

## **Scientific Activity of Professor Naim Afgan at the Laboratory for Thermal Engineering and Energy, Institute of Nuclear Sciences – Vinča**

by

***Dr. Predrag Stefanović,***  
**Research Professor**

Laboratory for Thermal Engineering and Energy,  
Institute of Nuclear Sciences VINČA, Belgrade, Serbia

<https://doi.org/10.2298/TSCI200628265S>

Professor Naim Afgan graduated in 1956 at the Mechanical Engineering faculty, University of Zagreb and in 1957, joined nuclear research program at the “Boris Kidrič” Institute of Nuclear Sciences in Vinča. Officially he finished work at the Institute in Vinča on March 1993, but he was always in contact and had co-operation with colleagues from his initial-basic research organization: Laboratory for Thermal Engineering and Energy in the Institute of Nuclear Sciences „Vinča“.

Professor Naim Afgan belong to the first generation of the researchers – engineers dealing with heat and mass transfer which established in 1961 a Laboratory for reactor thermal engineering, formulated research programs during the Nuclear Program, lead the research projects and educated the next generation of researchers. With his hard work and internationally recognized results, he highly contributed to the successful development of the Laboratory, its international co-operation and reputation, and especially to the advanced education of young researchers.

His scientific work in the Institute Vinča can be grouped in few research areas of primary interest, but as a leading researcher with very wide knowledge and experience, he was usually involved simultaneously in different projects:

- Initially his research was focused on processes in water cooled nuclear reactors (later in steam generators), especially on problems of heat and mass transfer in boiling liquid and in two phase (liquid-vapor) flows. This fundamental knowledge and experience were excellent base for applied research and studies that Professor Naim Afgan lead in later periods;
- In period from 1973 up to 1986 his research was focused on problems/processes in coal fired steam boilers of Thermal Power Plants, especially on problems of ash slagging and fouling problems of coal fired power plants;
- In period from 1980-1993 his research besides heat transfer in the boiling processes, thermal and hydrodynamic problems of steam generators and nuclear reactors, was focused on nuclear power generation problems, including thermodynamic and hydrodynamic problems nuclear reactor safety aspects and strategy of nuclear fuel cycle;
- After 2007 (although he was retired and came back permanently to Belgrade), he continued supervision of research activities of young scientists in his basic institution – Laboratory for Thermal Engineering and Energy of the Institute Vinča on sustainability problems of energy/environmental systems.

Professor Naim Afgan started work at the “Boris Kidrič” Institute of Nuclear Sciences in Vinča as a member of the supervision team for the erection of the research reactor RA nominal power 6.5 MW, bought from SSSR and completed in 1959. During 1960/61 he was a guest research fellow at the Nuclear reactor Department of the Argon National Laboratory US, on heat and mass transfer problems of liquid boiling processes. Based on this experience, with a group of young engineers in the Institute Vinča, a wide research program was determined, advanced experimental instrumentation was obtained, and different experimental installations were built. Based on this research he made a Ph. D. thesis: Ethyl Alcohol-Benzol Mixture Boiling Heat transfer and Heat Flux Crisis in 1965 at the School of Electrical Engineering, Belgrade University, but few more Ph. D. and M. Sc. thesis were done also in the following years under his supervision and many papers were published in International Journals (see Thematic research area I – Ph. D. and M. Sc. thesis including some papers in journals).

Advanced research results on heat and mass transfer problems of liquid boiling processes generated in the Institute Vinča, were the base for chapter: Boiling Liquid Superheat, which Professor Naim Afgan published in *Advances in Heat Transfer*, in 1975, for which he obtained October Scientific Award of the town Belgrade in 1976.

At the end of 60's, transformation of the research program in the “Boris Kidrič” Institute of Nuclear Sciences was started, and at that critical period, Professor Naim Afgan with a group of young researchers gave important contribution to the new research policy and program that was formulated in 1972 in the Laboratory for Thermal Engineering and Energy. Professor Naim Afgan with a group of younger researchers in the Laboratory formulated, organized and realized applied research devoted to solving numerous process problems in newly built coal fired Thermal Power Plants all over former Yugoslavia, especially problems of ash fouling and slagging in coal fired boilers.

