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Saeid Eslamian

# Recent Advances in Energy, Environment & Economic Development

Proceedings of the 3rd International Conference on Development, Energy, Environment, Economics (DEEE '12)


Paris, France, December 2-4, 2012

Mathematics and Computers in Science and Engineering Series | 6

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## Plenary Lecture 1

# On the Relation between Marine Pollution, Biofouling, and Undersea Metallic Corrosion – An Interdisciplinary Knowledge-Based Approach

**Professor Fragiskos A. Batzias**
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**Abstract:** Marine pollution takes place when potentially dangerous species enter seawater, coming from point and non point sources, like agricultural runoff. Biofouling is caused by the attachment and population growth of microorganisms (microfouling) or larger organisms (macrofouling) on undersea structures, either moving or fixed (like ships' hulls or pipelines, respectively). Metallic corrosion is the deterioration of the metal through interaction with its environment, mainly by means of the establishment of local electrochemical cells on the metallic surface. All these phenomena (due either to natural causes or/and anthropogenic actions) are economically significant, since they decisively influence the energy expenditure and the maintenance schedule. In this lecture, we present the interaction between pollution, biofouling and corrosion by using the combination of an interdisciplinary environmental ontology (forming the knowledge base) with an algorithmic procedure using directed graphs (forming the inference engine background), including IF...THEN rules in a fuzzy version in order to count for uncertainty). Two case examples are presented, the first referring to ships' hulls and ballast seawater tanks, and the second to undersea pipeline transport of natural gas.

**Brief Biography of the Speaker:**
Prof. Fragiskos Batzias holds a 5years Diploma and a PhD degree in Chemical Engineering, and a BSc in Economics. He has also studied Mathematics and Philosophy. He is Director of the Laboratory of Simulation of Industrial Processes and Head of the Research Group on Systems Analysis at the Department of Industrial Management and Technology of the University of Piraeus, Greece. He is teaching at the interdepartmental postgraduate courses (i) Systems of Energy Management and Protection of the Environment, running by the University of Piraeus in cooperation with the Chem. Eng. Dept. of the Nat. Tech. Univ. of Athens, and (ii) Techno-Economic Systems, running by the Electr. & Comp. Eng. Dept. of the Nat. Tech. Univ. of Athens in cooperation with the University of Athens and the University of Piraeus. His research interests are in chemical engineering systems analysis and knowledge based decision making. He has >100 publications in highly ranked journals and conference proceedings, including 29 research monographs in collective volumes, with 171 citations and an h-index of 8 (for the period 2004-2011, source: ISI Web of Science, Thompson Scientific; self-citations have been excluded). He has participated (and chaired after invitation from the organizers) in prestigious international conferences, such as those organized periodically by the IEEE, the European Federation of Chemical Engineering (EFCE), the DECHEMA, CHISA, WSEAS Organizations. He organizes the annual Symposium on Industrial and Environmental Case Studies running successfully since 2004 within the International Conference of Computational Methods in Sciences and Engineering (ICCMSE).

## Plenary Lecture 2

## Tourism-Environment-Sustainable Development and Crisis

**Professor Mirela Mazilu**
University of Craiova
Faculty of Social sciences
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Romania
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**Abstract:** "Mainstreaming sustainability" means to rise to the challenge of the mass tourism market. It is a well-known fact that tourism involves commercial exchanges, commitments, development and cultural sustainability, towards the tranquility and the satisfaction of the people's aspirations. The world crisis means a moment of incertitude, but opens, also, immense possibilities. It is true that we face one of the highest economic deficits from the last half a century, with an economic disorder, with the increase of the unemployment and the decrease of the trust in the market, all these generating a recession whose end is not entirely known. The fact that this crisis overlaps the problems caused by the climate changes determines increased difficulties in the creation of new workplaces, in the imperious attempt to reduce poverty. This crisis places, at the same time, a constant pressure on tourists, but also on the employees from the tourism industry and the tourist market, considerably threatening the policies and the actual practices. But, as Phoenix bird that rises again from its own ashes, tourism has constantly proved a remarkable capacity of recovery and it has done that even more powerful, proving that it is a perfectly viable sector. Post-crisis challenge for Romania is the organization and development of its natural and cultural resources in a range of tourism products with a wide appeal to the public, and transforming these attractions in a flow of tourists and benefits for the country. This requires an integrated product development and strategic marketing approach, and more attention to the environmental problems and sustainable development of tourism and environment. This study uses a framework developed from the industrial ecology literature to assess the impacts of the tourism industry on the environment. Three categories of impact are discussed: direct impacts, including impacts from the tourism to a destination, the tourist activities in and of themselves at that destination, and from the creation, impacts, resulting from travel service providers' ability to influence suppliers; and another category impact, where service providers can influence the behavior or consumption patterns of customers. Educational efforts to promote environmentally responsible tourism should be framed in accordance with the targeted audience (e.g., tourists, industry sectors). Tourists may be more receptive to educational efforts that focus on the environmental benefits of altering their behavior than to regulatory prohibitions per se. The greening of tourism, which involves efficiency improvements in energy, water, and waste systems, is expected to reinforce the employment potential of the sector with increased local hiring and sourcing and significant opportunities in tourism oriented toward local culture and the natural environment. Green tourism embraces all aspects of sustainable tourism, based on four basic principles (UNWTO): environmental, social, economic and climate (i.e. the "quadruple bottom line" of sustainable tourism). Green tourism minimizes the environmental impact of tourism and maximizes its adaptation to climate change. However, educational efforts geared towards industry sectors seem most effective when cost savings and the marketing benefits of "being green" are emphasized in this article.

