



## ANEXO F.- Documentos científicos encontrados en la búsqueda que mencionan el uso de polímeros en Switchgear.

Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Electrical aging tests on epoxy insulators in GIS	Diessner, A.; Luxa, G.; Neyer, W.	Siemens AG, Berlin, West Germany	Electrical Insulation, IEEE Transactions on	1989	Due to the relatively small insulator dimensions in gas-insulated switchgear (GIS), the electrical stressing is high by comparison to that of insulators for conventional switchgear. Aging tests on a large number of full-sized insulators in several vessels in an outdoor test station have been carried out to determine the stress limits. The tests, with voltages of several hundred kilovolts, last for several years. The aim is to work out conditions (by extrapolation) for a trouble-free switchgear operating life of at least 50 years. The most important test objects are postinsulators weighing 2 kg each. It has been confirmed that partial discharges have a major effect on the failure probability. The life curve obtained from the test results of six batches of partial-discharge-free insulators is compared with the required reliability data	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=90286">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=90286</a>
Determination of gases and gas pressure in GIS spacer voids	Braun, J-M; Groeger, J.H.	Ontario Hydro Res., Toronto, Ont., Canada	Electrical Insulation and Dielectric Phenomena, 1989. Annual Report., Conference on	1989	The gas contents of voids found in commercial epoxy spacers and laboratory samples are investigated as part of a broader investigation into the aging characteristics of GIS (gas-insulated switchgear) spacers. Gas chromatography techniques were successful in identifying permanent gases and organic vapors in epoxy spacers. Simple crushing and, where practical, drilling were used to release the gaseous effluents. Analyses performed on production epoxy spacers yielded predominantly nitrogen and oxygen with, in much smaller concentrations, uncured residues and curing by-products similar to those dissolved in the epoxy mass. Given the high temperatures at the time of formation of the cavities, diffusion processes in the liquid-like mass will establish rapid equilibrium between the voids and the surrounding epoxy mass. Control of the gas and pressure content in epoxy cavities is similarly difficult to achieve where desired because of diffusion effects in the curing mass. While oxygen depletion can be readily ascribed to reaction with the uncured epoxy, the presence of excess nitrogen cannot yet be explained satisfactorily	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=69531">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=69531</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Studies of epoxy spacers subjected to internal and external partial discharge and SF <sub>6</sub> byproducts	Braun, J-M; Chu, F. Y.; Tyman, A.	Ontario Hydro Res. Div., Toronto, Ont., Canada	Conduction and Breakdown in Solid Dielectrics, 1989., Proceedings of the 3rd International Conference on	1989	The early phases of the internal and external spacer surface degradation process were characterized using electrical and chemical techniques in order to develop a better understanding of the long-term aging mechanisms. Reaction of nitrogen gas in a discharge cavity with the epoxy void wall was readily detected by ESCA (electron spectroscopy for chemical analysis), and the technique could find application in determining the void size below which no damage occurs. A similarly substantial modification of spacer surface properties could be brought about by exposure to localized corona discharges, associated with material transfer from the electrode and leading ultimately to the formation of tracklike paths on the epoxy surface. The results are of interest in connection with the electrical treeing of GIS (gas-insulated switchgear) spacers	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=69217">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=69217</a>
Surface discharge switch design: the critical factor	Engel, T.G.; Kristiansen, M.; Baker, M.; Hatfield, L.	Texas Tech. Univ., Lubbock, TX, USA	Power Modulator Symposium, 1990., IEEE Conference Record of the 1990 Nineteenth	1990	The authors report which dielectric properties are critical to designing a long-life surface discharge switch (SDS). Theory is correlated with experiment by evaluating the performance of a large group of polymeric and ceramic dielectrics. These dielectrics were tested in a single-channel, self-commutating SDS operating at ~35 kV and ~ 300 kA (oscillatory discharge) with a pulse length of ~20 1/4s (1/4 period ~2 1/4s). The performance of a dielectric is characterized by its shot-to-shot breakdown voltage and by its mass erosion. Theoretically, the voltage holdoff degradation resistance and the arc melting/erosion resistance of a dielectric can be qualitatively predicted from its 'formativity' and its 'impulsivity', respectively. The formativity and impulsivity are figures of merit calculated from the known thermophysical properties of the dielectric. The effects produced in dielectric performance by choice of electrode material (e.g., molybdenum, graphite, and copper-tungsten) and discharge repetition rate are also discussed	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=201000">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=201000</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Surface flashover and solid polymeric insulation in SF <sub>6</sub> gas	Rickman, J.; Milne, D.	