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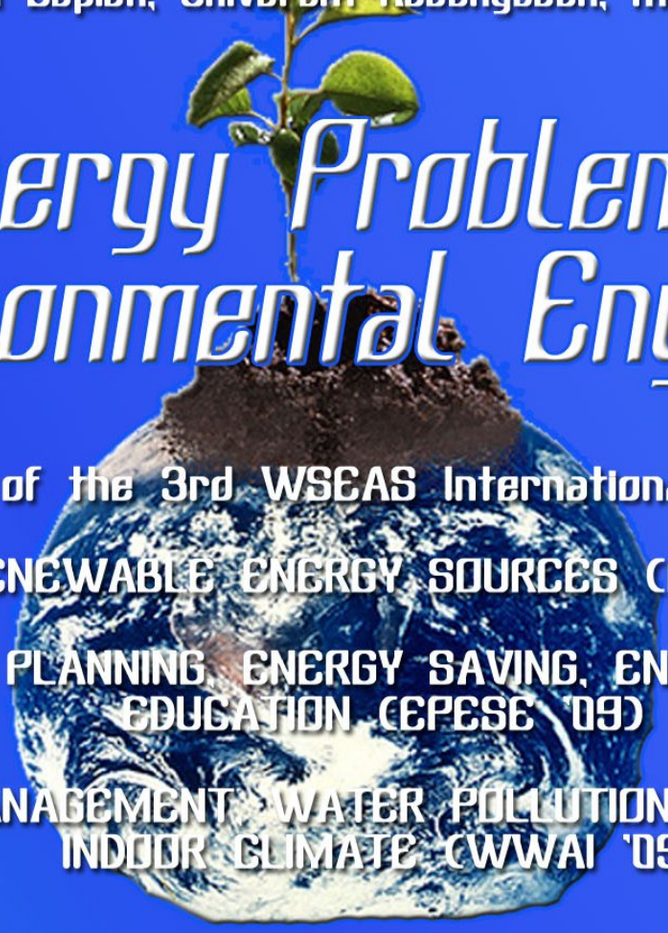
Energy Problems and Environmental Engineering

Energy Problems & Environmental Engineering



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- RENEWABLE ENERGY SOURCES (RES '09)

- ENERGY PLANNING, ENERGY SAVING, ENVIRONMENTAL EDUCATION (EPESE '09)

- WASTE MANAGEMENT, WATER POLLUTION, AIR POLLUTION, INDOOR CLIMATE (WWAI '09)

University of La Laguna, Tenerife, Canary Islands, Spain, July 1-3, 2009

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Preface

This year the 3rd WSEAS International Conference on ENERGY PLANNING, ENERGY SAVING, ENVIRONMENTAL EDUCATION (EPESE '09), the 3rd WSEAS International Conference on RENEWABLE ENERGY SOURCES (RES '09) and the 3rd WSEAS International Conference on WASTE MANAGEMENT, WATER POLLUTION, AIR POLLUTION, INDOOR CLIMATE (WWAI '09) were held in the University of La Laguna, Tenerife, Canary Islands, Spain. The Conferences remain faithful to their original idea of providing a platform to discuss energy planning studies, energy audits and on-site measurements, land use and management, environmental impact from the use of energy, climate and global change, wind energy, hydrogen energy, biomass, solar energy - photovoltaic systems, geothermal energy, hydroelectric energy, waste management, water pollution, air pollution, indoor climate etc. with participants from all over the world, both from academia and from industry.

Its success is reflected in the papers received, with participants coming from several countries, allowing a real multinational multicultural exchange of experiences and ideas.

The accepted papers of this conference are published in this Book that will be indexed by ISI. Please, check it: www.worldses.org/indexes as well as in the CD-ROM Proceedings. They will be also available in the E-Library of the WSEAS. The best papers will be also promoted in many Journals for further evaluation.

A Conference such as this can only succeed as a team effort, so the Editors want to thank the International Scientific Committee and the Reviewers for their excellent work in reviewing the papers as well as their invaluable input and advice.

