

Hydrophobic Coatings for Film Boiling Based Drag Reduction on a Torpedo Model

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Drag reduction for ships, submarines and other types of marine vehicles has been a focus of study for centuries and continues to be an important area of research today. Two of the most obvious benefits of drag reduction are increased speed and decreased fuel consumption. Many techniques for reducing drag exist, and some are more effective than others. One such technique is to establish and maintain a vapor layer around the object as it moves through the water.

Previous research has shown that porous, hydrophobic surfaces exhibit a dramatic reduction in critical heat flux (CHF), the heat flux required to transition from nucleate boiling to film boiling. Film boiling is characterized by the presence of a vapor layer which remains as long as the surface temperature remains above the Leidenfrost point. This vapor layer has poor heat transfer characteristics but has the potential to reduce drag by acting as a barrier between the solid surface and the liquid.

The goals of this research are to quantify the drag reduction due to film boiling, examine the durability of the hydrophobic coating and explore the feasibility of this concept for torpedo drag reduction. A torpedo was chosen due to its high speed and reduced emphasis on durability, since it is only used operationally once. A hydrophobic coating was created in the laboratory using a layer-by-layer (LBL) process and its performance was compared to a commercial hydrophobic coating. Drop tests of coated and uncoated torpedo models were conducted in a custom-built apparatus housing a water column and recorded with a high-speed video camera in order to measure velocity. Terminal velocity was extrapolated from instantaneous velocity measurements and used to calculate a drag coefficient for each model.

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