Introduction
According to IBIS World, the market value for the power circuit breaker manufacturing industry is $3.4 billion. Understanding the different circuit breaker types can be tricky, especially if you don't have an electrical background. There are many types, from home to commercial usage that you should know about.

A circuit breaker is an electrical component that switches either manually or automatically to control a power system. All buildings with electricity must have circuit breakers. On a bad day, a circuit breaker can save your premises and employees from shock, electrical fire, or even electrocution.

Circuit breakers offer electrical protection to people and equipment from sudden surges, overloads, and short circuits. This article guides you through the different types of circuit breakers.

Classification of Circuit Breakers
Circuit breakers can be classified according to different mechanisms. The criteria below are used to classify circuit breakers:

- Voltage
- Interruption Mechanism
- Installation Location
- Features or Design

These are the most popular classes of circuit breakers that you will ever encounter. To understand each classification well, below is a breakdown of the circuit breaker types.

1. Voltage
Circuit breakers are classified according to their voltage rating. The amount of power that can pass through the breaker can determine what type of a circuit breaker it is. Under voltage, a circuit breaker can fall into three categories;

- High-voltage circuit breakers
- Medium-voltage circuit breakers
- Low-voltage circuit breakers

Different types of circuit breaker types are suited for different applications.
High-Voltage Circuit Breakers
According to the International Electro-Technical Commission, when the voltage rises above 72,000 volts, it ranks as high voltage. High voltage circuit breakers are not the common ones you see in your building. These circuit breakers use solenoids that are usually operated by current transformers and protective relays.

High voltage circuit breakers are used in a system with very high voltage such as power transmission lines. They are very complex but highly capable of minimizing overcurrent.

To break the arc, these circuit breakers use different methods such as oil, air blast, carbon dioxide, or vacuum. However, sulfur hexafluoride has become more popular because of its environmental friendliness.

Medium-Voltage Circuit Breakers
These circuit breakers handle less voltage than their high voltage counterparts. Generally, they are used for voltage between 1,000 and 72,000 volts. Also, they can be installed for both indoor and outdoor use.

These circuit breakers help in monitoring medium voltages and use protective relays to check any dangerous abnormalities.
Low-Voltage Circuit Breakers
What you see around your workplace is probably a low-voltage circuit breaker. These are the same basic type of circuit breakers that you can purchase at the hardware store in your town.

Some low voltage circuit breakers are serviceable and can be disassembled. In case of damage, you could repair the circuit breaker without having to make a replacement.

There are different types of low-voltage circuit breakers; Miniature Circuit Breakers (MCB) are used for handling current below 100 amps. They are a favorite for applications that don't have high currents. If your application has current exceeding 100 amps, a molded-case circuit breaker (MCCB) might be ideal.

There are two types of circuit breakers commonly called MCB's, UL 489 and UL 1077.

**UL 489 Circuit Breakers**
UL 489 circuit breakers are “intended for installation in a circuit breaker enclosure or as parts of other devices, such as service entrance equipment and panelboards.” They are regularly required on panel designs, per the National Electrical Code.

**UL 1077 Supplementary Protectors**
UL 1077 defines supplementary protectors as devices intended for use as overcurrent, over-voltage or under-voltage protection within an appliance or other electrical equipment where branch-circuit overvoltage protection is already provided or is not required.

*Important Note: While the term circuit breaker is used to describe both UL 489 and UL 1077 devices, UL 1077 devices are not considered Circuit Breakers by UL. They are defined as Supplementary Protectors.*
2. Interruption Mechanism
The interruption mechanism is how the circuit breakers cut the flow of current. Different circuit breakers function differently from the others. There are four types of interruption mechanisms:

- Air circuit breakers
- Oil circuit breakers
- Sulfur hexafluoride circuit breakers
- Vacuum circuit breakers

Each method has different advantages when breaking an arc.

Air Circuit Breakers
In this circuit breaker, the air is the primary insulating and interrupting mechanism. They are either air blast or air magnetic circuit breakers. When breaking the current, the air is initiated by the static air in which the arc moves.

Magnetic breakers interrupt the arc using the magnetic field as interruption medium.