Under the leadership of Professor Naim Afgan and Dr. Ljubomir Jovanovic, long-term research of the slagging and fouling processes *i.e.* of the formation of deposits on heating surfaces in coal-fired boilers, and simultaneous research of the physical, chemical properties and transformations of the mineral part of coal were organized for the needs of Electric Power Companies. In the Laboratory for Thermal Engineering and Energy, appropriate measurement methods for testing in real operating conditions in furnaces/boilers of TPP and in the laboratory have been developed, and based on a series of measurements on site performed with Yugoslav lignite and other coals, criteria for assessing the tendency of ash to form deposits have been established and influence of operating parameters (gas temperature and heat flux) on the rate of formation of deposits have been determined. Recommendations have been determined for the selection of: a) the type and concept of the furnace/boiler based on ash characteristics of domestic coals, and b) of critical values of the furnace parameters (temperature at the outlet of the furnace, volumetric and surface heat loads) corresponding to the characteristics of coal intended for combustion. Research results were published in a Ph. D. and M. Sc. thesis, numerous Studies, Reports and papers in the Journals (see Thematic research area II – Ph. D. and M. Sc. thesis including some papers in journals).

Taking into account the problem, of service life extension and the need for modernization of existing power plants, Serbian Electric Power Industry started financing an extensive study in the mid-1980's with the aim of determining the methodology and procedures for determining the current state condition of installed metal in boiler units and determining the remaining service life of vital boiler elements. Professor Naim Afgan, as a project leader, organized international meetings and cooperation with top European experts in this field,

which enabled the definition of advanced methodology and its application on thermal power units in the region. These applied research combined with the knowledge of two-phase flow of boiling water in the furnace screen pipes gave also clear picture of the conditions and causes of frequent screen pipes failures which increase operational costs and decrease the production and availability of Thermal Power Plants (see Thematic research area III.).

Research activities of Professor Naim Afgan in the Institute Vinča in the 80's included heat transfer in the boiling processes, thermal and hydrodynamic problems of steam generators and nuclear reactors, strategy of nuclear fuel cycle. Here are noted only two most important scientific monographs:

- N. Afgan, D. Spasojević, V. Jović, S. Milojević, J. Riznić, Z. Stošić: *Thermodynamic and hydrodynamic problems related to the safety of nuclear power plants*, Monograph published by IBK, Belgrade-Vinča, 1981
- Naim Afgan and Maurizio Cumo, *Nuclear Power Plants*, Monograph published by University of Rome La Sapienza, 1994, p. 131

Being successful scientific researcher, Professor Naim Afgan, since 1970 elected as Full professor at Belgrade University, was also a great educator, humanist and intellectual who, as a magnet, brought together young students, engineers and researchers, and selflessly assisted and directed them in research activities and their professional and scientific development. Even after return in Belgrade Professor Naim Afgan supervised three Ph. D. thesis of young researchers in the Institute Vinča after 2007:

- M. Jovanović, Sustainable development of Belgrade's energy system, (in Serbian), University of Belgrade, Mechanical Engineering Faculty, 2009
- B. Vučićević, Analysis and assessment of sustainable development of the energy system in buildings, (in Serbian), University of Niš, Mechanical Engineering Faculty, 2014
- P. Škobalj, Multi-criteria analysis of sustainability of thermal power units using ASPID methodology (in Serbian), University of Belgrade, Faculty of Technology and Metallurgy, 2017.

