EIU 105 – Types of Non-Electrical Insulation Materials

Section 1 – General Description

1.1 The categories and terms used in this general category are used in reference to Electrical Insulation Barrier and Electrical Insulation Systems (EIS) only. This general category of materials is not used to imply or refer to the value, benefit or actual purpose of the use of any materials in the end-product. The category of non-electrical insulating materials refers to any material needed for a properly operating end-product but not selected to function as a major electrical insulation barrier. These materials are selected for physical properties, environmental seal, sound quieting or one of many other non-electrical insulation purposes.

Section 2 – Other Materials Needed for Manufacturing

2.1 Minor Materials / Minor Insulation / Minor Components

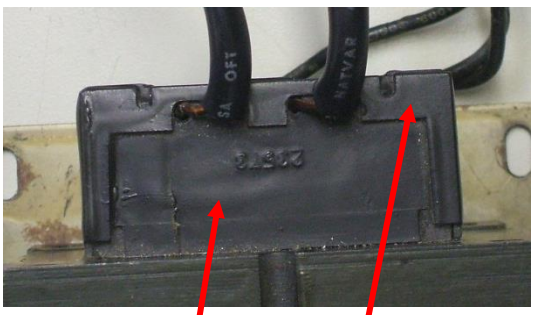
These three terms are interchangeable. These labels refer to any material which is used or needed in construction of an end-product; however, the selection and use of the material is not to be a primary electrical insulation barrier. Any minor insulation material selected for use in an end-product can and should be expected to add to the total insulation. However, the end-product is to have a complete insulation system even if any or all of the minor insulation materials are removed or not used at all.

With respect to the EIS, minor materials/components need to be evaluated for compatibility with the EIS before being used by the end-product manufacturer. There are many types of compatibility test. The appropriate compatibility test is selected based on the application.

Compatibility tests are covered in more detail in a separate class.

2.2 Types of, Examples of, Minor Materials (Components)

2.2.1 Potting Compounds are not the same as encapsulants. Potting compounds are resins which are similar to encapsulant in terms of processing the material in a mold or housing, but for a potting compound, the mold or housing remains in place. The potting compound is not expected to be the only material used to hold the coil(s) in a protected enclosure.



Potting compound in Housing

Potting compounds are most commonly used for dissipation of heat or for reduction of sound. When used for dissipation of heat, the potting compound is expected to have a high level of a filler. (The roll of fillers is covered in a separate class.)

When the application is for reduction of sound, the resin is expected to have good adhesion to all components in the end-project. It is expected to bond to the wire insulation, the walls of the housing, tapes, bobbins and all other individual material the compounds directly contacts.

Some designs use a resin, usually an injection molding resin, with a metal enclosure for the insulation. When there is another electrical insulation material included in the process, the resin is correctly identified as a potting compound. When the resin is the only material separating the windings from the metal, the application is correctly identified as an encapsulation process and is explained in EIU 104 Class 1.

There are no formal test methods to establish thermal class ratings for potting compounds.

2.2.2 Core tube for mechanical support only

A core tube is a formed component made by rolling a film, paper, or composite into a shape that can be placed between the windings and the metal core stack. The film, paper, or composite is usually processed with some type of binding resin, but other methods of binding the layers are possible.

Core Tubes

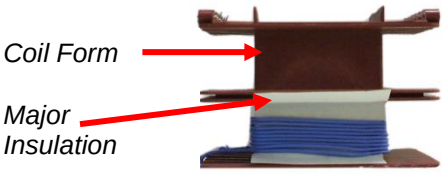
The phrase “for mechanical support only” refers to the fact that the material used to make the core tube is not one that has been documented to be able to function as an EIM or major insulation material. For insurance of safety, any material in this category should not be used without at least one of the major insulation materials being placed between the core tube and the windings.

2.2.3 Coil form (bobbin) for mechanical support only

A coil form is a component used in the same manner as a core tube. The difference between a coil form and a core tube is the process by which it is manufactured. A coil form is expected to be made with an injection molding resin or thermal set resin. The word *bobbin* is simply another word meaning *coil form*.

Coil Form (Bobbin)

The phrase “for mechanical support only” has the same meaning as presented in the above section.



