MAGIC Processes and Plants for Fine and Specialty Chemicals

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Dr Vivek V Ranade is a Deputy Director of CSIR - National Chemical Laboratory (www.ncl-india.org) and Chairman of Chemical Engineering and Process Development Division. He has contributed significantly to chemical engineering science and practice. His work has resulted in new insights and better designs of industrial flow processes. He has successfully developed solutions and has facilitated their implementation in a wide range of industry. He has also developed various devices (micro-reactors, filters, vortex diodes) and products. He is currently leading a large program on process intensification entitled Indus MAGIC (www.indusmagic.org) which is aimed at developing MAGIC (modular, agile, intensified and continuous) processes and plants. He has established first of its kind industry consortium on process intensification (Indus CPI) at NCL. He is actively working with a wide range of fine and specialty chemicals industries to transform the way we manufacture these chemicals.

Dr Ranade is a Professor at Academy of Scientific and Innovative Research (www.acsir.res.in) and an Adjunct Professor at ICT (formerly UDCT: http://www.ictmumbai.edu.in). He also worked at ETH, Zurich; TU Delft and University of Twente, The Netherlands as guest researcher. He has published more than 125 papers and four books (citations > 4200; h index=38). He is co-inventor of more than 20 patents (granted or filed). He is an Associate Editor of 'Industrial & Engineering Chemistry Research' and serves on editorial boards of 'Chemical Engineering Research & Design' and 'Indian Chemical Engineer' journals. He is a recipient of several awards including Shanti Swarup Bhatnagar award and DST Swarna Jayanti Fellowship. He is a fellow of Indian National Academy Sciences, Indian National Academy of Engineering and Indian Academy of Sciences. He is also an entrepreneur and has collaborated with start-up companies: Tridiagonal Solutions (www.tridiagonal.com); Vivira Process Technologies Pvt. Ltd. (www.vivira.in).

Abstract

Fine and specialty chemical industry caters to several key applications required for maintaining and enhancing quality of life. It is interesting to note that most of the fine and specialty chemicals are still manufactured in stirred batch reactors (devised centuries ago) operated as batch or semi-batch processes. A paradigm shift is necessary to transform this into new age, efficient and continuous processes, and plants. In this presentation, recent attempts of our group on developing MAGIC (modular, agile, intensified and continuous) processes and plants for fine and specialty chemicals industry will be discussed. There are several challenges in realizing this dream of MAGICally transforming the way fine and specialty chemicals are manufactured. Efforts on overcoming these challenges are initiated (see www.indusmagic.org). The present talk will cover key concepts in developing MAGIC processes and will summarize recent results obtained at CSIR - NCL.

Keynote Lecture: 21st December 2015 9.00-9.45 AM

Disruptive Innovation for the Coming Healthcare Revolution

Prof. Govind Rao
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Govind Rao is Professor of Chemical & Biochemical Engineering at the University of Maryland, Baltimore County. He has been a faculty member at UMBC since 1987 and has served as Department Chair from 2000-2006. In 2006, he founded the Center for Advanced Sensor Technology (CAST) and has been serving as its Director since its inception.

Dr. Rao's research is targeted towards disruptive innovation, where the goal is to create paradigm shifts in the state-of-the-art. He has focused on applications of fluorescence spectroscopy to create novel low-cost sensors for bioprocess, biomedical and environmental applications. His lab has developed next-generation sensors for low-cost non-invasive monitoring of oxygen, pH, pCO_2, Glucose and Glutamine in bioreactors. These sensors have led to a paradigm shift in bioprocess technology, as they collectively enable high throughput bioprocessing and are ideal for single use. Recently, the Rao lab has developed non-invasive sensor technology for neonatal monitoring and that is being commercialized by GE. He has published over 160 papers in professional journals. His funding has come from several diverse sources including NSF, NIH, JDRF, DARPA, FDA, ONR and from several companies.