Professor Naim Afgan was one of the most active participants in foundation of Yugoslav Society of Thermal Engineers in 1962. As a Deputy Secretary General of the Society, with colleagues from the Laboratory for Thermal Engineering and Energy, he organized in 1964, 1<sup>st</sup> Symposium of Thermal Engineers of Yugoslavia, in Herceg Novi and later 4<sup>th</sup> Symposium in 1968, but with international participation. In spite of difficult political situation at that time in the world (due to Cold war), thanks to excellent personal relations and good international cooperation of Professor Zoran Zarić and Professor Naim Afgan with leading world experts in heat and mass transfer, 115 participants from 11 countries: US, Canada, England, France, SSSR, Germany, Italy, Switzerland, Sweden, Czechoslovakia, and Yugoslavia, were present and enjoyed excellent organization and high quality presentations/discussions. At the end of the 4<sup>th</sup> Symposium, representative of the Society of the Thermal Engineers proposed the establishment of the Forum: International Center for Heat and Mass Transfer – ICHMT, with the aim to promote scientific cooperation and to organize international scientific meetings on different subjects/problems in heat and mass transfer. This proposal was supported by present leading world experts and later officially accepted by the French Society of Thermal Engineers, ASME, AIChE and scientific organizations from other countries including sponsorship by UNESCO since 1970. Officially ICHMT was located in the Institute in Vinča and leaded by Professor Zoran Zarić as general secretary (1968-1985) and Professor Naim Afgan as scientific secretary (1968-1985) and later as general secretary (1985-1993). In period 1968-1993, ICHMT organized 47 international scientific events/meetings. Proceedings, published by world leading publishing companies, mostly edited by Professor Naim

Afgan, are still among the best archive scientific publications/literature for the related area of heat and mass transfer (see Thematic research area IV).

Scientific community in the Institute of Nuclear Sciences VINČA, and particularly researchers of the Laboratory for Thermal Engineering and Energy are thankful to Professor Naim Afgan for his large contribution to organization and realization of many high quality fundamental and applied research. Based on his wide international scientific cooperation with most reputed Universities and Institutes, as well as high known scientists he enabled introduction of new modern research topics, use of modern experimental methods and education of young researchers.

### **I – Thematic research area**

#### **Heat and Mass Transfer in Boiling Liquid and Two Phase Flows**

##### ***Ph. D. thesis***

- Ljubomir Jovanović, Determination of flow structure of two-phase boiling high quality water vapour mixture under forced flow, Ph. D. thesis, University of Belgrade, Mechanical Engineering Faculty, 1972
- Dušan Spasojević, Contribution to the knowledge of the rheological characteristics of a ferromagnetic suspension in a magnetic field Ph. D. thesis, University of Belgrade, Faculty of Technology and Metallurgy, 1974
- Miodrag Stefanović, Analysis of temperature fluctuations in two phase flow under sub-cooled boiling conditions, Ph. D. thesis, University of Belgrade, Mechanical Engineering Faculty, 1975
- Jovica Riznić, Vapour phase generation under nonequilibrium conditions, Ph. D. thesis, University of Belgrade, Mechanical Engineering Faculty, 1989
- Valerije Jović, Contribution to the study of non-stationary flows of a two-phase water-air mixture in parallel channels, Ph. D. thesis, University of Belgrade, Mechanical Engineering Faculty, 1992

##### ***M. Sc. thesis***

- Stanimir Lazić, Overheating liquid droplets, M. Sc. thesis, University of Belgrade, Mechanical Engineering Faculty, 1966
- Valerije Jović, Model of hydrodynamic behaviour of a reactor channel with two - phase flow in natural circulation, M. Sc. thesis, University of Belgrade, School of Electrical Engineering, 1967
- Ljubomir Jovanović, Dynamics of bubble growth during boiling, M. Sc. thesis, University of Belgrade, School of Electrical Engineering, 1969
- Miodrag Stefanović, Overheating of liquid and boiling heat transfer from an ideally smooth surface, M. Sc. thesis, University of Belgrade, School of Electrical Engineering, 1969
- Dušan Spasojević, Minimum heat load of the evaporator channel at the limit of parameter stability, M. Sc. thesis, University of Belgrade, Mechanical Engineering Faculty, 1970
- Milan Dimić, Investigation of the phenomenon of transfer during boiling of binary mixtures at atmospheric pressure, M. Sc. thesis, University of Belgrade, Faculty of Technology and Metallurgy, 1970
- Mića Marić, Temperature fluctuation in the two-phase boundary layer during boiling of water-ethyl alcohol solution, M. Sc. thesis, University of Belgrade, Faculty of Technology and Metallurgy, 1970

