NOTE ON TEMPERATURE RISE TEST

Temperature rise limits clause 10.10 of IEC 61439-1

A switchgear panel has electrical components and connecting bus bars and cables inside. When the panel is charged and starts its normal function, current starts flowing in all the circuits which are switched ON. Because of this current flow basically two things will happen. (1) a portion of the electrical energy gets converted in to thermal energy (Heat). Secondly the current flow in bus bars and cables develops a magnetic field. At low currents this magnetic field does not cause any concern but at higher currents in excess of 600Amps may induce eddy currents in the surrounding enclosure parts made out of CRCA being a magnetic material. These eddy currents will also develop heat in addition to heat developed in the conductors because of the flow of current and the resistance of the conducting material

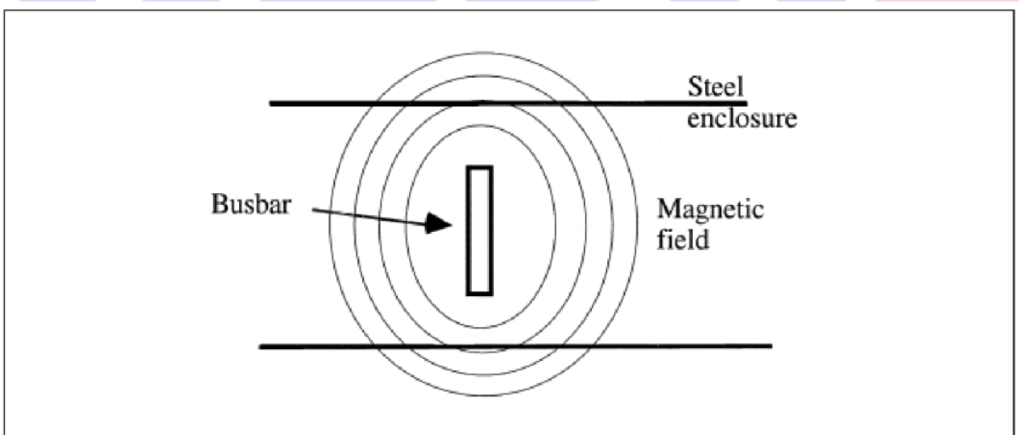

Fig-1a

It could be explained here that when a bus bar carries electric current, a magnetic field will be set up around the same, as shown by the circular lines in sketch-
When a magnetic material like CRCA parts of enclosure, happens to come inside the magnetic zone, eddy currents will get induced (generated) and keep circulating inside the magnetic material there by this eddy current also develops heat and will raise the temperature of the enclosure parts in the surrounding area of bus bars. The higher the current the stronger will be the magnetic field and there will be more heat generated.

So, panel designers have to be cautious about this aspect also while making their panel designs with respect to internal heat generation and the ventilation requirements that may become necessary to dissipate the thermal energy (generated heat)

