator conductors. The laminations are insulated from each other usually by a varnish layer. This breaks up the conducting path in the steel and limits the losses (known asEddy current losses) in the steel.

The stator coils are normally made ofCopper; round conductors of many turns per coil are used for small motors, and rectangular bars of fewer turns are employed for larger machines. The coils are electrically insulated. It is common practice to bring only three leads out to a terminal block whether the winding is connected in wye or in delta.

The magnetic part of the rotor is also made of steel laminations, mainly to stamping conductor slots of the desired shape and size. In most induction motors, the rotor winding is of the Squirrel-cage type where solid conductors in the slots are shorted together at each end of the rotor iron by conducting end rings. In such machines there is no need to insulate the conductors from the iron. For motors up to about 300 kilowatts, the squirrel cage often consists of an aluminum casting incorporating the conductors, the end rings, and a cooling fan. For larger motors, the squirrel cage is made of copper, aluminum, or brass bars welded or brazed to end rings of a similar material. In any case, the rotor is very rugged and is also economical to produce in contrast to rotors requiring electrically insulated windings.

12b)

Stator Frame

The stator frame is the outer part of the machine and is made up of cast iron. It protects the enter inner parts of the machine.

Stator Core

The stator core is made up of thin silicon laminations. It is insulated by a surface coating to minimize hysteresis and eddy current losses. Its main purpose is to provide a path of low reluctance for the magnetic lines of force and accommodate the stator windings.

Stator Winding

Enamelled copper is used as the winding material. In the case of 3 phase windings, the windings are distributed over several slots. This is done to produce a sinusoidal distribution of EMF.

Rotor Synchronous Motor

The salient pole type rotor consists of poles projecting out from the rotor surface. It is made up of steel laminations to reduce eddy current losses.

A cylindrical rotor is made from solid forgings of high-grade nickel chrome molybdenum steel forgings of high-grade nickel chrome molybdenum motor.

Q13 :

Mechanical properties

Density – Electrical insulations are used on the basis of their volume and not weight. Insulating materials of low density are mainly suitable for small portable equipment and aircraft components.

Viscosity – This property is important in case of liquid dielectrics. Uniform viscosity leads to uniform electrical and thermal properties.

Moisture absorption – Water lowers the electrical resistance and also its dielectric strength. With its absorption properties, certain chemical and mechanical effects such as swelling and warping the corrosion may result.

Hardness of surface – Hardness of surface helps the dielectric to resist surface scratching and abrasion while lower surface resistivity permits irregular moisture films to form and also contribute to corona and other surface deteriorating effects. Roughness of surface is objectionable.

Surface tension – In liquid dielectrics, we prefer to have low surface tension as it causes greater wetting of the electrical components and thus gives better cooling, impregnation and greater voltage uniformity, to make an improvement to this property, we can add some wetting agent.

Uniformity – Dielectric should be uniform throughout as it keeps the electrical losses as low as possible and the electric stresses uniform under high voltage differences. In case of solid insulators, tensile strength, compressive strength, shear strength, bending strength and impact strength are of importance. Machinability and resistance to splitting are also of great importance. In addition to this, there are certain other mechanical properties uniquely important to varnish products.

Physical properties

Property 1: In an insulator, the valence electrons are tightly held together. They do not have free electrons to conduct electricity.

Property 2: The ability of the material to not allow the electric current to pass through it is called electrical resistance. The resistance of an insulator per unit cross-sectional area per unit length is called resistivity. Insulators have very high resistivity. For example, insulators like glass have a resistivity value as high as 1012 Ωm. The resistance of the insulator is considerably reduced in the presence of moisture and when there is an increase in temperature.

Property 3: Insulators have large dielectric strength. The dielectric strength is the maximum electric field that the insulator can withstand without undergoing electrical breakdown and becoming electrically conductive.

Property 4: Good insulators have a high air permeability (the ability of the material to allow air to flow through its pores) since air itself is an insulator.