- Vladimir Valent, Bubble growth dynamics and analysis of heat and mass transfer during boiling of ethyl alcohol-water mixtures, M. Sc. thesis, University of Belgrade, Faculty of Technology and Metallurgy, 1971
- Ejup Ganić, Bubble growth and detachment during bubble boiling, M. Sc. thesis, University of Belgrade, Faculty of Technology and Metallurgy, 1972
- Slavimir Marković, Analysis of pressure change due to sudden expansion of channel cross-section in forced flow of steam-water mixture, M. Sc. thesis, University of Belgrade, Mechanical Engineering Faculty, 1974
- Larisa Jović, Development of the method of conditional sampling of temperature fluctuation in the superheated layer of boiling liquid, M. Sc. thesis, University of Niš, Faculty of Electronic Engineering, 1978
- Jovica Riznić, Thermohydraulic behaviour of the heated channel of the water reactor under disturbed conditions, M. Sc. thesis, University of Belgrade, Mechanical Engineering Faculty, 1983
- Vrhovac Miran, Determination of the U tube working part in the generator, M. Sc. thesis, University of Belgrade, School of Electrical Engineering, 1990
- Milan Josipović, A contribution to the study of flow and thermal processes in the conditions of heat carrier flow disturbances in the heated channel, M. Sc. thesis, University of Belgrade, Mechanical Engineering Faculty, 1991

#### ***Some published papers in International Journals***

- N. Afgan, M. Stefanović, Liquid Superheat for Vapor Formation with and without Presence of Solid Surface, *Int. J. Water Desalination*, (1971) No. 10
- N. Afgan, M. Stefanović, Lj. Jovanović, V. Pišlar, Determination of the Statistical Characteristics of Temperature Fluctuation in Pool Boiling, *Int. J. Heat Mass Transfer*, 16 (1973), pp. 249-286
- N. Afgan, M. Stefanović, Lj. Jovanović, V. Pišlar, An Approach to the Analysis of Temperature Fluctuation in Two-Phase Flow, *Int. J. Heat Mass Transfer*, 16 (1973), pp. 187-194
- N. Afgan, Analysis of Temperature Fluctuation in Pool Boiling, *Z. Prikl. Mekh. i Tekn. Fiz.*, 5 (1973), No 5
- N. Afgan, *Кипение перегретой жидкости*, Москва, Энергия, 1973, pp. 48
- E. Ganić, N. Afgan, An Analysis of Temperature Fields in the Bubble and in its Liquid Environment in Pool Boiling Water, *Int. J. Heat and Mass Transfer*, 18 (1973), pp. 301-309
- D. Spasojević, T. F. Irvine, N. Afgan, The Effect of The Magnetic Field on The Rheodynamic Behavior of Ferromagnetic Suspensions, *Int. J. Multiphase Flow*, 1 (1974), pp. 607-622

## **II – Thematic research area**

### **Slagging and Fouling in coal fired boilers of TPP**

#### ***Ph. D. thesis***

- Slobodan Djekić, Slagging and fouling mechanism of tube mineral deposits formation during Kosovo lignite combustion at steam generators, (in Serbian), University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture, 1986
- Branislav Brajušković, Contribution to the study of radiation properties characteristics of ash deposits formed by lignite combustion in boilers, (in Serbian), University of Belgrade, Mechanical Engineering Faculty, 1992

- Predrag Radovanović, Contribution to the study of the influence of the ash deposits formation on the efficiency of the boiler heating surfaces for the development of an appropriate expert system, (in Serbian), University of Banja Luka, Mechanical Engineering Faculty, 1994

### ***M. Sc. thesis***

- Pavle Pavlović, Development of the methods for measuring the radiation heat load of boiler screen pipes, (in Serbian), M. Sc. thesis, University of Belgrade, Faculty of Technology and Metallurgy, 1974
- Branislav Brajušković, Development of a new type of heat fluxmeter for determining the level of slagging in the furnace, (in Serbian), M. Sc. thesis, University of Belgrade, Mechanical Engineering Faculty, 1989

