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ENERGY HARNESSING OF AIR FORCE IN AUTOMOTIVE

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INTRODUCTION & AIM

Faced with increasing **greenhouse gas emissions** and **stricter regulations**, the optimization of automotive aerodynamics is being analyzed to reduce them.

The research focuses on transforming the negative effect of airflow resistance on vehicles into a positive one, by harnessing the force of the air itself for propulsion and thus **reducing fuel consumption**.

The objective is to design a cavity-like deflector that captures and channels the air hitting the front of the vehicle, redirecting it to the rear and mitigating the problem of vacuum generation by increasing air pressure. This would **reduce aerodynamic drag** while driving.

In Figure 1, the airflow path at the rear follows the red arrows, revealing a vacuum below that acts as a brake. However, in Figure 2, with the deflector incorporated, the green arrows represent the **redirection of airflow** and the filling of the vacuum area.

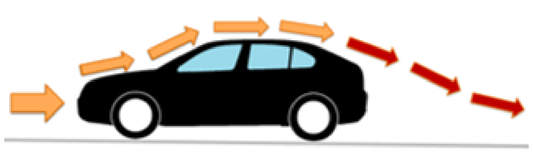


Figure 1

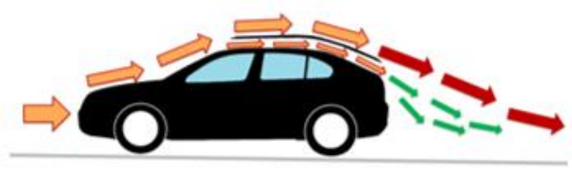
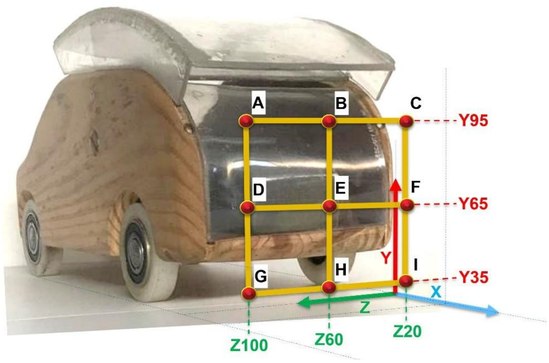


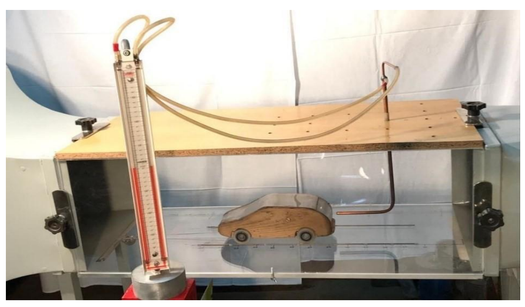
Figure 2

METHOD

Initially, the device was verified using **CFD**, and then the deflector was physically built and incorporated into a 1:12 scale car model.

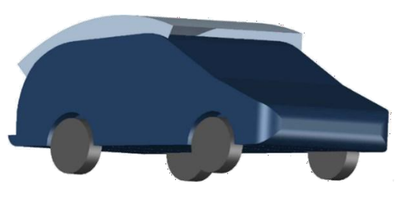
378 measurement points have been established across 7 planes, with each plane being a matrix of 9 points. **756 experimental tests** have been carried out, comparing with and without a deflector in a **wind tunnel**, also of our own design.

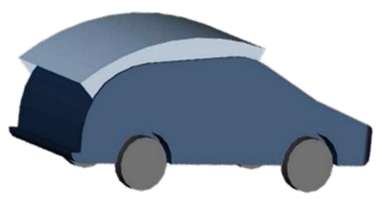


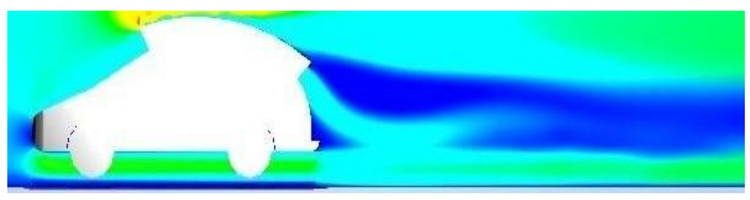


RESULTS & DISCUSSION

By introducing the three-dimensional design created in AutoCad 3D into CFD software, with the built-in channeling system, it can be seen that the wake is filled with an airflow represented in light blue, thanks to the **redirection** provided by the deflector.



