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Aerodynamic Study of Vehicle Wind Tunnel and Water Tunnel for Analysis of Bodies

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***Abstract*—**The simulation in wind tunnel is used thoroughly to model real situations of drainages of air. Besides the automotive industry, a great number of applications can be numbered: dispersion of pollutant, studies of pedestrians' comfort, and dispersion of particles. This work had the objective of visualizing the characteristics aerodynamics of two automobiles in different ways. To accomplish that drainage of air a fan that generated a speed exists (measured with anemometer of hot thread) of 4,1m/s and 4,95m/s. To visualize the path of the air through the cars, in the wind tunnel, smoke was used, obtained with it burns of vegetable oil. For "to do smoke" vegetable oil was used, that was burned for a tension of 20V generated by a thread of 2,5mm. The cars were placed inside of the wind tunnel with the drainage of "air-smoke" and photographed, registering like this the path lines around them, in the 3 different speeds.

***Keywords*—**Aerodynamics, Vehicle Drag, Wind tunnel.

I. Introduction

THE effect of the air if moving around a vehicle effects of three different manners your behavior. These three manners are:

- Resistance to the movement;
- Sustentation effects;
- Effect of lateral winds.

The builders' first concern was exactly with the problem of the aerodynamic resistance, since this affects the potency sensibly consumed by the vehicle. Although the first detailed studies have been initiate in 1920, until today most of the cars possesses a form that takes the waste of potency of the order from 30 to 40%. With relationship to the lateral winds, the project of the drag of the models in production almost disrespects completely them [1]-[5]. These facts are due mainly the following causes:

- Almost completely aerodynamic study should be experimental or numeric, with great expenditure of time and money;
- The best solutions in terms of aerodynamics adapt badly to an automobile project, in design terms and internal space.

The effects of vertical forces, on the vehicle, influence the adherence of each tire and, therefore, the directional behavior of the vehicle under the action of lateral forces as well as the potency that can be transmitted by the wheels and the break capacity. Therefore, your analysis is also very important in the project of vehicles of great acting.

The simulation in wind tunnel is used thoroughly to model real situations of drainages of air. Besides the automotive industry, a great number of applications can be numbered: dispersion of pollutant, studies of pedestrians' comfort and dispersion of particles [6]-[9].

Aerodynamics is the part of the mechanics that studies the movements and interactions of flowing bodies. The study of the drawings of aircrafts, ships, cars, antennas, bridges... kindred of improving your acting's and safety.

II. Materials and Methods

In the wind tunnel, it was accomplished tests with the objective of visualizing the characteristics aerodynamics of two automobiles in different ways. To accomplish that drainage of air a fan that generated a speed exists (measured with anemometer of hot thread) of 4,1m/s and 4,95m/s.

To visualize the path of the air through the cars, in the wind tunnel, smoke was used, obtained with it burns of vegetable oil.

To obtain the smoke vegetable oil is burned at a 20V voltage generated by a 2.5mm wire. The cars were placed inside of the wind tunnel with the drainage of "air-smoke" and photographed, registering like this the path lines around them, in the 3 different speeds.

Although the objective is to do experiments with drainage of air, similar experiments were also accomplished with drainage of water.

To visualize the path of the water through the cars, in the channel of water, a dye was used.

The cars were placed inside of the channel of water with the watercolor drainage and photographed, registering like this the path lines around them. Figs. 1 and 6 show aerodynamic tunnel set up respectively [10]-[16]. It was also projected and built a camera of stabilization with a rectification of flow of the type beehive. They were considered in the dimension of the camera of stabilization the observations of [17], according to which the length of the honeycomb should be from six to eight times the medium diameter of the cell, and the recommendation of [17], that stipulates a strip for the

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thickness of the wall of the cells between 0,5 and 2,0mm. The beehive was built starting from tubes of PVC that were cut with 200mm of length each one. Those parts were mounted and agglutinated, forming 625 cells of square section 50x50mm. In Fig. 2, the final assembly of the beehive.

Fig. 1 Aerodynamic Air Tunnel

Fig. 2 Box of harmonization of the type beehive

After the diffuser, the drainage suffers an acceleration, due to the presence of a contraction in which the drainage suffers a pressure loss, that is, turns into kinetic energy (speed) that goes to the rehearsal section. The whole construction of the structures of the tunnel (diffuser, contraction, rehearsal section), they were accomplished by techniques used by [17]. Parts as: The box of harmonization of the drainage; the cooker hood to retain the coming vibrations of the motor and the helix of the motor for generation of the wind, technical were accomplished used at the Laboratory of Aerodynamics. Figs. 3 and 4 show a view of the Pitot tube, the Fig. 5 presents the centrifugal fan used in aerodynamic tunnel.

Fig. 3 Pitot tube

Fig. 4 Height adjustment of the Pitot tube

Fig. 5 Centrifugal fan

Fig. 6 Water of tunnel

Fig. 7 Model 2

Fig. 8 Models 3 and 4

III. Results and Discussion

The presented results were obtained in the experimental rehearsal. In each one of the points, seven measurements were accomplished, of the five were taken advantage of, being eliminated the extreme measures.

In the wind tunnel, it was possible to notice that the drainage of air through the model 1 (Fig. 9) finds smaller resistance than the model 2 (Fig. 10). This happens due to form of the model 1 to be aerodynamic, produced minor I drag and turbulence formation.

Fig. 9 Text Model 1

Fig. 10 Text Model 2

In the water tunnel, it is observed that the model 4 (Fig. 11) has an upper aerodynamic to model 3 (Fig. 12) due to formation of less turbulence and production of least resistance. In the same way that the model 4 in relation to the model 3, this "better aerodynamics" of the model 4 is due to the fact of possessing a closer form of a "wing" and a smaller front area.

In the automobile branch, the aerodynamics is factor of highest importance that will contemplate later in the acting of the automobile, as economy or stability.

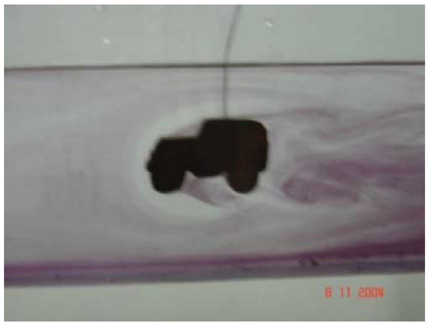

Fig. 11 Text Model 3

Fig. 12 Text Model 4

In a streetcar, the sustentation should not harm the aerodynamic efficiency, for they are obtained larger acting and smaller consumption.

IV. Conclusion

Before the rehearsals accomplished in elapsing of this research, the wind tunnel behaved in a satisfactory way, having reached the objective for which was built, being this of easy construction, simplified operation and of low cost. The expansion camera with beehive was fundamental to minimize the effect of the rotation imposed to the drainage by the axial fan.

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