### ***Some published Studies, Reports, and papers in Journals***

- Savić, D., Afgan, N., Jović, V., Jovanović, Lj., Arsić, B., Studović, M., Determination of the Conditions for Slagging on the Boiler Screen Tube Surfaces at TPP Obrenovac (in Russian), *Bulletin de l'Academie Serbe des Sciences et des Arts*, Tom LVIII, Classe des Sciences techniques, Belgrade, (1977), No 15., pp. 1-22
- Afgan, N., Jovanović Lj., *et al.*, Study of the ash slagging process on the heating surfaces of a steam boiler for coal from open pit mines Kolubara, Kosovo and Kostolac, Study IBK-LTFT-78, Published by Institute for nuclear sciences "Boris Kidrič"-Vinča, Belgrade-Vinča, 1977
- Afgan, N., Arsić, B., Jovanović, Lj., Comparative analysis of slagging characteristics of domestic coals, *Termotehnika*, No 2, IV, 1978, pp. 90-98
- Pavlović, P., Afgan, N., Jovanović, Lj., Analysis of the furnace operation on large boilers, *Termotehnika*, V (1979), 1, pp. 37-48
- Savić, D., Afgan, N., *et al.*, Investigation of Tendencies of the Lignites from the Kolubara, Kostolac and Kosovo Basins Towards Formation of Deposits on Heat Transfer Surfaces During Combustion in Boiler Furnaces, *Bulletin de l'Academie Serbe des Sciences et des Arts*, Tom LXV, Classe des Sciences techniques, Belgrade, (1979), No 15, pp. 21-46
- *Fouling and Corrosion In Steam Generators*, editor akad. D. Savić, akad. I. Opik, Published by: "Boris Kidrič" Institute for nuclear sciences -Vinča and Technical University-Tallinn, Belgrade, 1980

## **III – Thematic research area**

### **Exploitation control of metals and problems at TPP**

#### ***Some published reports and papers in Journals***

- N. Afgan, V. Jović, L. Jović, S. Zarić, Investigation of the cause of the pipes failure at Unit A2 of the Thermal Power Plant "Nikola Tesla"-Obrenovac, (in Serbian) Report IBK-LTFT-171, Belgrade-Vinča, 1978
- N. Afgan, V. A. Vares, V. Jović, Determination of the Temperature Field and Thermal Stress in Boiler Screen Tubes Placed in Subcooled Boiling Zone, *Proceedings IBK-Vinča - Politehnikal Institute -Talin*, str. 79-92 Belgrade, 1980
- N. Afgan, P. Radovanović, B. Brajušković, Investigation of the cause of the pipes failure in the furnace of the boiler Unit IV TPP "Kakanj", (in Serbian) Report IBK-ITE-418, Belgrade-Vinča, 1983

- N. Afgan, *et al.*, Reasons for the failure of the boiler production TPP "Gacko", (in Serbian) Report IBK-ITE-563, Belgrade-Vinča, 1985
- Afgan, N. *et al.*, Exploitation control of metals of high temperature parts of steam boilers and steam pipelines at TPP ZEP-a, Study IBK-ITE-611, Belgrade-Vinča, 1986
- *Operational inspection of metals, pipe systems, boilers and steam pipelines*, Special Issue of selected papers, editors J. Riznić, N. Afgan, P. Radovanović, Lj. Jovanović, *Termotehnika*, Belgrade, (1988), No 3-4

