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Effect of elastic deformation on the aerodynamic characteristics of a spinning projectile

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Elastic deformation can occur on spinning projectiles that are flying under aerodynamic loads at high speeds. The coupling of elastic deformation with a rolling movement may affect the stability and maneuverability of the projectile. A comparison between the numerical results and the wind tunnel experiments for a rigid secant-ogive-cylinder (SOC) spinning projectile proves that boundary layer flow and aerodynamic characteristics can be accurately estimated using the shear stress transport (SST) turbulence model. The equation describing the spinning and elastic movement was established. The projectile longitudinal deformation was defined as the low order bending mode of a free-free beam, and the deformation in crossflow plane was assumed as a heart-shaped curve. The spin and deformation movement were achieved by the sliding mesh method and the dynamic mesh with diffusion-based smoothing algorithm, respectively. Grid resolution and time independence studies were carried out for the accuracy of the unsteady computational fluid dynamics (CFD) results with both spin and elastic deformation. The numerical calculations indicate that the flow response lags behind the elastic deformation, and a difference is observed between the influence of upward and downward movements on the flow field, the boundary layer changes with elastic movement, resulting in a non-linear relationship between the movement and the induced aerodynamic forces. The induced time-averaged aerodynamic force increases with the elastic deformation rate, which in turn alters the direction of the time-averaged Magnus force.

Biography

Jintao Yin is now a PhD candidate from Beijing Institute of Technology. He is major in the aerodynamic characteristics of spinning vehicles, especially for those with structural deformation. He has published two papers in Aerospace Science and Technology.

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