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COMPUTATIONAL ANALYSIS OF RADIATIVE HEAT TRANSFER FROM SUPERSONIC FLOW WITH SUSPENDED POLYDISPERSE PARTICLES TO A BLUNT BODY

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ABSTRACT The present study is motivated mainly by the interest to thermal conditions in the experimental testing of composite materials used in design of rocket engines. Therefore, a model problem with parameters typical of engineering problems of this type is considered. At the same time, the computational methods and qualitative results are expected to be also applicable to some re-entry problems. This particular numerical analysis is focused on the effects of collisions between alumina particles and realistic size distribution of alumina particles on both the flow field of particles and radiative heat transfer to the front surface of the blunt body. The computational method used in the heterogeneous flow field calculations takes into account the collisions between the particles. The approximate models examined by the authors for the radiative transfer in recent publications are also employed in the present paper. The computational study of the problem showed that the effect of collisions between the particles is significant for both the flow field of particles behind the shock wave and the radiative heat transfer. It is also interesting that an equivalent average radius of particles in approximate monodisperse calculations is quite different in the cases of a relatively cold and hot surface of the body. A physical explanation of this result is given in the paper.

Keywords: Radiative heat transfer; Supersonic flow; Suspended particles; Blunt body; Collisions of polydisperse particles; Computational model.