Note: The paper “Explaining Firm's Decision to Invest in Pollution Abatement in Romania: An Empirical Approach using Panel Data Estimator” by Robert Sova, Ion Stancu, Anamaria Sova, Rault Christophe, was presented in the 4th IASME / WSEAS International Conference on ENERGY & ENVIRONMENT (EE'09), which took place in Cambridge, UK, in February 24-26, 2009.

The Editors

Table of Contents

Plenary Lecture 1

The Potential Development of Rainwater Harvesting in Malaysia

Assoc. Professor Ar. Zuhairuse Md Darus
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Abstract: Rainwater Harvesting lately has gained recognition as a sustainable means of domestic water supply globally. Malaysia as a country which received a very high rainfall throughout the year is not fully capitalized on this. Even though, traditionally is was done in remote area since long time ago using a primitive way of collecting rainwater from the roof or surface before it touch the ground and stored for domestic usage. The resurgence of rainwater harvesting is due to the paradigm shift in concept of resources and supply and supply water as demand increased due to the increase of the world population. The Malaysian Government has recognized that rainwater harvesting contribute toward National Water Conservation Policy. It has made a commitment to revise the Guidelines for Installing a Rainwater Collection and Utilization System in the Ninth Malaysian Plan within a period of 2006 – 2010. Encouragement from the government through various means of awareness program and incentive has increased the number of rainwater harvesting system in various building types. This paper will cover the potential development of rainwater harvesting which has been implemented in Malaysia. It will also explain the process of the Malaysian Government to encourage on the rainwater harvesting system.

Brief Biography of the Speaker: Zuhairuse Md Darus has been working as consultant in United Kingdom and Negara Brunei Darussalam for 4 years before joining Universiti Teknology MARA(UiTM) as a lecture. He stay for 11 years with UiTM before joinging Universiti Kebangsaan Malaysia in 2003. He is Associate Professor at the Department of Architecture, Faculty of Engineering and Built Environment, UKM and is currently seconded to the Department of Development Management as Deputy Director for Development since june 2008. He obtained in basic Architecturel education from UiTM before further his study for the professional and postgraduate studies in United Kingdom. His specialization is on tourism Architecture and now embark on sustainable Architecture and renewable energy especially on wind Energy. Professionally, he has involved in designing and completing various project from individual houses to complexes. Academically, he has until now published more than 60 research papers in journals and conferences.

Plenary Lecture 2

The Contribution of Terology for a Sustainable Future

Professor Torres Farinha
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Engineering School of Coimbra Polytechnic Institute
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Abstract: Terology is defined as the combined utilization of operational research techniques, information management and engineering, with the objective of accompanying the life cycle of facilities and equipment; it includes the definition of specifications of purchase, installation and reception, and also the management and control of its maintenance, modification and replacement and, too, its accompanying in service.
The author introduced this concept in 1994, with the objective to synthesize a large view of the maintenance activity, that is necessary to implement in the Organizations, in order to have good levels of reliability and a large life cycle of facilities and equipment.
When this concept is implemented in a large organization it is necessary, to re-equation the maintenance department, to increment its level of operation, and to introduce an information system for maintenance management.
After this stage, the next step is to put into operation on-condition maintenance techniques and a fault diagnosis system. Also, it is important to reevaluate periodically the costs of functioning and the level of maintenance of facilities and equipment, in order to guarantee the minimum costs and the largest possible life cycle.
Usually, in modern Organizations, it is necessary to use the state-of-art of technology but, also, it is necessary to minimize the impact over the nature with the manufacturing of new goods, namely through methods and also through the reduction of its production.
Then, the humanity needs to rethink the economy and to redesign this, in order to maintain and, if possible, to increment his quality of life, with, always, the biggest possible respect by the nature.
It is because of this that, with good terology management, good replacement politicizes, good on-condition maintenance politicizes, namely the ones connected to the environment, that terology or, by other words, this vision of maintenance, is so important for a better and sustainable future.
A real maintenance management system, called SMIT, the core of a group of other developments, some yet implemented and others under implementation and, also, new future perspectives, that will be described within the paper proposed. These developments are a real contribution for the perspective that is being described.
The planet, the nature, the future, it is not sustainable if the man continue destructing it to manufacture new good that, when its life ends, are destroy, usually recycling, reusing or doing not, but always with big consumption of energy and, many times, adding new materials not organics.
To have sustainability it is necessary to preserve, to increment life cycle of goods, to reutilize, to return to the nature what will be possible, to live together, humanity-nature and technology, friendly. To reach this objective terology really helps and, because of this, the way showed in this communication is a way that author believes that helps to have a better and more sustainable future.