**Brief Biography of the Speaker:**
Mirela Elena Mazilu is professor of the University of Craiova,Social Sciences Faculty,Department of Geography, Romania. She has many national and international researches naming 14 books which were published as a single author; 6 university manuals especially in tourism; over 187 articles which were published in the volumes of the national and international Congresses, symposiums, conferences and seminars and also in prestigious magazines with CNCSIS range and over 194 participations to scientific events. Also, she published over 44 articles in international magazines in different fields such as: Sustainable tourism,European integration, ecology, environment protection, tourism and 46 articles in national journals CNCSIS,etc. She has 36 articles published in International Journals of specialty with ISI range and 12 in Naun Journal and many others international journals. Her papers are cited in International Data Bases (42).With multiple preoccupations in the field of tourism, organizer of 2 Euro-regional fairs of tourism(with participation of Mondial Travel Organization) and 3 International Conferences(2004,2006,2009) and in the 4th Conference organized the Special Session "Sustainable Tourism" in collaboration with WSEAS,

Plenary Lecturer in Conference :Economy, Management and Transformation 2010 (EMT' 2010) ,ICAB ‘2012 Montreux,CUHT,2011,Corfu,organized by WSEAS, President Organizing Committee of TED’2011, Chairman in many national and international conferences, reviewer in 4 Journals of Tourism, coordinator of over 21 research grants, member of doctoral commissions, winner of many diplomas of excellence on tourism and prizes for the researches made in tourism, member of many national(16) and international(22) tourism organizations (AIEST,CIRET,TIES,SUSTAINABLE TOURISM,TTRA,REZOTOUR, SOUTHEASTERN EUROPE MOUNTAIN RESEARCH NETWORK, CEDIMES, etc.). Also member of Editorial boards of national and international journals on tourism, President of 2 NGO, in Tourism, reviewer in 6 international Journals.

## Plenary Lecture 3

# Numerical Methods of Accidental Leak localization on the Branched Main Gas Pipeline

**Professor Teimuraz Davitashvili**
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Tbilisi State University
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&
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**Abstract:** Analyses of a reliability of the main gas pipeline has shown high probability of the pipeline's some sections damage and gas leakage. The leaks caused by damage of pipelines are usually very dangerous. Intensive leaks can stimulate explosions, fires and environment pollution, which can lead to the ecological catastrophe. In this case there can be an enormous economical loss. That is why the determination of damage place in pipelines in time is the significant problem. Generally gas leakage (as a result the gas pressure and expenditure alteration) is accompanied by non-stationary flow of in the pipelines. After some time of gas leakage (under some conditions) gas movement in the pipelines has stationary character. That is way it is necessary to study both the non-stationary and stationary stages of the gas movement in the pipelines having gas escape in the some sections of the main gas pipeline. In the present paper disclosing the location of large scale accidental gas escape from the complicated gas (oil) pipe-line for the both gas stationary and non-stationary flow is studied. For solving the problem it has been discussed early-made method, reason is that the exact analytical method has not been existed. We have created quite general test, the manner of the solution has been known in advance. We consider this question as a reverse task of hydraulic calculation problem. The algorithm does not required knowledge of corresponding initial hydraulic parameters at entrance and ending points of each sections of pipeline. The algorithm is based on mathematical model describing gas stationary movement in the simple gas pipeline and upon some results followed from that analytical solution and computing calculations.Comparison results of calculation with real data has shown the affectivity of the suggested methods.

