

NOTICIAS DE INVESTIGACIÓN

ETS I+D+I

BOLETÍN BIMENSUAL DE INVESTIGACIÓN DE LA ETSIDI

NÚMERO 3

MAYO – JUNIO DE 2018

<http://www.etsidi.upm.es/Investigadores/ActivYpublicacDeInvestigacion/BoletinETSIDI>

Este boletín informativo electrónico de periodicidad bimestral tiene como objetivo informar de las actividades de investigación desarrolladas en la ETS de Ingeniería y Diseño Industrial y recopilar los resúmenes de los artículos publicados en la Web of Science (WoS) de los que son autores o coautores investigadores de la Escuela.

1. EVENTOS.

XVI CONGRESO IBÉRICO Y XII CONGRESO IBEROAMERICANO DE ENERGIA SOLAR (CIES2018)

Bajo el lema “**Energía limpia y gestionable para tod@s**” se celebró en la ETSIDI, del 20 y al 22 de junio, el congreso CIES2018 organizado por la [Asociación Española de Energía Solar \(AEDES\)](#), Sección Española de la [International Solar Energy Society](#), en colaboración con la propia ETSIDI y con la [Universidad de les Illes Balears \(UIB\)](#).

El Congreso Ibérico de Energía Solar viene celebrándose en sedes de España y Portugal desde el año 1982, y ha tenido lugar conjuntamente con el Congreso Iberoamericano de Energía Solar en nueve de sus quince ediciones. Constituye el congreso más importante y con mayor tradición en el ámbito de la energía solar en lenguas española y portuguesa. CIES es el evento de referencia para todos los profesionales ligados al desarrollo, implementación y formación en tecnología solar, y está dirigido a científicos, educadores, ingenieros, arquitectos, economistas, empresarios, tecnólogos, administración y usuarios finales, unidos por el objetivo de promover la energía solar en Iberoamérica ámbitos tan diversos como la edificación, el transporte, la generación eléctrica o el calor de proceso industrial.

El programa del congreso incluyó las sesiones técnicas habituales con la realización de talleres de expertos, seminarios, mesas redondas y actividades formativas promovidas por Asociaciones Industriales, Plataformas Tecnológicas y Universidades colaboradoras. Las temáticas principales en las sesiones fueron: Edificación solar sostenible, Energía solar térmica, Tecnología y sistemas fotovoltaicos, Recurso solar, Educación, formación y enseñanza de las energías renovables, y Energía solar y sociedad. Además se realizaron visitas técnicas tanto a la instalación fotovoltaica de la ETSIDI como al instituto [IMDEA Energía](#) y tuvo lugar una sesión paralela en colaboración la [Casa Encendida](#) sobre “[Electrificación Solar Aislada en Iberoamérica](#)”

El lema de esta edición del Congreso expresaba un triple objetivo. Por una parte recordar el papel fundamental de la energía solar en el impulso de la lucha contra el cambio climático acordado en el [COP23](#) celebrado en Bonn (Alemania) del 6 al 17 de noviembre de 2017, que se sustanciará en el próximo [Diálogo de Talanoa de 2018](#), con un aumento en los niveles de la acción climática antes de 2020. La gestionabilidad es el nuevo gran valor de la energía solar a nivel comercial con importantes avances en las distintas formas de almacenamiento térmico y electroquímico, que permiten cada vez más adaptar el despacho a la demanda. Por último resaltar que además la energía solar es ya una energía accesible para tod@s habiéndose consolidado como la forma más barata de generación eléctrica en diversos concursos y subastas en Iberoamérica y en el resto del mundo.

En el congreso participaron unos 150 investigadores procedentes de España, Portugal, Brasil, Argentina, Uruguay, Chile, Colombia, Perú y México. Además de 8 ponencias invitadas en sesiones plenarias, se presentaron un total 108 comunicaciones orales y 38 posters, entre ellas varias de profesores y alumnos de la ETSIDI.

La información completa sobre el Congreso puede consultarse en:

<http://www.cies-congreso.org/15227/detail/xvi-congreso-iberico-y-xii-congreso-iberoamericano-de-energia-solar.html>

2. PUBLICACIONES.

Improving power supply design for high speed lines and 2 x 25 systems using a genetic algorithm.

