

Transformer components

Comparison between porcelain and silicone rubber for use as outdoor insulation on high voltage bushings

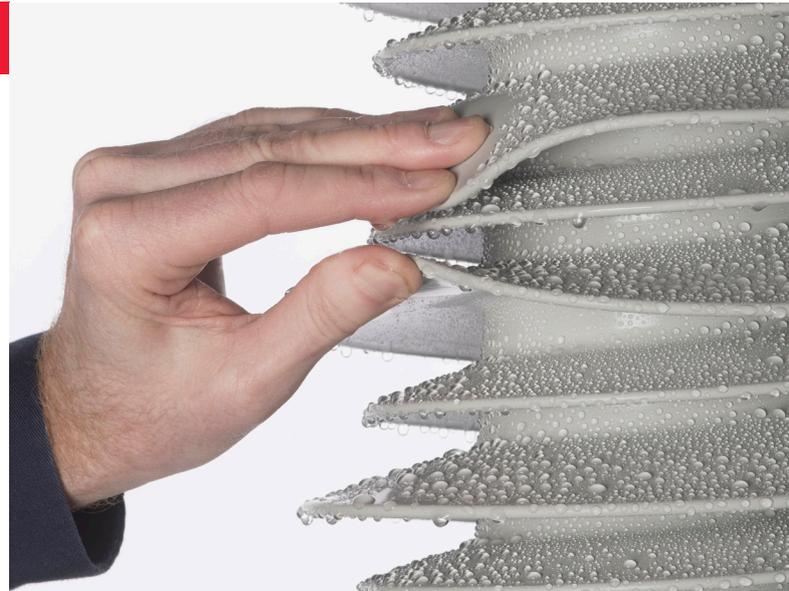
Product information

Hitachi Energy has been manufacturing bushings with porcelain as the main outdoor insulation since the early 1900s. Silicone rubber has been in use as outdoor insulation for suspension insulators and in other applications since the 1970s.

Today, silicone rubber is the most used polymeric material for medium and high voltage outdoor insulation. The silicone rubber used by Hitachi Energy for high voltage equipment is made of a specially formulated HTV, High Temperature Vulcanising, silicone rubber which has several advantages compared to porcelain. This instruction lists the most important properties for outdoor insulation and a short comparison between the characteristics of HTV silicone rubber and porcelain both as materials and as an integral part of the bushing.

Hydrophobicity

The surface of silicone rubber maintains a high level of hydrophobicity even during severe environmental conditions. If the hydrophobicity of the surface is decreased, the surface will recover its hydrophobic properties since the silicone rubber continuously emits molecules of silicone oil to the surface. The layer of silicone oil is only a few molecules thick and provides the hydrophobic properties of the surface. The hydrophobicity of porcelain on the other hand is reduced already after a few days with medium severe pollution levels and will not recover unless the surface is cleaned. The design criteria for porcelain insulators according to standards is 31 mm/kV at severe pollution levels. In order to fulfil the standard requirements, the same design criteria for specific creepage distance for silicone rubber insulators as for porcelain is used which provides an even more robust design regarding the limitation of leakage currents.



Leakage currents

Thanks to the improved performance during and after severe environmental conditions with HTV silicone rubber, the leakage current level along the insulator is very low compared to porcelain. A typical value for porcelain is 10 mA and for silicone <1 mA. This property also reduces the risk for flash-overs and thus increases the reliability of the product and eliminates the disturbances in the power grid resulting from such events.

Lightweight

The density of HTV silicone rubber is 1530 kg/m³ and 2500 kg/m³ of porcelain. The electrical insulation inside the silicone rubber is made of resin impregnated paper. The high mechanical strength of the insulation material supports the silicone rubber, which need to be just 5 mm thick with the exception of the sheds. Thus the weight of the GSA bushings is reduced to approximately half of its equivalent oil impregnated bushings with porcelain as outdoor insulation. With a more light weight design, the ability to withstand earthquakes is increased as well.

Maintenance-free

The need for cleaning the insulator is almost eliminated when using HTV silicone rubber. Only in extreme environmental conditions may the insulator need to be cleaned. Porcelain on the other hand might have to be cleaned more often in medium polluted areas as well.

Non-shattering material

The HTV material has a non shattering failure mode if subjected to vandalism, mechanical shocks etc. The GSA bushings are well suited for applications where vandalism by for example stone or brick throwing can be expected. The risk for transport damage is almost eliminated as well. The safety of personnel is increased due to the non shattering material in the case of an unexpected failure on site.

Self-extinguishing

Silicone rubber is proved to be self-extinguishing even if a test sample is held vertically over an open flame. With this feature the bushing with it's HTV silicone rubber insulator will not cause fire, not even maintain or develop a fire. Porcelain will of course not burn but it can explode or crack by extensive heating from fire sources and consequently increase the fire when the oil is let out from the bushing.

Summary

The advantages of HTV silicone rubber compared to porcelain described above are unique and are not valid for other polymeric materials like EP-rubbers or epoxy. The GSA bushings and the HTV silicone rubber are thoroughly tested according to relevant standards and the outdoor insulators have proven their good performance during long time testing at test stations in severe environmental conditions.

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