A New Age for Toughened Glass Insulators – With Clarity Comes Safety

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Toughened Glass insulators are no strangers to rough working conditions.

INTRODUCTION

In 2005 an article about toughened glass insulators (TGI) titled "Return to Clarity" was published. Fifteen years later, this sequel article by a team including the two original authors, picks up where the former concluded with optimism about the future of TGI technology in the USA. Thanks to the deeper understanding of TGI, we are witnessing today a new age of toughened glass insulators. The built-in characteristics of Sediver TGI's provide safety, reliability and resilience, which yield measurable cost savings. This sequel article will further explore these attributes which are being recognized by a growing number of line crews and asset managers responsible for maintaining their HV lines.

HISTORICAL OVERVIEW

TGI technology was first introduced by Sediver in Europe in the early 1950's, and found its way to North America in the 1960's. With the advent of polymer technology in the 1970's, attention quickly turned to its promise for a swift evolution towards an ideal insulator that was no longer a string of modular units, but a single light-weight unit, virtually indestructible, vandalism proof and possessing unequalled pollution performance. True to its tradition of pioneering and innovation, Sediver also became an industry leader in polymer technology and a major USA producer until 2001. By that time, the USA was the largest polymer market in the world and TGI almost vanished from use across the country.

In 2003, EPRI published a comprehensive review of the first 25 years of the polymer in-service experience. Updated again in 2012, it identified many utilities reporting unacceptable numbers of polymer failures while expressing concerns for their long-term reliability. The emerging doubts about the ability of polymer technology to fulfill its early promises invigorated Sediver to re-introduce toughened glass to the USA for HV line suspension applications.

Today, utilities across the USA are using TG insulators on a regular basis. The trend has attracted several new suppliers of glass insulators to the US market, while allowing Sediver to justify the investment in a new US-based factory and state-of-the-art test lab in West Memphis, Arkansas.

KEY DRIVERS FOR THE RISE OF TOUGHENED GLASS

When selecting components for their HV Lines, utilities make choices among competing technologies. Design engineers and system planners must ensure that key design and performance criteria align with intended functional requirements of each component. The front-line workers of the industry ultimately deal with whatever components make up the system, and must focus on practical issues, as outlined here.

SAFETY AND DEPENDABILITY

Sediver TGI has a built-in condition detection mechanism that provides clear visual assurance of the safety and dependability of the insulator. This detector is not a device but simply a property inherent to high-quality toughened glass. The presence of an intact outer shell indicates the insulation is in excellent condition. Hidden flaws are not possible because it would cause the outer shell to completely break away, resulting in a "stub" that is mechanically and electrically sound.

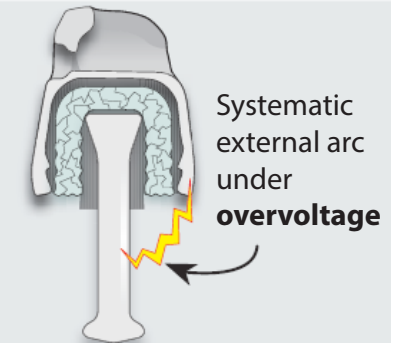
Insulators replaced with TGI

Toughened glass has an extremely high impact strength making it difficult to break. If it does break, the outer shell falls away completely in small kernel size pieces (like safety glass).

Sediver guarantees a minimum of 80% residual tension strength of a stub. The strength comes from the fragmented glass tightly wedged between the pin and the cap. Sediver also guarantees that the stub is not punctured and will continue to insulate. Should an overvoltage occur, the arc will discharge externally in air because the shortest gap is outside and not through the complex maze of fragmented glass in the head. Hundreds of thousands of pull tests on stubs have been performed by Sediver and independent labs. Numerous tests on new and aged stubs, including freeze-thaw cycles and line vibrations, all confirm the safe behavior of Sediver stubs. There are no records of any line being dropped by a stub in a Sediver insulator string.

Photo of arc on string of glass with stub

AGING & LONG-TERM RELIABILITY



The raw materials used to make glass are melted at high temperature, resulting in an amorphous liquid. While still viscous the glass is molded into its final shape and immediately toughened through a carefully controlled fast cooling process. This simple but precision operation increases the strength of the glass shell by a factor of 4-5 times, thus making it substantially stronger than porcelain. Because of the amorphous structure and highly compressed surface shield induced by toughening, glass does not age. It has no "aging mechanism".

