5.1 Physics of arcing phenomenon and arc interruption:

5.1. 1 Physics of arcing phenomenon

When a short-circuit occurs, a heavy current flows through the contacts of the circuit breaker before they are opened by the protective system. At the instant when the contacts begin to separate, the contact area decreases rapidly and large fault current causes increased current density and hence rise in temperature.

The heat produced in the medium between contacts (usually the medium is oil or air) is sufficient to ionize the air or vaporize and ionize the oil. The ionized air or vapor acts as conductor and an arc is struck between the contacts.

The potential difference between the contacts is quite small and is just sufficient to maintain the arc. The arc provides a low resistance path and consequently the current in the circuit remains uninterrupted so long as the arc persists.

During the arcing period, the current flowing between the contacts depends upon the arc resistance. The greater the arc resistance,the smaller the current that flows between the contacts. The arc resistance depends upon the following factors

(i) Degree of ionisation— the arc resistance increases with the decrease in the number of ionised particles between the contacts.

(ii) Length of the arc— the arc resistance increases with the length of the arc i.e., separation of contacts.

(iii) Cross-section of arc— the arc resistance increases with the decrease in area of X-section of the arc

5.1.2 Initiation of arc:

- The electric arc is a type of electric discharge between the contacts of the circuit breaker. Arc plays an important role in the behavior of an electric circuit breaker. A circuit breaker should be capable of extinguishing the arc without getting damaged.
- As the contacts of a circuit breaker begin to separate, the voltage is appreciable and the distance of separation is very small. Therefore, a large voltage gradient occurs at the contact surface.

- When the voltage gradient attains a sufficiently high value (10^6 V/cm) electrons are dragged out of the surface causing ionization of the particles between the contacts.
- The emission of electrons because of the high value of voltage gradient is known as field emission.
- Although this high voltage gradient exist only for a fraction of micro-seconds, but a large number of electrons are liberated from the cathode because of this. These electrons move towards the positive contact i.e. anode at a very rapid pace.
- On their way to anode, these electrons collide with the atoms and molecules of the gases and vapour existing between the contacts. Hence, each liberated electron tends to create other electrons. If the current is high, which is certainly in case of an electric fault, the discharge attains the form of an arc.
- The temperature of arc is high enough and causes thermal ionization. The liberation of electrons because of high temperature is called thermal emission. Thus, in an electric circuit breaker, an arc is initiated because of field emission but is maintained due to thermal ionization.