Q14 :

The thermocouple can be defined as a kind of temperature sensor that is used to measure the temperature at one specific point in the form of the EMF or an electric current. This sensor comprises two dissimilar metal wires that are connected together at one junction. The temperature can be measured at this junction, and the change in temperature of the metal wire stimulates the voltages.

The amount of EMF generated in the device is very minute (millivolts), so very sensitive devices must be utilized for calculating the e.m.f produced in the circuit. The common devices used to calculate the e.m.f are voltage balancing potentiometer and the ordinary galvanometer. From these two, a balancing potentiometer is utilized physically or mechanically.

Thermocouple Working Principle

The thermocouple principle mainly depends on the three effects namely Seebeck, Peltier, and Thompson.

See beck-effect

This type of effect occurs among two dissimilar metals. When the heat offers to any one of the metal wires, then the flow of electrons supplies from hot metal wire to cold metal wire. Therefore, direct current stimulates the circuit.

Peltier-effect

This Peltier effect is opposite to the Seebeck effect. This effect states that the difference of the temperature can be formed among any two dissimilar conductors by applying the potential variation among them.

Thompson-effect

This effect states that as two disparate metals fix together & if they form two joints then the voltage induces the total conductor's length due to the gradient of temperature. This is a physical word that demonstrates the change in rate and direction of temperature at an exact position.

Construction of Thermocouple

The construction of the device is shown below. It comprises two different metal wires and that are connected together at the junction end. The junction thinks as the measuring end. The end of the junction is classified into three type's namely ungrounded, grounded, and exposed junction.

Ungrounded-Junction

In this type of junction, the conductors are totally separated from the protecting cover. The applications of this junction mainly include high-pressure application works. The main benefit of using this function is to decrease the stray magnetic field effect.

Grounded-Junction

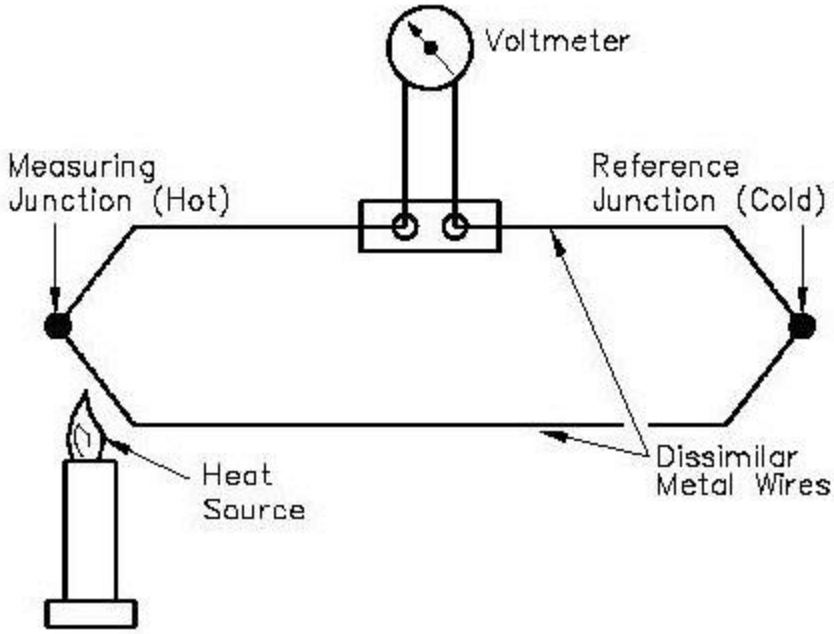
In this type of junction, the metal wires, as well as the protection cover, are connected together. This function is used to measure the temperature in the acidic atmosphere, and it supplies resistance to the noise.

Exposed-Junction

The exposed junction is applicable in the areas where a quick response is required. This type of junction is used to measure the gas temperature. The metal used to make the temperature sensor basically depends on the calculating range of temperature.

