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Selection of Contact Button Manufacturing Process for Low Voltage Protection Devices and Validate By EET Test

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ABSTRACT : The focus of the studies is on the influence of contact material production parameters, and the electrical life for breaker interaction of material combinations used for the low voltage protection devices. The influence of contact button manufacturing process will be scrutinized by practical validation as switching performance of AgC material with different size and fiber orientation will be compared. The paper represents guideline for contact button manufacturing process selection for low voltage protection devices as well as which is the suitable for the low voltage circuit breaker is also described by the EET testing.

KEYWORDS – *Circuit Breaker, Contact Material, Silver Graphite, Contact Button, Contact Button Erosion.*

I. INTRODUCTION

The development of electrical protection devices like circuit breakers is driven by device miniaturize and cost efficiency. Protection devices like circuit breakers have to fulfill various requirements like protection against overload and short circuit condition.[6] Contact button material for this kind of application should provide very good anti-welding behavior, low contact resistance, low contact button erosion rates and good arc mobility time. This type of contact material has been used for both fixed and moveable contact of circuit breaker. [1]

When arc has been produced between fixed and moving contact under abnormal condition at that time there is some amount of material loss observed. This material loss is mainly depending on the arc immobile time, contact material and its fiber composition. By reducing this material loss we can improve a life of circuit breaker.[2]

Contact materials made of silver refractory metals (e.g. AgC, AgW, AgWC) are often used as arcing contacts due to their resistance against arc erosion. [3]

Silver graphite (AgC) is rottenly used as a contact button material of circuit breaker. Because of its excellent resistance against welding and its low and stable resistance. Mostly a silver graphite variant with graphite contents from 2 to 6 weight percent is used. At another side silver graphite shows relatively high erosion rate because of random orientation of carbon and graphite content.[1] With increasing graphite content the resistance against welding increases but the material erosion rate also increases. Therefore a suitable composition and a suitable manufacturing process have to be found. This paper shows the suitable manufacturing process for contact button material and validates it by EET (Electrical Endurance Test)

II. DIFFERENT MANUFACTURING PROCESSES OF SILVER GRAPHITE MATERIALS

Silver graphite AgC is widely used as arcing contact material in circuit breaker. There are different manufacturing processes carried out in production of this material. The welding capability and erosion of material depends on these manufacturing process. The AgC material has been manufactured by

- Powder metallurgy
- Extrusion

With different manufacturing process the graphite fiber orientation with respect to contact surface and behavior of the contact button changes.[1]

2.1. Powder metallurgy

In this process the graphite particles are randomly oriented with respect to contact surface. By this orientation there is a random erosion of the contact button surface. The loss of the silver is mainly dependent on the rise in temperature in the form of sputters and the loss of graphite particles is mainly in the powdering form due to the continuous mechanical input at elevated temperature.

In the random orientation when the arc is produced between the contacts at that time erosion take place randomly. So in the some part of contact button erosion is more and in some part there is a less erosion so there may be chances of the single phasing.

2.2. Extrusion

In these manufacturing processes the graphite particles are perpendicular or parallel oriented to the contact arcing surface. The presence of the graphite particles increases a welding property of the material.

In the extrusion method graphite particles are perpendicular or parallel oriented. So the material erosion which takes place in particular manner and compared to powder metallurgy chances of erosion is low.

2.2.1. Graphite fiber parallel orientation with the contact surface tip

The weld resistance is high for materials with the graphite fiber orientation parallel to the arcing contact surface. Since the contact surface after arcing consists of pure silver the contact resistance stays consistently low during the electrical life of the contact parts. But the disadvantage is that it has high erosion rate. This can be improved by adding more amount of graphite in the composition but at the same time this will lead to the reduction in the conductivity of the button.[2]

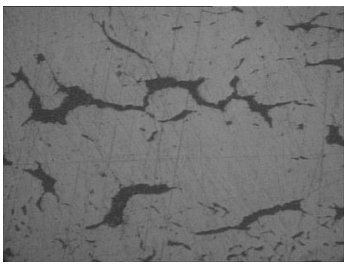
2.2.2. Graphite fiber perpendicular orientation with the contact surface tip

Such contact buttons are well suited for applications which require both, a high weld resistance and a sufficiently high arc erosion resistance. [2]

III. ANALYSIS OF DIFFERENT TYPE OF CONTACT BUTTON

3.1. Analysis of powder metallurgy type Contact button

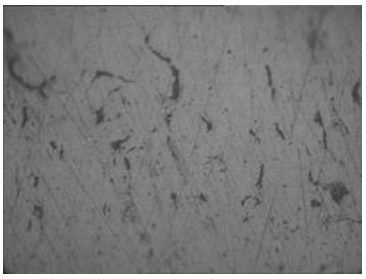
In the AgC (Silver Graphite) contact button with powder metallurgy the graphite fibers are randomly oriented. Because of the randomly orientation of graphite fiber the contact button erosion is uneven. Erosion is more towards the exit of the arc then the other end of the button. Because of the uneven erosion some part of contact button erode more and some part of contact button is erode less.[1]Due to this average erosion is increase and also the single phasing fault of breaker is increased. We will check the erosion of contact button by the (EET) Electrical Endurance Test. which will be described later on in this paper. In the figure the microstructure of powder metallurgy type contact button is described. In which we can clearly see that the graphite fibers are randomly oriented.



