

Circuit Breakers

Definition

“ Mechanical switching devices capable of making, carrying and breaking currents under normal and abnormal conditions



Circuit breakers Elements



- Main Contact
- Insulation between main contacts
- Interruption chamber
- Control, supervisory and auxiliary devices
- Insulating link between control unit and main contact.

Types of Circuit breakers

- Air-Blast Circuit breaker
- Oil Circuit Breakers
- SF6 Circuit breakers
- Vacuum Circuit Breakers

Principles of Operation

- Two sets of contacts per phase
- Moving contact made of copper rod.
- Fixed contact made of spring-loaded copper segments to exert pressure on moving contact and to make good contact.

Circuit Breakers Requirements

- Opens & closes in shortest possible time
- Conducts rated current.
- Withstands thermally & mechanically any short circuit.
- Maintains its voltage to earth across open contacts.
- Does not create overvoltages during circuit opening
- Easy to maintain.
- Not very expensive.

Particulars of a Circuit Breaker

- Medium for arc extinction.
- Rated line voltage.
- Rated breaking current.
- Type of construction e.g outdoor, indoor. Etc
- Type of operating mechanism
- Total breaking time.
- Other additional features such as switching resistors

Circuit Breakers rating

- Rated normal current: to be carried without temperature rise.
- Rated breaking current:
 - = Highest current to be interrupted
 - = rms of the peak value of the Asymmetrical current.

Circuit Breakers rating

- Generally and according to voltage range, a constant is used to multiply the short circuit current to obtain the breaking current
- Rated MVA = $\sqrt{3}$ * Line voltage (kV) * breaking current (kA)

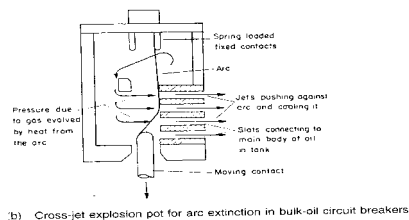
Principles of Operation

- On opening moving contact moves rapidly.
- An electric Arc is formed.
- The intensity of the arc depends on the current been interrupted.
- As the moving contact moves further, the arc is stretched.
- The gas in the chamber sweeps the arc which is cooled.
- Circuit opening is achieved if the arc does not re-ignite.

Oil Circuit breaker

- Heat from the arc breaks some oil to form gases mostly hydrogen.
- The high pressure of the gas blows out the arc
- Cold oil flows onto the arc which is extinguished.
- Used in low and medium voltages up to 110 kV.

An oil Circuit Breaker Diagram



Air-Blast Circuit breaker

- Air is compressed in reservoir up to 14 atmospheric pressure.
- The compressed air is released and directed towards the arc at high velocity
- The arc is then extinguished
- Used for 110 kV and above.

SF6 Circuit breaker

- Sulfur HexaFlouride (SF6) gas is used under pressure.
- It has high electric strength and outstanding arc-quenching characteristics.
- It is an electro-negative gas. It means that the free electrons are attracted to the gas and are not free to move to sustain the arc.

SF6 Circuit breaker

- SF6 Breakers are smaller than air-blast breakers.
- Temperature of up to 30,000 K are experienced in breakers.
- SF6 breakers are used from low voltage system and up to 1300 kV (rating 45 GVA).

Vacuum Circuit breaker

- Interruption chamber is vacuumed.
- No gas which is ionized to form the arc.
- An arc is formed from the vaporized contact material.
- The choice of the contact material is crucial.

Vacuum Circuit breaker

- Very small damage to contacts (life up to 30 years).
- Small mechanical energy required for tripping.
- Widely used in low voltage applications.