Prof. Dr. Ing. Gheorghe MARIA

PROF. DR. ING. GHEORGHE MARIA AT HIS 65th ANNIVERSARY –
Excellency in Chemical and Biochemical Engineering

Prof. Dr. Ing. Gheorghe Maria from University Politehnica of Bucharest, Department of Chemical and Biochemical Engineering is a valuable scientist in Roumania, being the successor and continuer of the Roumanian school of chemical, biochemical (enzymatic), biological reactors, and reaction engineering (founded by the late Prof. Raul Mihail), but also the creator of novel courses in the chemical engineer curricula at UPBuc.[1,2]

Prof. Maria was born on October 2, 1955 near Bucharest, in Fundeni village (Călăraşi county). He attended the Primary School in Bucharest, and then he followed secondary studies with "Gh. Lazăr" high school (1970–1974), in a specialized class in chemistry and math. He quickly became known for its original mathematical approach to solving complex chemistry problems. He has participated to numerous national chemistry and math school competitions (so-called Olympics), winning several prizes. Due to its outstanding results, on 1974 he participated with the Roumanian team to the 6th International Chemistry Olympiad for high school students (11 participating European countries).[1,2] At this famous traditional contest, Gheorghe Maria won the gold medal by presenting ingenious math solutions to difficult chemical problems. Impressed by his success, the writer E. Seceleanu dedicated a chapter to him in his book.[3]

Following his exceptional achievements, on 1974 he was admitted to the University Politehnica of Bucharest without exam, at Faculty of Industrial Chemistry, where he chose major studies in Organic Chemistry, and Chemical Engineering. He graduated from University Politehnica of Bucharest in 1979, as valedictorian. After a short internship with chemical companies in Bucharest (1979–1982), he was hired (1982) as a senior research engineer by ICECHIM – Chemical and Biochemical Energetics Inst. Bucharest (IECB), being in charge with modelling the kinetics of (bio)catalytic processes, and technological design of industrial plants.

Over 1981–1987 he performed the *PhD* studies under the supervision of Prof. Raul Mihail, entitled "Statistical estimation of (bio)chemical process models parameters", by approaching case studies related to the kinetic modelling of a large number (more than 20) of catalytic (bio)chemical processes mostly by using the IECB experimental data.

Gheorghe Maria has had an exceptional career as a chemical engineer, developed over four decades, gaining experience from all sides of the profession: production, research, and teaching. On 1990, Gheorghe Maria was hired by University Politehnica of Bucharest as a lecturer. Over the next two decades he was hired by top universities in temporary positions, or invited to make short summer internships. Thus over (1992–1998) he was Assistant Professor (Oberassistent Klass 18) with ETH Zürich (Switzerland), being involved in teaching (MSc/*PhD*), but also in research projects dealing with: a) chemical reactor math-model-based design, optimization, and risk analysis; b) (bio)chemical kinetics modelling; c) development of novel statistical estimation rules in chemical kinetics; d) large-scale prospective research projects with industrial realizations, below described.

On 1998 Gheorghe Maria returned to Roumania and completed all the university degrees up to the present one of Prof. Dr. Ing. (1999), with University Politehnica of Bucharest, Lab. of (bio-) chemical reactors.

Over 2002–2003 Gheorghe Maria was an invited Senior Res. Scientist with Texas A&M University, Dept. of Chemistry and Cell Biology (College Station, USA), to be part of a NIH project on bioinformatics, that is math-modelling / numerical simulation of gene expression regulatory modules (GERM), and of genetic regulatory circuits (GRC) dynamics in living cells, aiming to design genetically modified micro-organisms (GMO) of industrial / medical use.

After 1990, prof. Gheorghe Maria was invited as a visiting professor to participate to numerous (beyond 20) scientific research projects with prestigious universities worldwide. Thus, he carried out short

(3-months) research stages in (*i*) Canada at Queen's Univ. Kingston, (1994); (*ii*) in Germany at: Univ. des Saarlandes (1999); TU Erlangen (2000); TU Braunschweig (2006, DFG project); TU Hamburg (2009); (*iii*) in Portugal at Univ. Porto (1999, NATO project); (*iv*) in France at EP Grenoble (1998); (*v*) in China at Tianjin U. (2010).

In short, the approached topics during his stays abroad are related to (*i*) modelling / optimization of catalytic chemical reactors; (*ii*) bioinformatics applications dealing with in-silico design (using numerical simulators) of GMO for industrial/medical use (books B8-10); (*iii*) quantitative (math-model-based) risk analysis of catalytic chemical reactors (B2, and[2,4]) .