The railway's electrical system is a complex system the design of which requires an in-depth detailed survey of the main modules of which it consists. Not only is it highly complex, but it is also strongly non-linear. A number of research methods have arisen to secure the best possible design to facilitate the task. CITEF (Railway Technology Research Centre, Technical University of Madrid) has developed a methodology using an optimisation method with a railway simulator (HAMLET), which meets this objective.

The methodology takes account of the fact that a good design must meet a number of major requirements. It must meet current electricity regulations, it must meet the budget imposed, it must observe environmental zones as far as possible and contemplate maintenance-sensitive zones, and finally it must identify areas posing particular difficulties in terms of connecting electrical elements to the main grid.

Coordination between a genetic optimisation algorithm and a high-performance railway simulator gives the methodology a considerable analysis capacity. The 2 x 25 system requires a high computation capacity, and it was for this reason that the genetic algorithm AMGA-II was selected. Extension of the methodology to 2 x 25 systems called for adaptation of the railway simulator, a new approach to the characteristics of the genetic system, and adaptation of the mathematical model calculating costs by means of the objective functions and restrictions.

The methodology was able to adapt to these complex and strongly non-linear systems, and provide a range of optimum solutions with a genuine compromise between the costs of installation and operation (Capex and Opex), a minor impact on critical zones and electrical validation for railways operating AC 2 x 25 systems.

Autores:

1. Soler-Nicolau, M - Tech Univ Madrid UPM, Railway Technol Res Ctr CITEF, ETSII, Madrid, Spain.
2. Mera, JM - Tech Univ Madrid UPM, Railway Technol Res Ctr CITEF, ETSII, Madrid, Spain.
3. López, J - Tech Univ Madrid UPM, Railway Technol Res Ctr CITEF, ETSII, Madrid, Spain.
4. Cano-Moreno, JD - Tech Univ Madrid UPM, Railway Technol Res Ctr CITEF, ETSII & Dept. Mechanical, Chemical and Ind. Design Engineering, ETSIDI UPM, Madrid, Spain.

DOI: 10.1016/j.ijepes.2018.01.029

How to improve the students' affective dimension when learning science through a Flipped-Classroom setting: a case study.

For the last few years, the flipped classroom methodology or inverted instruction methodology is gaining attention, and instructors are applying more often this methodology in their classrooms. In a flipped classroom setting, the traditional roles are inverted: the time students spend in their house is used to lecturing while classroom time is used to complete the traditional homework and other collaborative activities. This classroom setting aims to engage students more successfully with the course. In order to gauge this relatively new methodology, a comparative study was conducted. Precisely, a traditional classroom was compared with a flipped-classroom setting for the same general science course. The study was conducted at the Teaching Training College of the University of Extremadura (Spain). The comparison was carried out in terms of how the instruction methodology had a significant influence in the students' affective dimensions toward the course and the learning outcomes achieved. According to the results, the students had a general positive perception to a flipped classroom setting, showing more positive attitudes toward the course. Besides, the students' emotions analysis revealed that they were more positive and less negative in the flipped classroom compared with the traditional one. Therefore, regarding the course learning outcomes, statistically higher average grades were achieved in the flipped-classroom course, as well as the number of students passing the course.

Autores:

1. González-Gómez, D - Univ Extremadura, Dept Didact Ciencias Expt & Matemat, Badajoz, Spain.
2. Su Jeong, J- ETSIDI UPM, Madrid, Spain.
3. Canada-Canada, F - Univ Extremadura, Dept Didact Ciencias Expt & Matemat, Badajoz, Spain.

DOI: 10.21125/iceri.2017.0799

Scaffolding and intervention of Web Education to assist sustainable spatial planning for Design students as interactive and collaborative method.

