Numerical Simulation of Solidification Phenomena of Molten Droplet at Different Impact Velocity

S. Kondo*, H. Mamori† , N. Fukushima† and M. Yamamoto†

* Tokyo University of Science, Graduate School of Mechanical Engineering
6-3-1 Niijuku, Katsusika-ku, Tokyo, 125-8585, Japan
e-mail: 4516618@ed.tus.ac.jp

† Tokyo University of Science, Department of Mechanical Engineering
6-3-1 Niijuku, Katsusika-ku, Tokyo, 125-8585, Japan

ABSTRACT

Jet engines ingest sand and dust in the air. They pass through a combustion chamber with high temperature and thus they become molten droplets because of the high temperature in it. On the turbine blades and the end walls, the molten droplet is rapidly cooled due to the relatively low temperature, and the droplet solidifies and finally adheres on the surface. This deposition phenomenon decreases the turbine performance, disturbs the cooling flow of turbine blade, and ~~thus~~ it can cause serious problems. However, the deposition mechanism is still unclear. In order to clarify the deposition phenomenon, therefore, we make three-dimensional numerical simulations of the deposition behavior of a single molten droplet on a cooled substrate. Furthermore, since the impact velocity changes in the actual condition, in the present study, the cases of impact velocity are simulated. Explicit-Moving Particle Simulation (E-MPS)[1] method was used because of the good feasibility for large interface deformation. In the simulations, latent heat was taken into acount. The computational results show reasonable agreements with the experimental data (S.Shakeri et al. 2002)[2]. We confirm that fingers around the edge of droplet which is a characteristic shape of the adhered droplet was successfully reproduced. And, the same behavior as the experimental data is also confirmed for the spread factor of a droplet.

Tokyo University of Science
Graduate School of Mechanical Engineering
6-3-1 Niijuku, Katsusika-ku
Tokyo, 125-8585, Japan
Tel: +81-3-5876-1717
Fax: +81-3-5876-1717
E-mail: 4516618@ed.tus.ac.jp

REFERENCES

[1] Masatoshi OOchi, Seiichi Koshiduka, Mikio Sakai, “Explicit MPS Algorithm for Free Surface Flow Analysis”, Trans. Jpn. Soc. Comput. Eng. Sci., 20100013, (2010), 8 pp.
[2] S. Shakeri and S. Chandra, “Splashing of Molten Tin Droplets on a Rough Steel Surface”, Int. J. Heat Mass Transfer 45, (2002), pp. 4561-4575.