Generally, a thermocouple is designed with two different metal wires namely iron and constantan that makes in detecting element by connecting at one junction that is named as a hot junction. This consist of two junctions, one junction is connected by a voltmeter or transmitter where the cold junction and the second junction is associated in a process that is called a hot junction.

The thermocouple diagram is shown in the below picture. This circuit can be built with two different metals, and they are coupled together by generating two junctions. The two metals are surrounded by the connection through welding.



In the above diagram, the junctions are denoted by P & Q, and the temperatures are denoted by T1, & T2. When the temperature of the junction is dissimilar from each other, then the electromagnetic force generates in the circuit.

If the temperate at the junction end turn into equivalent, then the equivalent, as well as reverse electromagnetic force, produces in the circuit, and there is no flow of current through it. Similarly, the temperature at the junction end becomes imbalanced, then the potential variation induces in this circuit.

The magnitude of the electromagnetic force induces in the circuit relies on the sorts of material utilized for thermocouple making. The entire flow of current throughout the circuit is calculated by the measuring tools.

Applications

Some of the applications of thermocouples include the following.

These are used as the temperature sensors in thermostats in offices, homes, offices & businesses.

These are used in industries for monitoring temperatures of metals in iron, aluminum, and metal.

These are used in the food industry for cryogenic and Low-temperature applications. Thermocouples are used as heat pumps for performing thermoelectric cooling.

These are used to test temperature in chemical plants, petroleum plants.

These are used in gas machines for detecting the pilot flame.

Q15 :

The effect of temperature

The operating temperature of a power device varies with the surrounding environment, and its insulation resistance also varies with temperature. In general, the insulation resistance decreases as the temperature increases. The reason is that when the temperature rises, the ions and molecular motion inside the insulating medium are intensified, and the moisture in the insulator and the impurities and salts contained therein also diffuse, which leads to an increase in conductance and a decrease in insulation resistance. This is not the same as the resistance of the conductor as a function of temperature. Different electrical equipment and electrical equipment made of different materials have different insulation resistances with temperature, and it is difficult for on-site children to ensure that they are carried out at a completely similar temperature. In order to compare the test results, the relevant units have given some temperature conversion factors for the equipment. However, due to the obsolescence of the equipment, the degree of drying, and the temperature measurement methods used, there are many influencing factors, and it is difficult to obtain an accurate conversion factor. Therefore, when actually measuring the insulation resistance, the test temperature (ambient temperature and equipment body temperature) must be recorded, and measurements should be made at similar temperatures as much as possible to avoid errors caused by temperature conversion.

Humidity and effects of surface contamination of electrical equipment

The change of the ambient humidity around the power equipment and the surface contamination caused by the air pollution have a great influence on the insulation resistance. When the relative humidity of the air increases, a large amount of moisture is adsorbed on the surface of the insulator, so that the surface conductivity increases and the insulation resistance decreases. When the surface of the insulator forms a continuous water film, the insulation resistance is lower. According to the above two conditions, when measuring the insulation resistance on site, the shielding ring must be used to eliminate the influence of surface leakage current or to dry and clean the surface of the equipment to obtain the true measured value.

Q16 :

Impregnation is the process of closing and sealing the voids between wires in a component such as an electric drive motor with an insulating material.

The primary function of impregnating materials is to protect electrical machines from insulation failure. They protect windings against electrical, mechanical, thermal, chemical and environmental stress.

Q17 :

Soft magnetic

The soft magnetic materials can be simply magnetised and demagnetised. This is because only small energy is needed for the same. These materials have coercive field very small which is less than 1000A/m.

The domain growth of these materials can be easily realised. They are mainly used to increase the flux or/and to make a way for the flux created by the electric current. The main parameters used to worth or consider the soft magnetic materials are permeability (used to determine how a material reacts to the applied magnetic field), Coercive force (which already discussed), electrical conductivity (the capability of the substance to conduct electric current) and saturation magnetization (utmost quantity of magnetic field that a material can generate).