He has received several awards. These include the Presidential Young Investigator Award from the National Science Foundation, Outstanding Teaching and Research Awards from UMBC, the Van Lanen Award from the American Chemical Society, the Gaden Award from Biotechnology & Bioengineering, the University System of Maryland Regents Award for Excellence in Research and he has been named a 2003 Innovator of the Year by the Maryland Daily Record. He has several patents and these have been licensed to Fluorometrix, which he co-founded. Dr. Rao has served as the Chair of the Biotechnology Division of the American Chemical Society and on the Editorial Board of several prominent journals. In 2009, he was named as Editor of the PDA Journal of Pharmaceutical Science and Technology. In 2015 he received a "50 bright ideas" award from UMBC for the number of inventions filed and named an Eminent Engineer by Tau Beta Pi.

Abstract

Advances in key industries like computers, automobiles, and telecommunication have not been matched by the healthcare industry. This is because in addition to regulatory hurdles, science has moved slowly from the bench to the bedside. We will show several case studies that illustrate out-of-the-box approaches to address these shortcomings. We demonstrate novel disruptive approaches that put the possibility of high technology yet affordable healthcare within reach. In one instance, we show how an entire pharmaceutical plant can be replaced with a suitcase size device to produce therapeutic proteins on demand. In another, we demonstrate how state-of-the-art biomedical analysis for blood glucose and blood gases can be done completely non-invasively. Finally, we show approaches that can bring quality healthcare for the majority of the world's population that lives with little or no access to basic care.

Keynote Lecture: 21st December 2015 9.45 - 10.30 AM

PID Controllers Tuning for Unstable Multivariable Systems

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Dr. M. Chidambaram obtained his B.E (Chemical) from Annamalai University in 1975 and M.E (Chemical) and PhD from I.I.Sc, Banglaore in 1977 and 1984 respectively. Since 1996, Dr. M. Chidambaram has been a Professor of Chemical Engineering in IIT-Madras. He served the department of Chemical Engineering as HOD during 2000-2003. He was the Director, National Institute of Technology-Triruchirappalli during 2005-2010. He has about 7 years teaching experience in IIT-Bombay and 25 years in IIT-Madras. He has guided 13 PhDs. He has published 180 research papers in Journals. He has authored/co-authored 5 books in the area of Process Control, and the recent book being 'Relay Auto Tuning for Identification and Control' (Co-author: S. Vivek Sathe), Cambridge Univ Press, 2015.

Abstract

In the present paper, the reported works on the design of PID controllers for multivariable unstable system are reviewed. Agamenini et al. (1992) have proposed a method of designing controllers based on an optimization method. Georgiou et al. (1989) suggested an optimization method for a system without a significant time delay. Govindha kannan and Chidambaram (1997) have applied the method of Tanttu and Lieslehto (1991) to unstable MIMO processes, where the interactions were found to be significant. Decentralized PI controllers designed by the detuning method proposed by Luyben and Luyben (1997), do not stabilize the system if the unstable pole is present in each of the transfer functions of the system. Only centralized PI controllers stabilize such systems. Govindhakannan and Chidambaram (2000) applied the two stage P–PI controllers for the unstable systems based on the Tanttu and Lieslehto method. However, the method resulted in significant interactions. Gundes et al. (2007) derived the conditions for the stabilization of unstable time delay multivariable systems by PID controllers.
Several works (Xiong et al., 2007; Huang et al. 2003; Shen et al. 2010) appeared for stable systems, that introduced the concepts of equivalent transfer functions and effective open-loop transfer functions (ETFs/EOTFs) to take into account the loop interactions in the design of multi-loop control systems. Rajapandiyan and Chidambaram (2014) recently proposed a method of designing controllers for MIMO stable systems by combining the simplified decoupler approach with the ETF model approximation. This method is applicable when the decoupler is a stable one. Both the formulation EOTFs and ETFs (decomposed into individual loops) are based on perfect control approximations and the assumption is fully validated only by the use of the decouplers. This method gives less interactions and better performances when compared to the ideal and inverted decoupling methods.
Hazarika and Chidambaram (2014) have designed a multivariable control system based on RNGA (Relative Normalized Gain Array) ETF (He et al. 2009; Rajapandiyan and Chidambaram, 2014) . This RNGA-ETF includes the steady state and the transient information of the transfer function matrix. The performance of the regulatory problem is not better than that of the single loop PI controllers. The need of static decouplers for an unstable multivariable system where the conventional decouplers become unstable is brought out by Hazarika and Chidambaram (2015) using an example of a two input two-output process.