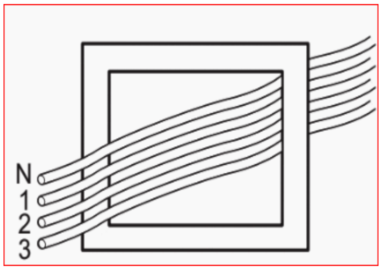

Fig- 1b

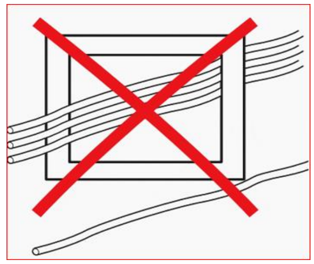

Fig-1c

Another example of generation of eddy currents is shown in Fig 1a,1b &1c
To make the vectoral sum of current flowing in all the three phase conductors zero, (Avoiding the eddy current effect) all the phase and neutral conductors are to be laid such that they do not get separated from others
In the present scenario we have been trying to understand as to what is temp rise test and why is it required to be conducted as one of the important tests under IEC 61439-1 standard
The reason /requirement for this test is as follows
Every electrical component has been designed to work satisfactorily up to a threshold temperature
Some of the components with British design are designed for a maximum of 65 degree centigrade (Ambient + rise)
And by and large 70 degree centigrade is considered as a maximum at which any electrical component could work satisfactorily
Hence it becomes necessary to energise the test panel, load it to the specified level of current depending on the load diversity factor, allow the various temperature measuring points to stabilise at not more than a degree centigrade in one hour and note down the measured temperatures
These measured temperatures are compared with the maximum limits specified by the standard to ensure that at no point it has exceeded the limit specified
Different limits are specified as applicable to different locations of the panel

Several combinations are allowed by the standard for testing but most important will to conduct the test on the entire assembly by loading all incoming and outgoing circuits either at their rated currents or after applying the load diversity factor (load diversity factor could be like 80%=0.8 or 90% = 0.9 etc,) but preferably it would be advantageous to conduct this test at 100% to prove that the design caters for 100% loading (customers prefer testing done at 100% loading)

Challenges

Experience only could tell us as to what type of challenges may have to be encountered. Some of them which are important are explained below

1. **Bus bar joints**

   There are several aspects that are to be adequately and properly to be taken care of while making bus bar joints

   (a) Cleaning of both of the jointing surfaces
   (b) Smoothening the surfaces which are touching each other
   (c) Maintaining required amount of joint overlap
   (d) Providing adequate No. of holes of required size as per recommended bolting schedule
   (e) Maintaining the proper and required amount of torque to keep the joint resistance at the minimum level and also to see that the bus bar material remains within its elastic limit (on the stress /strain diagram)
   (f) Applying good quality conductive contact grease to work as moisture inhibiting compound and also to reduce the contact resistance and to avoid surface oxidisation
   (g) Making the contact immediately after cleaning the surfaces without allowing much time as in between (Maximum 2 to 3 hours)

2. **Joint resistance**

   Oxidisation of the bus bars at the jointing area unattended prior to making joint could pose a challenge of temp exceeding the limits. Hence it is suggested that the joint lap area needs to be mildly buffed and applied with good quality conducting contact grease which improves the joint by reducing the overall resistance in a joint

3. **Copper to aluminium joints**
   Copper to aluminium joints are to be mandatorily provided with bimetal shim to keep the temperature under control. Otherwise these joints could exceed the temperature limits
4. **Surface emissivity**
   As compared to providing red, yellow, blue and black heat shrinkable PVC sleeves on bus bars it would be better to provide black matt finish paint of thin layer of not more than 10
   Microns. This will improve the surface emissivity to a great extent so that bus bars could run
   Cooler than the PVC sleeved condition
5. **Compartment dimensions**
   Compartment dimensions also influence the temperature attained by the conducting parts inside the chamber depending on the volume of air present inside the chamber and the thermal status of the neighbouring chambers. Liberally dimensioned chamber size will help to keep the temperature inside the chamber as low as possible
6. **Eddy current or magnetic induction heating**
   Magnetic heating could generate additional heating as shown in Fig- 1a,1b,1c, given above. Care has to be taken to avoid such magnetic heating as this is undesirable and will add to the heat already developed due to flow of current and could worsen the thermal profile of the case
   Either relocating the particular problematic part or providing nonmagnetic material in such critical locations could be examined to resolve such issues
7. **Forced air cooling**
   Wherever forced air cooling is designed, adequate care needs to be taken to create an unimpeded air flow inside the area where cooling is expected. It is also important to select adequate rating of (Foot^3/ minute or metre^3 / hour) cooling fans considering the efficiency of the fan or fan and filter set including the % impediment for air flow

Criteria to pass the test

There are different limits of temperature rise as applicable to different locations of the panel as per Table-6 of IEC 61439-1

The measured temperature rise at the time of test should not exceed any of the specified limits