# CURRENT RATING OF FUSES AND MCBS

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## CALCULATIONS:

For the fuse   $\text{Fusing Factor} = \dfrac{\text{Minimum over current required to blow the fuse}}{\text{Current rating of the fuse}}$

For MCB  $\text{Tripping Factor} = \dfrac{\text{Minimum over current required to trip off the MCB}}{\text{Current rating of the MCB}}$

From graphs drawn,

**Fusing current** for 5A fuse =

Fusing Factor =

**Tripping current** for 2A MCB =

Triping Factor =

## RESULTS

| | |
|---|---|
| **Fusing Factor** | |
| **Tripping Factor** | |

## DISCUSSION:

Fuses and Miniature Circuit Breakers (**MCBs**) are used to protect electrical equipment and for the safety of the users. The conditions that require circuit protection are direct shorts, excessive current and excessive heat. When one or more of these conditions occur the above protective devices (connected in series with the supply) are able to disconnect the circuit thus preventing the danger.

### Fuses

Circuit symbol:

This provides protection by melting due to the heat produced because of ohmic resistance, when a higher than a rated current flows through it. There are three main types of fuses,

Re-wirable fuses

These have a thin wire that is held on a ceramic holder. The wire is designed to burn when a high current passes. An advantage is the reusability but it is vulnerable to mishandling where incorrect fusing elements can be fitted by inexperienced people, putting users in danger. Other Problems with this type are the oxidization (causes the cross section of the wire to reduce reducing the current carrying capacity) and longer fusing time.

Cartridge fuses

Fuse wire is enclosed in an inert environment. Once burnt, the fuse has to be replaced i.e. a repetitive cost when replacing.

High Rupture Capacity (**HRC**) fuses

These are used for high current protection. These have a ceramic outer barrel. The fuse wire is covered with sand in order to quench the arc produced when the fuse burns. The ceramic barrel can withstand the shock of the interruption of the high current.

Usually semi-enclosed rewireable fuses have about 1.7-2 times the rated current carrying capacity. In this practical the fusing factor was . This value is rather high. However the value might not be the exact fusing factor of the fuse used due to the errors that are present in the practical.

**MCBS**

Circuit symbol:

The MCB has several advantages over fuses which have been the reason that it has replaced the fuse in most domestic applications, these being reusability, reliability and added safety. Since there is a trip, the MCB can be used simply by tripping it back on. Also they have better response times and are also far more reliable. Added this won't be affected by the previous tripping and there is no room for mishandling. There are two main types of MCBs based on the principle employed for the tripping. These are;

Magnetic Mechanism

This is also called as instantaneous trip mechanism. This operates when there is a high current (may be a short circuit) in the current path. This uses a solenoid with an iron piece. When the circuit current is above a certain level, the magnetic field strength produced will cause the iron piece to move in the direction of solenoid causing the circuit breaker to trip

Thermal Mechanism

A bimetal strip is used as part of the current carrying path. This mainly operates in overload conditions. When there is an overload, the increased current flow heats the bimetal and causes it to bend. As the bimetal bends, it touches and rotates the trip bar causing the circuit breaker to trip. The tripping time of the circuit beaker varies inversely with the current. Used for fixed house circuit wiring protection (overload & short circuit) where normal household appliances are in use

Since the bimetal strip has to heat up to deform the tripping is not as fast as in the magnetic mechanism. Therefore magnetic mechanism is preferred over thermal mechanism. In cases where some equipments require a high current at the start, the thermal mechanism is used.

For the MCB the tripping factor is usually with in 1.5-2. The value obtained in the practical was . This value too is high. However this could be also attributed to the errors. As the time period for tripping is lower the error percentage can be higher than in the fusing factor practical

The tripping/fusing factor changes from the actual values may be due to following practical errors.

- Physical defects and damages on the fuse wire.
- Errors in drawing the graph, difficulty of choosing the line of best fix.
- Errors caused due to the magnetism or heat being retained in the MCB.
- The difficulty in reading the initial current at the point of switching on the circuit.
- Difficulty in measuring the time accurately, especially when the time take to fuse/trip is only a few seconds (particularly in the MCB practical).

In our practical the fusing factor of the 5A fuse was 2.97 where as the MCB had a tripping factor of 1.35. This means that the MCB is far better than the Fuse in terms of response time. In actuality the ideal factor should be above one because normally it is necessary to allow the circuit to the capacity to carry some amount of current higher than the recommended. Else the protection device will disconnect the circuit every time there is a slight surge. Also the protection device will take different times to disengage for different currents because the time the current flows through is equally important as the size of the current. A large current for a very small time dose not harm the equipment and the fuse/MCB has that included. In the experiment the fuse showed variable fusing times even for the same current some times not even fusing at all for a long time. Thus it is evident that apart from responsiveness the MCB has the edge in reliability as well.

**Advantages of using MCBs in place of Fuses**

- Reacts faster than fuses i.e. damage is minimal - Although the fuse requires a very high current to burn within a short period the MCB will trip during a very short period even if the current is not much more that the minimum tripping current. Therefore the damage that can be done to the equipment due to over current is reduced when using MCBs.

- Easier to reset/use - The fuse must be rewired once burnt but MCB needs just a pulling of a tab.

- No mishandling – There is a great chance of using a wrong fuse wire in a normal fuse. Using a thicker wire will cause more current to flow damaging the equipment. Using thinner wire will cause the fuse to burn unnecessarily causing disruption and hassle. But MCB avoids all these problems.

- Rewireable fuses tend to weaken with time due to oxidization. So the fuse will not be able to withstand the rated current.

**Other Protection Techniques**

1. Large Current Protection - Here simply breaking the circuit is not enough to stop the flow of current. The current in some circuits is strong enough to jump, or arc, across the gap in the circuit, even after the circuit breaker has been tripped. Circuit breakers that deal with high levels of current, especially direct current, have methods of getting rid of the energy in the arc and stopping the current.

- In oil breakers, the design of the circuit breaker forces the arc of broken circuit through a sealed container of oil or gas. The arc heats the oil around it. The hot oil begins to circulate in the tank, carrying heat and energy away from the arc.

- Air-blast circuit breakers send the arc through compressed air, which is immediately released to the outside, carrying the heat and energy of the arc with it.

2. Fuses used in vehicles and motors - Some of these fuses are Ribbon type, Knife blade cartridge type, Plug type with ribbon tube, Copper fuse link, Fibre tube, Cartridge type with glass tube and wire fuse link.

3. Sensitive Equipment - Fuses used in 13A plug tops as well as in some sensitive equipment for additional protection (voltage stabilizers, computer power supplies) – These are mostly cartridge type fuses.

## REFERENCES

Electrical Engineering Handout