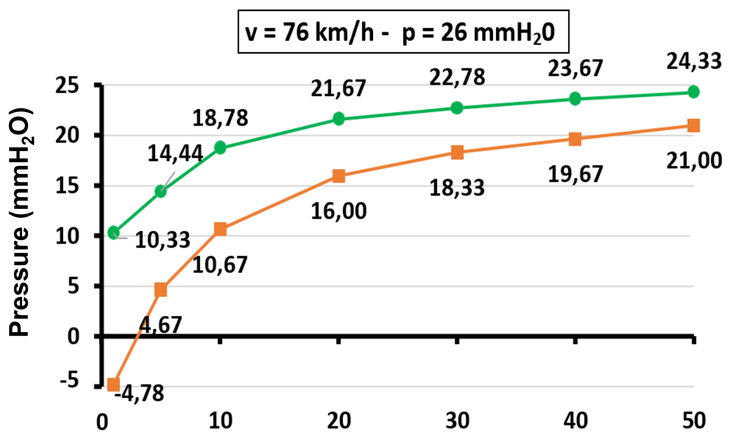




Subsequently, the results obtained in the experimental tests in the wind tunnel were analyzed and it was detected that the pressure difference (with deflector compared to without deflector) at all points is positive, which means that at all points there is an **increase in pressure** and, therefore, the advantage of its contribution by decreasing aerodynamic resistance.

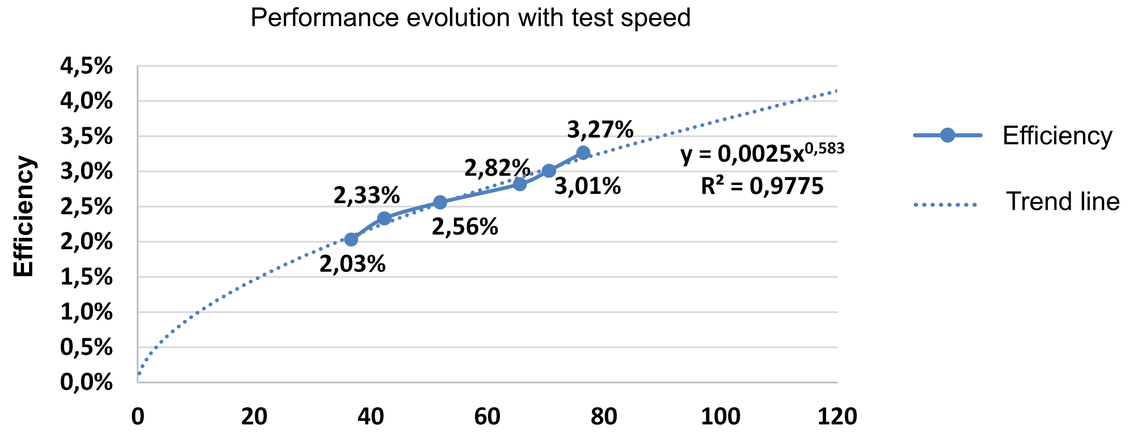
Figure 1 analyzes the X-axis, evaluating the distance from the model at which the measurement was taken. Green represents the model with the deflector, and orange represents the model without it, i.e., the conventional vehicle. The curve without the channeling system (orange) begins with negative pressure values. However, the curve with the deflector begins with positive values, demonstrating the optimization provided by the deflector, as the **negative pressures** that created the vacuum effect (suction, braking) **have been eliminated**. Furthermore, the entire curve with the deflector reaches higher values compared to those measured without it.

Figure 2 shows the efficiency achieved for each of the six speeds evaluated. It also displays the trend line, which **increases with circulation speed**.



X-axis distance (km/h)

Graphic 1



Test speed (km/h)

Graphic 2

The feasibility analysis at the technical, economic, social, and environmental levels is favorable for all vehicle propulsion alternatives. Therefore, it has been possible to patent this innovation as a **utility model** at the Spanish Patent and Trademark Office, **U202330067**.

CONCLUSIONS

- **Aerodynamic drag** caused by negative pressure in the vacuum zone, and also in areas without vacuum, **is reduced** because **higher pressures are achieved at 96.3 % of the 378 points measured**.
- **Vehicle propulsion is enhanced**, as positive pressures, mostly of greater magnitude, are obtained at the rear.
- At a speed of **76 km/h**, the invented deflector provides an **energy efficiency of 3.27 %**.

FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

- **Different deflector heights** are being analyzed to evaluate the influence of the incoming air volume and its channeling and utilization capacity in the vacuum zone.
- To improve the **regulation of the channeled airflow**, the incorporation of a hydraulic system and a stepper motor is planned, allowing it to adapt to environmental conditions.
- The influence of the **vehicle body geometry** is also being investigated.