In industrial design, architecture, landscape architecture and urban planning education and practice, computer, information, internet and World Wide Web (WWW) are challenged to combine these technologies into design education as a scaffolding and intervention mechanism. This work presents a web-scaffolding education model, teaching/learning strategy, to assist undergraduate and graduate design students' sustainable spatial planning as building integration in a dispersed environment, particularly for selecting a suitable housing site. The objective of this research is to examine the measurement and verification of the model, which would assist students to have more broad understandings of sustainable spatial design and planning in a collaborative teaching/learning context while having communication with professors and/or experts. Two variables, multi-criteria selection and survey questionnaire, are measured and verified in two design studios as experimental groups to reflect on how using it affects students' sustainable spatial design and planning process and their learning activities. Afterwards, objective comparison is done with two comparable groups to identify the direct effect of the model, promoting students' learning activities, enhancing knowledge acquisition and satisfying a mix of students with different necessities within a collaborative learning context. Particularly, in the survey results it is apparent that the model proposed is beneficial to students not only from preliminary and initial site analysis but also to further planning progress and final housing design. In the results of objective comparison, the experimental group chooses 90% suitable areas while the comparable group chooses only 20% suitable areas. In conclusions, the research presents solid results of content analysis, survey questions and objective comparison to introduce new possible sustainable spatial design and planning as building integration, starting with site selection, other than what are now employed in design education. Therefore, this research embodies to examine new web-scaffolding education model potentials and continues further to open new education research venues.

Autores:

1. Su Jeong, J - ETSIDI UPM, Madrid, Spain.
2. González-Gómez, D - Univ Extremadura, Dept Didact Ciencias Expt & Matemat, Badajoz, Spain.
3. Canada-Canada, F - Univ Extremadura, Dept Didact Ciencias Expt & Matemat, Badajoz, Spain.
4. Ramírez-Gómez, A - Dept. Mechanical, Chemical and Ind. Design Engineering, ETSIDI UPM, Madrid, Spain.
5. García Moruno, L - Univ Extremadura, Dept Expres Graf, Badajoz, Spain.
6. Hernández Blanco, J - Univ Extremadura, Dept Expres Graf, Badajoz, Spain.

DOI:10.21125/iceri.2017.0801

Optimal Control of a Ball and Beam Nonlinear Model Based on Takagi-Sugeno Fuzzy Model

In this work, an improved approach for Takagi-Sugeno system identification is used. Linear Quadratic Regulator is applied for an optimal state feedback. Duality theorem and Linear Quadratic Regulator is applied for an optimal state estimation. Simulation results over the ball and beam nonlinear model show a stable closed loop in the full range and good transient response.

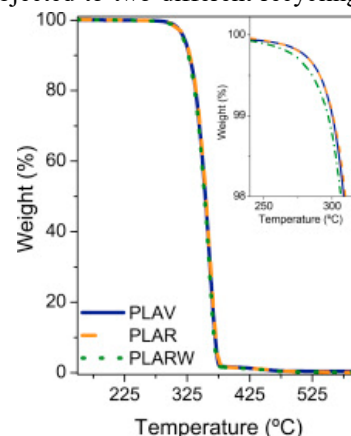
Autores:

1. Miguel Adánez, Jose - Univ Politecn Madrid, Intelligent Control Grp, Ctr Automat & Robot, CSIC, Madrid, Spain.
2. Mohammed Al-Hadithi, B - Univ Politecn Madrid, Intelligent Control Grp, Ctr Automat & Robot, CSIC & Dept. Electrical Eng., Electronics, Automation and Applied Physics, ETSIDI UPM, Madrid, Spain.
3. Jiménez, A - Univ Politecn Madrid, Intelligent Control Grp, Ctr Automat & Robot, CSIC, Madrid, Spain.
4. Matia, Fernando - Univ Politecn Madrid, Intelligent Control Grp, Ctr Automat & Robot, CSIC, Madrid, Spain.

DOI: 10.1007/978-3-319-66830-7_1

Effect of simulated mechanical recycling processes on the structure and properties of poly(lactic acid)

The aim of this work is to study the effects of different simulated mechanical recycling processes on the structure and properties of PLA. A commercial grade of PLA was melt compounded and compression molded, then subjected to two different recycling processes. The first recycling process consisted of an accelerated ageing and a second melt processing step, while the other recycling process included an accelerated ageing, a demanding washing process and a second melt processing step. The intrinsic viscosity measurements indicate that both recycling processes produce a degradation in PLA, which is more pronounced in the sample subjected to the washing process. DSC results suggest an increase in the mobility of the polymer chains in the recycled materials; however the degree of crystallinity of PLA seems unchanged. The optical, mechanical and gas barrier properties of PLA do not seem to be largely affected by the degradation suffered during the different recycling processes. These results suggest that, despite the degradation of PLA, the impact of the different simulated mechanical recycling processes on the final properties is limited. Thus, the potential use of recycled PLA in packaging applications is not jeopardized. (C) 2017 Elsevier Ltd. All rights reserved.



