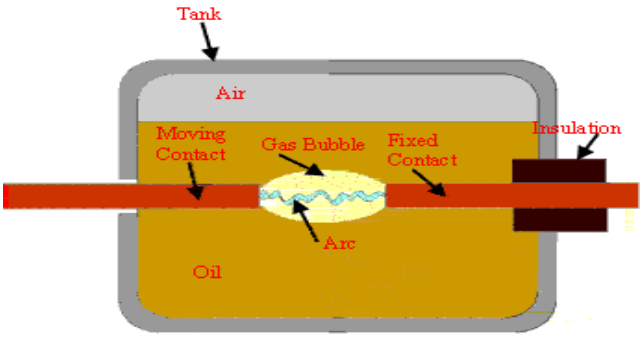
Oil Circuit Breaker

In such circuit breakers, some insulating oil (i.e., transformer oil) is used as an arc quenching medium. The contacts are opened under oil and an arc is struck between them. The heat of the arc evaporates the surrounding oil and dissociates it into a substantial volume of hydrogen gas at a high pressure. This large volume of the hydrogen gas pushes the oil away from the arc.

In an oil circuit breaker, the arc quenching process is entirely dependent on arc energy generated. The arc drawn across the contacts is contained inside the interrupting pot, and thus the hydrogen gas formed by the vaporized oil (gas) is also contained inside the chamber. As the contacts continue to move, and the moving contact rod separates itself from the hole of the chamber, an exit similar to a nozzle (a cylindrical or round spout at the end of a pipe) allows escape of the hydrogen gas trapped inside the interrupting chamber. The escaping high pressure hydrogen gas, having a high thermal conductivity, takes away the heat, thus making the contact gap cool and free from ionization, immediately after current zero.



Conceptual view of Bulk Oil Circuit Breaker

The arc extinction is facilitated mainly by two processes:

1- Firstly, the hydrogen gas has high heat conductivity and cools the arc, thus aiding the de-ionization of the medium between the contacts.
2- Secondly, the gas sets up turbulence in the oil and forces it into the space between contacts, thus eliminating the arcing products from the arc path. This results in extinguishing the arc and as a result the circuit current is interrupted.

Advantages:

As an Arc extinguishing medium oil has the following advantages:
1- Oil absorbs the arc energy to produces hydrogen gas during arcing. The hydrogen has excellent cooling properties and helps extinguish the arc. (In addition to hydrogen gas, a small proportion of methane, ethylene, and acetylene are also generated in oil decomposition.)
2- The oil provides insulation for the live exposed contacts from the earthed portions of the container.
3- Oil provides insulation between the contacts after the arc has been extinguished.
4- The oil close to the arc region provides cooling surface.

Disadvantages:

1- Oil is inflammable and may cause fire hazards. When a defective circuit breaker fails under pressure, it may cause an explosion.
2- The hydrogen generated during arcing, when combined with air, may form an explosive mixture.
3- During arcing, oil decomposes and becomes polluted by carbon particles, which reduces its dielectric strength. Hence, it requires periodic maintenance and replacement.

Types of Oil Circuit Breakers

The oil circuit breakers find extensive use in the power systems. They can be classified with the reference to the quantity of oil used. The types are:

1- Bulk Oil Circuit Breakers 2- Minimum Oil Circuit Breakers

a) Bulk Oil Circuit Breakers

These circuit breakers use a large quantity of oil. The oil has to serve two purposes:

1. It extinguishes the arc during opening of contacts.
2. It insulates the current conducting parts from one another and from the earthed tank.

In the bulk oil circuit breakers, the interrupting unit is placed in a tank of oil at earth potential and the incoming and outgoing conductors are connected through insulator bushings.

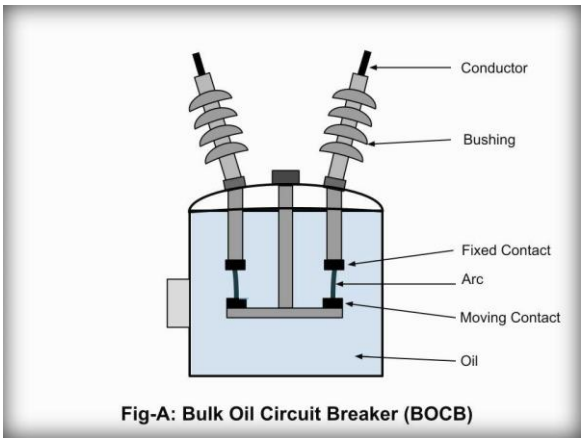


Fig-A: Bulk Oil Circuit Breaker (BOCB)

Figure: Oil Circuit Breaker

b) Minimum Oil Circuit Breakers

These circuit breakers use a small quantity of oil. In such circuit breakers, oil is used only for arc extinction; the current conducting parts insulated by air or porcelain or organic insulating material.