NEI Int. Res. & Dev. Ltd., Newcastle, UK	Charging and Tracking of Insulators in Gaseous and Vacuum Environments, IEE Colloquium on	1990	The application of synthetic resins as dielectric materials in the design and construction of switchgear originated early in this century. Since then a very large and ever widening number of materials and their compounds have been developed. The authors consider flashover tests which have been carried out to compare the performance of various polymeric formulations and relate these results to the chemical structure of the resin tested. There are many factors which influence surface flashover performance and these are outlined by the authors	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=190081">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=190081</a>
Proceedings of the 1991 IEEE Power Engineering Society Transmission and Distribution Conference (Cat. No.91CH3070-0)			Transmission and Distribution Conference, 1991., Proceedings of the 1991 IEEE Power Engineering Society	1991	The following topics are dealt with: cleaning solvents and cable pulling; cable testing; cables and accessories; high voltage cables; cable performance; moisture impervious and shielded cable; new and specialized products; system dynamic performance; system planning and demand-side management; power system instrumentation and measurement; power system relaying; surge protective devices; substations; switchgear; transformers; distribution automation and design; distribution reliability; EMF from power lines; DC transmission; towers, poles, and conductors; transmission and distribution design and safety; transient and steady state analysis of power systems; shunt and series VAR compensation in power systems; and six-phase power transmission systems	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=169475">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=169475</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Endurance estimation of epoxy resin systems under synergistic environment of high relative humidity and electrical stress	Udayakumar, K.; Panneerselvam, M. A.; Dharmalingam, K.	Coll. of Eng., Anna Univ., Madras, India	Properties and Applications of Dielectric Materials, 1991., Proceedings of the 3rd International Conference on	1991	The authors report on an experimental investigation undertaken to quantify the effect of high humidity on the performance of epoxy resin insulations. The data obtained from the investigations have been used to calculate a new index called the cumulative characteristic factor, which uniquely grades the material and insulation systems exposed to permanently elevated humidity conditions. To assess the long-term behavior, endurance tests were also conducted with a newly designed environment cycle representing tropical climatic conditions. Based on the accelerated test data, a system model has been developed for predicting the insulation life. To validate the laboratory aging tests, a 11 kV current transformer was installed in a highly humid region in Madras City, India. The place of installation was a switchgear plant for air conditioning purposes. From the experimental investigations and model developed it was concluded that in the presence of permanently elevated humidity conditions bisphenol epoxy resins are susceptible to severe surface degradation within 2 to 3 years of installation	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=172164">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=172164</a>
PD scaling relationships in GIS insulators: theory and experimental verification	Braun, J-M; Fujimoto, N.; Dirven, R.; Teng, M.; Addis, G.	Res. Div., Ontario Hydro, Toronto, Ont., Canada	Dielectric Materials, Measurements and Applications, 1992., Sixth International Conference on	1992	Partial discharge (PD) testing is commonly used as a quality control measure for epoxy insulators in gas-insulated switchgear (GIS). Occasional inservice failures have indicated that improvements to the technology should be considered. Recent theoretical developments have provided a means of assessing the detectability of partial discharges in such insulators. The theory also provides a model which can be used to relate the characteristics of voids within insulators with the measured signal and the inception/extinction voltages. The authors describe measurements which provide the experimental evidence in support of the theory. Application of the theory results in more stringent PD acceptance criteria for higher voltage class insulators	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=186908">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=186908</a>