Chandrashekar and Chidambaram (2014) extended the Effective Relative Gain Array (ERGA) based ETF method (Xiong et al. 2007) to unstable delay TITO system with time delay. The control system was designed using the ETF based on the concepts of Effective Relative Gain Array (ERGA) and Relative Frequency Array (RFA).This ERGA-ETF included the steady state; transient information of the transfer function matrix, and it is valid for wide range of frequencies. The performance of the control system is shown to be better than that proposed by Hazarika and Chidambaram (2014). Dhanyaram et al. (2014) presented a method to calculate the steady state gain matrix of a multivariable unstable system from the closed loop and also proposed a modified Davison method to design multivariable PI controllers for unstable systems. Dhanyaram and Chidambaram, (2015) presented a simple method of designing centralized PI controllers for multivariable systems based on SSGM.

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Keynote Lecture: 21st December 2015 2.00 - 2.45 PM

Defining role of Chemical Engineering Science in Emerging Clean Energy Technologies

Dr. R.R. Sonde
EXECUTIVE VICE PRESIDENT
THERMAX LIMITED, PUNE
(formerly with Atomic Energy Commission)

Dr. R. R. Sonde graduated from KREC (now NITK) in 1979 in Chemical Engineering after his 5 years of stimulating stay at KREC, Surathkal. He was a University topper and has received Dr. M. Vishweshwaraya Gold Medal for being first amongst all the disciplines.

He started his early career working as a scientist in Bhabha Atomic Research Center (BARC). In the formative part of his career, he was deeply involved in nuclear energy research, developing technology on Heavy Water Plants while interphasing with various scientific, academic and research institutions. Subsequently, he was invited to join as Executive Director in the country's premier power generator namely National Thermal Power Corporation (NTPC), a mega public sector undertaking with over 75,000 MW of power plants to its credit. In his current assignment as Executive Vice President and a member of the Executive Council of THERMAX, his main thrusts of activities is bringing innovation and enhance knowledge. He is also involved in the developing new technologies in the field of energy, environment, and water. Towards that, his activities can be summarized as follows :

Development of gasification technologies both coal gasification, coal to liquid, IGCC and biomass gasification, development of waste heat to power generation technology in the form of development and integration of Organic Ranking Cycles (ORC), renewable technologies with a focus on solar, both thermal and PV, biomass, geothermal and developing hybrid distributed scale power plants, developing newer technologies using advanced technologies in the field of biomass, material and system integration of building hydrogen based cooling technologies, Fuel Cells, storage, hydrogen generation etc.

He is a Fellow of National Academy of Engineers (FNAE), member on the CII / FICCI Consortium for Power & Renewable Energy, member of DST Committee on Water and many other committees.

He has been awarded the Dr. M. Vishweswarayya Gold Medal for standing first in the University of Mysore, Dr Homi Bhabha Gold Medal during the Golden Jubilee celebrations of BARC in the year 2006 by Hon'ble Prime Minister for his outstanding contribution in the nuclear field, Dr. Doraswami IIChE Medal and Gold Medal from the Indian Nuclear Society (INS).

ABSTRACT

The next generation energy technologies are going to be complex and posing challenges to the scientists and technologists involved in developing these new technologies. How to deliver the energy with greatly enhanced efficiency, how to expand the mix of energy resources in the ways that are clean, reliable, affordable and sustainable and, how to quickly deploy these new technologies will demand highest level developments. The climate change will demand accelerated developments for faster deployment in the society.