Coil Form (bobbin) with Major Insulation between Winding Wire and Coil Form

2.2.4 Sleeving / Tubing

Sleeving

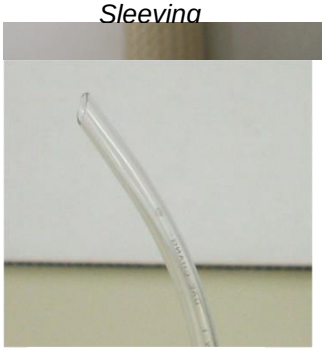
Sleeving and tubing has the same application purpose. Both are of a tube construction that can be placed over a splice or junction of two of more bared conductors to help re-insulate the conductors or to isolate the bared conductors.

Sleeving is the proper word when the construction consists of fibers being interwoven to make the product. While glass fibers can be the only material used in the construction, most grades of sleeving include a resin.

The basic construction is Heat Treated Glass [fiberglass].
The three most common types of resins used for sleevings are

- Vinyl [PVC]
- Acrylic
- Silicone

Other resins can be used, with flexibility being a significant factor in the selection of the resin.



Tubing

Tubing is made without fibers. Tubing consists of a resin only. One of the most popular is heat shrinkable tubing, which can be used to secure the conductors after processing. The most common chemistry used for this type of tubing is a PET material.

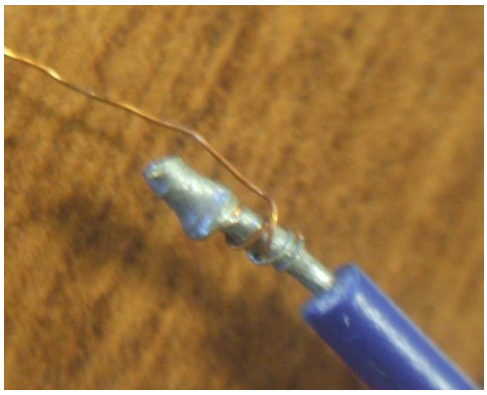
2.2.5 Connecting Cables / Lead Wires

Lead wire is also referred to as connecting wire or connecting cables. The function is to connect between the wire used to make the coils and an external connection such as a switch or power source.

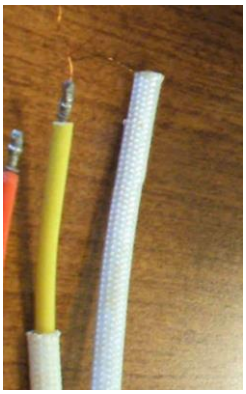
A simple description of lead wires is to describe them as sleeving or tubing with the conductor already inserted. A lead wire is expected to have a single conductor pass through it; the conductor may be single or multistranded. A sleeving is expected to be a junction of more than one conductor.

Lead wires are commonly made from a wider range of chemistries than sleevings and tubings. The more common chemistries are:

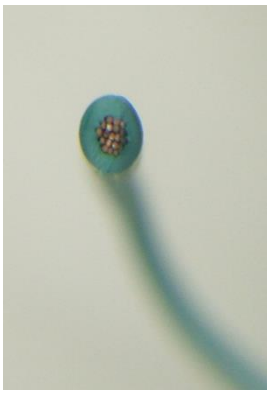
- Polyvinylchloride (PVC)
- Chemically cross-linked Polyethylene (XLPE)
- Irradiated cross-linked Polyethylene (XLPE)
- Silicone rubber
- Silicone
- Ethylene-Propylene Diene (EPDM)
- Ethylene Tetrafluoroethylene (ETFE)
- Fluorinated Ethylene Propylene (FEP)



Coil Wire Connected to Connecting Cables



Sleeving before covering junction and Sleeving after covering junction



Connecting Cable/ Lead Wire

2.2.6 Ties / Tie cords / Lacing cord

Tie cords or lacing cords are used to reinforce the ends of the windings in motors. This adds to the physical strength of the windings to minimize movement as the electrical and magnetic forces pulse through the motor. These cords are typically used only in motors and generators.

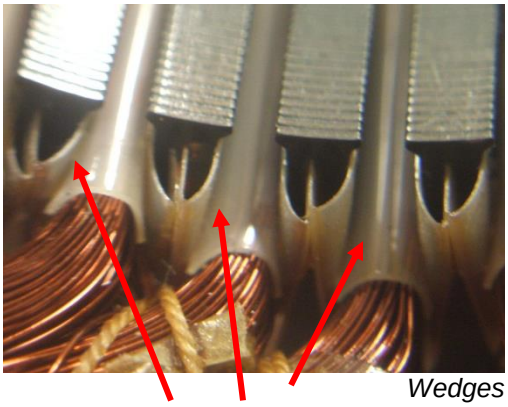
These cords can be glass fibers, polyester fibers or combinations.

