Introduction

The physical basis of all the solutions considered in this book is the notion of radiation transfer in absorbing and scattering medium as some macroscopic process, which can be described by a phenomenological transfer theory and kinetic equation for spectral radiation intensity. The question of the radiation transfer theory applicability is very complicated and is dealt with in the theoretical physics [1]. It is of great importance, that the problems, for which the radiation transfer theory can be applied, are quite numerous and contain the thermal radiation of various disperse systems.

Here one should make certain assumptions, dealing with disperse systems properties and radiation transfer process:

– radiation propagation is more rapid than any change of physical parameters, therefore radiation intensity field is quasi-stationary;

– radiative properties of the medium do not depend directly on the radiation intensity, but they vary only with the change of the temperature;

– the local thermodynamic equilibrium is preserved;

– in calculations of the thermal radiation flux the wave polarization need not be taken into account;

– radiation scattering in a medium is not accompanied by frequency variation;

– radiation absorption and scattering properties of disperse system elementary volume can determined from individual particles parameters regardless of the couple effects.

The last assumption simplifies the problem, and also gives a chance for direct investigation of the medium disperse composition influence on thermal radiation transfer. The restrictions occurring from the above assumptions are not significant, as it might seem, since the assumption about small couple effects remains valid up to high enough particle concentration [2].

The radiation transfer theory has been long studied by a number of famous scientists, working in physical optics, astrophysics, nuclear reactor theory, and heat transfer theory. The mathematical theory was created, containing up-to-date analytical and numerical methods. Numerous special publications dealt with computational methods applied to radiation transfer problems [3–9].

Together with the development of the radiation transfer theory, significant achievements took place in theoretical investigations of particle radiative properties for various disperse systems. Properties of particles, comparable to the wavelength, turned out to be diverse and complex. Many applied investigations and well-known monographs [10–13] were published on this subject. For the solution of some practical problems dealing with thermal radiation of disperse systems it is necessary to combine achievements of the scattering theory and the radiation transfer theory. In this case, a reasonable choice of method for the solution of the radiation transfer equation depends upon the scattering medium properties. At the same time, requirements for completeness and accuracy of individual particle properties calculations are determined by essential precision of radiation flux calculation. This was also reflected in the manuscript.

While solving most practical heat transfer problems one must take into account not only the thermal radiation, but also heat transfer by conduction and convection in medium. Most general problems of combined radiative-convective heat transfer are very complex, and their solution may be possible only by employing approximate computational methods for radiation transfer [14, 15]. Therefore, for orientation in mathematical description development for such problems it was not necessary to discuss all the computational methods. The description of this methods can be found, for example, in monographs [8, 9]. Contrary to the above mentioned papers, more attention was given to errors, resulting from the simple approximate methods for solution of the radiation transfer equation (Chapter 1), to analysis of some optical properties of various particles (Chapter 2), and to solution of model problems including combined heat transfer problems (Chapter 3).

The choice of material for this book and, particularly, the combination of model problems correspond to the author's field of practical work.

Taking into consideration the main questions, connected with thermal radiation of disperse systems, the author paid no attention to radiative properties of gases (see, for example, [16]) and to description of selective radiation; nor did he review radiative properties of materials, that can be presented in boundary conditions for radiation transfer equation [17, 18].

It should be noted, that this book was written as a practical handbook for radiation heat transfer calculations in disperse systems, rather than a theoretical monography. Computer codes are presented in appendices. They may be useful for studying the methods, discussed in the book. Computer modules presented may be also used for the initial investigation of some real practical problems.

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