The key note address will cover all these aspects and focus how in this multi disciplinary nature of developments, chemical engineering sciences play a pivotal role. New generation Clean Coal technologies, Waste-to-Energy conversion technologies, Solid fuels to transport fuels, Fuel Cell technologies, Solar, Biomass & Geothermal technologies, Energy storage systems are the new big developments. The coal gasification reactor design, catalysts for gas to liquids, carbon capture and sequestration using liquid solvents or adsorbents or membranes, organic Rankine cycle for waste heat to electricity conversion, electro chemistry and developments of materials for fuel cells, selective coatings for concentrated solar thermal

technologies etc. are rooted in the chemical engineering science.

Further, at the frontier, low temperature CO2 and water splitting to produce hydrogen and methanol and mimicking the artificial photo synthesis will demand highest level of involvement of chemical sciences in emerging energy technologies. The transition to hydrogen based economy or even perhaps methanol / hydrogen as energy carrier will probably define a major role that Chemical Engineering is expected to play in coming years.

The talk will give an overview and emerging opportunities for the chemical engineering fraternity.

Keynote Lecture: 21st December 2015 2.45 - 3.30 PM

Applications of Carbon Nanotubes in Separation Technology – An Overview

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Prof. Murugesan is a Professor in Chemical Engineering Department at Universiti Teknologi PETRONAS, Malaysia, has about 30 years of teaching and research experience. His areas of research include Ionic liquid/ Eutectic solvents for CO2 capture and chemical Engg. Applications, Development of new solvents for CO2 capture, mixed matrix membranes for gas separation, Aqueous two-phase extraction of biomolecules. He has about 205 publications to his credit, guided 22 PhDs and guiding 5 PhD scholars. He has successfully completed about 15 externally funded research projects and executed 10 Industrial consultancy projects. He has received "Effective Education Delivery Award for the Years 2008,2009 & 2010" awarded by Universiti Teknologi Petronas for Best Teaching and Researcher of the Year 2009" awarded by Universiti Teknologi Petronas for Contribution towards Publications and Research Grants.

ABSTRACT

Over the last two decades, CNTs, either SWCNTs or MWCNTs, have formed part of extensive and multidisciplinary research due to their superior properties and wide range of applications over other materials. In fact, they have even been designated in several occasions as the most researched materials of the 21st century. As a result, important and extensive achievements and applications have come up in different fields, including Chemical engineering. Due to the intensive and multidisciplinary research carried out during the last two decades on carbon nanotubes (CNTs), the scientific community understands, nowadays much better the chemistry, structure and properties of these interesting materials. In fact, they have found their particular place in a wide number of application fields and separation sciences, in particular. The aim of this paper is to provide an updated report of the most recent research regarding the use of CNTs in separation processes particularly in wastewater treatments. Most of the waste water treatment process involve the removal of inorganic, organic volatile compounds (VOCs) and heavy metals via adsorption, photo catalysis and membrane process etc. The major applications of CNTs in unit operation processes are critically reviewed based on their functions. The present paper covers the details of CNTs, functionalization of CNTs for targeted application, mechanism and the predictive models by focusing their application towards water treatment process.. These CNTs, multidisciplinary materials still generate great expectations and therefore new and challenging applications and contributions in the field of separation technology and water treatment in particular, will surely come out in the forthcoming years. The limitations in the applications of CNT towards commercialization of the unit operations for wastewater treatment applications are also discussed.

