Laudatio for Prof. Dr. Ir. K. R. Westerterp

Klaas Roelof ("Roel") Westerterp was born on March 5, 1928, in the province of Drente, The Netherlands. His CV characterizes him both as someone very familiar with the world of practical engineering and as a famous scientist:

1952	M.Sc. degree ("Ingenieur") at the Technical University of Delft.
1952−1958	Various positions at the Royal Dutch Shell Group in Curacao, Argentina, and Venezuela.
1958−1962	Doctoral thesis (Prof. Hans Kramers' group in Delft), head laboratory engineer.
1963	Publication of the textbook: *Elements of Reactor Design and Operation*; Kramers, H.; Westerterp, K. R. Academic Press: New York, 1963.
1962−1968	Managing director of N.V. Petrochemie AKU−AMOCO, a Dutch−American joint venture between the Dutch company AKU and Standard Oil of Indiana, establishment of a chemical plant in Delftzijl, which began production of aromatic chemicals in 1964.

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1968−1970	Joint general manager of the Fine Chemicals Division of ENKA Glanzstoff (a Dutch−German group with 5 plants and 2000 employees); responsible for marketing and finance.
1970−1979	Technical managing director at Philips Duphar B.V. (5 major plants, 35 smaller ones, annual sales of over 500 million dollars) with worldwide responsibility for manufacturing of pharmaceuticals, fine chemicals, and agriculture chemicals, for engineering, and research and development; part-time professor at Twente University, Enschede, The Netherlands.
1979	Full-time professor at Twente University; established the group Industrial Processes and Products (two associate professors, three assistant professors, four technicians, currently seven Ph.D. students who are in the position of project leaders, and about 30 undergraduates (M.Sc.) per year).
1984	Publication of the textbook *Chemical Reactor Design and Operation*; Westerterp, K. R.; van Swaaij, W. P. M.; Beenackers, A. A. C. M. John Wiley & Sons: 1987.
To present	Establishment of the High Pressure Laboratory, at Twente University, which is worldwide one of the best equipped laboratories for chemical engineering research in academia (4 laboratory rooms, 9 concrete bunkers, 300 m^2 of offices).

During the spring of 1958, he shared his office in Delft with a visiting professor from University of Wisconsin (Bob Bird), who was most impressed by Roel's ability to handle many tasks at the same time, and a 40-year friendship began.

Roel Westerterp has published more than 250 papers in English, German, Dutch, and Spanish—languages he speaks fluently—and one in French. His scientific papers include a wide field of topics, all the way from the social and economic aspects of industrialization in developing countries to the development of his "wave model": optimization of chemical reactors, gasification of coal and biomass, use of waste energy from evaporators, air oxidation by hydrocarbons, gas−liquid reactors, mixing, reactor safety, hydrodynamics in multiphase reactors, design of cooled tubular reactors, particle runaway in catalytic gas-phase reactors, decoking of fixed-bed reactors, methanol synthesis in gas−solid−solid trickle flow reactors, cooling of reactors by evaporation, catalytic hydrogenation, catalytic fluid-bed reactors, bioreactors, multifunctional reactors, air purification in reverse-flow reactors, startup of reactors, heat transfer in packed-bed reactors, explosion regions under flow conditions, catalytic olefin polymerizations with Ziegler−Natta catalysts and metallocenes, development of a wave model for longitudinal dispersion, high conversion modeling in radical polymerizations.

In 1963 he published a paper on interfacial areas in gas−liquid contactors (Westerterp, K. R.; van Dierendonck, L. L.; de Kraa, J. A. Interfacial areas in agitated gas−liquid contactors. *Chem. Eng. Sci.* **1963**, *18*, 157−176. This later became a "Citation Classic", because it was the first development to demonstrate that one can use chemical reactions to determine the correct magnitude of the interfacial areas between gases and liquids. In the Netherlands only Roel Westerterp and J. J. van Deemter hold a "Citation Classic" for outstanding work in chemical engineeering.

