Team first Report

MCEN 5151

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Introduction

In this experiment, I use an ultrasonic humidifier and a model car to simulate the aerodynamic of the car. We can see both laminar flow and turbulent on one single picture, which excited and end up with high quality result picture.

Process Setup

First, I used a normal ultrasonic humidifier as shown in figure 1, and plug a straw to its exhaust hole, which would work as a throttle to concentrate the flow.

Figure 1

Second, I bought a model car and it is a Tesla model X. As shown in figure 2, its upper curve is a whole piece and it looks very aerodynamic. It is about 3-inch-long and 1-inch-height. Made by steel and plastic.

Figure 2

After humidifier plug into the power, it starts generating steam and it could flow over the car to see the stream lines over the Tesla as shown in figure 3.

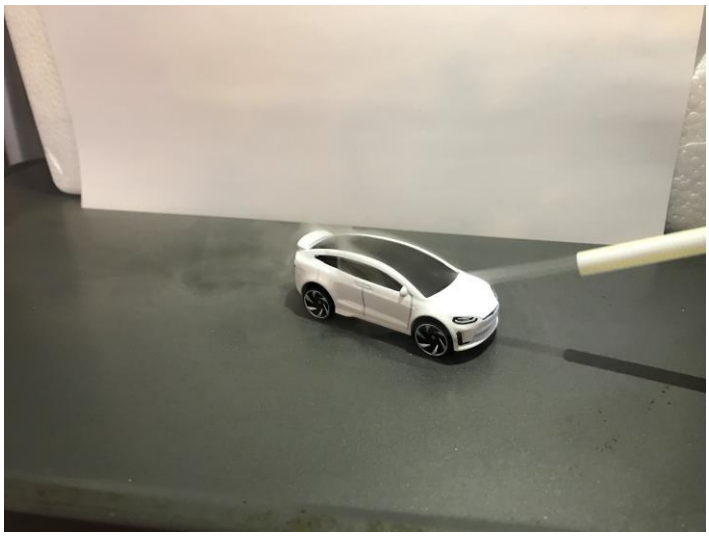

Figure 3

This is very excited to see stream lines in Tesla, they flow the fluid theory that it start from laminar flow, and with longer distance the flow boundary layer become thicker and thicker. After some critical point, it goes into transient region, then become turbulent flow at end and shows swirls at end of vehicle. This is very cool in my opinion.

Flow

The exhaust steam exit from the nozzle then hit the surface of the model car, the phase of flow is changed from laminar to turbulent. As shown in figure 4, the fluid flow through a flat plate is a suitable model for this experiment.

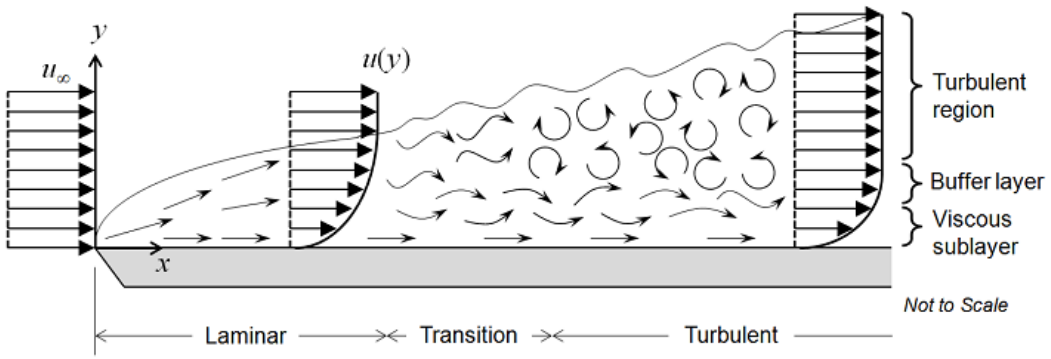

Figure 4 Fluid Flow Over Flat Plate[1]

The outlet flow shows a significant feature of laminar flow, the it hit the car body. Flow over the upper body of the model, at top it changes to Turbulent flow. We can calculate Reynold's number by the equation below

$$Re = \frac{VL_2}{v}$$

Reynold's number is a dimensionless number, and it represent the $\frac{Internal\ Force}{Drag\ Force}$. When Reynold's number $\leq 5x10^5$ flow is considered as laminar flow, when it greater than it, it will go into transition area then turbulent flow at end. In this experiment, flow speed is considered as constant through out the car, and with the increase of L, Reynold's number grown larger and larger, then it goes into turbulent flow.

Photograph

After setup equipment, I used a Canon 5D Mark II with 50mm fixed lens took the pictures. The original picture is shown in figure 5. The F/stop is set to f 1/8, and ISO setting is 200. The distance from object is about 5 inches. Lighting method I used is 4 times 65W LED lamps, along with a 1000 Lumen surefire flashlight.

Figure 5

I am very satisfied with this picture, the smoke around Tesla is very beautiful. The flow is visible, and the texture is also good for this one.

Then I put it into the photoshop and change couple settings, and chop off the background objects. it ends up with figure 6

Figure 6

Now flow become more visible and have more detailed turbulent flow at end of vehicle. The focus and light not too bad for this short distance photograph.

Conclusion

This experiment is very successful, and pictures are pretty good. But there is still some space to improve. The improvement for this picture would be use a higher power humidifier to generate a higher velocity flow over model, that would have better view of the flow transient. Also if I could use a better light to project flow on the wall would be fantastic.

Reference

[1]. *Which Turbulence Model Should I Choose for My CFD Application? - Walter Frei – 2017*
[2]. *Heat and Mass Transfer – fifth edition – Yunus A. Cengel, Afshin J. Ghajar - Ebooks Chemical Engineering*