Brief Biography of the Speaker: Jose Manuel Torres Farinha (www.torresfarinha.com), is Licentiate in Electrical Engineering by Coimbra University, and PhD in Mechanical Engineering by Oporto University. He is Senior Member and Specialist in Industrial Maintenance by “Ordem dos Engenheiros”, that is the Association that represents the long-cycle theoretically scientific studies in-depth in Portugal (CLAIU member). He is Coordinator Professor at Engineering School of Coimbra Polytechnic Institute (www.ipc.pt). Since 1994 he is member of Mechanical Engineering Center from University of Coimbra – CEMUC - (http://www2.dem.uc.pt/cemuc/index.htm), that is classified as Excellent by “Fundacao para a Ciencia e a Tecnologia” - (http://alfa.fct.mctes.pt/index.phtml.en). His main research is in Terology, around information maintenance systems, fault diagnosis, and on condition maintenance, with emphasis in an ecological approach. He wrote a book, chapters of books and has more than thirty papers published in national and international journals and conferences. He is President of Coimbra Polytechnic Institute (IPC), since 2001. In charge of these functions he reached several innovative objectives, namely, by the first time in Portugal, to certify a higher education institution, IPC – Coimbra Polytechnic Institute - (Central Services, Social Services and Colleges) by ISO 9001; IPC has 14.000 students, 6 schools, 1.000 teachers.

Plenary Lecture 3

Analysis of Irreversible Thermodynamic Processes of Control Valves

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Abstract: The thermodynamic analysis of irreversible processes has an important influence in energy efficiency growing of any thermodynamic processes or systems. All of thermodynamic processes are entropy generators but there are processes with such a high level of irreversibility so that couldn't be ignored. That is why is so important to provide a feel for what causes entropy generation and to identify those system components that contribute the most to the overall irreversibility of the thermodynamic system. One of the processes with the highest level of entropy generation is flow with friction in various ducts and flow networks such as control valves. In order to see the direct connection between frictional pressure drop and thermodynamic irreversibility the paper will firstly analyze the steady and adiabatic flow of pure substance through a short segment of pipe with variable section (control valve).
Because the entropy generation value during the throttling process is proportional to control valve pressure drop, the paper will do a flow thermodynamic analysis inside the control valve and the conclusions about drop pressure in different working conditions will be taken. Pressure drops along a valve are not constant, but rather vary in relation to the port left open by the plug. They normally increase as the vena contracta section is reduced, although the upstream drop does increase at a slower rate than the downstream one. Actual increases and decreases in pressure drops and their effects are related to valve type and flow direction. It can be deduced that, for all types, pressure drops increase at flow tending to close, mainly as a result of the increased drop generated downstream.
Also the paper will take into account the drop pressure variation during the substance flow and will be analyzed its influence on the process irreversibility.
In the same time, the paper will analyze the change of state influence during the liquid throttling process on the entropy generation, in situations of low titer bipolar phase fluid or high titer bi phase fluid and will identify this phenomenon effects and remedies.

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 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 eight 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. She is author of three books and more than 70 scientific papers published at international conferences and journals. She is Romanian and Bulgarian evaluator for R&D projects.
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 4

SEE - Society Energy and Environment: The "Zeroth Religion" for Everybody!

Professor Milivoje M. Kostic
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Abstract: Energy, as the 'building block' of all material and space existence, and as the cause for all (re)creations in time, could be metaphorically considered as the most basic "Zeroth Religion," with all due respect to the "First Religion," the way the Zeroth Law of thermal equilibrium is more basic than the grandiose First Law of energy conservation in Thermodynamics. Energy is more than universal currency. The world view, from inside to outside, is only possible, figuratively and literally, through the energy prism. From shining stars to rotating planets, to global water, atmospheric and life cycles, to evolution, industrialization and modernization of civilization, energy is the cause and measure of all there has been, it is, and will be.

