Government Polytechnic College Alwar

Department of Electrical Engineering

Second Mid Term Test 2017-18

Switchgear and Protection (EE-309)

Time: 1 Hr | Date: 19/01/2018 | Max Marks: 15

Attemp all Questions.

Q: 1 Write various Arc extinction methods used in circuit breakers. **5 Marks**

Q:2 Write Construction ,working and application of

(a) SF6 circuit breaker (b) Air Blast circuit breaker **5x2=10 Marks**

IInd mid term Test 2017-18. 309(1/5)

Sub:- Switchgear & protection, code EE-309.

Soln (1) :-

Methods of Arc Extinction in Circuit Breaker

There are two methods of extinguishing the arc in circuit breakers

1. High resistance method
2. Low resistance or current zero method.

1. High Resistance Method

In this method, arc resistance is made to increase with time so that current is reduced to a value insufficient to maintain the arc. Consequently, the current is interrupted or the arc is extinguished.

The principal disadvantage of this method is that enormous energy is dissipated in the arc. Therefore, it is employed only in d.c. circuit breakers Land low-capacity a.c. circuit breakers.

The resistance of the arc may be increased by

- ***Lengthening the arc*** - The resistance of the arc is directly proportional to its length. The length of the arc can be increased by increasing the gap between contacts.
- ***Cooling the arc*** - Cooling helps in medium between the contacts. This increases the arc may be obtained by a gas resistance. Efficient cooling blast directed along the arc.
- ***Reducing X-section of the arc*** - If the area of X-section of the arc is reduced, the voltage necessary to maintain the arc is increased. In other words, the resistance of the arc path is increased. The cross section of the arc can be reduced by letting the arc pass through a narrow opening or by having smaller area of contacts.
- **Splitting the arc** - The resistance of the arc can be increased by splitting the arc into a number of smaller arcs in series. Each one of these arcs experiences the effect of lengthening and cooling. The arc may be split by introducing some conducting plates between the contacts.

2. Low Resistance or Current zero Method

This method is employed for arc extinction in AC Circuits only.

In this method, arc resistance is kept low until current zero where the arc extinguishes naturally and is prevented from restriking inspite of the rising voltage across the contacts.

All modern high power AC Circuit Breakers employ this method for arc extinction.

In an a.c. system, current drops to zero after every half-cycle. At every current zero, the arc extinguishes for a brief moment.

Now the medium between the contacts contains ions and electrons so that it has small dielectric strength and can be easily broken down by the rising contact voltage known as restriking voltage.

If such a break-down does occur, the arc will persist for another half-cycle. If immediately after current zero, the dielectric strength of the medium between contacts is built up more rapidly than the voltage across the contacts, the arc fails to restrike and the current will be interrupted. The rapid increase of dielectric strength of the medium near current zero can be achieved by

- (a) causing the ionised particles in the space between contacts to recombine into neutral molecules.
- (b) sweeping the ionised particles away and replacing them by unionised particles.

Therefore, the real problem in AC arc interruption is to rapidly deionise the medium between contacts as soon as the current becomes zero so that the rising contact voltage or restriking voltage cannot breakdown the space between contacts. The de-ionisation of the medium can be achieved by

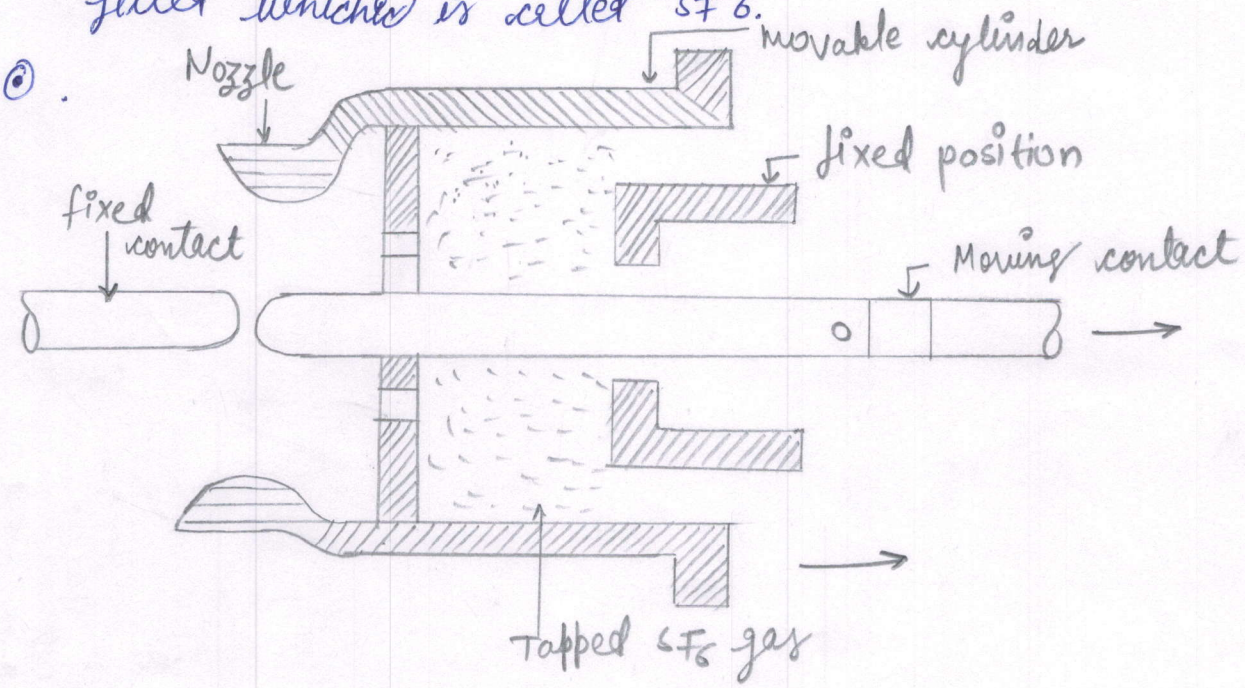
- (i) *lengthening of the gap* : The dielectric strength of the medium is proportional to the length of the gap between contacts. Therefore, by opening the contacts rapidly, higher dielectric strength of the medium can be achieved.
- (ii) *high pressure*. If the pressure in the vicinity of the arc, is increased, the density of the particles constituting the' discharge also increases. The increased density of particles causes higher rate of de-ionisation and consequently the dielectric strength of the medium between contacts is increased.
- (iii) *cooling* : Natural combination of ionised particles takes place more rapidly if they are allowed to cool. Therefore, dielectric strength of the medium between the contacts can be increased by cooling the arc
- (iv) *blast effect* : If the ionised particles between the contacts are swept away and replaced by un-ionised particles, the dielectric strength of the medium can be increased consider-ably. This may be achieved by a gas blast directed along the discharge or by forcing oil into the contact space.