In these circuit breakers, the oil requirement can be minimized by placing the interrupting units, in insulating chambers at live potential, on an insulator column.

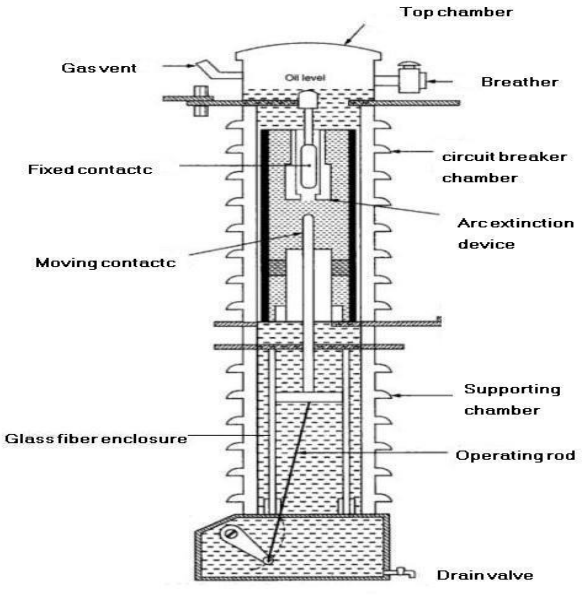
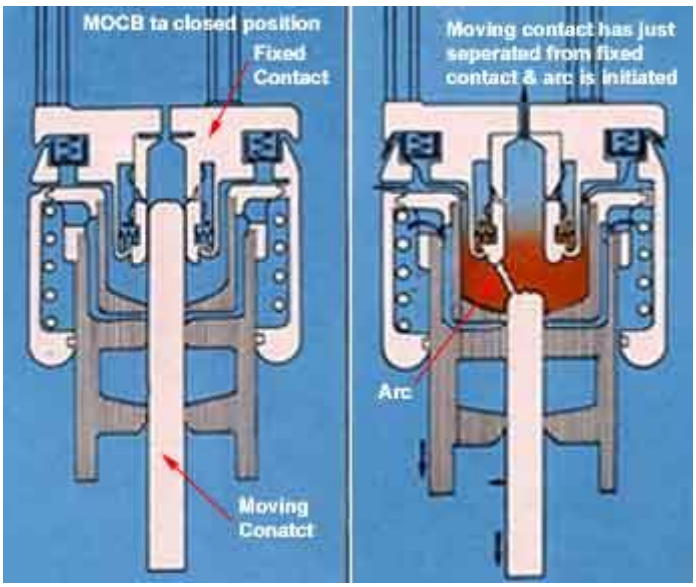


Fig: Simplified diagram of an outdoor minimum oil circuit breaker pole, with one interrupter

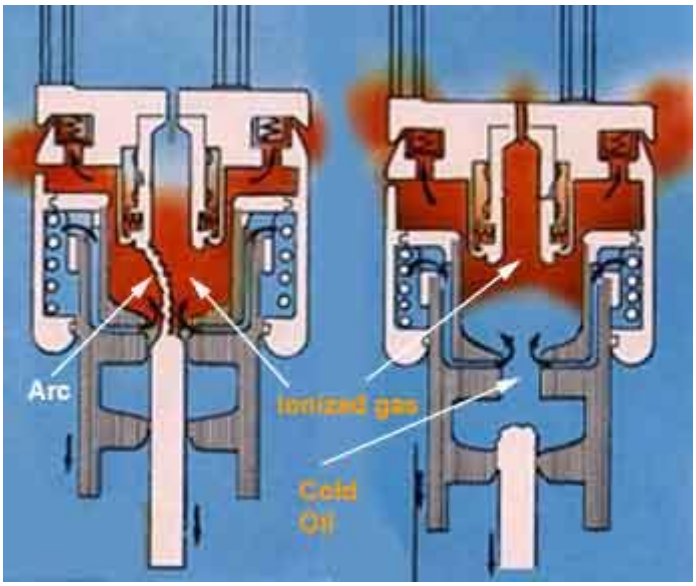
Working Principle or arc quenching in minimum oil circuit breaker

Working Principle of minimum oil circuit breaker or **arc quenching in minimum oil circuit breaker** is described below. In a **minimum oil circuit breaker**, the arc drawn across the current carrying contacts is contained inside the arcing chamber. Hence the hydrogen bubble formed by the vaporized oil is trapped inside the chamber. As the contacts continue to move, after its certain travel an exit vent becomes available for exhausting the trapped hydrogen gas. There are two different types of arcing chamber is available in terms of venting are provided in the arcing chambers. One is axial venting and other is radial venting. In axial venting, gases (mostly Hydrogen), produced due to vaporization of oil and decomposition of oil during arc, will sweep the arc in.

