Silicone insulation advantages are numerous in wire, cable applications

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With a clear trend in the electric transmission and heat distribution industry away from glass and ceramic insulation, silicone is seeing increased use in the production of wires and cables—primarily due to its performance advantages in high voltage and fire safety applications.

"Silicone is your friend in electric applications," said Detlef Klingberg, technical manager, application engineering energy with Wacker Chemical Corp. U.S.A., a division of Germany-based Wacker Chemie A.G. "With its crack resistance, UV protection, hydrophobicity and light weight, the industry overall is clearly going in the direction of silicone being the preferred material."

Klingberg, who has been with Wacker since 1996, spoke Nov. 11 during the second day of the virtual International Silicone Conference, offering his expertise on "Interesting Aspects of Special Cables with Silicone."

Although silicone—especially liquid silicone rubber—remains a niche market, its versatility in application, performance and production is getting noticed. The raw material has been selected for commercial and industrial use in hotels across the globe, airports (including Las Vegas' McCarron International and Dallas-Fort Worth),

the Mont Blanc tunnel in Switzerland, German soccer stadiums and major European high rise buildings.

"There are so many examples, too many to name, of this technology being used successfully," Klingberg said.

In electrical applications, silicone can be used in hollow core and rod insulators, cable accessories, insulating fluids and high voltage insulator coatings.

Three properties should be considered in these uses, Klingberg said, including dielectric strength (typically between 23-25KV/mm, and up to 30 KV/mm with special grades of silicone); volume resistivity; and dielectric constants—all conductivity traits that silicone has in abundance.

In rod and hollow core composite insulators and arresters, the choice of silicone is made in part due to weight, Klingberg said.

"Silicone is so much lighter than materials used in the past," he said. "I've held both (insulating materials) in my hand and the difference is night and day."

Klingberg noted that silicone's hydrophobic (water resistant) properties also are attractive for use as insulation in conductive wires and cables.

And in a pinch, traditional materials used for insulation, including glass, ceramic, EPDM and epoxy resins, can be spray-coated to become pseudo-silicone insulators, Klingberg said, since silicone exhibits excellent adhesion, protection against flashover, a wide temperature range and weathering qualities.

"The advantages of silicone make it a prime material for use in middle, high and ultra-high voltage applications," Klingberg said, adding that silicone gels and pastes also are available to fill empty spaces in hollow core insulators and cable joints. "You cannot have any air entrapment with these products, and silicone can fill these potential air gaps."

Another application becoming more widespread is the use of silicone for fabricating fire safety cables, where ceramifiable silicone elastomers offer an alternative "to the incumbent technology for fire safety cable," Klingberg said.

According to U.S. fire safety regulations, a fire safety cable needs to be able to retain its circuit integrity for two hours in the midst of a raging fire. Then it has to be able to survive a hose stream of up to 70psi to simulate fire extinguishing activity.

Remarkably, prior to 2006 in the U.S., a fire alarm cable—considered a signal cable—did not have to be fire rated. Ceramifiable silicone can remedy this, since it burns quickly and transforms into insulating ceramic, which allows for circuit integrity for up to five hours, Klingberg said.

"The circuit has to survive this harsh treatment," he said. "Wacker has been at forefront of these applications for quite sometime now."

In addition, silicone can be used to insulate power cables (up to 600V and typically armored), used in mega-structures to power fire extinguishing equipment.

And the complete combustion of silicone produces non-toxic byproducts, including silicone dioxide, water and carbon dioxide, as opposed to some nitrile rubbers which can produce certain cyanide compounds when burned.

Since silicone is so flexible, it is easy to install and produce, typically through injection molding and extrusions.

"Silicone elastomers offer key advantages to the cable industry that range from excellent flexibility and high-speed productivity on the fabricator end all the way to ease

of handling and installation on the end user side," Wacker's chemist said. "They are much more forgiving than other polymers on the market."

And silicone can be easily colored for the coding of wires and cables, Klingberg said.

"Something that I underestimated for many years," he said.

With all its virtues in wire and cable applications, silicone does maintain one vice in the industry: Don't ask it to be successful in insulating communication cables.

"It's always a dream of the silicone manufacturing community to participate in this industry segment because it is humongous," Klingberg said. "But the dielectric strength is too high, causing signal distortions. This makes it non-usable in the communications cable sector."