**Brief Biography of the Speaker:**
Prof. Teimuraz Davitashvili holds a 5-year Diploma in Mathematics (specialization Hydro-air Mechanics) from Tbilisi State University (1972). In 1985 he received the Ph.D and in 1997 the Doctor of Physics and Mathematics upon the doctoral thesis " Numerical Modelling of Some Problems of Atmosphere Physics for Mountain Regions". Since 1972- researcher, senior researcher, head of department and currently head of laboratory of Mathematical Modelling and Numerical Analyses at I.Vekua Institute of Applied Mathematics of Tbilisi State University. From 1994 to 1998 an Associate Professor and from 1999 to 2006 a Full Professor of Tbilisi State University. Since 2006- head of department of Weather Forecast and Modelling of Natural and Anthropogenic Catastrophic Events at the Hydrometeorological Institute of Georgia. He published 1 book, about 120 research papers in various scientific journals and international conference proceedings. His general research interests are: applied mathematics, computational simulation of non-ordinary events, numerical modeling of environmental pollution and weather forecast by numerical methods.

## Plenary Lecture 4

# The Specifics of the Operation of Photovoltaic Systems in the Czech Republic

**Associate Professor Petr Mastny**
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**Abstract:** Photovoltaic systems are within the Czech Republic currently quite topical. It can be said that the Czech Republic has lately become the country with fastest growing installed capacity of photovoltaic systems in Central Europe. The turning point came in early 2011, when there came into existence new legislative conditions for the installation of photovoltaic (PV) systems. Therefore the installations of new PV systems to be connected to the electricity system were stopped. The reason for this change has become the problems associated with managing the power supply of electricity produced by these sources to electricity network. To the forefront there came the issue of operating characteristics of PV systems related with the operation economy under the current legislative conditions in the Czech Republic. Lecture is focused primarily on the issue of operation of photovoltaic systems and methods for immediate detection of defects on photovoltaic panels using infrared camera. Part of the lecture is the economic analysis of the operation of photovoltaic systems in the current legislative conditions in the Czech Republic based on taking into account the influence of defects photovoltaic panels on the economy of operation.

**Brief Biography of the Speaker:**
Petr Mastny was born in 1976. He graduated in Electrical Power engineering in 2000 from Brno University of Technology. His Ph.D. he obtained in October 2006. In December 2010 he has been appointed as Associate Professor at Brno University of Technology. He has been with Department of Electrical Power Engineering, Brno University of Technology, Czech Republic since 2005 and with Centre of Research and Utilization of Renewable Energy since 2010. His current position is assistant professor. His field of interest covers the problems of utilization of renewable energy source and questions of energy management systems with renewable energy sources and their influence on environment. At present he is head worker or co-worker of five research projects in the field of Alternative Power Sources and he cooperates with several private companies to solve of real applications. Petr Mastny has been member of WSEAS (The World Scientific and Engineering Academy and Society) since 2007, member of NAUN since 2009, member of IEEAM since 2010 and member of CIRED since 2009. He is author of about 70 publications in international scientific journals and conferences in field of Power Engineering and Alternative Power Sources. He has more than 50 presentations in international conferences and technical seminars and he has more than 10 citations in international scientific journals.

