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Original Article

Designing A Model for Next-Generation Electric Vehicles: Aiming for Enhanced Performance

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Abstract *- What makes F1 cars faster than any other commercial cars? It is because of their aerodynamic optimized design, which plays a crucial role in the car's performance. F1 teams invest heavily in aerodynamic research and development, using wind tunnels and Computational Fluid Dynamics (CFD) simulations to optimize the aerodynamic performance of their cars. The major problem with F1 cars was due to its hybrid engines causing large sums of carbon emissions. In this research paper, we designed an EV car in terms of aerodynamic design, which leads to a better-performance car than other commercial cars due to its better aerodynamic optimization. Due to better aerodynamic optimization would also lead to better charge efficiency, increased safety, and reduced emissions. We researched current EV cars and their design and found how they lacked in their aerodynamic design. On the basis of the research, we proposed the model, which resulted in showing features such as a maximum speed of 120 km/h, and the design demonstrated the capability to withstand turbulence at high acceleration due to its better structural integrity.*

Keywords *- Sustainable, Performance, Aerodynamic, Model, Next generation electric vehicle, Improved design, Researched.*

1. Introduction

F1, also known as Formula One, is the highest level of international motorsport and is widely considered the most prestigious [1]. F1 cars are designed to be the fastest racing cars in the world, with speeds exceeding 230 mph (370 km/h) on certain tracks. The cars are powered by hybrid engines that combine a traditional internal combustion engine with an electric motor [2]. However, the sport has also faced criticism over the years, particularly in regard to its environmental impact and the cost of competing. This research aims to design a model for next-generation electric vehicles that pushes the boundaries of performance, efficiency, and sustainability. Aerodynamics plays a critical role in the performance of an F1 car. F1 cars are designed with aerodynamic features optimized to create maximum downforce and least drag. The purpose of this is to increase cornering speeds and improve acceleration and braking [3]. The front and rear wings are the most prominent aerodynamic features of an F1 car. These wings are designed to generate downforce, which is the force that pushes the car down onto the track [4]. The front wing is designed to direct air over the car and towards the rear, while the rear wing is designed to direct air upwards, creating more downforce. F1 teams invest heavily in aerodynamic research and development, using wind tunnels and Computational Fluid Dynamics (CFD) simulations to optimize the aerodynamic performance of their cars.

2. Methodology

The methodology for designing a model for next-generation electric vehicles will involve multiple approaches. The following steps will be undertaken that can be seen via the flow chart:

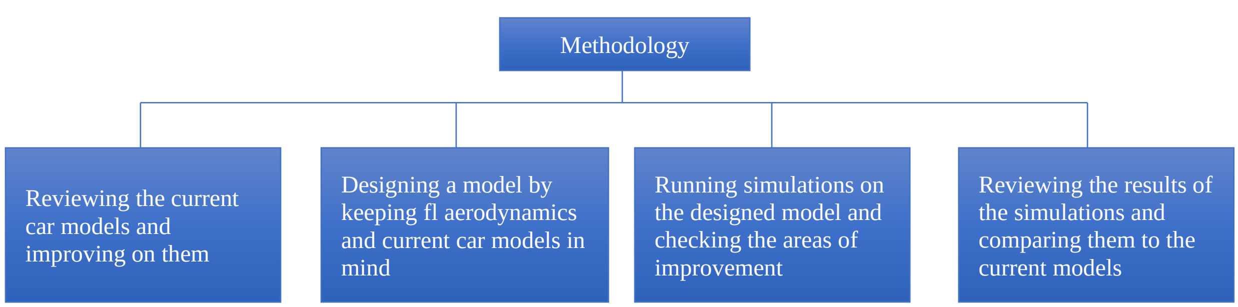

Fig. 1 Flowchart in Methodology

3. Aim

The study aims to design a model for next-gen electric vehicles with a better aerodynamic design than other commercial vehicles.

4. Research Design

The research aims to develop a design for the next generation of electric vehicles. This research design outlines the methodology, data collection, and analysis techniques to investigate various aspects of EV design. The goal is to propose innovative solutions that enhance future electric vehicles' performance, affordability, and sustainability.

5. Hypothesis

Null Hypothesis

“Assuming that there is no relation between aerodynamic design of the car to that of performance of the car.”

Alternative hypothesis

“Assuming that there is a relation between aerodynamic design of the car to that of performance of the car.”