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Surface flashover sustained by electrostatic surface charge on epoxy resin insulator in SF <sub>6</sub> [GIS insulators]	Wang, C. X.; Wilson, A.; Watts, M. W.	National Grid Co., Leatherhead, UK	Dielectric Materials, Measurements and Applications, 1992., Sixth International Conference on	1992	It has been confirmed that sufficiently high electrostatic surface charge density can sustain surface flashover when the stored surface energy released can cause further ionisation and establish a chain reaction. Therefore, in addition to the widely reported results that surface charges can aggravate the triple junction field enhancement under certain conditions, it is now clear that once triggered, surface flashover can self-propagate a long distance away from the initiation sites, resulting in unexpected and erratically low flashover voltages. The proposed self-sustained surface flashover criterion has been tested to apply for different geometries and at various SF <sub>6</sub> pressures. The criterion simply states that the electrostatic surface energy should be sufficient for renewed ionisation activities	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=186912">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=186912</a>
Space charge induced field variation on epoxy spacers under AC stresses in SF <sub>6</sub> [GIS]	Jing, T.; Morshuis, P. H F	Delft Univ. of Technol., Netherlands	Dielectric Materials, Measurements and Applications, 1992., Sixth International Conference on	1992	Large scale cylindrical spacers of commercial epoxy resin were used to have measured the charge accumulations under AC stresses. Using a finite-element program, the field variation due to the surface charges was calculated, and the influence of them on the dielectric performance was then discussed	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=186911">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=186911</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Investigation of the effect of repetitive voltage surges on epoxy insulation	Stone, G.C.; Van Heeswijk, R. G.; Bartnikas, R.	Ontario Hydro, Toronto, Ont., Canada	Energy Conversion, IEEE Transactions on	1992	The aging of epoxy electrical insulation by unipolar, repetitive voltage surges has been investigated to determine whether such surges can precipitate premature failure of high-voltage motor windings and gas insulated switchgear spacers. A full factorial statistical test was devised and performed on 180 pure epoxy insulation specimens to examine the effect of voltage magnitude, polarity, and surge repetition rate on the life of unfilled epoxy specimens containing a needle-plane electrode geometry. All factors and interactions were determined to have a significant effect on the life, and life prediction equations were estimated. Increasing the voltage magnitude or repetition rate, decreased or increased the life, respectively. Aging was found to occur at as low a stress as 2 MV/cm. Gradual aging of the epoxy does occur under repetitive voltage surges. Based on a realistic number of surges with typical voltage amplitudes which can normally occur from vacuum switchgear during service, gradual deterioration of the epoxy turn insulation in motor stator windings is possible in some situations. Situations where surge aging may occur are identified	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=182659">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=182659</a>
A multistress test procedure for qualification of composite insulation materials in GIS	Kutil, A.; Frohlich, K.	Inst. of Switchgear- and High Voltage Technol., Tech. Univ. Wien, Austria	Electrical Insulation, 1994., Conference Record of the 1994 IEEE International Symposium on	1994	A multistress test procedure for composite polymer insulation materials as they are used in gas insulated systems (GIS) is introduced. Tube materials are dielectrically and mechanically stressed simultaneously. In a power frequency ac field up to 120 kV/cm partial discharge (PD) patterns are recorded by means of phase resolving and statistical evaluation of PD impulses. First results show a significant dependence of the PD activity on mechanical stress conditions. Also two distinctive modes of PD impulse levels were observed which seem to be related to the interface between fibres and matrix. A qualitative assessment of different materials concerning their aging behaviour seems to be possible, however. For quantification a comparison with endurance tests is necessary and thus planned in the near future	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=401468">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=401468</a>

Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Early stages of discharge development on insulating spacers in gases-a photographic study	Li, S. Y.; Theophilus, G. D.; Srivastava, K.D.	British Columbia Univ., Vancouver, BC, Canada	Conduction and Breakdown in Solid Dielectrics, 1995. ICSD'95., Proceedings of the 1995 IEEE 5th International Conference on	1995	In gas insulated substations (GIS) spacers are subjected to a large number of transient overvoltages and the transients associated with switching operations have very small rise-time (&ap;10 nanoseconds). An understanding of the early stages of discharge development should be useful in the design of GIS insulation system. As a part of this investigation, dedicated high speed streak photography techniques have been developed to study pre-discharge phenomena on spacers made from polytetrafluoroethylene (PTFE), acrylic and nylon. Since the discharge path may not always follow along the electrode axis, thus making streak photographic records difficult to interpret, it was decided to make a very shallow (0.5 mm) and narrow (1 mm) groove along the spacer axis. The arc was observed to propagate along the groove consistently. Although the breakdown voltages for different spacer materials varied significantly, the lowest flashover voltage being for PTFE spacers, the temporal development of the discharge on different materials was substantially the same in all cases. However, the flashover voltage with a spacer was lower than that for a plain air gap. In the present paper results of additional experiments in nitrogen (N <sub>2</sub> ) and sulphur hexafluoride (SF <sub>6</sub> ) at different ambient pressures are described and discussed	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=523009">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=523009</a>
Insulator charging in SF <sub>6</sub> produced by impulse voltage	Vasconcelos, F.H.; Cornick, Keith J.	Dept. de Engenharia Eletrica, Univ. Federal de Minas Gerais, Belo Horizonte, Brazil	Electrical Insulation and Dielectric Phenomena, 1996., IEEE 1996 Annual Report of the Conference on	1996	This work is concerned with the study of the charging process on insulators. The charges were produced by discharges inside a test-cell containing SF <sub>6</sub> . The discharges were due to impulse voltage applied to a point-plane arrangement with the dielectric covering the flat electrode. The charging current was measured along with the impulse voltage. The surface charge deposited on the dielectric was scanned using an electrostatic probe. The results presented are concerned with the previous state of the samples (in terms of charging) associated with change in polarity and in magnitude of the applied voltage	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=564645">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=564645</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Improvement of the heat resistance of epoxy casting resin for insulating spacers	Ichikawa, I.; Goto, K.; Takei, M.; Nakano, T.; Kanazashi, Y.	Power & Ind. Syst. R&D Center, Toshiba Corp., Japan	Electrical Insulating Materials, 1998. Proceedings of 1998 International Symposium on	1998	New research has succeeded in producing more compact insulating spacers for gas insulated switchgear (GIS) by increasing the heat resistance (from 105Å°C to 115Å°C) of casting resin and by increasing the heat resistance of the interface bond between metal and resin. The newly developed resin is composed, like conventional types, of epoxy resin blended with alumina filler. In the new compositions, both increased thermal resistance and favorable mechanical properties are achieved by reducing shrinkage during curing and the viscosity of the matrix resin, and by increasing the content of alumina filler. The creep rupture characteristics of the newly developed resin at 115Å°C equal those of conventional resin at 105Å°C	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=741740">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=741740</a>