## Plenary Lecture 5

# Nanotechnology Health Security Challenges in Mexico

**Professor Armando Barranon**
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**Abstract:** Nanoparticles used in Mexican industries pose new challenges in terms of standards implemented to regulate the use and disposal of nanoparticles that should be handled in a sustainable way. While worldwide there is a need to elaborate new laws to secure a safe use of Nanotechnology in industrial settings, in Mexico there is a lack of undestanding about these new challenges. Mexican government has denied the Nanotechnology section of IMNC, the Mexican organization for implementing norms and standards, any authority to produce new norms related to nanotechnology. Nevertheless this Nanotechnology section of IMNRC participates voting new global laws for Nanotechnology, This is only an example of the lack of enforcement of sustainable laws for industrial applications of Nanotechnology in Mexico. Simmilar problems exist in mining, water disposal and other enviromental threats in Mexico. Nevertheless Baccalaureates in Nanotechnology have been implemented in many Mexican cities, which can be used in the future to educate new workers in Nanotechnology that could be used to develop a network of inspectors to enforce Nanotechnology security laws. Social unrest related to Nanotechnology threats has resulted in bombings of somre Mexican Universities where Nanotechnology is developed, which is a sign of the urgent need of a Nanoeducation program funded by Mexican Government, Industries and Civil Society. Also an example is given of optical applications designed in Mexico that are envorimentally safe, a method is designed and applied to design optical filters of Ultrafine particles. Particles by means of Lyapunov Function and intensive computation based on Parallel Threading where the a genetic algorithm is used to obtain the best grid of the holographic optical Tweezers in terms of the efficiency for trapping ultrafine particles of a given size. Applications for Mining and industrial atmosphere cleaning is discussed.

**Brief Biography of the Speaker:**
Armando Barranon was born in Mexico City. B.Sc. in Mathematical Physics, Instituto Politecnico Nacional, Mexico City, 1986.
M.Sc. in Applied Statistics, The University of Texas at El Paso, 1989. Dr. in Philosophy, U. La Salle, Magna Cum Laude, Mexico City, 2004. M.Sc. Physics, Instituto Politecnico Nacional, Mexico City, 2005. Dr. in Physics of Materials, Instituto Politecnico Nacional, Mexico City, 2008.
Postdoctoral Fellow, U. Zacatecas, Mexico, 2008. Postdoctoral Fellow, U. of Texas at El Paso, 2009. Postdoctoral Fellow, CINVESTAV, 2009.
He is Full Professor at Department of Basic Sciences, Universidad Autonoma Metropolitana-Azcapotzalco, Mexico City. Research interests include Nuclear Physics, Computational Physics and Philosophy of Technology. In 2007, Dr. Barranon founded the Nanoeducation Seminar at UAM-Azcapotzalco.
Dr. Barranon is member of the Mexican National Research System, Scientific Projects Evaluator of the Mexican Council of Science and Technology, member of American Physical Society, Sociedad Mexicana de Fisica, Sociedad Mexicana de Matematicas, Sociedad Mexicana de Termodinamica, Sociedad Mexicana de Historia de la Ciencia y la Tecnologia, among others.

## Plenary Lecture 6

# Concept of Sustainable Development under Pressure of Crisis: Case Study of Latvia

**Professor Maris Klavins**
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**Abstract:** The sustainability concept is recognized as one of the key importance principles for the development and its planning. In the same time the actual importance of the sustainability in the development process differs quite significantly worldwide. Also in Latvia sustainable development (SD) is considered as a basic principle for the development of the country at the level of the basic state policy declarations. This is especially important if financial resources are limited, when society is faced by major social, economic and environmental problems as in the Baltic States. Sustainable development planning include possible solution identification, economic considerations, the public opinion formation process and scientific expertise as well as subjective factors in connected with the general process in the society. Economical aspects do have a great importance in the setting the priorities. The processes influencing sustainability prospects in Latvia and its impact on environmental policy depending on problems of restructuring of national economy has been studied. The communities of western countries play a great role in the transition process and the increased internationalization of identified problems. Of these, environmental problems have a high priority. Environmental problems are often international such as transboundary transport of airborne substances and pollution of the Baltic Sea. The internationalization of environmental questions plays a crucial role in the strengthening of democratic traditions and newly developed democratic institutions in the formed Republics. Thus, the rapidly changing economic system, and also character of environmental problems requires development of environmental policy oriented towards local rather than international problems.

However the actual interpretation of the sustainable development concept even at the level of state policies does not follow the basic principles of the SD. The sustainability concept often is identified as a need to develop nature protection capacity and classical conservationism is regarded as a basic element of the SD.

In this study the role of sustainable development has been analysed from perspective of its importance in the national planning processes and analysis of achieved progress. A major emphasis has been put on the analysis of economic crisis on the implementation of sustainable development. As a significant part of the sustainable development is considered the character of development and implementation of SD in the planning of cities and in general, urban territories. A new challenge for the demonstration of the readiness to follow the sustainable development is the ongoing development planning process and the existing way of development of national economy.

The achieved progress in environmental education in Latvia can support the development of education for sustainable development aimed at the promotion of values and ethics through education at different levels in order to make an impact on people's lifestyles and behavior and help to build a sustainable future.

