World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:18, No:11, 2024

Computational Fluid Dynamics Modelling of the Improved Airflow on a Ballistic Grille Using a Porous Medium Approach

Authors : Mapula Mothomogolo, Anria Clarke

Abstract : The ballistic grille has become a mission critical component for protection on an armoured vehicle. They are designed to protect the armoured vehicle against ballistic threats while maintaining sufficient airflow for under-hood thermal management. Improving the ballistic grille for better ballistic protection can compromise the airflow to the engine. This reduces the cooling capacity of the armoured vehicle, thus reducing the overall power performance of the vehicle. This paper investigates the airflow through a grille using a computational fluid dynamics modelling approach. A comparative study was conducted between a standard armoured vehicle grille and a ballistic grille. The results were used as a benchmark for optimising the airflow through the ballistic grille by reducing the pressure drop through the grille. The ballistic grille was modelled as a porous medium to account for the pressure drop in the porous region. The effects of the porous zone were accounted for in the source term of the momentum Navier Stokes equation. The source term defines the pressure drop in the porous region as a function of the velocity. A pressure gradient curve approach was used to determine the Darcy coefficient and inertial resistance coefficient of the source term. The empirically defined coefficients were used as simulation input for a more accurate pressure drop prediction in the porous region. Additionally, the ballistic grille geometry was optimised using an adjoint solver (shape optimisation module in Ansys fluent) to reduce the pressure drop through the ballistic grille by 30%. Based on the simulation results, the optimised ballistic grille geometry will be further tested experimentally to validate the numerical model.

Keywords : ballistic grille, computational fluid modelling, Darcy’s law, porous medium, pressure drop
Conference Title : ICAMAME 2024 : International Conference on Aerospace, Mechanical, Automotive and Materials Engineering
Conference Location : Cape Town, South Africa
Conference Dates : November 04-05, 2024