Characterization of epoxy resin surfaces exposed to partial discharges in SF <sub>6</sub> and N <sub>2</sub> -SF <sub>6</sub> mixtures	Paun, I.; Frechette, M.F.; Wertheimer, M.R.; Larocque, R.Y.	IREQ, Hydro-Quebec, Varennes, Que., Canada	Electrical Insulation and Dielectric Phenomena, 1998. Annual Report. Conference on	1998	In order to improve our understanding of surface degradation of epoxy resin used in high-voltage gas-insulated systems (GIS), discharge-induced microstructural, morphological, and compositional changes have been investigated using Atomic Force Microscopy (AFM) and X-ray Photoelectron Spectroscopy (XPS). The AFM technique enables direct observation of any possible relationship that may exist between electrical aging and structural changes on polymer surfaces. Samples of epoxy resin aged under the effects of partial discharges (PD) were studied with the high-resolution AFM technique to explore their surface topography. PD (corona) were produced in SF <sub>6</sub> and in nitrogen with 1% of SF <sub>6</sub> in a plane-point-plane electrode configuration at 800 Torr, and these discharges were made to interact with virgin epoxy resin samples. As expected, the resin surfaces exposed to PD in pure SF <sub>6</sub> were found to be more readily modified than those exposed to discharges in the gas mixture, because of the higher concentration of reactive fragments resulting in the former case. Surface homogenisation and/or enhancement of nanometric surface "nodosities" could be observed with increasing total surface energy deposited ( "dose" ). At the same time, XPS was carried out on the same samples, the results of which confirmed the dominating role of reactive neutrals; when pure SF <sub>6</sub> was used, results indicated that surface changes were due mainly to the effects of fluorine-containing species	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=732995">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=732995</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Evaluation of contamination resistance of GFR epoxy rods for indoor application by means of a salt fog test	Ross, R.; Schmuck, F.; Megens, M. G M	KEMA, Arnhem, Netherlands	Conduction and Breakdown in Solid Dielectrics, 1998. ICSD '98. Proceedings of the 1998 IEEE 6th International Conference on	1998	GFR (Glass Fibre Reinforced) epoxy insulators are very useful where both mechanical and electrical stress are to be endured. Outdoor applications are e.g. suspension insulators in overhead lines and hollow insulators for cable terminations and bushings. Indoor applications can be found in switch gear in the form of support insulators or pull rods. The present paper focuses on indoor applications in particular. Discussed are: the equipment and possible environmental impact, the kind of degradation to be expected, principles of fog tests, the application of fog tests to rank materials and finally a discussion of the results	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=709315">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=709315</a>
On the use of dielectric coatings in particle-contaminated gas insulated switchgear	Morcos, M.M.; Zhang, S.; Holmberg, M.; Srivastava, K.D.	Kansas State Univ., Manhattan, KS, USA	Solid Dielectrics, 2001. ICSD '01. Proceedings of the 2001 IEEE 7th International Conference on	2001	Electrical insulation performance of GIS/GITL systems is adversely affected by metallic particle contaminants. These particles may be free to move in the electric field, or may be fixed on the conductors, thus enhancing local electric fields. Dielectric coatings applied to the inside surface of the outer enclosure of a coaxial GIS/GITL system improve the insulation performance. Coating reduces the degree of surface roughness on conductors, thus decreasing the high local electric fields. The electric field necessary to lift a particle resting on the bottom of a GIS/GITL enclosure is much increased due to the coating. In a horizontal coaxial system with particles resting on the inside surface of the enclosure, the motion of such particles is random in nature. Particles in practical systems can exist in a wide variety of shapes and sizes, and of materials of different densities. In this paper, only aluminum wire particles of 0.27 mm diameter in a 110 mm/304 mm diameter coaxial electrode system under 50 Hz AC applied voltage are considered. In the theoretical calculation, wire particles were represented by a cylinder hemispherically terminated at both ends	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=955510">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=955510</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
The electrical performance of air or nitrogen gas with solid insulation and the application for switchgears	Mizuno, T.; Morita, K.; Kurata, Y.; Miyagawa, H.	Core Technol. Res. Dept., Meidensha Corp., Tokyo, Japan	Transmission and Distribution Conference and Exhibition 2002: Asia Pacific. IEEE/PES	2002	<p>The electrical performance of air or N<sub>2</sub> insulated system could be improved by composite gas/polymer insulation. Extensive investigations on composite insulated system have shown the possibility of substitution for SF<sub>6</sub> insulated system. We applied the covered hemisphere-rod/plate electrode for studying the effect of composite insulated system for an application of switchgears. It was found in our studies that this system improved the dielectric strength up to maximum 1.5 times higher than that of air or N<sub>2</sub> insulated system at 0.2 MPa<sub>a</sub>g, using a liquid rubber as a cover of the rod. However, a liquid rubber cannot be applied in air as an insulated gas where oxidant degradation occurs in constant heat. On the other hand, it is presumably possible to utilize a liquid rubber in N<sub>2</sub> where oxidant degradation does not occur, since the examination of heat degradation showed that its electric characteristics was maintained. This paper presents the improvement effect for a composite insulated system with a liquid rubber, compared with some fundamental results about air or N<sub>2</sub> gas insulation performance.