**Brief Biography of the Speaker:**

Maris Klavins graduated from the University of Latvia in 1979, doctoral dissertation defended in Moscow University (Russia) in 1985, but habilitation thesis in University of Latvia in 1993. Maris Klavins (professor, dr.habil.chem.) is head of Environmental science department of Faculty of Geography and Earth sciences, University of Latvia. M.Klavins is member of editorial boards of 6 scientific journals, member of 3 societies related to environmental chemistry issues and full member of Academy of Sciences of Latvia. M.Klavins has been leader of several projects related to the environmental issues mostly doing with environmental pollution and management, and quality of water, but including also political and social sciences and sustainable development science.

## Plenary Lecture 7

# Modern Technology to Improve Steam-Power Plant Efficiency

**Professor Ioana Diaconescu**
Research Center for Mechanics of Machines and Technological Equipment
"Dunarea de Jos" University of Galati
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**Abstract:** Energy is of vital importance in our lives. We rely on it for transport, for heating our homes in winter, for cooling them in summer, for the operation and proper functioning of our factories, farms and offices. Fossil fuels, however, are finite resources, on the one hand, and on the other – the main cause of global warming. Therefore, we can no longer continue to take energy for granted so is time to adopt integrated energy-saving and environment-friendly policy based on clear goals, as well as a program for reducing the use of fossil fuels, for saving energy and for developing alternative energy sources.
Electric energy and the energy-producing techniques and technologies connected with it are the foundation of the economic development of modern society. The technology for producing electric power, as well as the type of the resources used to this end, plays an important role both in economy and in ecology. The economical utilization of the mineral resources of the earth is an exceptionally important task for us, and especially for the generations to come, as these resources are finite. In addition, the pollution of the environment and the threat of increase of the concentration of CO2, SO2 and nitric oxides in the atmosphere calls for the development of new technologies, for new technical and technological solutions in the production of electric power, as well as for new energy-saving and environment friendly technological solutions in our industry and economy.
This paper's goal is to present a new technology and an installation for converting waste heat into electric power. What distinguishes the proposed installation is the opportunity to increase significantly the efficiency of converting heat into electric power that is to enhance the thermal efficiency of the process by using a heat pump operating in the Rankine cycle mode.

**Brief Biography of the Speaker:**
Ioana Diaconescu received her Master's degree in Electrotechnics and Energetic from Polytechnic Institute from Bucharest, in 1987. She has earned her Ph.D in Advanced Engineering Thermodynamics from "Dunarea de Jos" University-Galati, in 1998. She is recognized as mechanical engineering associate professor at the department of Technical Sciences, Machines and Drives from "Dunarea de Jos" University from Galati and she teaches mainly Thermodynamics, Heat and Mass Transfer and Electrical Drives. Since 2001 she is a senior research at the Research Center for Mechanics of Machines and Technological Equipments and she focused her research activities during the last ten years to energy saving and trigeneration, mass and heat transfer (paper drying process), exergy and energy analysis of thermal processes, irreversible processes analysis, renewable energy and energy management. She is author of three books and more than 90 scientific papers published at international conferences and journals. She is Romanian and Bulgarian evaluator for R&D projects and also European evaluator for education's quality. Also, Ioana Diaconescu is reviewer for WSEAS papers and other prestigious journals.
Ioana Diaconescu was invited two times as visiting professor in City University of Honk-Kong-China, were developed a fruitful collaboration with Mathematical Department regarding PDEs in mass transfer issues (paper drying process).

## Plenary Lecture 8

# Large RES Penetration in Autonomous Electric Grids – The Role of Pumped Hydro Storage

**Associate Professor John S. Anagnostopoulos**
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**Abstract:** In recent years, the energy policy of EU and of many other countries worldwide has paid major attention to renewable sources, focusing on a drastic increase and possible maximization of their share in power production. Wind and solar energy are the most significant and mature renewable technologies, which are already incorporated at a certain degree in many electricity systems. However the stochastic, intermittent and fluctuating nature of the power production of these sources obstructs their unlimited penetration in the existing grids. A maximum value of 40 to 50 percent is considered feasible for large interconnected systems, whereas in isolated autonomous grids the feasible penetration is quite smaller, of the order of 30%. Consequently, the continuous installation of RES units into an electricity power system will eventually lead to saturation conditions and inability for further exploitation of RES potential. Such conditions are encountered today only in some autonomous Island systems, but in the next years it is expected to confront also in larger mainland electricity systems, due to the rapid development of RES units worldwide.