Energy is the cause for all processes across all space and time scales, including global and historical changes. Energy is both cause and consequence of formation and transformation within the universe at the grand scale, down to the smallest sub-nano-structures within an atom nucleus and electromagnetic radiation (everything we are capable of observing and comprehending). Energy warms our planet Earth and keeps it alive. It moves cars and trains, and boats and planes. Energy bakes foods and keeps them frozen for storage. It heats and lights our homes and plays our music. Energy makes our bodies to grow and alive, and allows our minds to think. Through centuries people have learned how to harvest and use energy in different forms in order to do work more easily and live more comfortably.

Zooming in through space and history from the formation of our planet Earth some 4.5 billion years ago, it has been changing ever since due to energy exchanges or "energy flows" in different astrophysical, geological, thermo-physical, electro-chemical, biological, and intellectual processes. Hundreds of millions of years ago, life emerged from the oceans and transformed the landscape. Just a few million years ago the first human species evolved and began their own process of interaction with the environment, our planet Earth. About one million years ago our own species, homo sapiens, first appeared, strived most of the history and boomed with agricultural and industrial revolution, after learning how to harvest, control and use energy.

The human metabolism, to maintain life, is approximately equal to the dietary energy reference value of 2000 kcal/day, which is equivalent to 97 Watt. Human sustained working power is about 75 W or one tenth of the "horse power." The human muscular power bursts may be a hundred times greater than the basal metabolic or sustained power. In comparison, the World's population is about 6.5 billion with total energy consumption about 2.2 kW/c (per capita), compared to 0.3 billion population and 11.3 kW/c in the U.S. (the total energy rate in kW needs to be scaled by usual 33% efficiency to be qualitatively compared with electrical energy rate in kW). The corresponding per capita electricity consumption rate is about 0.3 kW/c and 1.5 kW/c in the World and the U.S., respectively.

All energy coming to the Earth surface is 99.98 % solar, 0.018% geothermal and 0.002% tidal-gravitational. About 14 TW (Tera-Watt, or 2.2 kW/capita, i.e. per person) the world energy consumption rate now, represents only 0.008%, a tiny fraction of the solar energy striking Earth, and is about 6 times smaller than global photosynthesis (all life), the latter is only 0.05% of total solar, and global atmospheric water and wind are about 1% of solar energy. As an ultimate energy source for virtually all natural processes, the solar energy is available for direct 'harvest' if needed, and is absorbed by vegetation and water surfaces on Earth, thus being the driving force for natural photosynthesis, and in turn for biosynthesis processes, as well as natural water cycle and all atmospheric processes. The solar radiation power density incident to the Earth atmosphere, known as the Solar Constant, is 2 cal/min/cm2 or 1.4 kW/m2, which after taking into account average day/night time (50%), varying incident angle (50%) and atmospheric/cloud scatter and absorption (53%), reduces to only 0.5·0.5·0.47=11.7% of the Solar Constant, or about 165 W/m2 at the Earth surface, as all-time average.

If all energy is literally expelled from a confined space, then nothing, empty space will be left. As long as any matter is left, it will contain the energy - even at zero absolute temperature the electrons will be orbiting around very energetic nucleus. Matter is and must be energetic, E=mc^2, thus literally, "energy is everything," no energy, nothing in the space. Energy is the fundamental property of a physical system and refers to its potential to maintain a material system identity or structure (forced field in space) and to influence changes (via forced-displacement interactions, i.e.

systems' re-structuring) with other systems in space and time by imparting work (forced directional displacement) or heat (forced chaotic displacement/motion of a system molecular or related structures). Energy exists in many forms: electromagnetic (including light), electrical, magnetic, nuclear, chemical, thermal, and mechanical (including kinetic, elastic, gravitational, and sound). Energy is the 'building block' and fundamental property of matter and space, and thus, the fundamental property of existence. Energy exchanges or transfers are associated with all processes (or changes), and thus are indivisible from time.