Sol^{n} (2) :-

(a) SF_6

◎ construction :- In SF_6 circuit breaker, there are two contacts, one is movable contact and other one is fixed contact. In this circuit breaker a gas is filled which is called SF6.

◎ .



◎ working :- SF_6 gas which is filled in this circuit breaker has the dielectric strength and arc interrupting ability of high Vacuum is superior to those of porcelain, oil, air and SF_6 at atmospheric pressure.

• SF_6 at atmospheric pressure, its dielectric strength is about 2.5 times that of air. At 3 atmospheric pressure its dielectric strength is equal to that of transformer oil. It is an electronegative gas, i.e, it has high affinity for electrons. when a force free electrons comes in collision with a neutral gas molecule, the electron is absorbed by the neutral gas molecule and a negative ion is formed. As the negative ions so formed are heavy they do not attain sufficient energy to contribute to ionisation of the gas. This property gives a good dielectric preoperty. besides good dielectric strength, the gas has an excellent property of recombination after the removal of the source which energize the arc. this gives an excellent arc quencing property. The gas has also an excellent heat transfer property. its thermal time constant is about 1000 times shorter than that of air.

under normal conditions, SF_6 is chemically inert and it does not attack metals or glass. However, it decomposes to SF_4, SF_2, S_2, F_2, S and F at temperatures of the order of 1000°C. After the extinction, the products of decomposition recombine in a short time, within about 1 micro second. In the presence of moisture, the decomposition

products can attack contacts, metal parts and rubber seelings in SF_6 circuit breaker. therefore, the gas in breaker must be moisture free. to absorb decomposition products, a mixture of soda lime ($NaOH + CaO$) and activated alumina can be placed in the arcing chamber.

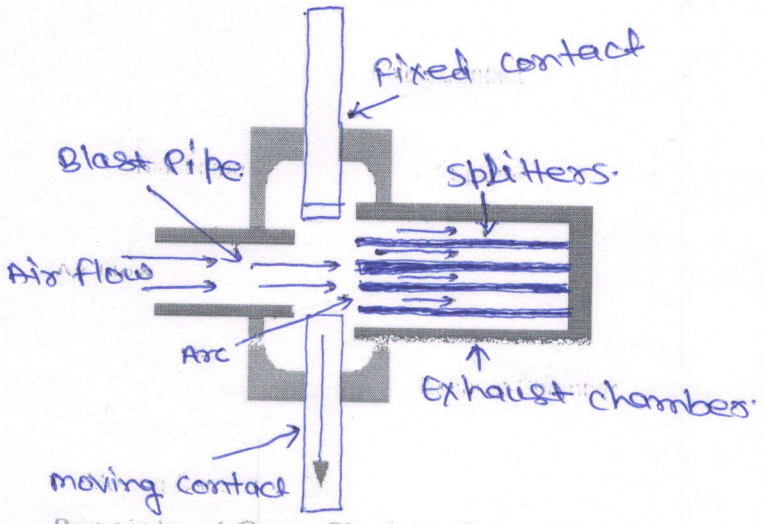
⊙ Application :- SF_6 circuit breaker are manufactured in the voltage range 3.6KV to 765 KV however, they are prefered for voltages 132KV and above.

Soln:

(2) (b)

Air Blast Circuit Breaker:-

Construction and Working:-



Principle of Cross Blast Air Circuit Breaker

The working principle of cross blast air circuit breaker is quite simple. In this system of air blast circuit breaker the blast pipe is fixed in perpendicular to the movement of moving contact in the arcing chamber and on the opposite side of the arcing chamber one exhaust chamber is also fitted at the same alignment of blast pipe, so that the air comes from blast pipe can straightly enter into exhaust chamber through the contact gap of the breaker. The exhaust chamber is spit with arc splitters. When moving contact is withdrawn from fixed contact, an arc is established in between the contact, and at the same time high pressure air coming from blast pipe will pass through the contact gap and will forcefully take the arc into exhaust chamber where the arc is split with the help of arc splitters and ultimately arc is quenched.

Advantages Air Blast Circuit Breaker

These types of circuit breaker were used for the system voltage of 245 KV, 420 KV and even more.

1. There is no chance of fire hazard caused by oil.
2. The breaking speed of circuit breaker is much higher during operation of air blast circuit breaker.
3. Arc quenching is much faster during operation of air blast circuit breaker.
4. The duration of arc is same for all values of small as well as high currents interruptions.
5. As the duration of arc is smaller, so lesser amount of heat realized from arc to current carrying contacts hence the service life of the contacts becomes longer.
6. The stability of the system can be well maintained as it depends on the speed of operation of circuit breaker.
7. Requires much less maintenance compared to oil circuit breaker.