Airflow Analysis of Engine Cooling Grille using Computational Fluid Dynamics

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Abstract*—Engine-bay-cooling system is an important part of the vehicle engine, maintaining the operating temperature. One of the factor determines heat-transfer efficiency of the system is the inflow air velocity which is controlled by the grille shape. A specific military vehicle designed for amphibious use intakes cooling air from the top of the vehicle via high performance exhaust fan. The grille and engine bay are modelled and analyzed by computational fluid dynamics to determine the suitable grille shape. The simulation has shown that vehicle speed has insignificant effect on the amount of air intake, and the grille blade setting at 45-degree gives the highest flow velocity into the engine bay.

***Index Terms*—Engine bay cooling system, cooling grille**

I. INTRODUCTION

Cooling system is tremendously important for vehicles as it keeps the engine running at operating temperature. Air is considered as a function of cooling. Therefore, cooling system of most commercial vehicle located at the front bumper to directly intake air. The intake air is normally controlled by a grille which is carefully designed to direct the air into the engine chamber because the shape of the grille has much effect in the aerodynamic and cooling performance of the vehicle [1]. Unlike a commercial vehicle, military vehicle has its cooling air intake on top of its body to allow amphibious use. The air is no longer entering the engine bay directly, and needed high performance fan to increase the amount of airflow into the engine bay. To enhance the cooling performance airflow through the engine bay must be managed [2]. As the amount of airflow through the engine bay varies with the inlet grille shape *i.e.* the settings of the grille blade, and the increase in velocity of the airflow through the engine has much impact on the overall heat transfer coefficient [3], the grille must be designed to allow the maximum air velocity into the engine bay.

Figure 1 Military Vehicle

II. THE MODEL

The engine chamber is as illustrated in figure 1. The cooling air enters the chamber through the inlet grille on top of the chamber, pass through the cooling pack, and exit through the high-performance-exhaust fans. The flow into the engine bay is driven by the velocity of the vehicle and two fans. However, as the simulation is aimed to study only the airflow through the grille, the cooling system is simplified. The grille slope with respect to the horizon is 10 degrees. The grille dimension is shown in figure 3 which affect to characteristic of airflow.

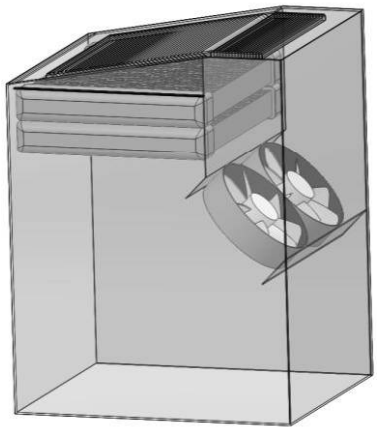

Figure 2 Engine-bay-cooling chamber