The Riblet Effect

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1. Introduction

1.1 The purpose of the investigation

Reducing friction can help swimmers swim faster. „Speedo“ uses the material called Fastskin. The scientists who developed this material were inspired by the way the shark's skin reduces friction. The skin of fast-swimming sharks exhibits riblet structures aligned in the direction of flow, which are known to reduce skin friction drag in the turbulent flow regime. Such a shark skin drag reduction is called the riblet effect.
One of the purposes of our investigation was to explore this effect. Microbubbles represent another interesting effect that occurs in nature. During a sudden dive, the penguin releases air bubbles from its feathers. These reduce the density and viscosity of the water around the penguin’s body, cutting the drag and enabling the bird to reach speeds that would otherwise be impossible. We were interested to prove the hypothesis that the riblet effect in combination with microbubbles further reduces water resistance.

2. Method of the investigation

In order to examine the riblet effect, it was necessary to find a material with microstructural surface (for example, parts of certain swimming suits), or make our own sample, whose surface texture would be similar to the skin of the shark. The idea was to make the material from a negative impression of the skin, then to use the negatives to make a positive impression of the shark skin. At the begining of our research, we did not look for a specific type of shark and we obtained some shark skin. It had not come from a fast-swimming shark, but the skin was rough to the touch resembling fine sandpaper. A mixture of silicon and hardener proved to be the best option from all of the sampled skin imitation materials. To examine the performance of the material texture, measurements were taken in the vertically placed plastic tube with a closed bottom, and filled with water. Same-sized plastic spheres filled with the same mass were wrapped with various materials and the time for each ball to pass through the water column was measured. The experiment showed that the material with microstructural surface takes less time to pass through water.
For a more detailed study of the riblet effect and the effect of microbubbles, a simple, open circular water channel was designed (figure 1). In order to have the water flow at constant speed, an engine was required to run the water wheel. For this purpose, a wiper motor was used. Also, we investigated several ways to induce microbubbles. Their average diameter was 2,3mm.
To investigate the influence on the drag force reduction in water, two plates were cut out from plexiglass. One plate retained its smooth surface while on the other a microsructured material was glued.

Fig.1. Experimental set-up

To measure drag force, the test plate was placed in the water flow (figure 2).

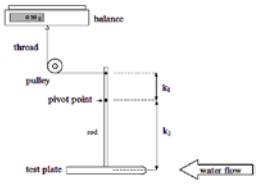

Fig.2. Sample set-up

3. Results of the experiment

Three series of measurements were carried out. Each series of measurements was performed at voltages of 4V, 5V, 6V and 7V (velocity of 0.33m/s, 0.36m/s, 0.40m/s and 0.43m/s). Each individual measurement was taken for the cases of the smooth sample without blowing microbubbles (1), the smooth sample with introducing microbubbles (2), the rugged sample without blowing microbubbles (3) and the sample with microbubbles (4). Figure 3 shows a comparison of the average amplitude (Δm) in each measurement.

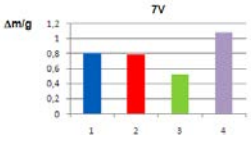

Fig.3. Average amplitude

The values were read every 0,1s in the period of 3 minutes. The drag force (as well as the total force, expressed through the mass) during the measurements oscillated over time, more or less periodically. The measurements were affected by the resistance of shape, the disturbance of the surface of the wheel blade hitting the water surface, the whirling at bars, etc. To determine the frequencies of the signals and to filter the required signal, Fourier transform are made.

4. Conclusion

The measurements proved that the materials used were microstructured. However, the effect of the combination of microbubbles and the riblet effect in further reducing the hydrodynamic drag has not been proved yet. The sample surfaces are not enough microstructured or the microbubbles are too large. We applied our own sensitive method of drag force measurement.