Keynote Lecture: 22nd December 2015 9.00 - 9.45 AM

Physical Methods for Fibre Separation from Corn Flour

Dr. Radhakrishnan Srinivasan

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Dr. Radhakrishnan is a proud alumnus of NITK Surathkal, did B.Tech in Chemical Engineering in 1991. He has done PhD from University of Illinois at Urbana-Champaign, in the area of Agriculture Engineering and currently working as a faculty in Dept. of Agricultural and Biological Engineering, Mississippi State University, USA. His research interests are grain processing and bioenergy / bioproducts areas such as biomass pre-treatment, cellulosic feedstock, co-product utilization, gasification, pyrolysis and prebiotics. He has three patents to his credit and authored a book chapter on "Fractionation of DDGS using Sieving and Air Classification".

Abstract

Corn (also known as maize) is used worldwide for feeding broiler chicken and hogs (pigs). Broilers and hogs are classified as non-ruminant animals and do not digest fibre well. Separating fibre from corn flour, prior to feeding, helps broilers and hogs gain weight faster. In the US, corn is also used for fuel ethanol production. Fibre separation makes ethanol production more efficient and results in a new co-product, the fibre. Fibre could be used as food and for producing value added products such as cellulosic ethanol, xylo-oligosaccharides, and corn fibre gum and polymer composites.

A simple process that uses a combination of sieving and elutriation (air classification), called the Elusieve process, was developed for separating fibre from corn flour. Hammer milled corn flour was sieved into four size fractions. The three largest size fractions were air classified at appropriate air velocities to separate fibre. Aspirators, which are off-the-shelf equipment, were used for air classification. Separating 6.2 wt% of corn flour as fibre increased starch content from 62.5% in original corn to 65.2% in enhanced corn. A pilot plant (1 ton/hr) has been built and is operational at Mississippi State University. The addition of an electrostatic step improved separation effectiveness. Electrostatic separation is used to separate particles from granular mixtures under the influence of electrical forces, which impart charge to the particles. The electrostatic method, when applied on fibre separated using the Elusive process, improved separation by selectively attracting fibre particles.

Keynote Lecture: 22nd December 2015 9.45 - 10.30 AM

Environmental Biotechnology for Sustainable Development: Waste to Energy, Green Mining and Wastewater Reuse in the City of the Future

Prof. Piet Lens

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Prof. Piet Lens is professor of Environmental Biotechnology at the Pollution Prevention and Resource Recovery Chair Group of the Department of Environmental Engineering and Water Technology of UNESCO-IHE. He is a founding Editor-in-Chief of the Review Journal "Re/Views in Environmental Science and Bio/Technology" and founding editor of the IWA Publishing series "Integrated Environmental Technology". He presently serves on the editorial board of the journals Biodegradation, Environmental Technology and Bioresource Technology and he is actively involved in a variety of scientific organizations (Nederlandse Biotechnology Vereninging, International Water Association and European Federation of Biotechnology), funding agencies (NWO, FWO, Irish EPA, EU), and European networks (SOWACOR, SWITCH and CAREX).

His research focuses on biofilms, sulfur biotechnology, metal speciation, bioavailability and removal, natural treatment systems, anaerobic wastewater and waste gas treatment for resource recovery and reuse. He is the initiator of the Marie Curie Training Site "Sulfur and Metals – HEMEP", the Erasmus Mundus Joint Doctoral programme "Environmental Technologies for Contaminated Soils, Sediments and Solid Waste (ETECOS3)" and the Erasmus Mundus Master Course "International Master of Science in Environmental Technology (IMETE)". He has authored over 240 scientific publications and edited nine book volumes. Besides innovative research, he is also a leader in education and capacity building, organising numerous study-days, conferences, summer schools and short courses.His awards include the IWA Publishing Award (2002), a Marie Curie Excellence Grant (2004) and a nomination as IWA fellow (2010).

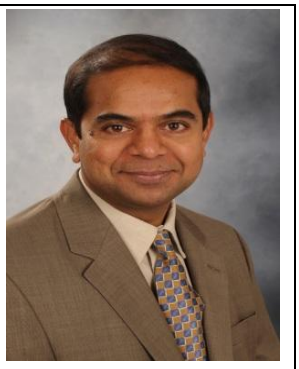
Abstract

The world is facing formidable challenges in meeting the rising demands of potable water and consumer products. The health and welfare of people are closely connected to the availability of adequate, safe and affordable water supplies. Also cost-effective recovery methods of chemicals and resources from waste and wastewater play an increasing role in sustaining human civilization on Earth.

