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Review on Circuit Breakers

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***Abstract*— Any power system needs protection to protect it from any undesirable fault currents and that's why we have protection devices such as Circuit breakers which will break the current during faults to protect the system. This paper shows the basic classification of circuit breakers types and the basic knowledge for students to know this information.**

***Keywords*— Circuit Breaker, SF6, Vacuum, Air Blast, Air-Break**

I. INTRODUCTION

Circuit breakers break the current during faults by opening the contacts which were closed during the normal operation conditions, to isolate the fault part of the power system. There are different types of Circuit breakers that go under different classifications depend on different aspects shown in this paper.

II. CIRCUIT BREAKERS

The circuit breakers are capable of making, carrying, and breaking currents under normal circuit conditions. This relates to making and then carrying currents for a specific time, as well as breaking currents under specified abnormal circuit conditions such as those of short circuit.[2] Circuit breakers are used in the power system to protect it from any undesired fault by breaking the circuit or as we say open the circuit to interrupt the current. We have different classification for circuit breakers depends on different aspects depending on the voltage level, installation location, external design, and the interrupting medium. [1]

III. CIRCUIT BREAKERS TYPES CLASIFICATION

A. Circuit breakers types classification by voltage level

1) Low Voltage Circuit Breakers: By its name, they deal with low voltages which is usually less than 1 kV.

2) High Voltage Circuit Breakers: There are two mains different HV ratings, the first one deals with 132kV and above, the second one deals with 72kV and below.

B. Circuit Breakers types classification by installation location

1) Indoor Circuit Breaker: Any building which has 4 walls and a roof is considered as an indoor location even if its door is kept open for entry of vehicles.

2) Outdoor Circuit Breaker: In addition to the outdoor locations, a building that has 3 walls with a roof is considered as an outdoor location.

C. Circuit Breakers types classification by external design

Both of them (Dead Tank and Live Tank Circuit Breakers) are considered as Outdoor Circuit Breakers.

1) *Dead Tank Circuit Breaker*: There enclosures and current interrupters grounded at the ground level.

Fig. 1. A Dead Tank Circuit Breaker

2) *Live Tank Circuit Breaker*: On the opposite to the dead tank circuit breaker, the interruption is above
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Fig. 2. A Live Tank Circuit Breaker

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D. Circuit Breakers types classification by interrupting medium

1) Oil Circuit Breaker: Oil can be classified as an insulation between the live parts because it has good dielectric strength. Arc can be cooled down by the high-pressure gas produced by the Oil interrupting medium, this interrupting called the self-extinguishing technique. During the interruption, the oil will produce a bubble that contains Hydrogen. Compared to other types of gasses, arc burning in hydrogen extinguished faster but cannot be practically handled. Considering the interruption methods there are two types of Oil Circuit breakers:

1.1) Bulk Oil type

Plain-break Circuit Breakers is an example of the Bulk Oil type, it interrupts the arc freely in oil. The disadvantage of these CB is that when they explode, they cause environmental problems and they require large space because of the large amount of oil required.

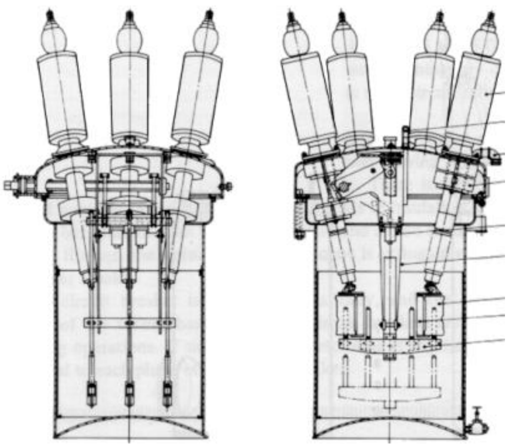

Fig. 3. Bulk oil circuit-breaker (Source: Allis Chalmers Ltd.)