Autores:

1. Beltrán, FR - ETSIInd UPM, Dept Ingn Quim Ind & Medio Ambiente, Grp Polimeros Caracterizac & Aplicac, Madrid, Spain.
2. Lorenzo, V - ETSIInd UPM, Dept Ingn Quim Ind & Medio Ambiente, Grp Polimeros Caracterizac & Aplicac, Madrid, Spain.
3. Acosta, J - Dept Mecan Quim & Diseno Ind, ETSIDI UPM, Madrid, Spain.
4. de la Orden, MU - ETSIInd UPM, Dept Ingn Quim Ind & Medio Ambiente, Grp Polimeros Caract & Aplicac Madrid, Spain.
5. Martínez Urreaga, J - ETSIInd UPM, Dept Ingn Quim Ind & Medio Ambiente, Grp Polimeros Caracterizac & Aplicac, Madrid, Spain.

DOI:10.1016/j.jenvman.2017.05.020

Rapid prototyping prosthetic hand acting by a low-cost shape-memory-alloy actuator

The purpose of this article is to develop a new concept of modular and operative prosthetic hand based on rapid prototyping and a novel shape-memory-alloy (SMA) actuator, thus minimizing the manufacturing costs. An underactuated mechanism was needed for the design of the prosthesis to use only one input source. Taking into account the state of the art, an underactuated mechanism prosthetic hand was chosen so as to implement the modifications required for including the external SMA actuator. A modular design of a new prosthesis was developed which incorporated a novel SMA actuator for the index finger movement. The primary objective of the prosthesis is achieved, obtaining a modular and functional low-cost prosthesis based on additive manufacturing executed by a novel SMA actuator. The external SMA actuator provides a modular system which allows implementing it in different systems. This paper combines rapid prototyping and a novel SMA actuator to develop a new concept of modular and operative low-cost prosthetic hand.

Autores:

1. Soriano-Heras, E - Univ Carlos III Madrid, Madrid, Spain.
2. Blaya-Haro, F - Dept Mecan Quim & Diseno Ind, ETSIDI UPM, Madrid, Spain.
3. Molino, C - ETSIDI UPM, Madrid, Spain.
4. de Agustín del Burgo, JM - ETSIDI UPM, Madrid, Spain.

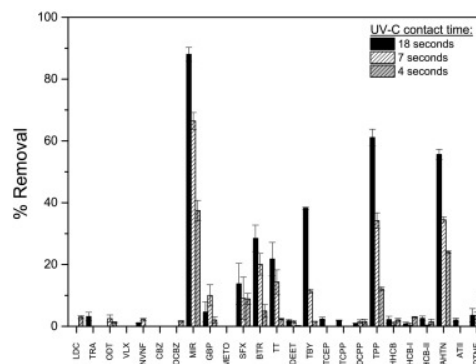
DOI:10.1007/s10047-017-1014-1

Micropollutants removal by full-scale UV-C/sulfate radical based Advanced Oxidation Processes

The high chemical stability and the low biodegradability of a vast number of micropollutants (MPs) impede their correct treatment in urban wastewater treatment plants. In most cases, the chemical oxidation is the only way to abate them. Advanced Oxidation Processes (AOPs) have been experimentally proved as efficient in the removal of different micropollutants at lab-scale. However, there is not enough information about their application at fullscale. This manuscript reports the application of three different AOPs based on the addition of homogeneous oxidants [hydrogen peroxide, peroxymonosulfate (PMS) and persulfate anions (PS)¹], in the UV-C tertiary treatment of Estiviel wastewater treatment plant (Toledo, Spain) previously designed and installed in the facility for disinfection.