#### IV – Thematic research area

##### **International symposiums, meetings, summer schools, and advanced courses organized by**

##### ***International Centre for Heat and Mass Transfer, from 1968 to 1993***

- Summer School, 9-12. Sept. 1968, Herceg Novi, Yugoslavia, *Heat and Mass Transfer in Turbulent Boundary Layers*, Proceedings N. H. Afgan, Z. Zarić, and P. Anastasijević (eds.), Pergamon Press, Oxford, Vol. 1-2, pp. 1040, 1972
- International Meeting, 1-13. Sept. 1969, Herceg Novi, Yugoslavia, *Heat and Mass Transfer in Flows with Separated Regions and Measurement Techniques*, Proceedings Z. Zarić (ed.), Pergamon Press, Oxford, 1972
- International Meeting, 8-12. Sept. 1970, Herceg Novi, Yugoslavia, *Heat and Mass Transfer in Rheologically Complex Fluids*, Proceedings W.R. Schowalter, A.V. Luikov, W.J. Minkowycz and N. H. Afgan (eds.), Pergamon Press, Oxford, pp.349, 1972
- International Meeting, 6-11. Sept. 1971, Trogir, Yugoslavia, *Heat Transfer in Liquid Metals*, Proceedings O. E. Dwyer (ed.), Pergamon Press, Oxford, pp. 595, 1973
- International Meeting, August 30- September 6. 1972, Trogir, Yugoslavia, Recent Developments in Heat Exchangers
- Monography *Heat Exchangers: Design and Theory Sourcebook*, N. H. Afgan and E. U. Schlünder (eds.), Washington, Scripta Book Co. and McGraw-Hill, p. 893, 1974
- Summer School, 20-24. August. 1973, Trogir, Yugoslavia, *Heat Transfer in Fires*, Proceedings, P. L. Blackshear (ed.), Washington, Scripta Book Co. and John Wiley & Sons, pp. 516, 1974
- International Meeting, 27-31. August. 1973, Trogir, Yugoslavia, *Heat Transfer in Flames*, Proceedings, N. H. Afgan and J. M. Beer (eds.), Washington, Scripta Book Co. and John Wiley & Sons, pp. 501, 1974
- International Meeting, 26-30. August. 1974, Dubrovnik, Yugoslavia, *Heat and Mass Transfer in the Biosphere*, Proceedings, D. A. De Vries and N. H. Afgan (eds.), Washington, Script Book Co. and John Wiley & Sons, pp. 591, 1975
- Summer School, Future Energy Production – Heat and Mass Transfer Problems 18-23. August. 1975, Dubrovnik, Yugoslavia, Book *Alternative Energy Sources*, J. P. Hartnett (ed.), Hemisphere Publishing Corp. and Academic Press, pp. 328, 1976
- International Meeting, 25-30. August. 1975, Dubrovnik, Yugoslavia, *Future Energy Production Systems*, Proceedings, J. C. Denton and N. H. Afgan (eds.), Hemisphere Publishing Corp. and Academic Press, Vol. 1-2, pp. 866, 1976
- Advanced course 23-28. August. 1976, Dubrovnik, Yugoslavia, *Thermal Effluent Disposal from Power Generation*, Book, Z. Zarić (ed.), Hemisphere Publishing Corp. and McGraw-Hill, pp.375, 1978