6. Tool Used

To test the aerodynamic optimisation of cars, major companies use wind tunnels and CFD (Computational Fluid Dynamics). Similarly, Simscale, a virtual platform, was used to conduct simulations of the designed car models and find out how to improve the model. Simscale also showed the turbulent kinetic energy to show whether the model would show turbulence at high speeds. With the use of CFD, we were able to analyze the airflow around the vehicle to find out its performance. With the help of velocity magnitude, we were able to find out the vehicle's top speed, which helped in comparing it to other commercial vehicles.

7. Results

In the results, we will be showing the results for the simulation we ran in simscale on the proposed model and taking initial values as stated in the table above. The figure below would show the airflow in the model and hence show aerodynamic optimisation. Our main focus would be to look at the model's performance, the aerodynamic air flow, and the structural integrity the model would show at high speed, which can be evaluated by looking at velocity magnitude, pressure, and turbulent Kinetic Energy.

Performance Analysis (refer to figures no. 2 and 3): In performance analysis, we analyze how the designed model will show the top speed acceleration by running a simulation on simscale. The proposed next-generation electric vehicle model demonstrated a maximum speed of 120 km/h, aligning with industry urban commuting standards.

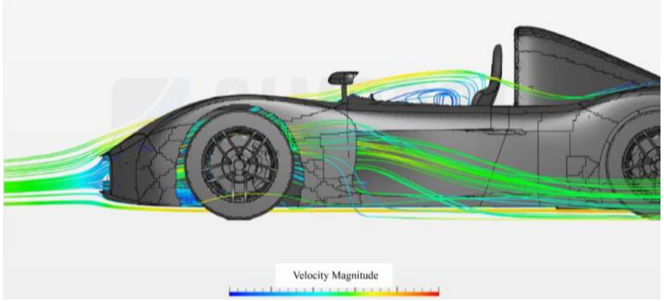

Fig. 2 This image represents the flow of air with the velocity of a car at a speed of 120 kmph [10]

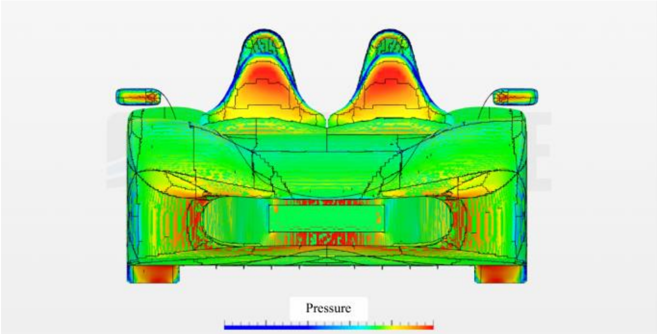

Fig. 3 This image shows the pressure exerted on the model via air flow[10]

Aerodynamic optimization (refer to figures 4 and 5): Aerodynamic optimization talks about how the airflow would affect the model's design and show streamlined airflow around the model. By utilizing SimScale's Computational Fluid Dynamics (CFD) capabilities, aerodynamic simulations were conducted to optimize the vehicle's shape.

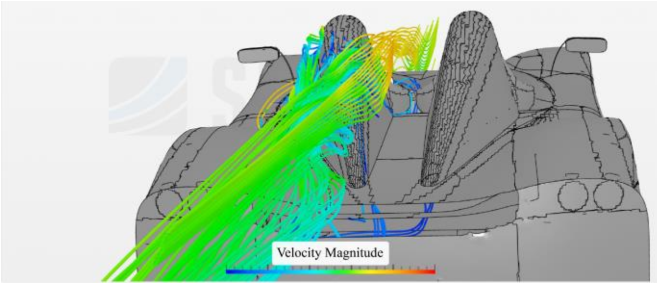

Fig. 4 This image shows the air flow via the model(slanted) [10]

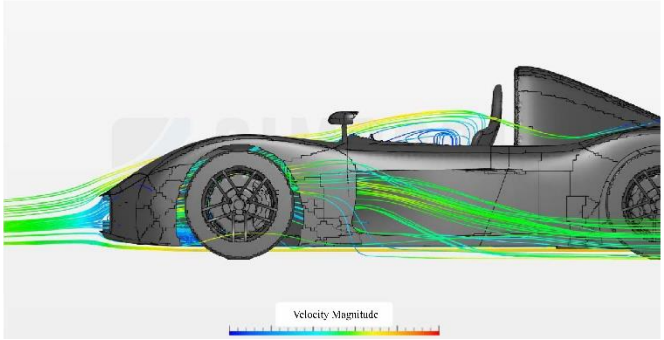

Fig. 5 This image shows the airflow via the model (sideways) [10]