Tie Cord on Stator

2.2.7 Wedges / Top Sticks

Another motor/generator term. Wedge implies the purpose, to wedge or tighten the windings into the slots. Top stick implies the location, at the top of the winding to close the slot section.

These components can be made from a wide range of materials, such as pressboard, laminated composites, wood, or glass reinforced resins systems.

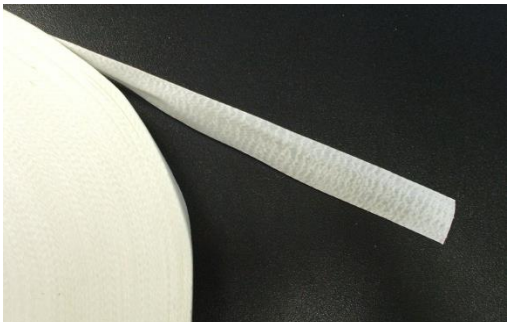


Wedges

While these components are in direct contact with the windings, they are not considered to serve as an EIM since there is no grounded metal or arcing path on the exterior side of the component.

2.2.8 Banding Ring

Used in large motors and generators to add significant physical support to the end turns of the windings. As motors and generators become larger in terms of power the force on the ends of the turns is enough to move the coil several centimeters; enough to quickly damage or



Banding Tape

break the conductors.

Banding rings are commonly made of glass fiber cords which are intended to absorb a high level of the impregnating resin which, when cured, results in a solidified band around the exterior of the windings. For some applications, the band is constructed with a pre-impregnated resin into a tape which is then wrapped around the windings resulting in the same physical supporting structure.

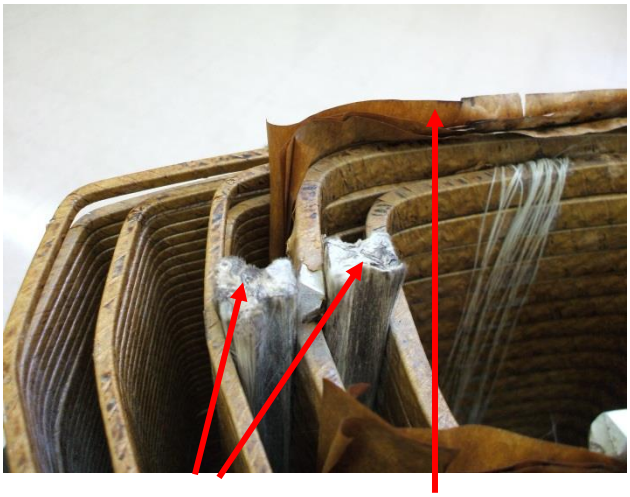
2.2.9 Phase Insulation [major]

Phase insulation is placed between coils of different phases in the same slot of a motor or generator. Coils in two of the three phases are on opposite sides of this insulation. While the voltage difference between phases can be higher than between a single phase and the metal of the core stack, for some agencies phase insulation is defined as a minor insulation material. Phase insulation is of equal significance to the safe operation of a three-phase motor or generator as the EIM used as the slot liner. In the real world, phase insulation should be viewed as an EIM, regardless of the requirements of a particular certification agency.

2.2.10 Spacers

A transformer term used to identify a material used to separate the windings of a single coil. Spacers are used to hold the winding open to allow for air, oil or some cooling media movement to help cool the interior of the coil.

To be identified as a spacer the winding on both sides of the spacer must be of the same continual piece of conductor meaning inside of a single coil.



Spacers and Layer Insulation

2.2.11 Layer Insulation

Layer insulation is also a transformer term and similar to the use of a spacer. Layer insulation is placed between layers of a single winding of a single coil. To be identified as layer insulation, the material must be inside of a single coil, not between two separate coils. The purpose may be to assist in movement of a cooling fluid or to help minimize movement of the turns of the adjacent layers.

It is expected the voltage stress level from one side of a layer insulation to the opposite side will be low.

3. Concern About Compatibility

The actual electrical insulation of the end-product is addressed by the EIS which is a long term thermal aging evaluation of the system or group of materials composing the EIS. Some end-products can be constructed and operated in a completely safe manner using only the materials in the established EIS. However, most designs require the need of additional materials besides those in the EIS. The long term potential performance is established by the EIS, but the long term potential performance of the non-electrical materials is not included in the long term testing.

The need to evaluate compatibility of the non-electrical materials for use with the EIS and the most common test methods are covered in a separate EIU class.

VISUAL REPRESENTATION