The time spent with these research groups allowed him not only to exchange / develop valuable scientific ideas, but also to establish strong cooperations in its research areas (chemical kinetics / reactors, bioinformatics), thus enabling exchange of students, access to international grants, joint publications, etc. The significant number (ca. 25) of invited lectures presented at esteemed universities reflects the value of his world-wide recognized contributions to his specific field. Among the invited lectures are to be mentioned: ETH Zurich 1992–1997, RWTH Aachen 2006, U. Leeds 1996, U. Liverpool 1996, EPF Lausanne 1993–1996, U. Zagreb 2007, BASF Germany 1995, TU Erlangen 2000, TU Hamburg 2009, TU Saarbrucken 1999, TU Braunschweig 2006; in USA (Princeton U. 1994, Texas A&M U. 2002–2003), etc.

His research area includes a wide range of "classic" engineering fields, that is: chemical, biochemical, and biological reactors (math model-based design, optimization, control); modelling (bio)chemical kinetics (B5,6); numerical engineering analysis; theoretical and applied statistics (B1,3,5,6); numerical optimization methods (B1), etc., but also "modern border fields", namely: quantitative (model-based) risk analysis of chemical reactors (B2); bioinformatics (math modelling and simulation of cell metabolic process dynamics, of GERM, GRC, books B8–10), and math modelling of the controlled drug release in biological fluids (B4).

The theoretical (fundamental) scientific works in the above mentioned topics, as well as the industrial practical achievements of Prof. Gheorghe Maria are impressive.[1,2,4] Its high scientific productivity includes over 230 papers in ISI journals and intl. Conferences proc. (from which 45 in Q1–Q2 top journals), most of them as principal author, 12 ISBN books (7 in RO, and 5 in USA); 5 teaching books at University Politehnica of Bucharest, and 6 ISBN book chapters (see below selection).

Based on the research experience gained as a participant as a key-investigator to a large number of research projects with various EU and US universities, Prof. Gheorghe Maria has promoted in the chemical engineering education and research in Roumania (at University Politehnica of Bucharest) advanced directions, compatible with those developed in the EU. Thus, as a professor with University Politehnica of Bucharest, Gheorghe Maria was highly appreciated as being a dynamic element in the perpetual renewal of the faculty curricula, and its adaptation to the requirements of a modern European education and performance. Thus, Gheorghe Maria was the architect of new courses in the curricula of the chemical engineering at University Politehnica of Bucharest, namely: (*i*) "Risk and safety quantitative assessment of chemical processes/reactors" (BSc/MSc); (*ii*) "Metabolic engineering of living cells and bioinformatics" (MSc); (*iii*) "Statistical treatment of experimental chemical data" (BSc,MSc); iv) "Biochemical engineering".[1,2] While Prof. Raul Mihail (1920–1985)[5] was the creator of the Roumanian School of Chemical, Biochemical, and Biological Reactors, by publishing the first course in Roumania of "Chemical Reactors" (1971), Prof. Gheorghe Maria was one of the valuable continuators of his work, making a bridge over the years by developing a modern school of (bio)chemical reactors at University Politehnica of Bucharest, by promoting it both at theoretical and applied levels, within numerous research projects, and publications,[2,4] but especially through materialized innovative applications in the chemical industry (see below).

Major industrial achievements of Prof. Gheorghe Maria include the followings realizations:

Gheorghe Maria was the key-engineer in-charge with the math-model-based design, putting into operation (1985), and optimization of an industrial-scale plant at PWB (Petrochemical works and Refinery Brazi-Ploieşti, Roumania),[2,6,7] for developing novel cutting-edge technologies, such as: MTO (methanol conversion to olefins), MTG (methanol conversion to gasoline), BTX (methanol conversion to aromatic hydrocarbons), C4 olefins alkylation with methanol, ethanol conversion to hydrocarbons; benzene, or ethyl-benzene alkylation with ethylene to obtain higher aromatics, all using zeolite catalysts from ICECHIM - Chemical and Biochemical Energetics Inst. Bucharest. At that time, this industrial plant at PWB was the first in the world used to test these novel processes by using an original construction / operating alternative. Thus, the plant includes a fluidized bed catalytic reactor (FBR) for conducting the main reactions, connected to a

FBR used to regenerate the micro-particles of porous catalyst. The continuous circulation of the catalyst between the two FBRs is realized by pneumatic transport with an inert gas. It should be noted that a similar plant of Mobil Oil co. (USA) operated in New Zealand during the same time using a different approach that is a complex of 5 multi-tubular catalytic reactors operated in parallel.[7] Similar plants later developed by UOP/Hydro/Mobil co. adopted different constructive/operating solutions.[7]

Gheorghe Maria was also dealing with optimization of existing industrial reactors, such as the pyrolysis plant of Arpechim refinery Pitești (RO);[4]

