FOURTH ALL-UNION CONFERENCE ON RADIANT HEAT EXCHANGE

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The Fourth All-Union Conference on Radiant Heat Exchange, organized by the Scientific Soviet on "Mass and heat transfer in technological processes" (Radiant heat-exchange section), the State Committee of the USSR on Science and Technology, the Scientific Soviet on "Thermophysics" (heat and mass transfer section) of the Academy of Sciences of the USSR, and the Institute of Technical Thermophysics of the Academy of Sciences of the Ukrainian SSR took place in the city of Kiev, Sept. 19-21, 1978.

More than 100 scientific-research organizations, consisting of institutions of higher education, scientific-production unions, and industrial departments, were represented by 412 delegates at the conference.

The conference commenced with remarks from the president of the organizational committee, director of the Institute of Technical Thermophysics of the Academy of Sciences of the Ukrainian SSR, Corresponding Member of that Academy, O. A. Gerashchenko.

Three survey papers were presented at the first plenary session.

In the report of Gerashchenko and L. S. Kremenchugskii entitled "Current experimental methods for study of radiant heat exchange" it was announced that the major task of current studies is the search for new means of obtaining primary scientific information on fundamental natural processes. In radiant heat exchange the calculated value of the Stefan—Boltzmann constant has been obtained to an error two orders of magnitude smaller than in direct measurements. It is thus most necessary to increase the accuracy of radiometric measurements. It was noted that the traditional treatment of the concepts of density, temperature, etc., as scalar quantities is open to criticism. A tensor approach opens new possibilities, requiring the development of apparatus which considers the anisotropic structure of radiant energy.

The necessity of radiometric measurements for various scientific—technical purposes has led to significant progress in the creation of new detectors and measurement systems.

The report presented current data on devices classified in the following groups: 1) evaporographic; 2) pneumatic; 3) dilatometric; 4) enthalpic; 5) resistometric; 6) pyroelectric.

In conclusion, the authors stressed the role of metrology in design and development of measurement systems, and reached the conclusion that measurements performed in the presence of radiant heat exchange are in severe need of improved metrology in experimental techniques.

A report by Professor A. B. Karasev "Radiant—convective heat exhange (the present state and prospects)" contains a description of a complete physical and hydrodynamic model of radiant—convective heat exchange applicable to a wide range of scientific—technical problems: thermoenergetics, metallurgy, high-temperature flows behind shock waves, atmospheric physics, etc.

Results were offered from theoretical and experimental studies of the effect of basic physicochemical and hydrodynamic processes on the magnitude of radiant—convective heat exchange: chemical reactions and their reaction rates, diffusion, ionization, draft, radiation scattering, all over a wide range of temperature, pressure, characteristic dimensions, and gas mixture composition. Special attention was given to the effect of the gas layer adjacent to a wall on simultaneous radiant—convective heat exchange and radiation transfer in the IR portion of the spectrum.

Basic directions for further study of radiant—convective heat exchange were formulated: a search for more effective methods for controlling the magnitude of the heat exchange, study of the optical properties of two-phase flows and the basic principles of radiant—convective heat exchange in the presence of radiation scattering, development of experimental methods and their role in the overall approach to determination of the dependence of radiant and convective thermal fluxes on problem conditions.

Translated from Inzhenerno-Fizicheskii Zhurnal, Vol. 35, No. 6, pp.1136-1138, December, 1978.

0022-0841/78/3506-1512$07.50

In his report "Radiant transfer under conditions of resonant radiation and absorption" Corresponding Member of the Academy of Sciences of the USSR R. I. Soloukhin considered specific questions of radiant transfer in media which interact in resonant fashion with fluxes of monochromatic (laser) radiation.

There are problems related to such interaction in the working volumes of light beam generators (lasers) and in "reception" devices which convert laser radiation in gas systems. Examples were offered of media which resonantly absorb IR range laser radiation (heated carbon dioxide and propane), and absorption mechanisms and experimental data on radiation characteristics of such media over wide temperature and pressure ranges were considered.

The survey reports produced significant interest and much discussion.

The conference's further proceedings were conducted in five sections.

In the section "Theory of radiant heat exchange" (President, Yu. A. Surinov; Vice-president, N. A. Rubtsov) questions of the present state and prospects for development of the theory of radiant heat transfer were considered, including development and application to concrete problems of the zonal method of calculation, consideration of selectivity of absorbing, radiating, and scattering media over wide parameter ranges, including inhomogeneous plasma, and study of the optical geometric characteristics of radiating systems.

The section "Complex heat exchange" (President, S. N. Shorin) considered the following basic topics: radiant—convective heat exchange in the presence of draft, complex heat exchange in selectively radiating media and plasma, radiant—conductive heat exchange behind shock waves and in semitransparent bodies. The present state and prospects of electrical simulation of radiant and complex heat exchange were also considered.

In the section "Experimental methods for study of radiant heat exchange" (President Gerashchenko; Vice-presidents, L. S. Kremenchugskii and B. A. Grigor'ev) presentations were made on development of methods and devices for thermometry and pyrometry, including devices for measurement of thermal fluxes and temperatures during heat treating of materials and in the fireboxes of steam generators, together with presentations on device calibration and metrology and methods for determination of systematic error in measurements of surface temperature and thermal flux.