AOPs based on the photolytic decomposition of oxidants have been demonstrated as more efficient than UV-C radiation alone on the removal of 25 different MPs using low dosages (0.05-0.5 mM) and very low UV-C contact time (4-18 s). Photolysis of PMS and H₂O₂ reached similar average MPs removal in all the range of oxidant dosages, obtaining the highest efficiency with 0.5 mM and 18 s of contact time (48 and 55% respectively). Nevertheless, PMS/UV-C reached slightly higher removal than H₂O₂/UV-C at low dosages. So, these treatments are selective to degrade the target compounds, obtaining different removal efficiencies for each compound regarding the oxidizing agent, dosages and UV-C contact time.

In all the cases, H₂O₂/UV-C is more efficient than PMS/UV-C, comparing the ratio cost:efficiency (/m³). Even H₂O₂, UV-C treatments are more efficient than UV-C alone. Thus, the addition of 0.5 mM of H₂O₂ compensates the increased of UV-C contact time and therefore the increase of electrical consumption, that it should be need to increase the removal of MPs by UV-C treatments alone. (C) 2018 Elsevier B.V. All rights reserved.



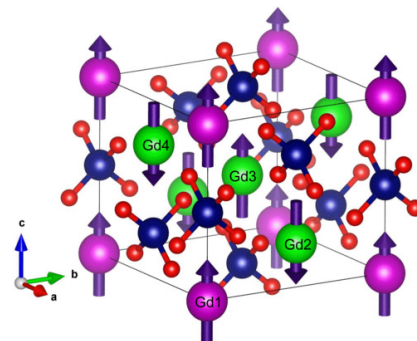
Autores:

1. Rodríguez-Chueca, J - Univ Rey Juan Carlos, Dept Chem & Environm Technol ESCET & Tech Univ Madrid UPM, Dept Chem & Environm Engn, Madrid, Spain.
2. Laski, E - Univ Stuttgart, Inst Sanit Engn Water Qual & Solid Waste Manageme, Dept Hydrochem & Hydrobiol, Stuttgart, Germany.
3. García-Canibano, C - Univ Rey Juan Carlos, Dept Chem & Environm Technol ESCET, Madrid, Spain.
4. Martín de Vidales, MJ - Mech Chem & Ind Design Engn Dept, ETSIDI UPM, Madrid, Spain.
5. Encinas, A - FCC Aqualia SA, Dept Innovat & Technol, Badajoz, Spain.
6. Kuch, B - Univ Stuttgart, Inst Sanit Engn Water Qual & Solid Waste Manageme, Dept Hydrochem & Hydrobiol, Stuttgart, Germany.
7. Marugán, J - Univ Rey Juan Carlos, Dept Chem & Environm Technol ESCET, Madrid, Spain.

DOI:10.1016/j.scitotenv.2018.02.279

Magnetic structures and magnetocaloric effect in RVO₄ (R = Gd, Nd)

We report the magnetic properties and magnetic structure of the zircon-type compound GdVO₄, together with the magnetic structure of the isostructural NdVO₄. At T similar or equal to 2.5 K, GdVO₄ undergoes a phase transition to antiferromagnetic G(z), driven mainly by the exchange interactions, while the magnetic anisotropy and dipolar interactions are minor contributions. Near the liquid-helium boiling temperature, the magnetocaloric effect of GdVO₄ is nearly as large as that of the structurally closely related GdPO₄. It is noteworthy that GdVO₄ has been recently proposed as a good passive regenerator in Gifford-McMahon cryocoolers, since adding a magnetization-demagnetization stage to the cryocooler refrigeration cycle would increase its efficiency



for liquefying helium. NdVO₄ is a canted G(z)-type antiferromagnet and shows enhancement of the magnetic reflections in neutron diffraction below ca. 500 mK, due to the polarization of the Nd nuclei by the hyperfine field.

