TechTalk

MV Oil Circuit Breaker Contacts

Compiled by John Sherriff | January 2019 | Rev 1

The scope

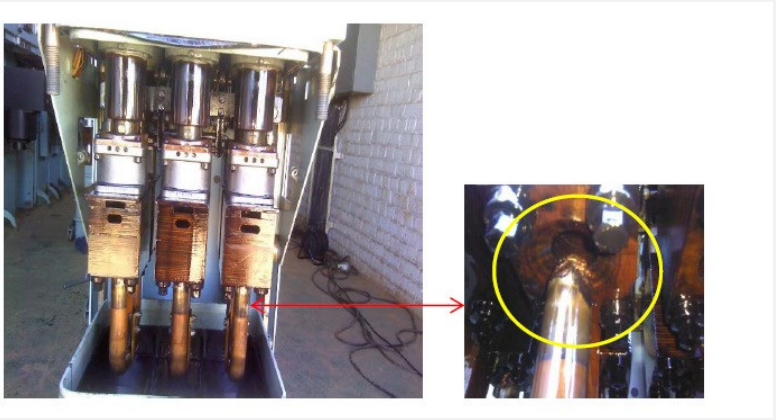
One of the major sources of problems with circuit breakers is that caused by the deterioration of the main switching electrical contacts. The contacts in switchgear are required to provide two main functions that are mutually incompatible.

On the one hand, the switching contacts have to provide a low resistance electrical joint with negligible heating during normally closed operation - this requires the use of relatively soft and malleable materials such as silver or copper which give good (low) contact resistance but have very poor resistance to arcing damage.

On the other hand, when the contacts open to interrupt fault current they are subject to severe damage from the high temperature arcing which occurs - ideally, this task requires the use of hard refractory metals such as tungsten or molybdenum which have good arcing resistance but very poor (high) electrical contact resistance.

Some compromise is necessary, and various solutions include sintered mixtures of, for example, tungsten and copper, or the use of two separate contact systems, one for arcing and one for normal closed contact operation, with the transfer of the current flow occurring during the opening. Chemical contamination is also often present in contacts, particularly in oil circuit breakers and those air circuit breakers where the contacts are exposed to atmospheric air. In the case of the oil circuit breakers, the contamination may arise from the chemical decomposition products of the arcing, including carbon deposits and chemical films, such as oxides, on the contacts. The effect of these contaminants is to increase the contact resistance, and this can eventually lead to thermal runaway and arcing and melting in the contacts. This is a relatively common problem with oil switchgear breakers.

Deterioration of the main switching electrical contacts



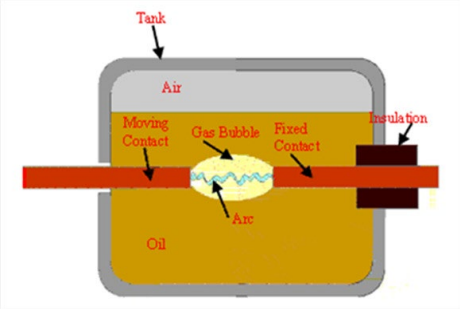
Contact welding can occur in situations where the fault currents are very high and where DC offset transients occur as these will generate substantial electro-dynamic forces on the contacts. This occurs because of the constriction of current streamlines which occurs at contacts and particularly at switching contacts. The constriction results in an electrodynamic

force which tends to separate the two contact faces. If the retaining spring is not strong enough, the separation may occur before the unlatching mechanism operates. Then, as the contacts separate momentarily, the arcing melts the surfaces and then after the first half cycle of current the force decreases and the contacts close on to molten surfaces and weld together. Then when the unlatching process does occur a little later, the contacts will not open.

Contact arc

When the current carrying contacts in the oil are separated, an arc is established between the separated contacts.

This arc will produce rapidly growing gas bubble around the arc. As the moving contact moves away from fixed contact, the length of the arc is increased. As a result, the resistance of the arc increases.



- The increased resistance causes lowering the temperature and hence reducing the formation of gasses surrounding the arc.

- The arc quenching in bulk oil circuit breaker takes place when current passes through zero crossings. If we go through the arc quenching phenomenon more thoroughly, we will find many other factors affects the arc quenching in bulk oil circuit breaker. As the gas bubble is enclosed by the oil inside the airtight vessel, the oil surrounding it will apply high pressure on the bubble, which results highly compressed gas around the arc.

- As the pressure is increased the deionisation of gas increases, which helps the arc quenching. The cooling effect of hydrogen gas also helps in arc quenching in oil circuit breaker.