1.2) Minimum Oil type

Smaller space and less oil than bulk oil type and the interruption happen in an explosion chamber. The insulation is made of Porcelain or solid insulating materials which is the difference between Minimum and bulk oil types. [1]

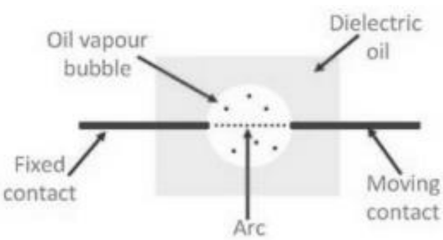

Fig. 4. Oil CB operation principal

2) Air-Break Circuit Breakers: It uses air at atmospheric pressure as the medium to interrupt the current, best used for low voltages with the high interrupting current. They are available for 400V to 12kV voltages. [3]

3) Air blast Circuit Breakers: Compressed air at 20-30 kg/cm2 pressure used as a quenching medium. Air is available for free and these types of CB are cheap with operation at high speed. There are two types of Air blast CB*:*

3.1) Cross-blast Circuit Breaker

The high-pressure blast air directed perpendicularly to the arc for the interruption.

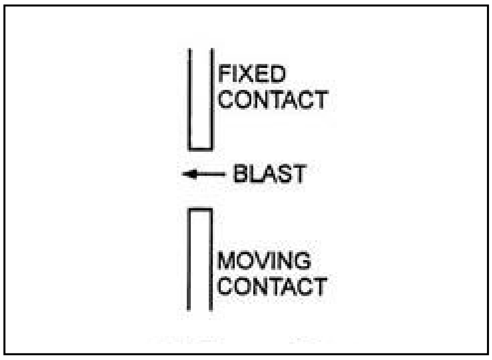

Fig. 5. Cross-blast Circuit Breaker

3.2) Bulk Oil type

Here the high-pressure air directed longitudinally with the arc, the best use for EHV because the interrupting channels in porcelain tubes can be fully enclosed. [3]

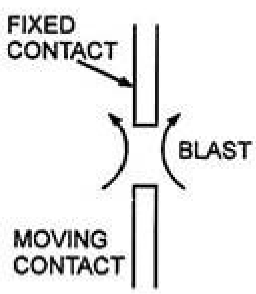

Fig. 6. Axial Blast Circuit Breaker

4) SF6 Circuit Breaker: The main advantages are they have a good arc quenching property and good dielectric strength, SF6 is non-flammable, non-toxic, and heavy gas. But SF6 is a greenhouse gas with a huge impact on global warming. [8] It's a chemical inert at the normal condition. The dielectric strength around 2.35 times of air at atmospheric pressure which makes SF6 Circuit Breakers smaller in dimensions and the contact gaps are shorter. SF6 Circuit Breakers suitable for 3.3kV to 765V voltages range and preferred for 132kV and above. There are two types of SF6 Circuit Breakers:

4.1) Single Pressure Type SF6 Circuit Breakers

The most popular type of design works by compressing the gas by moving the cylinder system and releasing it through the nozzle during arc extinction.

4.2) Double Pressure Type SF6 Circuit Breakers

An obsolete type works by employing a double pressure system which was the gas during the arc extinction process released from high pressure to low pressure compartment. [3]

5) Vacuum Circuit Breaker: At atmospheric pressure, high vacuum interruption and dielectric strength are far better than oil, SF6, and porcelain. Comparing it to the other types of circuit breakers, the construction is simple. The arc drowns between the separated contacts in high vacuum take place on a few spots of the contact surface. Porcelain, glass, and glass fiber reinforced plastic are the insulation materials types in the enclosure. [3]

IV. CONCLUSIONS

Circuit breakers play a big and important part in protecting the power system to save lives and protect critical machines, devices, and other parts from any damage that may be caused by the fault current. There are several classifications for circuit breakers based on its operation, voltage level, packaging etc.

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