</p>	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1177728">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1177728</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Thermal interruption capability of carbon dioxide in a puffer-type circuit breaker utilizing polymer ablation	Uchii, T.; Shinkai, T.; Suzuki, K.	Toshiba Corp., Tokyo, Japan	Transmission and Distribution Conference and Exhibition 2002: Asia Pacific. IEEE/PES	2002	When adopting an alternative arc quenching gas to SF <sub>6</sub> which has recently been recognized as a greenhouse gas, it is easily anticipated that the thermal interruption capability of the GCB will be lower than that in using SF <sub>6</sub> . In this paper, adopting CO <sub>2</sub> as an alternative gas, the means utilizing ablation phenomenon of polymer materials as one of the breakthrough technologies compensating the drop in the interruption performance will be proposed and tested by a full-scaled GCB model. As a result, a change in the blasting pressure characteristics was observed, and also the peak pressure for the ablation application model was about 1.3 times higher than that of the conventional model without the ablation element. Furthermore, even if compared at the same blasting pressure condition at current zero, the thermal interruption capability of the CO <sub>2</sub> gas in the ablation application model was presumed to be improved with comparison to the conventional model without the ablation element. The thermal interruption capability of the CO <sub>2</sub> gas in the ablation application model could be estimated to be about 50 % of that of SF <sub>6</sub> gas in the conventional model in this interrupting test.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1177719">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1177719</a>
SF <sub>6</sub> reclaiming from SF <sub>6</sub> /N <sub>2</sub> mixtures by gas separation with molecular sieving effect	Toyoda, M.; Murase, H.; Imai, T.; Naotsuka, H.; Kobayashi, A.; Takano, K.; Ohkuma, K.	High Voltage Switchgear Dept., TM T&D Corp., Kawasaki, Japan	Power Delivery, IEEE Transactions on	2003	This paper discusses the various methods for sulfur hexafluoride (SF <sub>6</sub> ) separation from a mixture of low concentrations of SF <sub>6</sub> in N <sub>2</sub> pressure swing adsorption (PSA) with a suitable kind of synthetic zeolite, which has the expected molecular sieving effect. This molecular sieving effect, derived from molecular size difference between SF <sub>6</sub> and N <sub>2</sub> , is confirmed by the difference between two equivalent volumes filled with SF <sub>6</sub> and N <sub>2</sub> . Prototype equipment of SF <sub>6</sub> separation and liquefaction, that is about 1 m cube in size and 150 kg in weight, has been assembled and tested. The ability of gas mixture handling is 13 l/min on average, and the SF <sub>6</sub> content is reduced to 0.0% (undetectable level) in separated N <sub>2</sub> to exhaust into the atmosphere.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1193862">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1193862</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Insulation technology for medium voltage solid insulated switchgear	Shioiri, T.; Sato, J.; Ozaki, T.; Sakaguchi, O.; Kamikawaji, T.; Miyagawa, M.; Homma, M.; Suzuki, K.	Toshiba Corp., Tokyo, Japan	Electrical Insulation and Dielectric Phenomena, 2003. Annual Report. Conference on	2003	The authors have developed solid insulated switchgear that does not use SF <sub>6</sub> gas at all as an insulating medium. This paper describes the insulating material technology, diagnostic technology for partial discharge, insulation technology of the vacuum disconnecting switch and aerial composite insulation technology which are applied to this solid insulated switchgear. A new epoxy resin, which was dispersedly configured with spherical silica and rubber particles, was developed. The insulation performance of this resin is 50% higher compared with filling of alumina. Utilizing the features of the solid insulated switchgear, a diagnostic technology for partial discharge employing an acoustic emission (AE) sensor was developed. A vacuum disconnecting switch with high insulation reliability was developed applying Weibull distribution to dielectric breakdown in a vacuum. The insulated parts of insulating rods of circuit-breakers and disconnecting switches were miniaturized through composite insulation.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1254863">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1254863</a>