Solutions to overcome this problem has been proposed for small and medium autonomous electricity grids, and they may be applicable at some extend also to larger interconnected systems. The principal concept is the combination of RES production with energy storage facilities, in order to be able to store the surplus RES production which cannot be absorbed (usually during the night-time hours), and use it again to produce electricity in high demand periods. Pumped hydro storage is at present the most mature and suitable technology for energy storage in medium to large power quantities and capacity sizes, and consequently, is the option considered in some pilot plants that have been designed and are being constructed today, like in the Canary Islands and in the Greek island Ikaria.

This RES hydro storage procedure is however quite different than the conventional pumped storage practice, and for this reason needs special investigation. It was found that the exploitation of RES and hydroturbine production becomes more flexible and efficient if the production system is treated as a single, combined unit, forming a hybrid RES-hydro power plant. This concept introduces two major issues: The optimum design and sizing, and the optimum operation strategy of this hybrid plant. The main objective is usually the maximization of the economic results of the investment, whereas, on the other hand, minimization of the fossil fuels usage and maximization of RES penetration in the electricity system constitute important parallel targets. The major controlling parameter and a challenging issue is the proper electricity pricing policy, which will be able to support the economic viability of such investments and at the same time to retain or reduce the electricity production cost in the entire system. Moreover, the installation of such hybrid plants should not affect the interests of other independent RES producers already operating in the system.

The first part of this lecture presents the basic energy and technology aspects, and the limitations of large RES integration and operation in autonomous electricity systems, with some examples of ongoing pilot projects. The second part focuses on the case of Greece and the recently established legislation and regulations that control the design and operation of hybrid power plants in the non-interconnected systems of the Islands. It analyses the new concepts of guaranteed power and guaranteed energy of these units, and lists some technical and operation issues that remain open.

**Brief Biography of the Speaker:**

John S. Anagnostopoulos graduated in Mechanical Engineering from the National Technical University of Athens, Greece, and received his Ph.D. in Computational Fluid Mechanics from the same University in 1991. He worked for several years as research scientist in the NTUA and as R&T consultant in the private sector, where he has been involved in feasibility studies for various industrial innovations. He has participated in many research projects and

developed several computer codes for the simulation of various fluid mechanisms in industrial applications (pulverized coal combustion, fouling, coal grinding, liquid fuel spray aerodynamics, electrostatic precipitation, atmospheric flows and pollutant dispersion, pollutant formation and photochemical kinetics, pulsating flows, steel continuous casting, metal thermal spraying, mechanical erosion wear, flow in centrifugal pumps and impulse hydro turbines), as well as for modelling of hydroelectric and hybrid energy systems. He is Associate Professor in Hydraulic Turbomachines at the School of Mechanical Engineering, NTUA, and his current research activities include flow simulation and hydrodynamic design optimization in hydraulic turbomachinery with Eulerian and Lagrangian techniques, and optimal design and operation strategies of autonomous and integrated power production systems combining RES and pumped hydro storage.

## Plenary Lecture 9

# Application of Descriptive Statistical and Time Series Analysis on Atmospheric Pollution

**Assistant Professor Efthimios Zervas**
Hellenic Open University
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**Abstract:** In several scientific fields the results are obtained in the form of time series, i.e. the series of observations in constant, or not, time intervals. The analysis of time series data can be performed using several statistical methods. Two of these methods are presented here, and their advantages, disadvantages and limitations are compared and discussed. The first one uses four descriptive statistical measures: mean value, standard deviation, skewness and kurtosis of the data distribution. Those measures can be applied on different time frames, such as annual period, monthly, weekly, daily, etc. The second method uses the time series analysis. More specifically, the time series is represented by a dynamic model (model ARIMA, process Box&Jenkins), where each observation is considered as a function of the past values. The Box–Jenkins (ARIMA) method first analyses the time series in order to find its trend, its periodicity, its constant term and its noise. In a second part, the time series is transformed to stationary one (without trend and periodicity), by appropriate data transformation. The combination of the moving average of the stationary time series with autoregressive parameters yields to a comprehensive model linking each value with the previous ones. This model can be used not only to explain the underlying process generating the time series, but also as a basis for forecasting of future values.
The previous two methods, the descriptive statistical analysis and the time series analysis, are applied in the case of Athens atmospheric pollutants. Several pollutants measured in different stations and during several years are analyzed. The results, but also the limitations, of the two methods are compared and discussed.