(Contact button structure with powder metallurgy)

3.2. Analysis of Extrusion type contact button

In the Proposed AgC Contact button the manufacturing process is changed to extrusion with the graphite fiber perpendicular to the switching contact surface. In this type of contact button graphite fibers are perpendicularly oriented to the contact surface. So when the arc is produce on the contact button surface at that time erosion occurs in particular manner. In this type of contact button erosion is less compared to other contact button.[2] Also the welding property as well as erosion property is better compare to powder metallurgy. We will check the erosion of contact button by the (EET) Electrical Endurance Test. That will describe later on in this paper In the figure the microstructure of extrusion type contact button is describe. In which we can see that the graphite fibers are perpendicular to the switching contact surface.



(Contact button structure with Extrusion type)

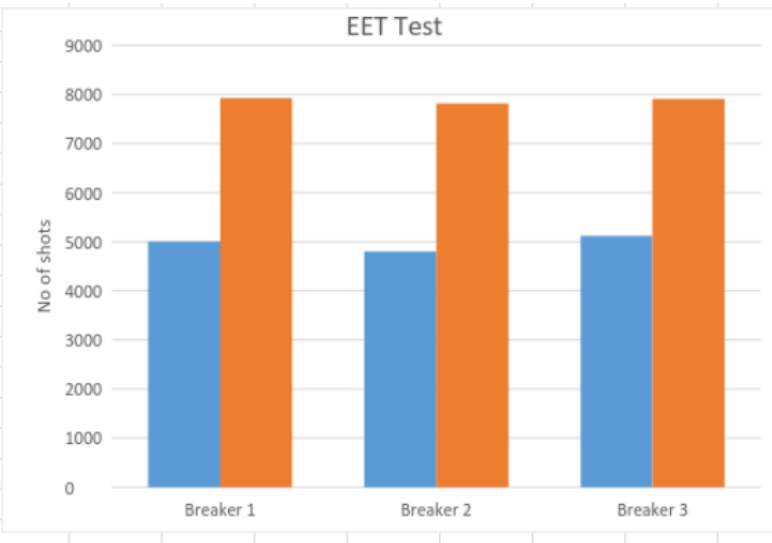
IV. Result of Electrical Endurance Test

Firstly we have to understand that what is the EET test? EET means Electrical Endurance Test which is conducted on a Circuit breaker on the rated current and rated voltage. One cycle is for 60 sec in which breaker complete its one operation. In this one cycle breaker is operate on rated current. This test is continuing till the contact button get fully erode or the single phasing observe in that breaker. [6]

Now we will compare the EET test result of both the type of contact button. By which we will get to know that which type of button metallurgy is more useful and efficient.

This EET test has been carried out with the powder metallurgy type button as well as the extrusion type of contact button on the voltage of 415 V, current of 400 A as well as current of 630 A, frequency of 50 Hz and power factor is 0.8. One operation is complete in 60 seconds.[6]

Firstly this test has been carried out on MCCB of rated 400 A on the rated current and rated voltage. As we know this test has been carried out until the contact button get fully erode or the single phasing fault.

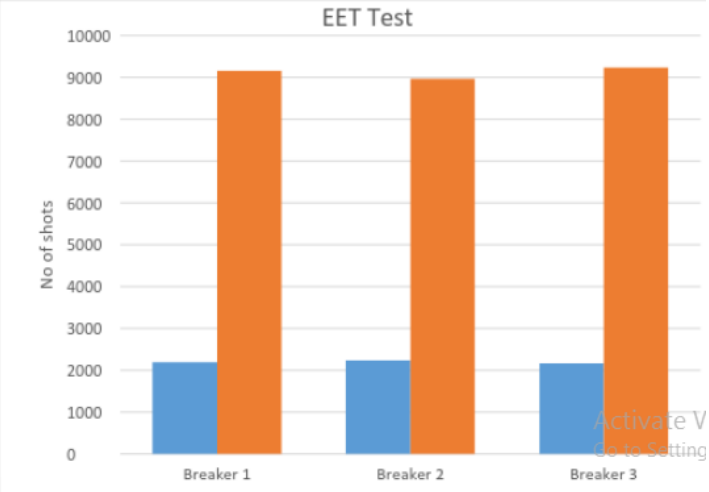


(EET test on 400A MCCB)

This test has been carried out on three MCCB rating of 400A with both the contact button like powder metallurgy type as well as extrude type contact button. The blue portion of the graph describes the testing result of powder metallurgy type contact button and orange portion describes the testing result of extrude metallurgy type contact button. By the graph we observe that EET life of powder metallurgy type contact button is nearer 5000 and EET life of extrude metallurgy type contact button is nearer to 8000. By which we can conclude that extrude metallurgy type contact button are more useful in low voltage MCCB.

Also this same test has been conduct on 630 A MCCB on same condition. Here in graph that result is also describe. The blue portion of the graph describes the testing result of powder metallurgy type contact button and orange portion is describes the testing result of extrude metallurgy type contact button. By the graph we observe that EET life of powder

metallurgy type contact button is nearer 2300 and EET life of extrude metallurgy type contact button is nearer to 9000. By which we can conclude that extrude metallurgy type contact button are more useful in low voltage MCCB.



(EET test on 630A MCCB)

V.CONCLUSION:

The focus of the presented experimental studies was on the influence of contact material composition and production parameters on the switching behavior, and the interaction of contact material and low voltage protection devices. From the results obtained, it has been found that Extrude metallurgy type contact button has low contact button erosion and high EET life compared to the powder metallurgy type contact button. So, in low voltage application Extrude metallurgy type contact button are more useful than powder metallurgy type contact button.

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