Frequently Asked Questions about the Magnetic Actuators and AMVAC Circuit Breakers

Are the permanent magnets dependent on temperature?

At an ambient temperature of 120°C, the flux density of Koerdym 280[1] is reduced only fractions of percent over a 100 year time period. With a standard service life of 30 to 40 years for medium voltage equipment, safe operation is therefore in no way impaired. In addition, the maximum permissible temperature for switchgear under normal operating conditions is 40°C.

Do permanent magnets or armature bearings age due to physical vibration during switching operations?

Concerns regarding aging of magnets or bearings have been proven to be unfounded. The AMVAC breaker design has demonstrated 100,000 operations in many tests. UL Laboratories have witnessed testing throughout the development process.

What is the risk of corrosion over time to the material of permanent magnets?

The permanent magnets used are of the rare earth magnetic material neodymium-iron-boron. The first magnets made of neodymium-iron-boron were susceptible to corrosion, however the risk of corrosion has been virtually eliminated by the addition of corrosion inhibiting materials to the magnets. The permanent magnets used in the AMVAC circuit breaker are further protected by tin plating.

Is there risk of corrosion to the laminated core?

The laminated core is coated with protective paint resistant to corrosion.

What are the recycling requirements for components of the circuit breaker?

For reasons of possible environmental pollution, capacitors have to be disposed of as controlled waste. The aluminum electrolyte capacitors utilized in the AMVAC breaker design contain no polychlorinated biphenyls (PCBs) or similar substances that could give rise to dioxins on incineration.

There are no fundamental problems with disposal of encapsulated breaker poles. Disposal requires slightly more work in comparison to standard breaker poles. Where required by law, the interrupter has to be physically broken out of the pole part. The reduction in the number of parts more than compensates for this disadvantage.

[1] Koerdym 280 is the trade name for neodymium-iron-boron.

What happens if the auxiliary voltage fails?

An energy storage device is integrated in the mechanism enclosure. The breaker can be operated electrically for up to 200 seconds after failure of the auxiliary power supply. Thereafter, the circuit breaker can be opened by the emergency manual operating system.

Are there concerns with the expected lifetime of the electronic controller due to the large physical vibration during switching operations?

These concerns have also been demonstrated to be unfounded by the numerous endurance tests completed as part of the development process.

What is the anticipated lifetime of the components on the electronic controller?

The empirical feedback gained so far from extensive testing indicates a lifetime of over 25 years under normal environmental conditions.

Are sensors monitored during the switching operation?

The sensor logic is included in the self-monitoring system of the electronic controller. The controller will detect an error if a switching command is issued and the sensors do not detect a change in mechanical state.

Are there any concerns with regards to performance over the lifetime of the capacitors?

Progress achieved in the field of capacitor design in recent years provides for sufficiently long service lives. The long service life is enhanced by the fact that the power supply of the AMVAC circuit breaker provides constant DC voltage without AC component. This constitutes ideal electrical conditions for operation of electronics. At 50°C capacitor lifetime is approximately 45 years. The usual life of medium voltage equipment is thus considerably exceeded.

How are the vacuum interrupters replaced when necessary?

Since vacuum interrupters of the AMVAC breaker are completely embedded in the pole parts, complete breaker poles have to be replaced. This is usually not required during the lifetime of the equipment except under extreme service conditions.

Does the AMVAC conform to all design specifications of the ADVAC circuit breaker too?

The AMVAC circuit breaker will satisfy all in-service requirements and ratings fulfilled by the ADVAC circuit breaker, tried, tested and in service worldwide. The combination of magnetic actuation and encapsulated pole design a nearly maintenance-free circuit breaker is available for the first time. The familiar reliability of the ADVAC breaker is exceeded by reducing the number of moving parts. The input/output characteristics of the electronic controller will provide controls never before available with standard circuit breakers.

Frequently Asked Questions concerning Vacuum Switching Technology

Is it possible to check the integrity of a vacuum interrupter chamber?