Properties of Soft Magnetic Materials

Utmost permeability.

Slight coercive force.

Small hysteresis loss.

Small remanent induction.

High saturation magnetisation

Some of the significant soft magnetic materials are the following:

Pure Iron

Pure iron contain a very minute carbon content (> 0.1%). This material can be refined to get the utmost permeability and less coercive force with the help of suitable technique to make it a soft magnetic material. But it produces eddy current loss when subjected to very high flux density due to low resistivity. So, it is used in low frequency application such as components for electrical instruments and core in electromagnet.

Hard magnetic

These materials are really hard in the basis that it is very difficult to get magnetised. The reason is that the domain walls are motionless owing to crystal defects and imperfections.

But if it gets magnetised, it will be permanently magnetised. That is why; it is also called as permanent magnetic material. They have coercive force greater than 10kA/m and have high retentivity. When we expose a hard magnet to an external magnetic field for the first time, the domain grows and rotates to align with the applied field at the saturation magnetization. After that, the field is removed. As a result, the magnetization is somewhat reverted but it does not track the magnetization curve any longer. A certain amount of energy (Br) is stored in the magnet and it becomes permanently magnetized.

Properties of Hard Magnetic Materials

Utmost retentivity and coercivity.

Value of energy product (BH) will be large.

The shape of BH loop is nearly rectangle.

High hysteresis loop.

Small initial permeability.

Some important hard magnetic materials are the following:

The carbon steel have large hysteresis loop. Due to any shock or vibration, they lose their magnetic properties rapidly. But tungsten steel, chromium steel and cobalt steel have high energy product.

Q19 :

Varnish coating, also termed as Secondary Insulation, is a significant component of the insulation system of an electrical machine. Varnishes, of dissimilar types are employed in the insulation system of electrical machines for the reason of impregnation and finishing applications.

Benefits of these coatings are as follow:

1. Greater mechanical bonding to the winding wires
2. Enhanced dielectric properties
3. Enhanced thermal conductivity
4. Protection to the winding in opposition to moisture and chemically corrosive environment.

Varnishes are categorized based on:

A. Applications of varnish.
B. Type of (varnish) curing method.
C. Based on main raw material used in varnish.

Insulating varnish derived from applications:

I. Impregnating varnishes.

II. Finishing varnishes.

III. Core plate varnishes.

IV. Bonding varnishes.

V. Special purpose varnishes.

Insulating varnish derived from Curing method:

I. Air drying type

II. Oven baking type

Major raw material that are employed: Epoxy ester Melamine, Polyester mide, Alkyd Phenolic, Alkyd, Modified polyester, Epoxy, Polyurethane,Isophthalic Alkyd, Phenolic, Phenolic Melamine – based. The above described varnishes arrives Solvent based and Solvent-less based.

Method of applying varnish:

1. Applying a coating with a paint brush.
2. Dipping the specimen into varnish.

3. Vacuum pressure method.

Conveyorised dip method.

Q20 :

Low resistivity is a material intrinsic property which readily allows the movement of electrons. Conversely, a high-resistivity material has a high electrical resistance and impedes the flow of electrons. Elements such as copper and aluminum are known for their low levels of resistivity.

Copper and Aluminium have low resistivity. Good conductors have less resistivity. Insulators have a high resistivity. The resistivity of semiconductors lies between conductors and insulators. Gold is a good conductor of electricity and so it has low resistivity.

The Physical Properties of Aluminum

Color and State: Solid, nonmagnetic, non-lustrous, silvery-white with slight bluish tint.

Conductivity:Good electrical and thermal conductor.

Corrosion: Aluminium is corrosive resistant due to a self-protecting oxide layer.

Aluminium is used in a huge variety of products including cans, foils, kitchen utensils, window frames, beer kegs and aeroplane parts. Aluminium is a good electrical conductor and is often used in electrical transmission lines.