Energy and feedstock materials for the industry are in increasing demand. With constraints related to availability and use of oil, the energy and chemical industry is undergoing considerable changes. The need for the use of cheaper and widely available feedstocks, and the development of sustainable and environmentally friendly chemical processes is rapidly growing under both economical and public pressure. Therefore, treatment of wastewaters, waste gas and solid waste need to be gradually integrated into process design. Instead of discharging their waste into the environment, industries need to become increasingly self-sufficient and recover compounds from their own waste streams or use (upgraded) waste streams of neighboring industries as raw material. Sustainable waste treatment concepts are under development with environmental biotechnology as key component, and can lead to the recovery of useful by-products like chemicals in the form of e.g. fertilizers (ammonia, phosphates), raw materials (elemental sulfur and selenium, sulfuric acid, quantum dots, ...) or energy (biogas, hydrogen or electricity). This presentation will give several examples related to waste to energy, green mining and wastewater reuse.

Keynote Lecture: 22nd December 2015 2.00 - 2.45 PM

Sustainable biochemical platform for biobased products



Prof. Praveen Vadlani

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Dr. Praveen V. Vadlani has earned his BE (Chemical Engineering) from NITK, Surathkal and MS, PhD in Biochemical Engineering & Biotechnology from Indian Institute of Technology, Delhi, India; and MBA from Kansas State University (KSU). After working in biopharmaceutical and biofuels industry for 12 years, he is now Gary and Betty Lortscher Associate Professor in Renewable Energy and Coordinator, Bioprocessing and Industrial Value-Added Program, Departments of Grain Science and Industry and Chemical Engineering, KSU. He has considerable expertise in biocatalysis and bioprocessing related to bulk and specialty chemicals from renewable resources. At KSU, he is primarily involved in the bioconversion of renewable biomass to value-added products, including advanced biofuels, chemicals, and premium animal feed products. Dr. Vadlani researched and taught at University of Malaya, Malaysia; University of Auckland, New Zealand; Texas A&M University and Rice University, USA; and has a visiting faculty appointment at Sri Sathya Sai Institute for Higher Learning, Puttaparthi, India. He is a senior member of American Institute of Chemical Engineers; Society for Biological Engineers; and life member of Indian Institute of Chemical Engineers, and has served as panel manager and member in the review panel for the USDA Biomass and Bioenergy CAP and SBIR programs. He has co-authored over 60 peer-reviewed publications and book chapters and has presented over 20 invited talks at reputed international meetings.

Abstract

In the last two centuries, a linear model of raw material conversion to finished products was followed by the industrialized world with limited concern to the associated byproduct formation and consequential emissions and pollutants; the primary motive being the market-driven economy. The first decade of this century witnessed unprecedented growth in bio-based industry due to escalating global oil prices and governmental thrust toward renewable fuels mandates; however, apart from the raw material being of renewable nature, the processing methods followed the same linear model with limited social and environmental benefits. While considerable research and development efforts are ongoing globally at academia and at research institutions to synthesize advanced biofuels and new platform chemicals, it is imperative to develop integrated bioprocesses that will consider all the constituents of the feedstock and the byproduct streams for value-added products. This integrated sustainable biochemical platform to biofuels and biochemical production from renewable biomass will provide significant additional cash flows and alleviate environmental problems associated with the disposal of byproduct and waste streams. In this talk, sustainable production of high optical purity D-lactic acid using recombinant *Lactobacillus plantarum* strains, 2, 3-butanediol at high titre and productivity, and oleaginous yeast-derived lipids *via* biochemical platform from renewable biomass will be discussed.

Keynote Lecture: 22nd December 2015 2.45 - 3.30 PM