The Use Of SF_6 to Assure Reliable Delivery of Power to Home and Industry

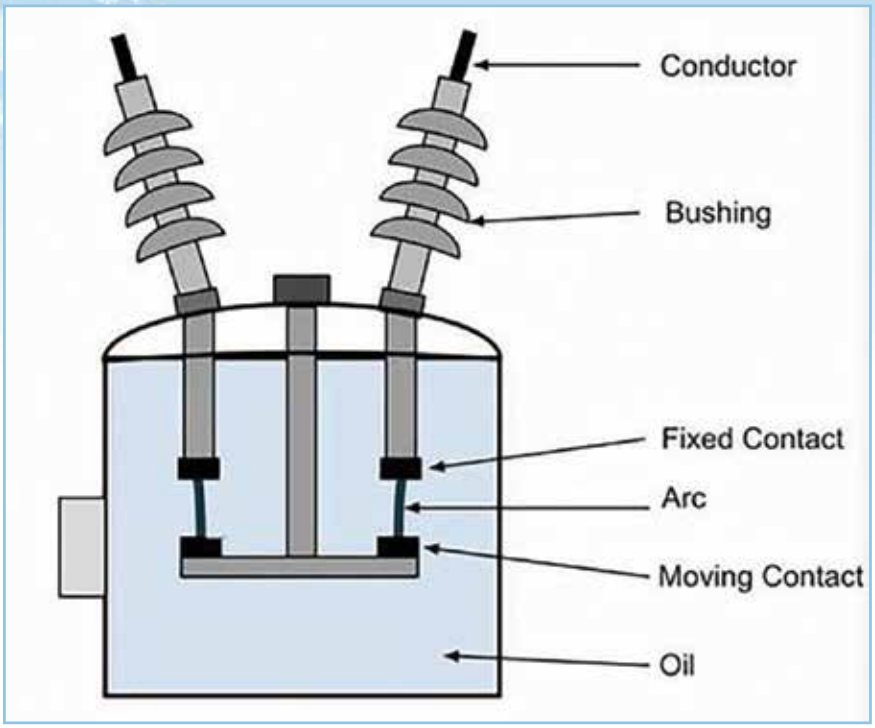

Figure 1 - Bulk Oil Type Circuit Interrupt Switch

Moving vast amounts of electrical energy over many miles from electrical generating plants to the end user requires the power to be "stepped up" to 230kV, 345kV, 500kV (thousand volts), and higher. It is then sent along transmission lines to many local sub-station distribution centers where the power is "stepped down" to customer usable levels. It is necessary for the sub-station to be able to turn these high voltage levels of power off and on as needed. Furthermore, power may arrive at the sub-station from more than one source and because of price or availability, it may become necessary to switch from one source to another. When power is interrupted at such high voltage levels, an arc forms between the switch contacts. This can produce temperatures in excess of 4700° C (8500° F). At these temperatures, it does not take long for the metal contact surfaces to melt and fuse. Therefore, it is necessary to quench and cool the arc as rapidly as possible. For many years this was accomplished by the use of oil-filled switches *[Figure 1]* referred to as "circuit breakers". These switches submerge the contact surfaces in oil, and then when the switch opens, the arc is quenched and cooled by the oil and by the "hydrogen" gas bubble which is formed around the arc. Flammable oil, hydrogen gas, and high arc temperatures create potentially hazardous conditions.Therefore a safer and more reliable method was needed.

In 1956, Westinghouse Corporation developed what is still considered today as the safe alternative to oil-filled switches *[Figure 2].* They did so by placing the switch in a vessel purged with SF_6 (sulphur hexaflouride) gas. SF_6 is a very strong dielectric man-made compound which resists the formation of arcs in high voltage interrupts. As the SF_6 gas-immersed contact surfaces open, a high pressure shot of SF_6 gas is blown into the area, further cooling and blowing out the arc *[Figure 3]*. SF_6 purged circuit breakers are the most commonly used in the high voltage power industry today, and have been for many years.

As with any other type of equipment, it occasionally becomes necessary to maintain gas-filled breakers. The gas needs to be safely removed, stored, filtered, dried and returned to the circuit breaker. This requires special equipment, designed not only to remove the gas, but to compress it and liquefy it, without introducing any air, moisture or other contaminants.