- International Meeting, August 30-September 4 1976, Dubrovnik, Yugoslavia, *Heat Transfer and Turbulent Buoyant Convection*, Proceedings D. B. Spalding and N. H. Afgan (eds.), Hemisphere Publishing Corp. and McGraw-Hill, Vol. 1-2, pp. 835, 1977
- International Meeting, August 29-September 2, 1977, Dubrovnik, Yugoslavia, *Energy Conservation in Heating, Cooling, and Ventilating Buildings*, Proceedings C. J. Hoogendoorn and N. H. Afgan (eds.), Hemisphere Publishing Corp., Vol. 1-2, pp. 901, 1978
- International Meeting, September 4-9, 1978, Dubrovnik, Yugoslavia, *Two-phase Momentum, Heat and Mass Transfer in Chemical, Process, and Energy Engineering Systems*, Proceedings F. Durst, G. V. Tsiklauri and N. H. Afgan (eds.), Hemisphere Publishing Corp. and McGraw-Hill, Vol. 1-2, pp. 1079, 1979
- International Meeting, September 3-7, 1979, Dubrovnik, Yugoslavia, *Heat and Mass Transfer in Metallurgical Systems*, Proceedings D. B. Spalding and N. H. Afgan (eds.), Hemisphere Publishing Corp. and McGraw-Hill, pp. 758, 1981
- Advanced course, June 23-27, 1980, Dubrovnik, Yugoslavia, *Mathematical and Physical Modelling of Metals Processing Applications*, Proceedings J. Szekely, J. W. Evans and K. Brimacombe (eds.), ICHMT and Hemisphere Publishing Co., pp. 400, 1980
- Summer School, August 25-29, 1980, Dubrovnik, Yugoslavia, *Nuclear Reactor Safety Heat Transfer*, O.C. Jones, Jr.(ed.), Hemisphere Publishing Corp. and McGraw-Hill, pp. 959, 1981
- International Meeting, September 1-5, 1980, Dubrovnik, Yugoslavia, *Heat Transfer in Nuclear Reactor Safety*, Proceedings S. G. Bankoff and N. H. Afgan (eds.), Hemisphere Publishing Corp. and McGraw-Hill, pp. 964, 1982
- International Symposium, October 6-10, 1980, Dubrovnik, Yugoslavia, *Structure of Turbulence in Heat and Mass Transfer*, Proceedings Z. Zarić (ed.), Hemisphere Publ. Corp. and McGraw-Hill, pp. 585, 1982
- Advanced course Nuclear Reactor Safety Assessment, October 5-9, 1981, Dubrovnik, Yugoslavia, *Guidebook to Light Water Reactor Safety Analysis*, P. B. Abramson (ed.), Hemisphere Publishing Corp. and Springer-Verlag, pp. 393, 1985
- Summer School, August 31-September 5, 1981, Dubrovnik, Yugoslavia, Heat Exchangers
- International Meeting, September 7-12, 1981, Dubrovnik, Yugoslavia, *Heat Exchangers: Theory and Practice*, Proceedings J. Taborek, G. Hewitt, and N. H. Afgan (eds.) Hemisphere Publishing Corp. and McGraw-Hill, pp. 979, 1983
- International Symposium, August 30-September 3, 1982, Dubrovnik, Yugoslavia, *Heat and Mass Transfer in Rotating Machinery*, Proceedings D. E. Metzger and N. H. Afgan (eds.), Hemisphere Publishing Corp. and Springer-Verlag, pp. 713, 1984
- Advanced course, August 29-September 3, 1983, Dubrovnik, Yugoslavia, *Measurement Techniques in Power Engineering*, Proceedings N. H. Afgan (ed.), Hemisphere Publ. Corp. and Springer-Verlag, pp. 356, 1985
- International Symposium, September 5-9, 1983, Dubrovnik, Yugoslavia, *Measurement Techniques in Heat and Mass Transfer*, Proceedings R. I. Soloukhin and N. H. Afgan (eds.), Hemisphere Publishing Corp. and Springer-Verlag, pp. 569, 1985
- Advanced course, August 27-31, 1984, Dubrovnik, Yugoslavia, *Fluidized Bed Combustion*, Proceedings M. Radovanović (ed.), Hemisphere Publishing Corp. and Springer-Verlag, pp. 307, 1986
- International Symposium, September 3-7, 1984, Dubrovnik, Yugoslavia, *Heat and Mass Transfer in Fixed and Fluidized Beds*, Proceedings W. P. M. van Swaaij and N. H. Afgan (eds.), Hemisphere Publishing Corp. and Springer-Verlag, pp. 732, 1986