Let us not be fooled by low oil prices now due to unforeseen economic recession! The two things are certain in not distant future: (1) the world population and their living-standard expectations will substantially increase, and (2) the fossil fuels' economical reserves, particularly oil and natural gas, will substantially decrease. The difficulties that will face every nation and the world in meeting energy needs over the next several decades will be more challenging than what we anticipate now. The traditional solutions and approaches will not solve the global energy problem. New knowledge, new technology, and new living habits and expectations must be developed to address both, the quantity of energy needed to increase the standard of living world-wide and to preserve and enhance the quality of our environment.

However, regardless of imminent shortages of fossil fuels, the outlook for future energy needs is encouraging. Energy conservation "with existing technology" (insulation, regeneration, cogeneration and optimization with energy storage) has real immediate potential to substantially reduce energy dependence on fossil fuels and enable use of alternative and renewable energy sources. There are many diverse and abundant energy sources with promising future potentials, so that mankind should be able to enhance its activities, standard and quality of living, by diversifying energy sources, and by improving energy conversion and utilization efficiencies, while at the same time increasing safety and reducing environmental pollution.

After all, in the wake of a short history of fossil fuels' abundance and use (a blip on a human history radar screen), the life may be happier after the fossil fuel era!

Brief Biography of the Speaker: Professor Kostic's teaching and research interests are in Thermodynamics (a science of energy, the Mother of All Sciences), Fluid Mechanics, Heat Transfer and related fluid-thermal-energy sciences; with emphases on physical comprehension and creative design, experimental methods with computerized data acquisition, and CFD simulation; including nanotechnology and development of new-hybrid, POLY-nanofluids with enhanced properties, as well as design, analysis and optimization of fluids-thermal-energy components and systems in power-conversion, utilizations, manufacturing and material processing. Dr. Kostic came to Northern Illinois University from the University of Illinois at Chicago, where he supervised and conducted a two-year research program in heat transfer and viscoelastic fluid flows, after working for some time in industry.

Kostic received his B.S. degree with the University of Belgrade Award as the best graduated student in 1975. Then he worked as a researcher in thermal engineering and combustion at The Vinca Institute for Nuclear Sciences, which then hosted the headquarters of the International Center for Heat and Mass Transfer, and later taught at the University of Belgrade in ex-Yugoslavia, Serbia now (MFB). He came to the University of Illinois at Chicago in 1981 as a Fulbright grantee, where he received his Ph.D. in mechanical engineering in 1984. Subsequently, Dr. Kostic worked several years in industry. In addition, he spent three summers as an exchange visitor in England, West Germany, and the former Soviet Union.

Dr. Kostic has received recognized professional fellowships and awards, including multiple citations in Marquis' "Who's Who in the World" and "Who's Who in Science and Engineering."; the Fulbright Grant; NASA Faculty Fellowship; Sabbatical Semester at Fermilab as a Guest Scientist; and the summer Faculty Research Participation Program at Argonne National Laboratory. He is a frequent reviewer of professional works and books in Thermodynamics and Experimental Methods. Dr. Kostic is a licensed professional engineer (PE) in Illinois and a member of the ASME, ASEE, and AIP's Society of Rheology. He has a number of publications in refereed journals, including invited state-of-the-art chapters in the Academic Press series Advances in Heat Transfer, Volume 19, and "Viscosity" in CRC Press' Measurement, Instrumentation and Sensors Handbook; as well as invited reference articles: Work, Power, and Energy in Academic Press/Elsevier's Encyclopedia of Energy; Extrusion Die Design in Dekker's Encyclopedia of Chemical Processing; and Energy: Global and Historical Background, and Physics of Energy, both in Taylor & Francis/CRC Press Encyclopedia of Energy Engineering and Technology. Professor Kostic is a member of the Graduate Faculty at Northern Illinois University.