Yes, it possible to check the integrity of a vacuum interrupter chamber. The circuit breaker is tested with a one minute AC withstand test. If air has entered the interrupter chamber, flashovers occur between contacts. This test is frequently performed prior to commissioning of a circuit breaker and recommended when servicing the breaker. This measure prevents systems from being put into service with circuit breakers in which an interrupter has previously been damaged.

Leakage is usually only caused by physical damage. The epoxy mold protects the vacuum interrupters of an AMVAC circuit breaker significantly reducing the risk of damage.

What about installing a pressure sensor to control the vacuum interrupter?

Permanent sensing of vacuum is technically not possible at this time. Vacuum technology manufacturing is recognized for its inherent high quality. A pressure monitor is not considered necessary.

How does a vacuum circuit breaker with an interrupter chamber containing air operate?

Consider two scenarios with different results:

A single phase short circuit fault occurs when a phase to ground fault occurs in one phase of a solidly grounded system. A sustained arc arises in the compromised interrupter chamber, please refer to the next question for consequences regarding persisting arcs.

Upon interrupting in an ungrounded or inductively grounded system, the flow of current is interrupted, as the two sound interrupters extinguish the arc properly. At 15 kV, the punctured interrupter withstands the phase to phase voltage, with the result that arc through generally does not occur. At higher voltages, flashover between the contacts can occur. The defective phase is not interrupted and a current reflecting the system conditions flows across the contact gap.

Do the vacuum interrupters on circuit breakers explode when arcing persists?

No, vacuum interrupters do not explode.

The sustained arc causes a temperature rise in the interrupter chamber. Only if the fault condition persists for several seconds and only if the arc current is sufficiently high may the chamber material melt and cause arcing in the circuit breaker compartment. Usually upstream protection will clear the fault condition.

Can a vacuum circuit breaker cope with an evolving fault?

An evolving fault occurs when a short circuit current suddenly appears during the interruption of a low current. It is known that minimum oil circuit breakers explode during this relatively rare occurrence.

A vacuum circuit breaker is the only type of breaker that perfectly master evolving faults, because it does not require the flow of an arc-quenching medium. Only a very small gap between contacts is required in vacuum to extinguish an arc.

Are hazardous X-rays created during switching with ABB vacuum interrupters?

No hazardous X-rays are created during breaker operation. When extremely high voltages are applied, charge carriers in the electrical field are accelerated and can cause radiation when they impact on the electrodes. Tests on the interrupters used in AMVAC circuit breakers have shown that no injurious X-rays appear even at standard test voltages. The permissible limit of 1 µSv/h is never exceeded.

Why are there currently no vacuum circuit breakers for higher voltages?

The request for vacuum interruption technology for higher voltages is based on the assumption that what works well for medium voltage must also work well for high voltage. Here are the facts:

Vacuum interrupters with a contact gap of up to approximately 7mm exhibit higher dielectric strength compared to SF6. Contact gaps of more than 7mm have higher dielectric strength when SF6 is used as medium.

At 16 mm (corresponding to the distance between contacts in a 36 kV vacuum circuit breaker), the measured dielectric strength is approximately 200 kV. This is slightly higher than the rated lightning impulse withstand voltage of a standard 38 kV breaker. For higher system voltages, therefore, one would have to connect two or more vacuum interrupters in series, something that is done by several manufacturers. Unfortunately, that is not always very economical. It can thus be deduced that the vacuum circuit breaker is economically advantageous up to a rated voltage of 38 kV, but less so above that level. This is why SF6 circuit breakers are typically used at voltages higher than 72.5 kV.

What role do vacuum circuit breakers currently play on the world market?

Unfortunately, there are no precise statistics available. Published estimations by ABB and Siemens show that more than 60% of all circuit breakers manufactured are vacuum circuit breakers. In the United States the market share of vacuum interrupters is greater than 90%.