Numerical study of heat exchange processes of finely dispersed Al_2O_3 powder in a thermal plasma flow

Murashov Iu V, Obraztsov N V@, Kurakina N K and Zhiligotov R I

Peter the Great Saint-Petersburg Polytechnic University, Polytechnicheskaya 29, Saint-Petersburg 195251, Russia

@ obraztsovnikita@yandex.ru

The efficiency of plasma spraying technology and the quality of the applied coating depend on the properties of the applied materials and the characteristics of the plasma flow [1–3]. This work is devoted to the development of a two-dimensional mathematical model of heating of fine-dispersed in thermal plasma flow. The developed model is based on the equations of thermal balance, gas dynamics, and particle tracing. Consideration of heat and mass transfer processes as applied to sputtered particles is simplified when the latter are represented as spherical bodies. In this case, description of heat transfers of heated powder in thermal plasma flows and do plasma jets is possible with application of criterion formulas [1], analysis of which is presented in this work. Particle motion in plasma flow can be described by using Newton's second law and taking into account all forces acting on the particle:gravity, aerodynamic acceleration, thermophoresis, attached mass, Archimedes, Magnus, Basse. The paper presents a numerical analysis of different particle velocity response time models for calculating aerodynamic acceleration (Stokes model, Schlieren-Neumann model, Hayder-Levenspiel model and standard aerodynamic drag correlation) and presents applicability limits, also based on experimental results an expression for calculation of drag coefficient of spherical Al_2O_3 particle is proposed.

[1] Dresvin S V and Mikhalkov S M 1992 *High Temperature* **30** 21–30
[2] Jog M A and Huang L 1996 *Journal of Heat Transfer* **118** 471–477
[3] Kadyrov A A, Yushin B A and Frolov V Y 2021 *Journal of Physics: Conference Series* **1753** 012019