Air blast circuit breakers use a blast of the air. This blast blows out the arc with compressed air stored in nozzles. This air is released through the vents thus producing a high-velocity jet which extinguishes the arc.
Oil Circuit Breakers

Mineral oil is most often used to break the arc in this type of breaker. Oil is highly preferable to air because of its insulating properties. Both the fixed and moving contacts are immersed in the oil.

During the breaking of the circuit, the arc is initialized at the point of separation. The arc in the oil is decomposed and vaporized as hydrogen gas, which finally creates a hydrogen bubble. The compressed hydrogen gas prevents the re-striking of the arch as the current reaches zero.

Oil circuit breakers are the oldest known breakers. There are two types of oil circuit breakers, namely minimum oil and bulk oil, or tank circuit breakers.

The minimum oil circuit breakers utilize oil during the interruption. This circuit breaker uses a minimal amount of oil since there is an insulating media between the current carrying contacts and the earth parts. The insulating material is available in the interrupting chamber and requires minimal oil.

The bulk oil circuit breaker uses oil as both the insulating and quenching media. When the current-carrying contacts are separated, the arc is generated between the contacts. This arc produces a rapid gas bubble around it, thus moving the contacts away.

Oil Circuit Breakers can be classified according to their structural designs. This category has two types of circuit breakers:

- Live tank circuit breakers
- Dead tank circuit breakers

These two circuit breaker types have a different construction.

Dead tank circuit breakers are the most preferred in the US. This circuit breaker has an enclosed tank at its ground. The tank encloses the insulating and interruption mediums.

A live tank breaker has the tank above the ground. This tank houses the insulation medium between it. The dead tank model offers higher seismic withstand capability because it’s near the ground.
In live tank circuit breakers, the enclosure that houses the contacts is energized, i.e. “live”. Dead tank circuit breaker’s contact enclosures are not energized and are connected to the ground grid. Live tank breakers are less expensive than dead tank breakers and require less space.

**Sulfur Hexafluoride Circuit Breakers**

In this circuit breaker, Sulfur Hexafluoride (SF6) gas is used to extinguish the arc. This gas has a great extinguishing property. Many manufacturers prefer sulfur hexafluoride gas over oil and air.

Sulfur hexafluoride has high electronegativity, perfect for insulation. It has about twice the insulating property as air. It is useful in both medium to high voltage electrical systems.

SF6 gas has excellent insulating, arc extinguishing and many other properties which are the greatest advantages of SF6 circuit breakers.
**Vacuum Circuit Breakers**

A vacuum medium is used to extinguish the arc in this breaker. The vacuum has a dielectric recovery character that provides excellent interruption, especially during the high-frequency current. This interruption mechanism uses electrodes that remain closed during normal operation.

When a fault is identified in the system, the trip gets energized, thus breaking the contact. When the electrodes open, an arc is produced by the ionization of the contacts. The arc then quickly extinguishes because the electrons and ions condense on the surface of the electrons. This result in the recovery of the dielectric strength.

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### 3. Installation Location

Circuit breakers are used in different installations. Depending on the requirements, they can be installed indoors or outdoors.

Indoor circuit breakers are designed to be installed in protected enclosures. These breakers should be installed in buildings for protection from weather conditions. Metal clad switchgear enclosures operate the indoor circuit breakers at medium voltage.

On the other hand, outdoor circuit breakers do not require any protection or roofing. They have stronger enclosure arrangements compared to their indoor counterparts. They are unaffected by wear and tear and are used for more complex power systems.

The only difference between these two models is that the outdoor ones are enclosed. The circuit interruption mechanism is the same for both types.
Identifying the Right Circuit Breaker
At some point in your workplace, you may need to buy or change a circuit breaker. This is the guide to the best circuit breaker for your application.

1. Voltage Rating
When choosing the circuit breaker type, consider the overall voltage rating of the electrical system. This rating is calculated by the highest voltage that can be applied across all end ports. Also, the voltage distribution and circuit breaker integration apply during voltage calculation.

The circuit breaker should have enough voltage capacity to meet the requirements of the end application.