Figure 2 - Typical Sf6 Circuit Breaker

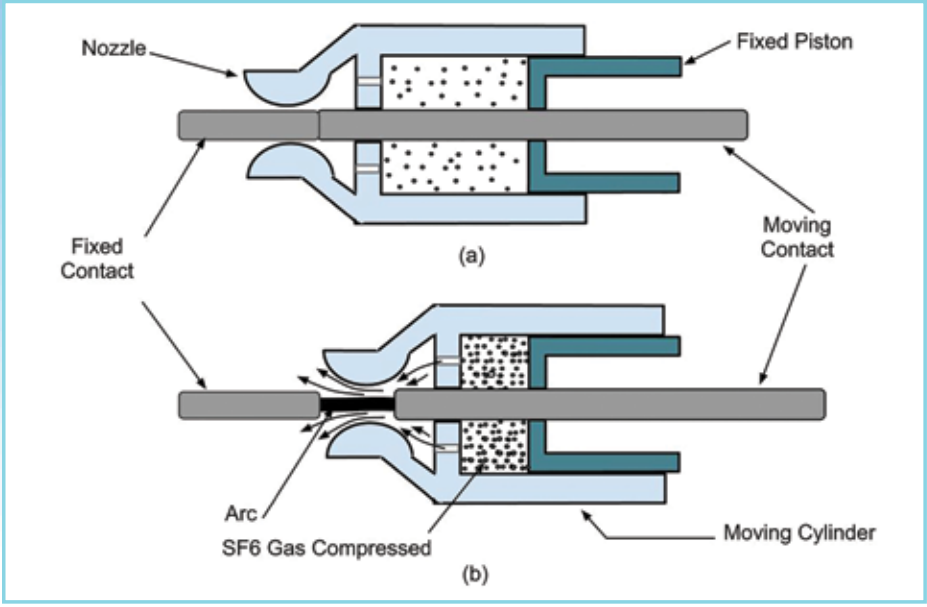

Figure 3 - Puffer Type SF_6 Circuit Breaker

One method of liquefying SF_6 for storage is by "High Pressure Liquefaction", which is accomplished by compressing the gas up to 700 psig then liquefying into cylinders or a vessel. The advantage of this method is that it does not require an oil removal system or refrigeration condensing unit to cool the gas. The disadvantage is that it requires frequent compressor maintenance and retains the inherent problems and dangers associated with higher pressures.

Another method is "Low Pressure Cooled Liquefaction". This employs a more reliable and higher speed oil lubricated compressor, oil removal system, and a refrigerated vessel to store the SF_6. Cryoquip has used this low pressure method in its design and manufacturing of SF_6 recycling equipment since 1984.

In addition to the standard oil removal coalescing filters, Cryoquip also uses an oil absorber filter designed to trap oil vapor prior to entering the storage vessel. The SF_6 compressed gas is next chilled and liquefied in the storage vessel, where it will remain until it is needed. When the SF_6 is returned to the circuit breaker it will return as a vapor from the top of the storage vessel. The gas passes through a dryer, by-product filter, and a fine particle filter, before being returned to the circuit breaker, thereby removing arc byproducts, moisture, and particle contaminants from the gas.

SF_6 gas is a green house gas and is declared to have a global warming potential almost 24,000 times that of CO_2. The National Oceanic and Atmospheric Association (NOAA) has monitored levels of SF_6 gas in the atmosphere since 1995. To date, SF_6 trace gas levels in the atmosphere have increased from 2ppt (parts per trillion) to 8ppt. This increase is driving rules and legislation concerning the inventory, tracking, usage and disposal of SF_6, and is especially relevant as it relates to SF_6 recovery and recycling equipment.

In order to meet these demands, Cryoquip has added several enhancements to its SF_6 recovery and recycling equipment. One is a magnetically driven SF_6 vacuum pump capable of recovering gas from a circuit breaker down to 100 mTorr (millitorr) of pressure. This, combined with the high speed semi-hermetic compressor, allows for removal, compression, and liquefaction of SF_6 without loss of gas to the atmosphere, and accomplishes this at high speed and relatively safe and low pressure.

For further information, visit www.Cryoquip.com

Figure 4 - Cryoquip 375TM Mobile SF_6 Service cart