Plenary Lecture 5

Numerical Methods for Fluid Dynamical Optimization of Hydro Power Plants

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Abstract: Hydro power plants of any size – be it large or small hydro - are always quite complicated arrangements as they cannot be designed for a definite duty point of operation but in fact the duty point varies strongly with the flow rate and in many cases also with the pressure head available. The optimization of these plants has always been a challenge to the design engineers from all faculties involved, in the course of this presentation mechanical or civil engineering are concerned.
Hydro power plants resemble each other as the basic set-up is always similar: Water flows from an upper reservoir to a lower reservoir and in between we find components like intake buildings, shut-off valves of different kind in different places, head race, moated castle, penstock, the turbine(s) and suction pipe. But due to the mentioned more or less - and sometimes extremely – variable duty points the dimensioning and the set-up in detail are remarkably different from on plant to another – and so is the stationary and transient operation.
Both the specific arrangement as well as the varying duty points often cause a number of problems as any hydro power plant exist exactly once and in so far is always a prototype thus often causing unforeseeable difficulties.
On the example of a number of components fluid dynamical optimizations by means of numerical methods are outlined for intakes, valves and different turbine designs. Specific problems as they can frequently occur in hydro power and remedy to solve the problems are described. On the example of a cavitating Francis runner a further trouble shooting method together with a new way for cavitation simulation will be presented.

Brief Biography of the Speaker: Prof. Jaberg holds the chair for Hydraulic Fluid Machinery at the University of Technology Graz, Austria where he and his team look both after the machinery equipment as well as after instationary behaviour of full systems. In parallel Prof. Jaberg works with his business consultancy and together with his partners on management of innovations, strategy and process optimization. Prior to these engagements Prof. Jaberg served as Vice President General Industry for KSB AG and Director Product Development in the French subsidiary of the same company. Prof Jaberg graduated from the University of Technology Munich and holds a PhD/Dr.-Ing. from Stuttgart University.

Plenary Lecture 6

Pico Hidro: Clean Power Production from Small Streams

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Solar Energy Research Institute
Universiti Kebangsaan Malaysia
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Abstract: Running the generator and use of battery to light up the house are common to rural folks. The difficulty of getting the fuel and the cost of fuel are the main problem. Use of other alternative renewable energy such as solar photovoltaic modules, which is avaible for a number of hours per day, is very costly. It is required to find suitable option to provide cheap and reliable option. While large hydropower provides electrical power for industry and domestic use, small-scale hydro is making some contributions toward providing this basic need to remote and off-grid areas especially in developing countries. This paper is focusing on pico hydro, a run-of-river application which does not require dam or reservoir for water storage. It is cost effective, environmentally friendly and the turbine can be manufactured locally. Several applications in developing countries are highlighted. Small-scale hydro turbines are reviewed and their applications at power production environment. Finally, the paper also discusses the efforts made by Universiti Kebangsaan Malaysia to promote this technology for rural electrification program.

Brief Biography of the Speaker: Prof. Dr. Kamaruzzaman Bin Sopian obtained his BSc in Mechanical Engineering from the University of Wisconsin-Madison in 1985, MSc in Energy Resources from the University of Pittsburgh in 1989 and PhD. in Mechanical Engineering from the Dorgan Solar Laboratory, University of Miami in 1997. He is presently the Professor in Renewable Energy at the Department of Mechanical and Material Engineering, Universiti Kebangsaan Malaysia. Currently, he is the Director of the Solar Energy Research Institute, a center of excellence for the research and development in solar energy technology. He has been involved in the field of solar energy for more than twenty years. His main contributions are in solar radiation modeling, alternative material for solar absorber, solar water heating system with integrated storage system, solar desalination, solar cooling, daylighting using solar light pipes, solar assisted drying systems, grid-connected photovoltaic system, thin film silicon solar cells, combined photovoltaic thermal or hybrid collector and solar hydrogen production system.
He has published over 400 research papers in journals and conferences. He has delivered keynotes speeches at national and international conferences on renewable energy. He is the founding member of the Malaysian Institute of Energy, member of the World Renewable Energy Network based in the United Kingdom and is an associate editor of the Renewable Energy published by Elsevier Ltd. He heads several national subcommittees on renewable energy by the Malaysian government to promote awareness, market enhancement, policy studies and the applications renewable energy.