Feasibility study on FGM (functionally graded materials) application for gas insulated equipment [solid insulators]	Shumiya, H.; Kato, K.; Okubo, H.	Nagoya Univ., Japan	Electrical Insulation and Dielectric Phenomena, 2004. CEIDP '04. 2004 Annual Report Conference on	2004	For size reduction of electric power equipment, the electric field stress around solid insulators is to be increased and must be carefully considered. This concern may be solved by the application of FGM (functionally graded materials). We investigated an application feasibility of FGM, from both an experimental approach and numerical simulation, and the fabrication technique for gas insulated equipment. Firstly, we investigated the fabrication techniques for the continuously graded permittivity distribution with an arbitrary direction and gradings. As a result, we established fabrication techniques for the grading of permittivity distribution in a higher or lower direction by centrifugal force application. Next, we fabricated a truncated cone FGM spacer, and carried out dielectric breakdown experiments under lightning impulse voltage application. Finally, we could confirm the significant effect of FGM application for gas insulated equipment.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1364262">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1364262</a>



Título	Autores	Institución	Publicación	Año	Resumen	Link al pdf
Polyurethane foam application for high voltage insulation	Karady, G.G.; Argin, M.; Rahmatian, F.; Rose, A.H.	Arizona State Univ., Tempe, AZ, USA	Electrical Insulation and Dielectric Phenomena, 2004. CEIDP '04. 2004 Annual Report Conference on	2004	In recent years, the improvement in optical technology has increased the use of optical instrument transformers (OIT). The active parts of many OITs are placed in SF <sub>6</sub> or N <sub>2</sub> filled insulating structures. The challenge with using these insulating gases initiated the replacement of them with polyurethane foam, which is frequently used in low-voltage switchgear. The insulation of an OIT was modeled by foam filled tubes: 61.0 cm (24") long, 20.3 cm (8") diameter and electrode gap 15.2 cm (6"), and electrode radius 1.27 cm (0.5"). The AC and lightning impulse breakdown voltages of these samples were determined by a large number of tests. The repeated lightning impulse test was conducted by using 600 impulses with a peak voltage of 120 kV. The partial discharge measurements were also investigated.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1364303">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1364303</a>
Special Requirements on Gas-Insulated, Metal-Oxide Surge Arresters	Gohler, R.; Klingbeil, L.	Siemens Surge Arresters, Berlin	Power System Technology, 2006. PowerCon 2006. International Conference on	2006	Equipment in high voltage power systems can be protected effectively by metal oxide surge arresters. Basically two different types of surge arresters are used: surge arresters with air insulation using porcelain or polymeric housings (AIS surge arresters) and surge arresters with SF <sub>6</sub> -insulation using a metallic housing (GIS surge arresters). The probability of a failure of a GIS surge arrester shall be considerably less than for an air insulated surge arrester. Failures of GIS equipment always will result in major outages and costly corrective maintenance. Potential sources of surge arrester failures are the metal oxide (MO) resistor, insulating parts as fiber reinforced (FRP) rods and partitions and the metal enclosure. MO resistors are not allowed to show any aging and must have a high energy discharge capability. The FRP-rods must be free of partial discharges and must withstand high electrical strength. The metal enclosure must be made of high quality material as well as the manufacturing process shall be of high standard including sufficient testing and final certification. Required routine testing on the completely assembled surge arrester does not suffice rather all parts used must be routine tested in a proper way to avoid failing within the life time of more than 30 years. In case of a failure caused by overloading the destruction must be limited to the surge arrester.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=4115883">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=4115883</a>