The section "Radiation characteristics of objects" (President, B. A. Khrystalev; Vice-president, A. E. Erinov) considered a wide range of studies of radiation characteristics (gaseous media and flames with and without solid bodies included in them, at high and cryogenic temperatures: various materials including metals, alleys, and tissues; semitransparent materials; polymers and materials with composite inclusions: industrial refractories and concretes.

A great deal of attention was given to experimental methods and apparatus used in determination of thermoradiant characteristics of materials.

The subjects of the reports presented to the section "Radiant heat exchange in power equipment and technological processes" (President, A. G. Blokh; Vice-president, A. S. Nevskii) were theoretical and experimental studies of the principles and peculiarities of radiant and complex heat exchange in the fireboxes of steam generators and naval boilers, combustion chambers of jet and internal combustion engines, tube furnaces in the chemical and petrochemical industries, heat-treating furnaces and other power apparatus and technological processes. Attention was also given to development of algorithms and programs for zonal calculation of apparatus, creation of mathematical models of radiant heat exchange, and solution of engineering problems of selective radiation in the calculation of industrial aggregates, together with the effectiveness of various regimes in heat transfer processes.

Approximately 120 reports and papers were heard and discussed in the sectional meetings.

It was noted by the conference that in the period since the Third All-Union Conference on Radiant Heat Exchange specific goals have been achieved by the joint efforts and cooperation of the "Radiant heat exchange" section of the Scientific Soviet on problems of "Mass and heat transfer in technological processes" of the State Committee on Science and Technology of the USSR and the heat and mass transfer section of the Scientific Soviet on Complex problems of thermophysics of the Academy of Sciences of the USSR.

There has also been significant success in the study of radiant and complex heat exchange in systems of bodies and media possessing significantly selective and anisotropic characteristics, and in the study of the physical mechanisms of radiant and complex heat exchange, which has permitted the development of methods for engineering calculations of heat exchange relative to concrete industrial complexes, based on numerical

solution of complex physicochemical and mathematical problems with the aid of modern computer technology. The use of zonal and iteration-zonal methods of calculating radiant heat exchange has expanded significantly.

Wide-ranging studies have been performed of the radiation characteristics of various bodies and media under normal and extremal circumstances and the publication of handbooks on the radiation properties of materials has commenced.

Detailed investigations are being undertaken of complex heat exchange and combustion, with consideration of the behavior of ash and soot particles in fireboxes and combustion chambers, and for the purpose of predicting the development and quenching of forest fires.

Significant results have been achieved in the development of reference and research radiometric equipment, and in the production of experimental models of radiometric devices. A major portion of the studies in radiant and complex heat exchange have been performed for the benefit of various branches of the economy and have had significant economic results. This is true most of all of the petroleum industry, ferrous and nonferrous metallurgy, the food industry, and a number of new branches of technology.

Together with recognizing the achievements which have been reached, the conference's resolution noted that the effectiveness of studies in the field of radiant and complex heat exchange and the rate of introduction of discoveries into the economy still fall short of the goals set for Soviet science by the Twenty-Fifth Congress of the Communist Party of the Soviet Union. In particular, there is a lag in the development of engineering methods for calculation of heat exchange in fireboxes of boiler apparatus, when the present state of knowledge and calculation technology are considered. It was stressed that the recommendation of the preceding conference on development of consistent specifications for full-scale studies of radiant and complex heat exchange in high power energy equipment has still not been fulfilled. As before, theoretical and experimental studies of radiant and complex heat exchange in nonstationary and thermodynamically nonequilibrium condition require improvement, as does the corresponding radiometric instrumentation. The necessity for intense study of the radiation characteristics of many materials, including newly developed ones which appear most promising for use in new technological processes, is still with us.

The conference recommends:

In the future, together with increased depth in the theoretical and experimental study of physical mechanisms, processes, and individual parameters upon which radiant and complex heat exchange in systems of bodies and various media rest, special attention must be given to development of methods for engineering calculation of heat exchange in high energy apparatus (especially boiler complexes), chemical reactors, various industrial equipment, and devices used in space, rocket, plasma, and laser technology. These methods should be based on numerical solution of the corresponding physicochemical problems with the aid of modern computer and simulation equipment.

The development of studies of radiation characteristics of various materials, media, and bodies which are needed in heat exchange calculations of existing and future technical equipment and processes must be continued.

The study of the physical mechanisms of radiant and complex heat exchange in scattering media must be continued and expanded, especially in situations where the distance between scattering centers is comparable to the radiation wavelength.

Theoretical and experimental studies of radiant and complex heat exchange under nonstationary conditions in the absence of local thermodynamic equilibrium must be extended and performed in greater depth.

The formulation of generalized specifications for full-scale studies of radiant and complex heat exchange in high power equipment must be completed ("Radiant heat exchange" section).

The institute of Technical Thermophysics of the Academy of Sciences of the Ukrainian SSR, the major organization in this field, must be requested to insure the introduction of radiometric apparatus into industrial production, and to accelerate the development of new radiometric devices for measurements under nonstationary heat exchange conditions.

Material contained in the conference reports and recommendations will be used for future planning of the development of scientific studies over the period to 1990-2000.

It was decided to call a Fifth All-Union Conference on Radiant Heat Exchange in 1982-1983.

The conference noted the great effort put forth by the Institute of Technical Thermophysics of the Academy of Sciences of the Ukrainian SSR in preparing for and conducting the present conference.