ELECTRIC DISCHARGE IN VACUUM

The electric discharge in vacuum results from the neutral atoms, ions and electrons emitted from the electrodes themselves. Cathode spots are formed depending upon the current flowing. For low currents a highly mobile cathode spot is formed and for large currents a multiple number of cathode spots are formed. These spots constitute the main source of vapour in the arc. The processes involved in drawing the discharge will be due to high electric field between the contacts or resistive heating produced at the point of operation or a combination of the two. The cathode surfaces, normally, are not perfectly smooth but have many micro projections.

Due to their small area of cross-section, the projections will suffer explosive evaporation by resistive heating and supply sufficient quantity of vapour for the arc formation. Since in case of vacuum, the emission occurs only at the cathode spots and not from the entire surface of the cathode, the vacuum discharge is also known as cold cathode discharge. In cold cathode the emission of electrons could be due to any of the combinations of the following mechanisms:

Field emission; (ii) Thermionic emission; (iii) Field and Thermionic emission; (iv) Secondary emission by positive ion bombardment; (v) Secondary emission by photons; and (vi) Pinch effect. The stability of discharge in vacuum depends upon: (i) the contact material and its vapour pressure, and (ii) circuit parameters such as voltage, current, inductance and capacitance. It has been observed that higher the vapour pressure at low temperature the better is the stability of the discharge. There are certain metals like Zn, Bi which show these characteristics and are better electrode materials for vacuum breakers. Besides the vapour pressure, the thermal conductivity of the metal also affects the current chopping level. A good heat conducting metal will cool its surface faster and hence its electrode surface temperature will fall which will result into reduction in evaporation rate and arc will be chopped because of insufficient vapour. On the other hand, a bad heat conductor will maintain its temperature and vaporization for a longer time and the arc will be more stable.

The process of multiplication of charged particles by the process of collision is very small in the space between the electrodes in vacuum, electron avalanche is not possible. If somehow a gas cloud could be formed in vacuum, the usual kind of breakdown process can take place. This is the line of action adopted by the researchers to study mechanism of breakdown in vacuum. By finding the way, gas cloud could be created in a vacuum.