Plasma Generation Underwater for Drag Reduction in Marine Technologies

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Abstract

Globalisation began in the 18th century when advances in marine transportation enabled the relatively rapid transportation of products around the world. The marine diesel engine started to be used in shipping around the beginning of the 20th century and is still today the propulsion technology powering most marine vessels. The shipping industry burns circa 300 mega tons of fuel every year. In recent years, to reduce fuel consumption, commercial ships have been ordered by their owners to drive at 12 knots rather than their designed 25 knots. This 'super-slow steaming' results in deliveries taking twice as long to reach their destinations. Travelling at lower speeds than the optimal hull design speed also increases the relative drag ratio. Drag force on ships is orders of magnitude more detrimental on fuel economy compared to drag force on objects moving through the air, due to the density of water. Drag in sub aqua environments is a sum of form drag (the shape of the ship's hull), wave resistance (the structures on the ship's hull), and marine biofouling (organisms that attach to the hull). Marine biofouling, alone, results in typical increases of drag coefficients by up to 20 % and consequently ships have to be taken out of the water at least once a year to have their hulls cleaned and antifouling coatings reapplied.

Plasma, discharged at atmospheric pressure in the air, on aircraft wings, whilst the aircraft is in flight, has been demonstrated to reduce drag on air flows over aircraft wings. Further, cold plasma jets discharged in medical settings have proven efficacy to inactivate microorganisms. Furthermore, air plasma technology has been proven to clean surfaces by removing microscale contamination. Therefore, a novel ship drag reduction system has been proposed, which will be attached to the surface of a ship's hull and will convert the water flowing past it into plasma. This paper will present the design concept and initial results.

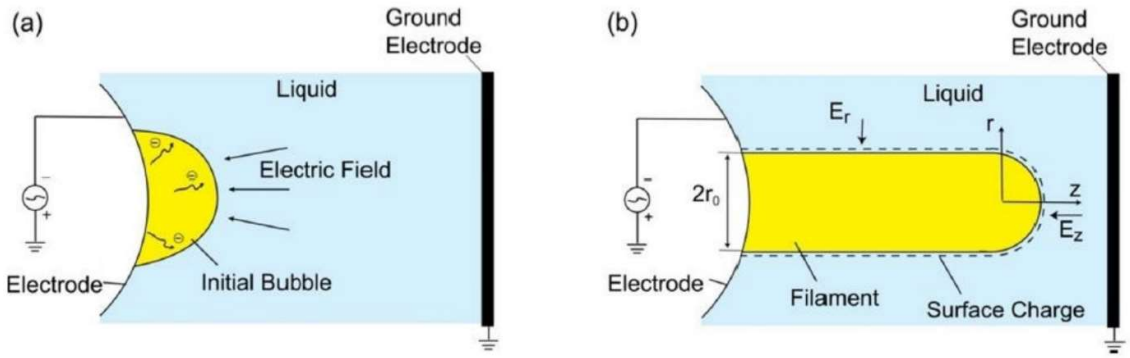

Figure 1: Sub Aqua Plasma Actuator