Structural integrity (refer to figure 6): Structural Integrity shows how the turbulence would be seen in the model when at high speeds. Simulations were conducted to evaluate the proposed next-generation electric vehicle's structural integrity in various scenarios. The simulations validated the effectiveness of the design and demonstrated the model's capability to withstand turbulence at high acceleration.

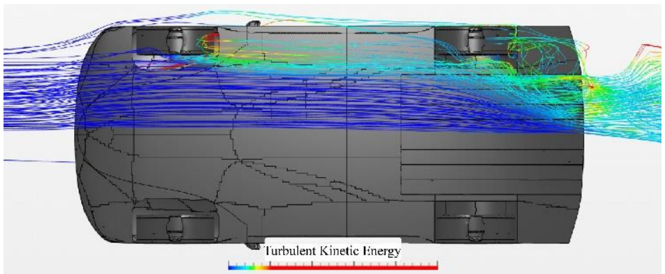

Fig. 6 This image shows the turbulence experienced by the floor of the vehicle[10]

Turbulent Kinematic Viscosity(refer to figure 7): The turbulent kinematic viscosity is the quantity that models the dissipation of energy and transport in the fluid flows of a turbulent nature. The turbulent kinematic viscosity is proportional to the density of the fluid. It is used to analyze and predict the behavior of the airflow over the car's body, including the formation of vortices, separation points, and drag forces. The simulations validated that the model would show less turbulent flow, suggesting that the airflow passing over and around the vehicle is relatively smooth and orderly.

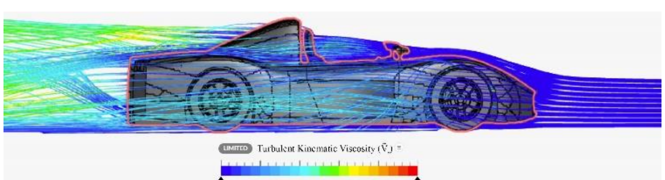

Fig. 7 This image shows the turbulent flow around the model (side view) [10]

Specific Dissipation Rate(refer to figure 8): The specific dissipation quantifies the amount of heat exchanged between the fluids per unit of time when the entrance temperatures differ by one degree. The simulations validated that there would be zero heat exchange between the fluids, keeping the designed model cool.

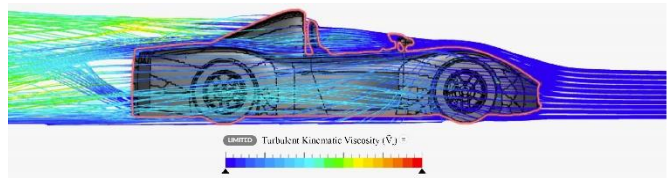

Fig. 8 This image shows the heat transfer exchanged between the fluids in the mode(side view) [10]

Overall, the results of this research showcase the successful design and simulation of a next-generation electric vehicle model using SimScale. The model exhibits excellent performance, efficiency, aerodynamics and structural integrity.

8. Discussion

The design is based on the utilization of SimScale, a cloud-based simulation platform, to analyze and optimize various aspects of the EV's performance and overall design. The application of SimScale's Computational Fluid Dynamics (CFD) capabilities allowed for thorough aerodynamic simulations. Whereas structural simulations were performed to assess the vehicle's crashworthiness and overall safety. Also, using SDR (Specific Dissipation Rate) validated a good cooling system of the car by reducing heat transfer between the fluids of the model. Using Turbulent Kinematic Viscosity, we were able to ensure low turbulent flow.

9. Conclusion

The proposed design for the next-generation electric vehicle model, developed through the utilization of SimScale, exhibits promising results in terms of performance and aerodynamics. The simulations and optimizations performed through this research provide valuable insights for designing and developing future electric vehicles. By leveraging simulation tools like SimScale, manufacturers can optimize various aspects of EV design, leading to more efficient, safer, and reliable electric vehicles that contribute to the sustainable transportation paradigm.

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