Plenary Lecture 7

Formation, Occurrence and Determination of Volatile Fatty Acids in Environmental and Related Samples

Professor Bogdan Zygmunt
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Abstract: Volatile fatty acids (VFA) are short chain alkane monocarboxylic acids containing from 2 to 8 carbon atoms in a molecule. They are formed in the process of anaerobic biodegradation of larger organic molecules and therefore are commonly present in municipal wastewater, effluents of food industry, cattle and swine farm wastewater, sewage sludge, landfill leachate, feces, urine, etc. VFAs play an important role in biological wastewater treatment, whereby their content ratio to phosphorous and nitrogen determine the effectiveness of removal of compounds of these elements by microorganisms. They are the most important intermediates in conversion of organic waste in landfills into methane. On the other hand, VFAs can have some harmful effects on the environment.
They should be monitored at different steps of wastewater treatment, in landfill leachate and also in treated wastewater and water bodies and some other samples. Different techniques have been used to determine the total content of VFAs in water and air. When individual VFA content is to be known, which is increasingly often the case, separation techniques, especially gas chromatography (GC), must be used. GC can separate both free acids and their derivatives. Increased selectivity and lower detection limit can be achieved by converting VFAs into derivatives containing fluorine atoms and then the application of GC with electron capture detection or by using mass spectrometry (MS) with negative chemical ionization for free acids.
Relatively clean aqueous samples can be directly injected into GC for analysis, possibly after removal of solid particles by centrifuging. In other cases, sample preparation is needed. It is generally based on matrix exchange and possible increase in analyte concentration to the value above the quantitation limit. Diethyl and methyl-t-butyl ethers (DDE, MTBE) were found to be appropriate solvents for VFAs extraction from water. Application of MTBE for extraction and GC-MS for the analysis proper permitted to determine VFAs in municipal, cattle and swine farm wastewater and in landfill leachates. Attempts were also made to apply headspace and solid phases microextraction and combination of both for VFAs isolation followed by GC-MS determination.

Plenary Lecture 8

Combined Effects of Discomfort Parameters on the Indoor Conditions of Buildings

Associate Professor Lajos Barna
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Abstract: The purpose of HVAC appliances is to provide a comfortable environment and set the conditions for efficient work. The enhancement of buildings' energy performance aims at meeting the comfort requirements indoors and, at the same time, ensures that less energy use is required to provide acceptable environments.
The comfort of the occupants is determined by the heat exchange between the body and the indoor environment. There are four local discomfort parameters that may cause discomfort on certain body parts even if whole-body thermal comfort conditions are met: radiant temperature asymmetry, warm and cold floors, vertical air temperature difference and draught.
Even though the sizing diagrams and values are results of extensive laboratory investigations, they do not apply to cases when the different local discomfort parameters are simultaneously present in the indoor space. Furthermore, it is an important goal in indoor environmental research to deepen our understanding of the mechanisms responsible for human perception to different exposures. Therefore, experiments and modelling for combined parameters have been carried out at the Department of Building Services and Process Engineering.
The plenary presentation summarises the findings of modelling carried out on manikins, human subjects and CFD simulations to investigate the combined effects of discomfort parameters.

Brief Biography of the Speaker: Dr. Lajos Barna PhD, Associate professor since 1999, Budapest University of Technology and Economics.
Qualifications: MSc in Mechanical Engineering in 1972, Technical University of Budapest. Comprehensive examination in mechanical engineering: 1983; PhD: 1998.
Teaching and research experience:
Lecturer of several subjects for building service engineering students: Heating, Water supply, Gas supply, District heating supply. Tutor of diploma works.
Major subjects of research works:
Energetic examination and evaluation of buildings; Modelling of comfort conditions in buildings; Investigation of air supply conditions in the room of gas appliances.
He has more than 100 publications in scientific journals and conferences. He has been lecturer at several WSEAS Conferences and was plenary speaker at the HTE '08 Conference in Rhodes.

Authors Index