

Ganapati Institute of Engineering and Technology
Jagatpur, Cuttack.

Lecture Notes
ON
Testing and maintenance of Electrical machines (744)

Branch :- Electrical Engineering.

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(For Diploma Electrical Engineering Students).

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Installation, Commissioning and Testing of machine:

Inspection: Inspection is the examination of certain machine or their parts to find their condition or state. The main aim of inspection is to check that the machine received is in good condition and also according to our requirements.

Inspection on arrival of machine:

On arrival of machine at sites, the packing cases should be checked against the despatch particulars. Any loss of packages on the transit should be intimated to the manufacturer or supplier and insurance company. The packing cases contain a part list, a duplicate of advice note and check tag which should be taken out of cases as soon as it is open.

The packing cases bear some marking indicating the sender and receiver addresses. The way bill as well as warning instructions such as "This side up", "Do not turn over", "Handle with care" etc must be followed strictly.

Handling of Electrical Machines:

Machines should be handled very carefully to increase life and service of the machine. The following precautions should be followed during handling.

- ① Always use lifting hook to lift the motor except in very small frames where no lifting hook is provided.
- ② Do not use any other part of the machine for lifting purposes.
- ③ Do not use shaft projections for dragging the motor.
- ④ Do not roll or drag the motor on floor.
- ⑤ Do not keep totally enclosed fan-cooled motors in vertical position with external cover as best.

⑥ Avoid jerks and jolts to machines to increase the life of the bearings.

Procedure for storing a machine at site:

- ① The machine should be stored in clean, dry, store house having uniform temperature.
- ② Large variations of temperature caused differential expansion, hence should be avoided.
- ③ Heaters should be provided to avoid dampness.
- ④ The air in the store room should be not humidity more than 65%. The temperature should not be below $+15^{\circ}\text{C}$.
- ⑤ Direct sunlight, rain water, dust, gases, water, smoke should not be present in the store room.
- ⑥ Machine should not be kept on mud floor.
- ⑦ The floor of store should not be subjected to vibrations. In case of vibrations, the machine should be placed on rubber blocks.
- ⑧ There should be "NO SMOKING" sign in the store room.

Procedure for Inspection of Electrical motor before its installation:

The inspection of the motor should be carried out as follows.

- ① External inspection of motors for conditions.
- ② Inspection of terminal by opening the terminal lid.
- ③ Blowing of motor with clean, dry air to removed dust.
- ④ Checking of the rotor for easy rotation when turned by hand.
- ⑤ Rectification of defects observed during inspection.

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⑥ Particular attention should be given towards anti-friction bearings of the motor.

⑦ Insulation Resistance between winding and frame tested by meggers and compared with the data supplied by the manufacturer for the insulation resistance. It should always be above 0.5 mega ohm.

Drying-out of Electric Rotating machines and its Necessity is

All the motors should be dried out before the full voltage is applied to terminals. To decide whether drying out is necessary, the insulation resistance should be measured. If it is found that the resistance when measured with megger between any terminal and frame is less than motor should be moved to warm and dry place where the air is from dust and where the temperature does not exceed 40°C .

Steps in Drying-out of a motor or a generator is

① Preliminary preparation of the machine, source of heat, measurements etc.

② Arrange the set-up

③ Apply heat by one of the suitable means gradually

④ Take periodic reading of clock time, temperature of winding, body and air, insulation resistance values of 1st second megger reading and 50 second megger reading winding resistance

⑤ Measure periodically of the insulation resistance value.

⑥ Initially, during the first few hours, the values of insulation resistance reduces even though the heat is being applied for drying out.

During initial heating period, the moisture trapped in the insulation in form of small globes gets

released within the insulation) then the insulation resistance value starts reducing.

(7) After a span of few hours or a few days the insulation resistance reaches a steady value. This indicates that the moisture has spread all over the insulation.

(8) Rising stage - After a few hours of steady value, the insulation resistance started rising.

(9) The drying out process is stopped when the desired value of insulation resistance is reached. In case of large machine the insulation resistance is important. The input power is switched off.

(10) The winding resistance was measured for various temperature as the temperature started falling.

Precautions while drying out :-

(1) Chamber should have thermal insulation to prevent heat loss.

(2) The machine body should be covered with canvas to prevent heat loss.

(3) Temperature of air shall be controlled by turning off the heats from time to time.

(4) Local temperature should not exceed 75°C . There should be proper circulation of air in the chamber.

(5) The temperature should be raised gradually not faster than 10°C per hour. Higher rate of heating results in damage due to differential expansion of metal and insulation.

(6) Heating should be continuous and steady. Temperature shall be maintained continuously during the entire drying period.

Methods of drying out electrical machines :-

① By using chamber and resistor heater :-

The machine to be dried is placed in a drying chamber. The drying chamber should be of volume about 4 times the volume of motor. The air circulates by means of fans and air circulating system. The air temperature is periodically measured by means of thermometer.

The moisture expelled from the machine is out of the drying chamber with outlet air.