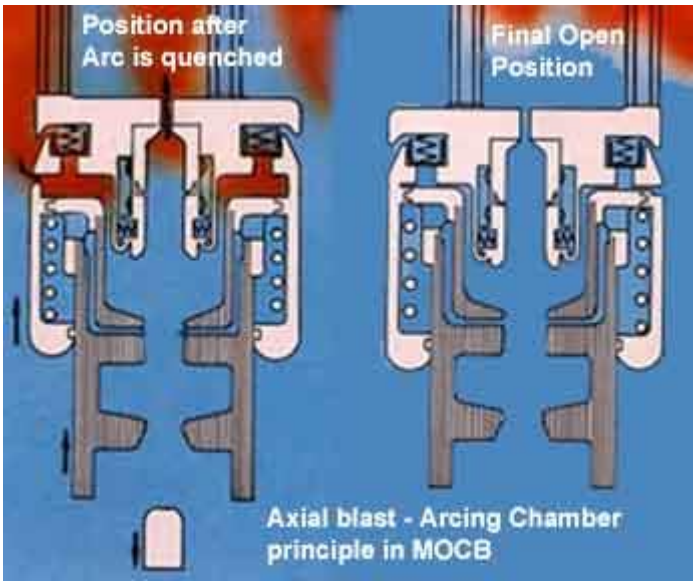
Let's have a look on **working principle Minimum Oil Circuit Breaker** with axial venting arc chamber



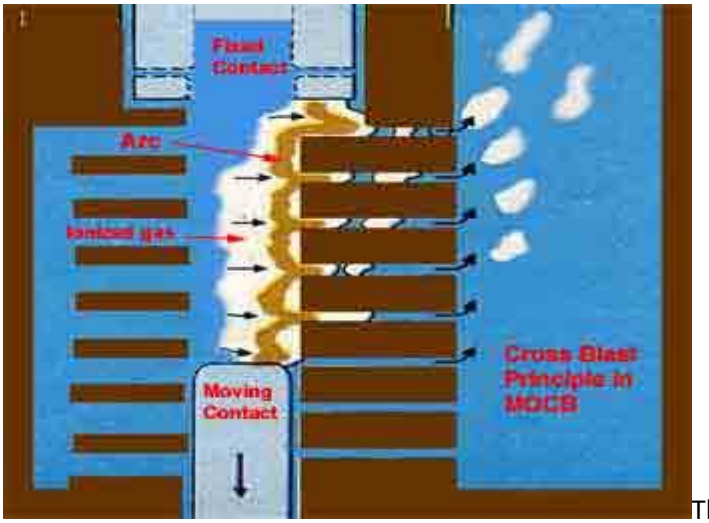
The moving contact has just been separated and arc is initiated in **MOCB**.



The ionized gas around the arc sweep away through upper vent and cold oil enters into the arcing chamber through the lower vent in axial direction as soon as the moving contact-tip crosses the lower vent opening and final **arc quenching in minimum oil circuit breaker** occurs



The cold oil occupies the gap between fixed contact and moving contact and the minimum oil circuit breaker finally comes into open position.

Whereas in case of radial venting or cross blast, the gases (mostly Hydrogen) sweep the arc in radial or transverse direction. 

The axial venting generates high gas pressure and hence has high dielectric strength, so it is mainly used for interrupting low current at high voltage. On the other hand radial venting produces relatively low gas pressure and hence low dielectric strength so it can be used for low voltage and high current interruption. Many times the combination of both is used in minimum oil circuit breaker so that the chamber is equally efficient to interrupt low current as well as high current. These types of circuit breaker are available up to 8000 MVA at 245 KV.

The main difference between the minimum oil and the bulk oil circuit breakers is that minimum oil circuit breakers use oil only for the interrupting function while a solid insulating material is used for dielectric purposes, as opposed to bulk oil circuit breakers where oil serves both purposes.