**Brief Biography of the Speaker:**
Efthimios Zervas has a degree of Chemical Engineering of National Technical University of Athens, Greece and a Ph.D. of Institut Français du Pétrole (IFP) and University of Haute Alsace - France. He worked for several years in Renault in the field of emission control and development of after-treatment devices. In 2006 he moved as Assistant Professor in the Department of Environmental Engineering of Democritus University of Thrace and in September 2009 he moved in Hellenic Open University. His scientific interests are in the fields of atmospheric pollution, control of pollutants emitted from combustion systems, development and use of alternative fuels, energy and environmental policy and economics. He is author of more than 50 publications in international scientific journals, has more than 70 presentations in conferences, is referee of more than 130 papers of international scientific journals and has more than 600 citations.

## Plenary Lecture 10

# Solar Photoelectro-Fenton: A Very Efficient and Low Cost Electrochemical Advanced Oxidation Process for Water Remediation

**Professor Enric Brillas**
Department of Physical Chemistry
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**Abstract:** This lecture reviews the characteristics of the solar photoelectro-Fenton process and the main results obtained in our facilities upon its application at laboratory and small pilot plant scale for the degradation of environmentally-relevant organic pollutants usually found in waters. This electrochemical advanced oxidation process is based on the removal of organic matter by •OH formed from (i) water oxidation at the anode and (ii) in the bulk from Fenton's reaction between H2O2 generated at the cathode and added Fe2+, along with the synergistic action of UV radiation from sunlight that photolyzes generated Fe(III)-carboxylate complexes. The mineralization of several herbicides, pharmaceutical residues and dyes in different electrolytic systems is examined using both, small tank reactors directly exposed to sunlight and pre-pilot flow plants with a filter-press electrochemical reactor coupled to a tilted planar glass compartment or a compound parabolic collector as solar photoreactors. Comparative results obtained with cells equipped with Pt and boron-doped diamond anodes, alone or coupled, and a carbon-polytetrafluoroethylene gas (O2 or air) diffusion cathode, are presented. It is demonstrated that solar photoelectro-Fenton has greater mineralization current efficiency and is much less expensive than other electrochemical advanced oxidation processes like anodic oxidation, electro-Fenton and photoelectro-Fenton with artificial UVA light tested with the same electrodes. The efficacy of the treatments is discussed for several model contaminants in terms of: (i) the abatement of the total organic load of aqueous solutions, (ii) the decay kinetics of contaminants and (iii) the evolution of their aromatic intermediates, generated carboxylic acids and final inorganic ions released, which leads to the proposal of the most plausible reaction pathways.

**Brief Biography of the Speaker:**
Enric Brillas was born in Barcelona, Spain, in 1951. He obtained his BS degree in Chemistry in 1974 and received his Ph.D. degree in Chemistry in 1977 from the Universitat Autònoma de Barcelona. In 1980, he joined the Universitat de Barcelona as Associate Professor of Physical Chemistry. In 1982, he completed his studies in electrochemistry at the Università di Padova, Italy, in the field of organic electrochemistry. From 1987 to present, he has worked as Full Professor of Physical Chemistry at the Universitat de Barcelona. He was Headmaster of the Department of Physical Chemistry of the Universitat de Barcelona from 2000 to 2008. He was President of the Electrochemistry Group of the Spanish Royal Society of Chemistry from 2004 to 2008. Currently, he is Director of the Laboratory of Electrochemistry of Materials and Environment at the Universitat de Barcelona. His research mainly focuses on organic electrochemistry, chemical kinetics, chemical catalysis, photocatalysis, electrocatalysis and electrochemical treatment of organic pollutants. In the latter field, he has developed several novel electrochemical advanced oxidation processes such as electro-Fenton, photoelectro-Fenton with UV light and solar photoelectro-Fenton. In 1995, he received the International Chemviron Carbon Award for his initial research on electro-Fenton degradation of organics with a gas diffusion electrode. Since 2008, he has been Associate Editor of the journal Chemosphere of Elsevier. He has supervised the doctoral theses of 16 Ph.D. students, published more than 250 ISI papers, six books and ten book chapters, and presented 190 contributions, including more than 20 invited conferences, to scientific national and international congresses.