② By radiating lamp or infrared lamps :-

This is a most convenient and simple method used for medium and small motors. The infrared lamps are used. The lamps are located in the chamber opposite to the motor winding. The heating should be continuous and carefully controlled so that it does not rise too high, thus scorching and damaging the insulation. Guarded to ascertain how drying out is proceeding, "megger" reading should be taken every 12 hours and drying should be continuing until figures obtained are constant for four successive readings.

③ By circulating short circuit current :-

This is most convenient method of drying any electrical machine such as generator, slip ring motor, synchronous motor, dc motor, field winding etc. The machine is connected to low voltage source. The input voltage, current, power, the temperature of winding, temperature of body temperature of air are periodically measured. The end shields of the machine are removed. The machine body is covered with tarpaulin. No cool air below shall come over hot winding.

The increase in temperature should be very gradual upto the value of not exceeding 75°C. The cooling down is also gradual.

During the drying out period, readings of temperature and insulation resistance shall be taken at short intervals of time in order to see how the drying out is progressing.

After drying out air drying varnish should be applied by brush on the winding surface. This should be only applied when this is in hot condition to prevent absorption of moisture. The motor should be watched constantly during drying period.

Installation:

Electrical motors and apparatus should always be installed where they can obtain adequate ventilation and clean dry air. They should be accessible for full inspection and repairs. If the air contains dust, moisture or corrosive gases, the equipment should be appropriately protected or else supplied with pure air through special pipes or ducting.

The main points regarding installation of motors are given as

- ① Motor and control gear should be protected by suitable polythene to prevent dust. It should be cleaned by using brushes. Dust may spoil the slip rings, when motor is started.
- ② All the protected moving parts must be guarded by metal screens to minimize the risk of hand, hair or clothing of person being caught.
- ③ Motor should have adequate ventilation to provide dissipation of heat generated.
- ④ Piece of installation of motor should have sufficient space all round the motor to facilitate movement of operating personnel and for maintenance and dismantling purpose.
- ⑤ Motor should be accessible for carrying out

• repair and maintenance in future and it requires lifting arrangement should be provided with the structure of the building.

⑥ Every motor has to be provided with efficient means of starting, stopping and should be within easy reach of a person in the control of motor.

Generalised procedure of Installation of Electrical machine

Installation procedure of an electric motor involves a series of activities like

- ① Location and layout
- ② positioning of machine
- ③ concrete foundation
- ④ Levelling and alignment
- ⑤ Gearing
- ⑥ Fitting of other parts, accessories, Piping etc
- ⑦ Final levelling and alignment.

① Location and layout :-

The location of an electrical machine depends on its purpose of installation, definite type and sizes. The location plan should permit to have required wide space all around for continuing the erection work and should facilitate regular inspection, repairing etc.

The location should also be finalised in such a fashion that it will not disturb or obstruct the operation and maintenance work of other machines.

once the location is finalised the work of laying out the foundation plan is to be undertaken.

Laying out means marking of the foundation plan. It may be done with the help of chalk on a concrete floor and by a string with number of pegs. Excavation of soil may be started only when the layout is completed as per requirement.

(b) Position of machines :- Positioning of the machine at the location is an important job which deserves care, skill and an efficient team work. An equipment may have the weight of a few tons. But it is to be loaded or unloaded, to be moved vertically or horizontally to bring it at the site and to place it on the foundation as well. Different types of lifting devices like pulley blocks, chain hoists, overhead crane etc may be required.

(c) Concrete foundation :- The part of a structure which provides a base or support for the machinery is called a foundation. The size and strength of foundation depends upon the size and nature of supported machine and surrounding soil condition. The qualities of good foundation are rigidity and freedom from vibrations.

The foundation carries and supports the weight of machine in order to prevent any settlement or crushing. It maintains the alignment of machine, it gives a level and firm surface for the machine. It absorbs the vibrations produced by the unbalanced forces created by reciprocating and rotary means of the machinery elements. The static load and dynamic load of running machine is transmitted to the ground via the machine foundation. The foundation should be firm, solid and level and the motor, etc bed plate should be securely bolted down. The best material for the foundation is concrete because the concrete bases are so easy to shape, they are almost universally used.

① Levelling and Alignment :- After having the machine on the foundation, the important job is to level and align it with other accessories. The levelling is performed with the levelling wedge, shoe etc. The horizontal and slight vertical movements of the heavy mass of machine is performed by pipes, rollers. The punch bars, straight edge, spirit level, dial indicator etc are generally used to level the machine. The levelling is to be checked on both longitudinal and transverse directions.

When levelling is completed, the foundation bolt, cavity along with the bolt may be made of concrete. Pouring of the cement concrete is generally made through the gap provided at the top of the foundation. This concreting will provide a bondage. When the foundation block is continuously made for a connected accessory the axial position of shaft, parallelism of shaft in vertical and horizontal plane, centering, fixing the shafts exactly in line procedure should be followed.

② Grouting :- Grouting is a procedure of connecting the machine with the foundation by a concrete mixture of plastic consistency or cement mortar. It is used in installing of the machines. A quick setting cement is used to perform grouting. The top of the foundation block is made roughened, made moistened with water and wooden partitions are placed all around the machine. The height of such wooden boards are kept much higher than the gap between the top of the foundation and the bottom of the machine. Quick setting cement is then poured with in the boundary with care to eliminate any gap within it.