Proceedings, ICCES, vol.23, no.1

Numerical Simulation of Particulate Erosion in a Single-Stage Turbine for Jet Engines

Masaya Suzuki[1,*], Manabu Ueno[2], Koji Fukudome[2], Yoji Okita[1] and Makoto Yamamoto[2]

[1]Japan Aerospace Exploration Agency, 7-44-1 Jindaiji Higashi-machi, Chofu-shi, Tokyo, 182-8522, Japan.

[2]Tokyo University of Science, 6-3-1 Niijuku, Katsushika-ku, 125-8585, Tokyo.

[*]Corresponding Author: Masaya Suzuki. Email: suzuki.masaya@jaxa.jp.

Abstract: Recently, ceramic matrix composites (CMCs) are expected to utilize for the components of gas turbine engines due to its low density, high strength, and high rigidity in the high-temperature condition. The environmental barrier coating (EBC) is a key technology for the practical application of CMC to prevent surface regression from particulate and water vapor environments. However, the anti-erosion characteristics of CMC and EBC have not been clarified. In the present study, the authors performed numerical simulations of particulate erosion phenomena in a high-pressure turbine first stage to investigate the differences in the damage pattern and the performance between particle sizes. The numerical method was based on a weakly coupling for flow-wall interaction and one-way coupling for gas-solid two-phase flow [1]. The computational target was a high-pressure turbine vane designed by JAXA [2]. The turbine material was CMC with EBC. The results showed that the small particles damage the stator vanes, but the large particles significantly erode the rotor blades, and the deterioration of the aerodynamic performance is the most severe due to small particles.

Keywords: Jet Engine; Turbine; Erosion; Multi-physics Simulation

References

1. Hataya, T., Suzuki, M., Yamamoto, M. (2014). Numerical simulation of sand erosion using Unified Platform for Aerospace Computational Simulation. *Proceedings of Asian Congress on Gas Turbines 2014, ACGT 2014-0082,* 1-5.
2. Japan Aerospace Exploration Agency. (2020). Green engine technology—highly efficient core engine technology. http://www.aero.jaxa.jp/eng/research/ecat/greenengine/.

DOI: 10.32604/icces.2021.08337