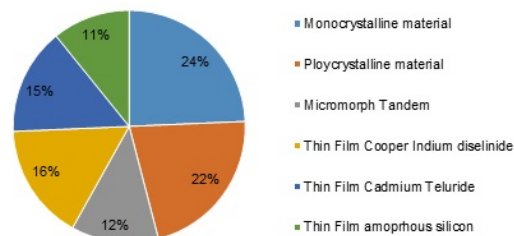
Autores:

1. Palacios, E - Univ Zaragoza, CSIC, ICMA & Dept Fis Mat Condensada, Zaragoza, Spain.
2. Evangelisti, M - Univ Zaragoza, CSIC, ICMA & Dept Fis Mat Condensada, Zaragoza, Spain.
3. Sáez-Puche, R - Univ Complutense Madrid, Dept Quim Inorgan, Madrid, Spain.
4. Dos Santos-García, AJ - Dept Ingn Mekan Quim & Diseno Ind, ETSIDI UPM, Madrid, Spain.
5. Fernández-Martínez, F -Dept Ingn Mekan Quim & Diseno Ind, ETSIDI UPM, Madrid, Spain.
6. Cascales, C - CSIC, Inst Ciencia Mat Madrid, Campus Cantoblanco, Madrid, Spain.
7. Castro, M - Univ Zaragoza, CSIC, ICMA & Dept Ciencia & Tecnol Mat & Fluidos, Zaragoza, Spain.
8. Burriel, R - Univ Zaragoza, CSIC, ICMA & Dept Fis Mat Condensada, Zaragoza, Spain.
9. Fabelo, O - Inst Laue Langevin, Grenoble, France.
10. Rodríguez-Velamazán, JA - Inst Laue Langevin, Grenoble, France.

DOI:10.1103/PhysRevB.97.214401

Polymeric Materials for Conversion of Electromagnetic Waves from the Sun to Electric Power

Solar photoelectric energy converted into electricity requires large surface areas with incident light and flexible materials to capture these light emissions. Currently, sunlight rays are converted to electrical energy using silicon polymeric material with efficiency up to 22%. The majority of the energy is lost during conversion due to an energy gap between sunlight photons and polymer energy transformation. This energy conversion also depends on the morphology of present polymeric materials. Therefore, it is very important to construct mechanisms of highest energy occupied molecular orbitals (HOMO)s and the lowest energy unoccupied molecular orbitals (LUMO)s to increase the efficiency of conversion. The organic and inorganic solar cells used as dyes can absorb more photons from sunlight and the energy gap will be less for better conversion of energy to electricity than the conventional solar cells. This paper provides an up-to-date review on the performance, characterization, and reliability of different composite polymeric materials for energy conversion. Specific attention has been given to organic solar cells because of their several advantages over others, such as their low-energy payback time, conversion efficiency and greenhouse emissions. Finally, this paper provides the recent progress on the application of both organic and inorganic solar cells for electric power generations together with several challenges that are currently faced.



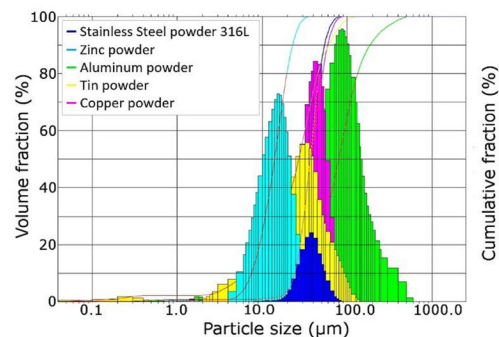
Autores:

1. Manirul Haque, SK - Jubail Ind Coll, Dept Chem & Proc Engn Technol, Jubail Ind City, Saudi Arabia.
2. Alfredo Ardila-Rey, J - Univ Tecn Federico Santa Maria, Dept Elect Engn, Santiago, Chile.
3. Umar, Y - Jubail Ind Coll, Dept Chem & Proc Engn Technol, Jubail Ind City, Saudi Arabia.
4. Rahman, H - Jubail Ind Coll, Dept Gen Studies, Jubail Ind City, Saudi Arabia.
5. Mas'ud, AA - Jubail Ind Coll, Dept Elect & Elect Engn, Jubail Ind City, Saudi Arabia.
6. Muhammad-Sukki, F - Robert Gordon Univ, Sch Engn, Aberdeen, Scotland.
7. Albarracín, R - Dept Ingn Elect Elect Automat & Fis Aplicada, ETSIDI UPM, Madrid, Spain.