2. Current Rating
The operating current or amperage is a factor to consider when choosing a circuit breaker. The circuit breaker should operate at 100% of the required load. However, you are advised to choose a circuit breaker approximately 120% of the required load.

A higher amperage helps offset the effects of heat generation in the power system. The amperage rating is the continuous current carried in the ambient temperature. Circuit breakers should be calibrated to a standard 104°F.

All the source of information about the load cycle is obtained from the National Electrical Code.

3. Trip Curve
To choose a circuit breaker, you need to determine which trip curve is the correct one for your application.

What is a trip curve?
Simply put, a trip curve, also know as a time current curve, is a graphical representation of the expected behavior of a circuit protection device.

Trip curves plot the interrupting time of overcurrent devices based on a given current level. They are provided by the manufacturers of circuit protection devices to assist users with selecting devices that provide proper equipment protection and performance, while avoiding nuisance tripping.
4. **Maximum Interrupting Capacity**
   The maximum amount that the current breaker can interrupt is the interrupting rating. It is crucial to determine the maximum interrupting rating of the power system. When buying a circuit breaker, the interrupting capacity must be equal or greater or equal than the fault current.

   An interrupting capacity less than the amount of fault current can damage the circuit breaker. This rule must always apply when purchasing any circuit breaker.

5. **Operating Conditions of the Circuit Breaker**
   When selecting the circuit breaker, it is essential to mind the location of usage. Some working conditions are very unforgiving for circuit breakers. Consider the following conditions when determining the circuit breaker to use.

   **Ambient Temperature**
   An ambient temperature higher than 104°F requires calibration. High ambient temperatures can alter the performance of the circuit breaker. Since most enclosures are about 104°F, this is the standard calibration for almost all indoor circuit breakers.

   Anything lower or higher than 104°F might require you to upward or downward calibrate.

   **Altitude**
   Different circuit breakers fit different altitudes. For instance, in high altitudes above 6,000 feet, the air is thinner and does not conduct heat away from the current-carrying components. This means that the circuit breaker has to be calibrated for voltage, carrying ability, and interrupting capacity.

   Thinner air prevents the build-up of dielectric charge that is capable of withstanding the voltage levels. Also, altitude can de-rate the power generation equipment. Talk to a power generation expert before purchasing circuit breakers for high altitudes.

   **Moisture and Corrosion**
   For humid conditions, there is a unique moisture treatment recommended for the circuit breakers. Treatment of circuit breakers helps in resisting fungus and mold, which are notorious for destroying the systems. In environments with high humidity, space heaters are often used in the enclosures.

   Corrosion affects the components of the circuit breakers and thus leading to faulty systems. If they have to be used in corrosive areas, specially manufactured ones that are corrosion resistant should be used.

   **High Shock Probability**
   Some workplaces tend to have high probabilities of electrical shocks. In this case, anti-shock devices should be installed to prevent any mishaps.

   Anti-shock devices consist of inertia counterweights over the poles that hold the trip bar. This weight, however, should not interrupt the functionality of the thermal or magnetic trip units.

6. **Maintenance**
   The maintenance requirements of the circuit breaker should also be considered when determining the appropriate circuit breaker. You should consider circuit breakers that require minimal maintenance. If you have to perform some maintenance on the circuit breakers, it should be easy with minimal cost.

   Molded circuit breakers are reliable because the closed unit has minimal exposure to dust, mold, moisture, and dirt. The enclosed models require minimal maintenance than the open models.

   Some circuit breakers require constant cleaning to reduce overheating and damage, therefore, the breakers should open freely for maintenance.
The Bottom Line
The operations of circuit breakers are not only complex but also delicate. A slight mishap can have far-reaching consequences. The circuit breaker you use in your applications should be highly reliable (limited false trips) and accurate.

Whenever making a move on circuit breakers, it is vital to engage certified electricians. Never attempt to operate the circuit breaker on your own. Always ensure the safe operation of all power systems in your business.

Research on different circuit breaker types before making a purchase. A great circuit breaker will save you from loss of property or even life.

For all your electrical control needs, be sure to check out our products.

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