Porcelain is comprised of various crystals pressed and partially fused together. Over time, microcracks form at the grain boundaries and eventually propagate into a full puncture. Older porcelain often suffers cracking induced from cement expansion visible on the shell or hidden in the head. Fault current from lighting or switching surge could travel through the punctured insulator, causing separation and line drop. Low cost, low quality porcelain ages faster, reducing the operating life and increasing the risk of failure.

Unlike ceramics, polymers are made up of organic materials prone to aging due to electrical stress, corona activity and pollution induced leakage currents. Once the rubber housing, seals or interfaces are compromised, moisture can enter and cause internal tracking or brittle fracture failure of the fiberglass rods. Damage is typically undetected and failure can happen suddenly. While

"Toughened glass suspension insulators are being applied by utilities worldwide to realize a reliable and resilient transmission infrastructure."

lighter and easier to install, polymer insulators have a shorter life-span, are more difficult to inspect and potentially unsafe for hot-line work.

HANDLING AND INSTALLATION

Over 70 years of experience from line crews around the world demonstrates the superior benefits of working with Sediver TGI. Weighing 20-25% less than porcelain equivalents, crews have less risk of back and shoulder strains. There is less risk of injury also because TGI doesn't chip, crack or break off in large sharp sections like porcelain. The increasing use of helicopters benefit significantly from the lighter weight, saving fuel, refueling stops and increases crew productivity. Rough handling is often unavoidable when working in remote sites typical of HV lines. The rugged nature of TGI results in virtually no damage during installation.

INSPECTIONS, MAINTENANCE & HOT LINE WORK

The longevity and ease of inspection of TGI are properties that inspire confidence with asset managers and line crews. Based on the experience of numerous utilities, TGI's provide the most resilient insulation technology and the lowest cost of ownership.

Since TGI can be inspected infallibly by a simple glance, requiring no instruments, it facilitates considerably the inspection and maintenance procedures. The inspection of TGI can be done by land or helicopter. It requires no climbing and it's by far the lowest cost and most reliable compared with all other technologies. Hot line insulator replacements and other work near energized strings is safer with TGI's. The clearly visible condition of a TGI string, even with stubs, allows a straight-up safety assessment and decision about approaching or working on that string.

Acts of vandalism can occur on nearly all components of a power line, including towers, conductors, and insulators. Interviews with maintenance crews has revealed that what counts most when it comes to vandalism on insulators is how a damaged insulator performs. Carefully considering the properties of TGI, it is clear this technology provides the safest behavior once vandalized, but also the easiest and quickest to assess by line crews.

CONTAMINATION, EXTREME EVENTS AND RESILIENCY

Extensive work by Sediver R&D and more than 20 years of in-service experience have contributed to Sediver's expertise in silicone coated glass. This technology combines all the benefits of TGI with the hydrophobic properties of polymers. It is gaining acceptance by many US utilities dealing with contamination and has become a viable replacement for aging polymers. Depending on the pollution involved, a fully coated or undercoated shell has shown superb performance in severely polluted areas where washing was previously required.

Sediver recently developed Smart insulator technology for monitoring and transmitting leakage

Ice Storm of the Century, Quebec, 1998 Resiliency at its best

current, humidity and temperature data. Units are now deployed on transmission lines around the world in highly contaminated areas to provide real-time analytics and early warning of potential flashover

The resiliency of TGI has been demonstrated in numerous situation such as the historical ice storm on 1998, in Northeast US & Quebec, Canada. Hundreds of HV steel towers around Montreal collapsed and numerous strings of TGI were severely damaged, but not separated. Thanks to the properties of TGI, it was possible for emergency crews to re-install the surviving TGI.

The devastating forest fires in western US and Canada, prompted Sediver R&D to initiate a study on the effect of such high temperatures on porcelain, polymers and TGI insulators. The outcome revealed that TGI's are the most resilient in the vicinity of fires.

CONCLUDING REMARKS

Toughened glass suspension insulators are being applied by utilities worldwide to realize a reliable and resilient transmission infrastructure. Sediver supplies insulators to more than 150 countries for new construction and replacement of aging porcelain or polymer insulators on HV lines and in substations. To the clear benefit of operations and maintenance personnel, the USA has now embraced the full value and added safety of this technology as well.