- Advanced course, August 19-23, 1985, Dubrovnik, Yugoslavia, *High Temperature Equipment*, A. E. Scheindlin, (ed.), Hemisphere Publishing Corp. and Springer-Verlag, pp. 402, 1986
- International Symposium, August 26-30, 1985, Dubrovnik, Yugoslavia, *High Temperature Heat Exchangers*, Proceedings Y. Mori, A. E. Scheindlin and N. H. Afgan (eds.), Hemisphere Publishing Corp. and Springer-Verlag, pp. 606, 1986
- International Symposium, September 1-5, 1986, Dubrovnik, Yugoslavia, *Heat and Mass Transfer in Cryoengineering and Refrigeration*, Proceedings Bougard and N. H. Afgan (eds.), Hemisphere Publishing Corp. and Springer-Verlag, pp. 665, 1987
- International Meeting, May 25-29, 1987, Dubrovnik, Yugoslavia, *Transient Phenomena in Multiphase Flow*, Proceedings N. H. Afgan (ed.), Hemisphere Publishing Corp., pp. 1052, 1988
- International Symposium, August 24-28, 1987, Dubrovnik, Yugoslavia, *Heat and Mass Transfer in Gasoline and Diesel Engines*, Proceedings D. B. Spalding and N. H. Afgan (eds.), Hemisphere Publishing Corp., pp. 746, 1989
- Advanced course, August 31-September 4, 1987, Dubrovnik, Yugoslavia, *Computer Simulation for Fluid Flow, Heat and Mass Transfer and Combustion in Reciprocating Engines*, N. C. Markatos (ed.), Hemisphere Publishing Corp. pp. 586, 1989
- International Meeting, May 16-20, 1988, Dubrovnik, Yugoslavia, *Near-Wall Turbulence: 1988 Zoran Zarić Memorial Conference*, Proceedings S. J. Kline and N. H. Afgan (eds.), Hemisphere Publishing Corp., pp. 959, 1990
- International Symposium, August 28-September 2, 1988, Dubrovnik, Yugoslavia, *Heat Transfer in Electronic and Microelectronic Equipment*, Proceedings A. E. Bergles (ed.), Hemisphere Publishing Corp., pp. 1036, 1990
- International Meeting, March 20-24, 1989, Sarajevo, Yugoslavia, *Mathematical Modeling and Computer Simulation of Processes in Energy Systems*, Proceedings K. Hanjalić (ed.), Hemisphere Publishing Corp., pp. 922, 1990
- International Meeting, May 22-26, 1989, Dubrovnik, Yugoslavia, *Fission Product Transport Processes in Reactor Accidents*, Proceedings J. T. Rogers (ed.), Hemisphere Publishing Corp., pp. 870, 1990
- International Symposium, September 4-8, 1989, Dubrovnik, Yugoslavia, *Heat and Mass Transfer in Building Material and Structure Proceedings*, Jack B. Chaddock, Branislav Todorović (ed.), Taylor & Francis Inc, pp. 500, 1991
- International Symposium, August 27-31, 1990, Dubrovnik, Yugoslavia, *Manufacturing and Materials Processing*, Proceedings W. Aung (ed.), Volume 1: pp. 728, Volume 2: pp. 649, 1997
- International Meeting, May 14-18, 1990, Dubrovnik, Yugoslavia, *Phase-Interphase Phenomena in Multiphase flow Proceedings*, G. W. Hewitt, F. Mayinger, J. R. Riznić, ISBN-13: 978-0891165477, 1992
- International Meeting, May. 20-24, 1991, Dubrovnik, Yugoslavia, *Heat and Mass Transfer in Porous Media Proceedings* M. Quintard, M. Todorović (ed.), Elsevier 1993
- International Symposium, September 2-6, 1991, Athens, Greece, *Macroscopic and Microscopic Heat and Mass Transfer in Biomedical Engineering Proceedings*, Kenneth Diller, Avraham Shitzer (ed.) Int. Centre for Heat and Mass Transfer, pp. 375, 1992
- International Meeting, March 17-20, 1992, Erlangen, Germany, *Expert Systems and Computer Simulation in Energy Engineering*, Proceedings K. Hanjalić and J. H. Kim (eds.), Begell House Inc., pp. 345, 1995

- International Symposium, March 21-23, 1992, Athens, Greece, *Spatio-temporal Structure and Chaos in Heat and Mass Transfer*, Proceedings L. M. Pismen and M. S. Todorović (eds.), Mrlješ & Sons Ltd, Beograd, Nicosia, pp. 1993
- International Meeting, May 21-23, 1992, Athens, Greece, *Imaging in Transport Processes*, Proceedings S. Sideman and K. Hijikata (eds.), Begell House, pp. 621, 1993
- International Symposium, 1993, Athens, Greece, *Heat Transfer in Turbomachinery*, Proceedings R. J. Goldstein, A. I. Leontiev, and D. E. Metzger (eds.), Begell House Inc., pp. 592, 1994
- International Symposium, August 22-25, 1993, Cancun, Mexico, *Heat and Mass Transfer in Energy Systems and Environmental Effects*, Proceedings J. Cervantes de Gortari (ed.), Begell House Inc., pp. 557, 1993

Presented at the 4<sup>th</sup> SEE SDEWES Conference,  
June 28-July 2, 2020, Sarajevo, Bosnia and Herzegovina