In 1987 he coauthored the first paper (Westerterp, K. R.; Kuczynski, M. Gas−solid trickle flow hydrodynamics in a packed column. *Chem. Eng. Sci.* **1987**, *42*, 1539−1551) in a series on principles of multifunctional chemical reactors. He developed two new proposals for methanol synthesis, which were patented (Westerterp, K. R.; Kuczynski, M. A model for a countercurrent gas−solid−solid trickle flow reactor for equilibrium reactions. The methanol synthesis. *Chem. Eng. Sci.* **1987**, *42*, 1871−1885; Kuczynski, M.; Oyevaar, M. H.; Pieters, R. T.; Westerterp, K. R. Methanol synthesis in a countercurrent gas−solid−solid trickle flow reactor. An experimental study. *Chem. Eng. Sci.* **1987**, *42*, 1887−1898). He obtained a full conversion of the raw materials in one pass by removing the product (by adsorption) in the reactor itself.

Starting in 1984, Roel and his group began to publish a series of publications dealing with wall-cooled catalytic tubular reactors (Westerterp, K. R.; Ptasinnski, J. J. Safe design of cooled tubular reactors for exothermic, multiple reactions; parallel reactions II: the design and operation of an ethylene oxide reactor. *Chem. Eng. Sci.* **1984**, *39*, 245−252). His objective was to produce a sure and reliable method to design such reactors on the basis of the determination of kinetics and heat-transfer properties in the laboratory and a process model, without costly and time-consuming pilot-plant work.

In addition, it appeared that the existing mixing models, based on the Danckwerts approach of dispersion and its boundary conditions, were inadequate for packed, tubular reactors. Therefore, Roel developed a new model, which he called the "wave model" (Westerterp, K. R.; Dil'man, V. V.; Kronberg, A. E. Wave model for longitudinal dispersion: Development of the model. *AIChE J.* **1995**, *41*, 2013−2028; Westerterp, K. R.; Dil'man, V. V.; Kronberg, A. E.; Benneker, A. H. Wave model for longitudinal dispersion: Analysis and applications. *AIChE J.* **1995**, *41*, 2029−2039; Westerterp, K. R.; Kronberg, A. E.; Benneker, A. H.; Dil'man, V. V. Wave concept in the theory of hydrodynamical dispersion—A Maxwellian type approach. *Trans. Inst. Chem. Eng.* **1996**, *74*, 944−952) and which is expected to work far better for real tubular reactors and might have a long-term impact on chemical engineering modeling and practice.

Roel has served as a consultant to chemical companies in the Netherlands, England, Germany, and the United States. He was the president of the organizing committee for the First World Congress of Chemical Engineering and the vice president of the scientific committee for the Fourth World Congress. He served on the governing board of the Royal Institute of Engineers in the Netherlands and on their board of process engineering and their educational committee. He has also been on the board of the chemistry committee of the Royal Dutch Academy of Sciences. He has also been a member of editorial boards for a number of journals: *Latin American Applied Research* (Argentina), *Theoretical Foundations of Chemical Technology* (Russia), *Chemieingenieurtechnik (Chemical Engineering and Technology)* (Germany), *The Indian Chemical Engineer*, and *Chemical Engineering and Processing* (Germany). Roel has been elected as the successor of Hans Hofmann (Erlangen) and thus will become the President of the European Federation of Chemical Engineers (EFChE) on January 1, 1998. The EFChE currently has 162 000 members representing about 50 European chemical engineering organizations.

His scientific and professional contributions, as well as his efficiency and performance, have not gone unnoticed: He received an Honorary Membership of Dechema (1988), The Mendeleev Medal of the USSR Academy of Sciences (1989), the Achemasia Medal of Dechema and CIESC (1989), the Mrs. Chinnamaul Memorial Prize for the best technical paper (1990), the Honorary Medal of the Wroclaw Politechnic Chemical Engineering Department (1995), and an Honorary Membership in the Royal Institute of Engineers of the Netherlands (1996). Recently the Institut Quimic de Sarria asked him to accept the Doctor Honoris Causa of the University Ramon Llull, Barcelona, Spain, and the Technical University of Warsaw, Poland, invited him to receive an honorary doctorate at their university.

Roel has been quite generous in donating his time and energy to committees and professional societies. Since he is gregarious by nature, always positive in his thinking, and able to exhibit good humor and enthusiasm in several languages, he has been very effective as a professional leader.

All the best for the future, Roel! Het ga je goed!

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