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Investigation using atomic spectroscopy for the analysis of arc discharges in switchgear operating with polymeric replacements for SF <sub>6</sub>	Brookes, R. J.; Looe, H. M.; Spencer, J.W.	Dept. of Electr. Eng. & Electron., Univ. of Liverpool, Liverpool, UK	Gas Discharges and Their Applications, 2008. GD 2008. 17th International Conference on	2008	It may be possible to replace SF <sub>6</sub> gas in power switchgear by exploiting the arc quenching properties of common polymeric materials. In this research, the complex interactions between polymers and arc plasma have been investigated in a realistic environment using a model circuit breaker. The polymers studied were polyethylene and polymethylmethacrylate, which exhibit different processes to quench the arc involving energy removal by melting and secondary reactions respectively.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=5379316">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=5379316</a>
Study and diagnosis of the power transformer bushing insulation system	Mehta, A.K.; Sharma, R. N.; Chauhan, S.; Agnihotri, S. D.	Nat. Inst. of Technol., Hamirpur, India	Pulsed Power Conference (PPC), 2011 IEEE	2011	Bushings are a critical component in electricity transportation. They are used in substation buildings, transformers, locomotives, and switchgear. Bushings cause more than 15% of transformer failures. The main purpose of a bushing is to transfer load currents in and out of metal (grounded) enclosures at system voltages. The insulation system breaks down, causes bushing failure results in catastrophic event such as tank rupture, violent explosion of the bushing and fire. Clearly, the risk and likelihood of collateral and personnel damage is a major concern in such an eventuality. This research is undertaken to study and diagnosis of the power transformer bushing insulation system and in-field measurement of power-factor and capacitance using the Doble M4100 insulation analyzer. The case studies on the different transformers showed how the trend of moisture and dielectric properties changes with the variation of power factor and capacitance of insulation system.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6191566">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6191566</a>
Low-Voltage Arc Simulation with Out-Gassing Polymers	Rumpler, C.; Stammberger, H.; Zacharias, A.	Fraunhofer Inst. SCAI, St. Augustin, Germany	Electrical Contacts (Holm), 2011 IEEE 57th Holm Conference on	2011	Polymer walls and inserts are an important design criterion in low-voltage switching devices. Besides their good insulation properties they are used to influence the switching arc. An important part of the energy dissipated in the arc is absorbed by the walls of the arc chamber. This leads to degradation and evaporation of the polymer and subsequent impact on and interaction with the switching arc. This contribution explains the enhancements of an existing simulation model for the interaction between the low-voltage switching arc and walls composed of polyamide PA 66. This includes a model of plastic ablation, the influence of the plastic vapor on the transport properties of the arc as well as on its radiation. Calculations and comparisons with experimental results show the applicability of the model in arc chambers that are close to reality.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6034770">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6034770</a>



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The complex permittivity of epoxy based nanocomposites with alumina and magnesium oxide fillers at very low temperatures	Andritsch, T.; Kochetov, R.; Morshuis, P. H F; Smit, J.J.	Delft Univ. of Technol., Delft, Netherlands	Electrical Insulation and Dielectric Phenomena (CEIDP), 2011 Annual Report Conference on	2011	Delivery of energy in areas with a large population density and little space for high voltage equipment is an issue for utility companies in metropolises. Gas insulated switchgear is an alternative to conventional cable systems, enabling higher energy densities. However, the sulfur hexafluoride used in GIS causes environmental problems, which may not be acceptable anymore in a society with emphasis on sustainability. An alternative to this are superconducting cables. High temperature superconducting cables operate at temperatures close to the boiling point of nitrogen, which is 77 K. Not much is known about the dielectric behavior of insulating polymers at such temperatures. This exploratory work investigates how the complex permittivity of epoxy based nanocomposites changes at very low temperatures. A broadband dielectric spectrometer was utilized to acquire the real and imaginary part of the complex permittivity, along with the loss factor. The base polymer for all samples is a commercially available bisphenol-A epoxy with anhydrite hardener. As filler material magnesium oxide powder was used with an average particle size of 22 nm and alumina filler with 50 nm average diameter. Both particle types were modified with a silane coupling agent, in order to achieve a uniform dispersion of particles in the host material. Neat epoxy samples were used as a reference.	<a href="http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6232657">http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6232657</a>