DOI:10.3390/polym10030307

Internal Friction Angle of Metal Powders

Metal powders are components with multidisciplinary usage as their application is very broad. Their consistent characterization across all disciplines is important for ensuring repeatable and trouble-free processes. Ten metal powders were tested in the study. In all cases, the particle size distribution and morphology (scanning electron microscope-SEM photos) were determined. The aim of this work was to inspect the flow behavior of metal powders through another measured characteristic, namely the angle of internal friction. The measured values of the effective internal friction angle in the range 28.6-32.9 degrees, together with the spherical particle shape and the particle size distribution, revealed the likely dominant mode of the metal particle transfer mechanism for stainless steel 316L, zinc and aluminum powder. This third piston flow mechanism is described and illustrated in detail. The angle of internal friction is mentioned as another suitable parameter for the characterization of metal powders, not only for the relative simplicity of the determination but also for gaining insight into the method of the movement of individual particles during the flow.



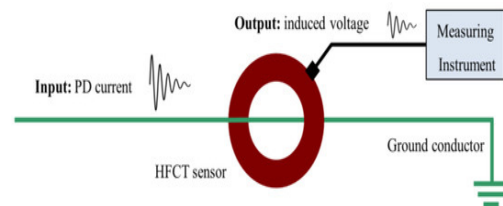
Autores:

1. Zegzulka, J - VSB TU Ostrava, ENET Ctr Energy Utilizat Nontradit Energy Sources, Bulk Solids Ctr & Fac Mech Engr, Inst Transportat, Ostrava, Czech Republic.
2. Gelnar, D - VSB TU Ostrava, ENET Ctr Energy Utilizat Nontradit Energy Sources, Bulk Solids Ctr, Ostrava, Czech Republic.
3. Jezerska, L - VSB TU Ostrava, ENET Ctr Energy Utilizat Nontradit Energy Sources, Bulk Solids Ctr, Ostrava, Czech Republic.
4. Ramírez-Gómez, A - Dept Mech Chem & Ind Design Engr, ETSIDI UPM, Madrid, Spain.
5. Necas, J - VSB TU Ostrava, ENET Ctr Energy Utilizat Nontradit Energy Sources, Bulk Solids Ctr & Fac Mech Engr, Inst Transportat, Ostrava, Czech Republic.
6. Rozbroj, J - VSB TU Ostrava, ENET Ctr Energy Utilizat Nontradit Energy Sources, Bulk Solids Ctr, Ostrava, Czech Republic.

DOI: 10.3390/met8040255

Diagnosis of Insulation Condition of MV Switchgears by Application of Different Partial Discharge Measuring Methods and Sensors

Partial discharges (PD) measurement provides valuable information for the condition assessment of the insulation status of high-voltage (HV) electrical installations. During the last three decades, several PD sensors and measuring techniques have been developed to perform accurate diagnostics when PD measurements are carried out on-site and on-line. For utilities, the most attractive characteristics of on-line measurements are that once the sensors are installed in the grid, the electrical service is uninterrupted and that electrical systems are tested in real operating conditions. In medium-voltage (MV) and HV installations, one of the critical points where an insulation defect can occur is inside metal-clad switchgears (including the cable terminals connected to them). Thus, this kind of equipment is increasingly being monitored to carry out proper maintenance based on their condition. This paper presents a study concerning the application of different electromagnetic measuring techniques (compliant with IEC 62478 and IEC 60270 standards), together with the use of suitable sensors, which enable the evaluation of the insulation condition mainly in MV switchgears. The main scope is to give a general overview about appropriate types of electromagnetic measuring methods and sensors to be applied, while considering the level of detail and accuracy in the diagnosis and the particular fail-safe requirements of the electrical installations where the switchgears are located.



Autores:

1. Alvarez Gómez, F - Dept Elect Engr, ETSIDI UPM, Madrid, Spain.
2. Albarracín-Sánchez, R - Dept Elect Engr, ETSIDI UPM, Madrid, Spain.
3. Garnacho Vecino, F - Dept Elect Engr, ETSIDI UPM, Madrid, Spain.
4. Granizo Arrabe, R - Dept Elect Engr, ETSIDI UPM, Madrid, Spain.

DOI: 10.3390/s18030720