Influence of Hydrophilic and Hydrophobic Coating on Hydrofoil Performance

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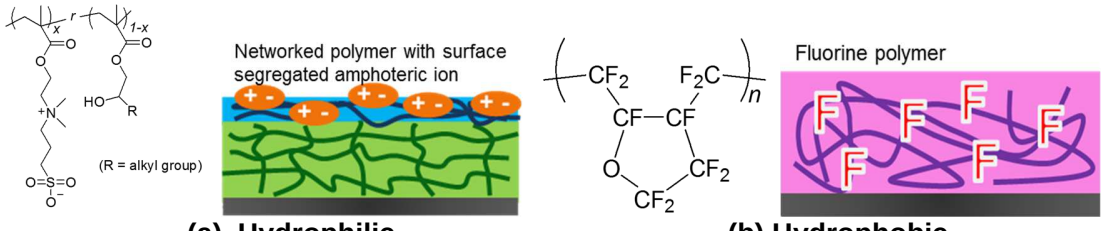
Long Abstract

Introduction

Nowadays, renewable energy has attracted a lot of attention due to its environmental friendliness and global warming prevention capabilities. Tidal power generation is one of the waterpower generation which generates power using tidal current. Since the tidal turbine is fixed in the ocean environment, marine organisms can easily attach to its blades and structure. When the marine organisms stick to the blades, the turbine would perform differently from what it is designed. In order to prevent marine organisms from attaching to the blade or structure, it is common to paint the turbine with antifouling coating. Therefore, it is important to predict the influence of the coatings to the fluid performance and evaluate their reliability. In this paper, hydrophilic and hydrophobic coatings which are reported to be useful in antifouling were studied in the perspective of flow field and cavitation. Cavitation was visualized using high-speed video camera and pressure fluctuation measurement was synchronized to it. From this recording, cavitation maps comparing incipient cavitation number of hydrophilic and hydrophobic coatings were made. In addition, cavitation growth was also compared.

1. Test apparatus and Methods

The characteristics of hydrophilic and hydrophobic coatings which were used in this research are shown in Figure.1. The contact angles of the bubbles to the coatings are about 15deg for hydrophilic coating, and about 100deg for hydrophobic coating. The experimental investigation was conducted at the closed loop water circuit tunnel which contains cavitation tunnel test section described in Figure. 2. The test section is made of acrylic to visualize the flow using a high-speed video camera. A single blade which has the symmetrical NACA16-021 cross section shown in Figure.3 was put into the test section. Its maximum chord length is 40mm and its span length is 60mm and its blade thickness distribution is an elliptical shape. Inlet pressure which was used in the cavitation number and pressure fluctuations were measured using pressure transducers on the wall. The incidence angle of the blade can also be changed with turn table at the bottom of the foil. The system pressure can be changed with vacuum pump which is connected to the tanks.



(a) Hydrophilic **(b) Hydrophobic**

Fig.1 Characteristics of the coatings

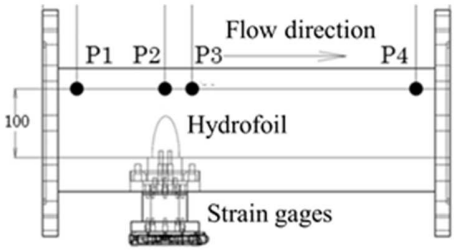


Fig.2 Test section

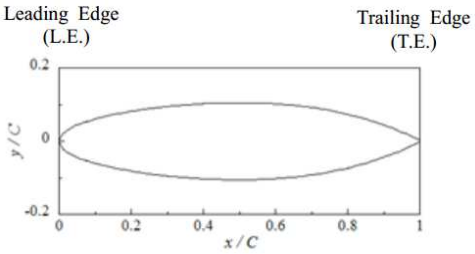
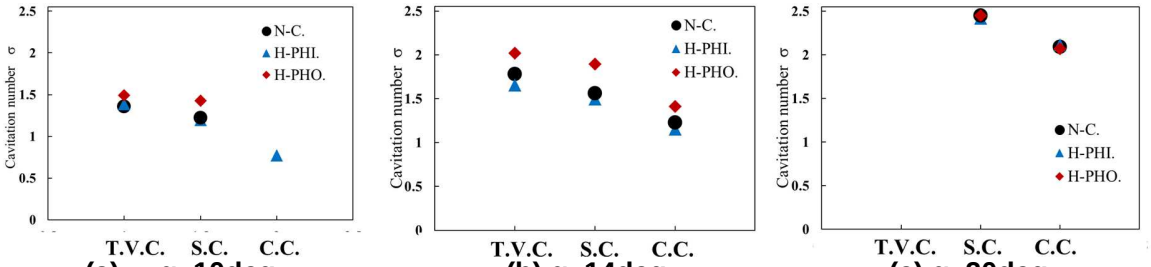


Fig. 3 Test hydrofoil

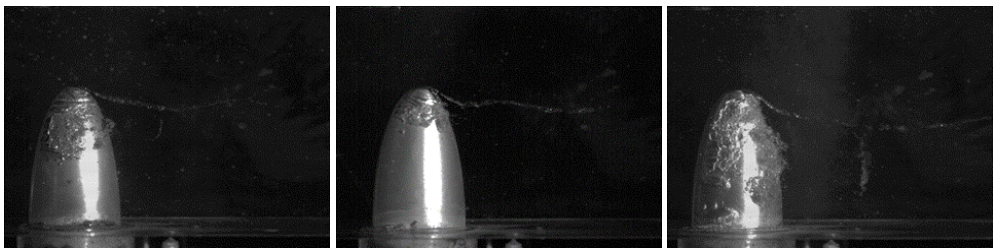
2. Results and discussion

Figure.4. shows incipient cavitation number of non-coating foil, hydrophilic foil and hydrophobic foil. The forms of the cavitation were classified into Tip Vortex Cavitation, Sheet Cavitation and Cloud Cavitation. When the incidence angles were 10deg and 14deg, incipient cavitation number was bigger at the hydrophobic foil. Figure.5 shows the visualization of cavitation growth. It was confirmed that cavitation volume was larger with hydrophobic foil than with hydrophilic foil at the same cavitation number. From this experiment, it was suggested that hydrophilic foil was useful in reducing cavitation occurrence.



(a) α=10deg **(b) α=14deg** **(c) α=20deg**

Fig.4 Incipient Cavitation number (Re=1.1×10^5)



(a) Non-Coating **(b) Hydrophilic** **(c) Hydrophobic**

Fig.5 Cavitation growth (α=14deg σ=1.04 Re=1.1×10^5)

References

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[2] Megan Williams *et al*, "Effects of Surface Characteristics on Hydrofoil Cavitation", 7th International Symposium on Cavitation, 2009.