During his work with ETH Zurich,[1,2] Gheorghe Maria realized the math-model-based design and putting into service of a medium-scale pilot plant in Switzerland (Paul Scherer Inst., Villigen, 1992–1995) to test the chemical storage of hydrogen. The plant, built-up in cooperation with DFG Germany, and Vinci co. (France) for testing this „avant-garde" process, that is the chemical storage of hydrogen and its transport between continents, includes two serial catalytic reactors (P3). Basically, H2 is stored by the catalytic hydrogenation of toluene (TOL) in the form of methyl-cyclohexane (MCH). Then, MCH is transported (by sea) to the beneficiary where it is catalytically dehydrogenated to TOL (thus releasing the H2). Eventually, TOL is returned to the source of hydrogen, and the cycle resumes.[2]

During his work with ETH Zurich,[2] Gheorghe Maria realized a safety-based optimization of a very risky semi-batch reactor at CIBA-Novartis, Basel (1994–1996) for pharma industry (P21);

Prof. Gheorghe Maria has published numerous contributions in fundamental research topics as followings:[2,4] (*i*) (bio)chemical reactor design, and multi-objective optimization of their operation (also including safety indices); (*ii*) proposal of a large number (over 40) of complex kinetic models for chemical catalytic, multi-enzymatic, or biological (cellular) processes; (*iii*) proposal of a new probabilistic index to evaluate the run-away risk of chemical reactors, as well as the limits of their safe operation; (*iv*) Bioinformatics (B8–10), namely kinetic-modelling of essential processes in living cells, such as GERM, GRC, and of the central carbon metabolism CCM. All these math-models and numerical simulations of metabolic fluxes were used for the in-silico (model-based) design of GMO of desired characteristics, to be used in medicine, or in industrial bio-synthesis; (*v*) Math-modelling of the drug delivery kinetics in biological fluids from porous supports aiming at in-silico design of optimized pharma systems with a controlled drug release (B4); (*vi*) Proposal of novel numerical algorithms / statistical tests for identifying or simplification of (bio)chemical kinetic models (B1,3,5,6, BC1,5,6) to facilitate chemical engineering calculations, by identifying the redundant part of the model, while keeping the reaction invariants (B6, P6,14); (*viii*) Development of expert systems (KINEXP using "artificial intelligence") for modelling the (bio)chemical kinetics (P4,P7,P32).

Based on their multiple fundamental contributions and industrial realizations, it can be stated that Prof. Maria has had a significant impact on the science and the practice of Chemical and Biochemical Reaction Engineering in Roumania and world-wide, its publications being well cited in the dedicated literature (Hirsch index 21, I10 index 55, with about 1600 citations).

In 2019 he was elected as corresponding member of the Roumanian Academy (section Chemistry). Starting with 2020 he is leading the Chemical & Biochemical engineering Commission of Roumanian Academy. He is member of several scientific (inter-)national organizations.[1,2]

Prof. Gheorghe Maria has been involved in numerous activities of the (inter-)national scientific community. Thus, he is member in the editorial board of several ISI scientific journals in his field: *Chemical and Biochemical Eng. Quarterly (Croatia); Revue Roumaine de Chimie; Revista de Chimie (Bucharest); The Scientific Bull. of UPBuc., etc.* Prof. Gheorghe Maria was a scientific expert for various national (Biotech, 2006), and international scientific programs (EU FP-6 2004, SNSF Switzerland 2009, Croatia 2006). Prof. Gheorghe Maria presented more than 10 plenary invited lectures to various intl. Conferences (Princeton U. 1994; ESCAPE5 Slovenia 1995; 20-CMCCE Zagreb 2007, etc.), being a reviewer for over 25 (bio)chemical eng. journals.

In recognition of his valuable scientific contributions in the field, he was honored over time with several awards, such as "Nicolae Teclu" Prize of the Roumanian Academy (1985) for kinetic studies, scale-up, design, and putting into service of an industrial plant for MTO/MTG process at the PWB (Roumania);[2,4,7] Gheorghe Maria received on 2006 Diploma of excellence in research of the Roumanian Federation of Biomedical Eng. Prof. Gheorghe Maria was also very active in the EFCE (European Federation of Chemical Engineering).[2]

The total devotion to school of Prof. Gheorghe Maria, even at the cost of his health (a severe AVC in 2014), his strong sense of responsibility, self-exigency, team spirit and involvement, brought to Prof. Maria respect and recognition from the colleagues from the Dept. of Chem. and Biochem. Eng. of University Politehnica of Bucharest. In any type of activity with students (scientific supervisor of 9 PhD, over 30 MSc, and more than 50 eng. Licence projects), Prof. G. Maria managed to mobilize his co-workers to participate in the research topics of great novelty at national and European level, by transmitting to them the passion for science, seriousness and education of the "well done job", the joy to participate through continuous self-improvement and getting results published in top international journals.

For his 65th birthday on October 2020, his colleagues and co-workers, his many friends, former students, and all those who had and have the honour to work with him send their wishes for many happy and fruitful years of scientific activity, by keeping alive the same intense scientific spirit for the benefit of the new generations of chemical engineers.

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