Active Infrared Observation for Ice Detection in Anti/De-Icing Systems for Marine Applications in Arctic Region

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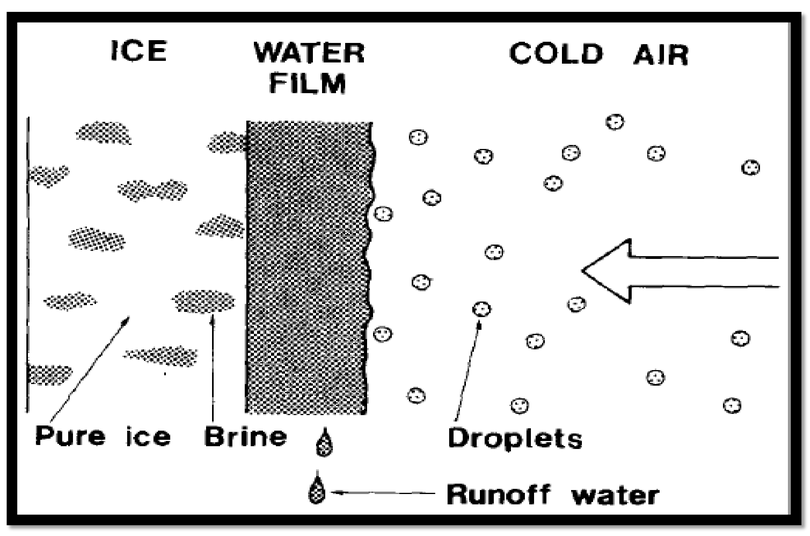
Abstract

The number of shipping operations is on the rise in the Arctic region. As a result of these increased activities, significant challenges are being encountered with respect to safety and reliability. One of the challenges is an accretion of ice. The icing on ships and offshore structures is caused by atmospheric sources and sea spray. The sea spray is the main source of icing and is generated by the wave collisions, the breaking of waves due to strong winds and bursting bubbles that float upon the waves. Heavy ice accretion poses a threat to the stability of ships and offshore structures by shifting their center of gravity. The study proposes an active infrared (IR) observation method for the detection of ice. This method is essential for automating the anti/de-icing systems, in particular for marine applications. There are a number of challenges to overcome before successfully deploying such a system. For example, adequate protection of the equipment and the electronics devices from the elements, ensuring proper functioning of electronic devices below zero temperatures, synchronizing of the IR image acquisition and processing / analysis and turning on/off timings of heating elements. The study focuses on identifying these technical issues and finding their appropriate remedies.

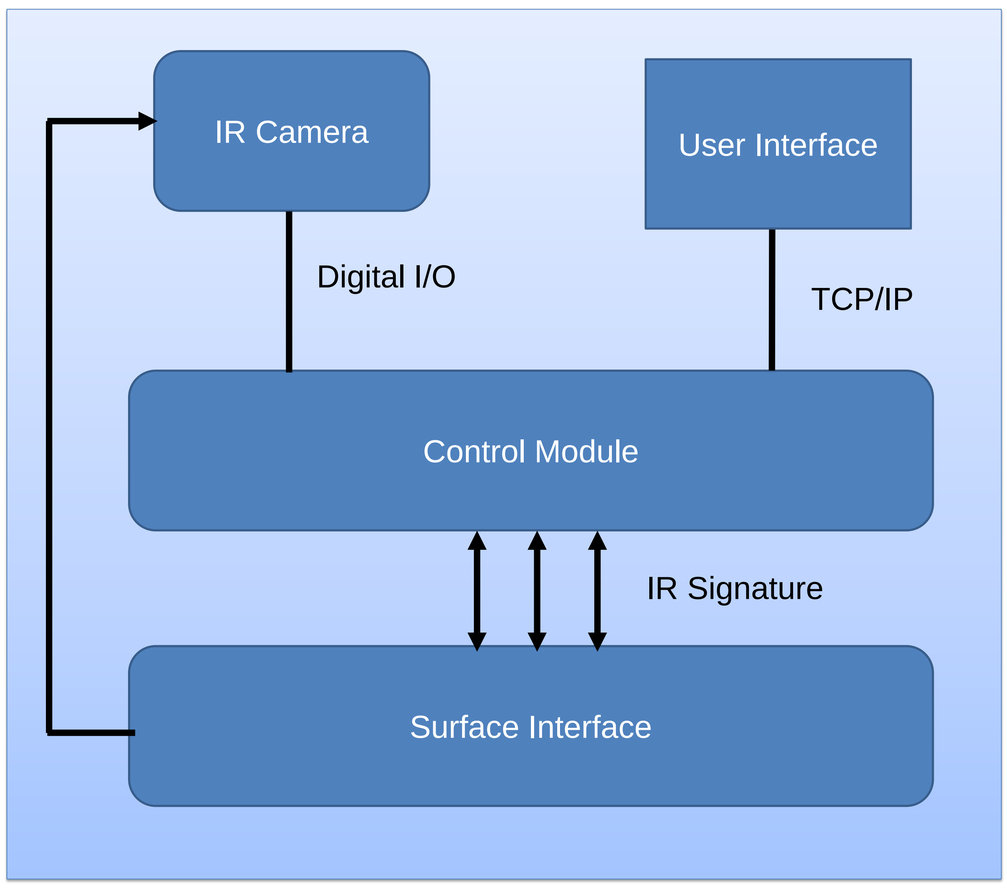
Ice Accretion Phenomena On ships

- Caused by Sea Spray
- Sea Spray is generated due to
  - Wave Structure Collision
  - Shearing of wave crests



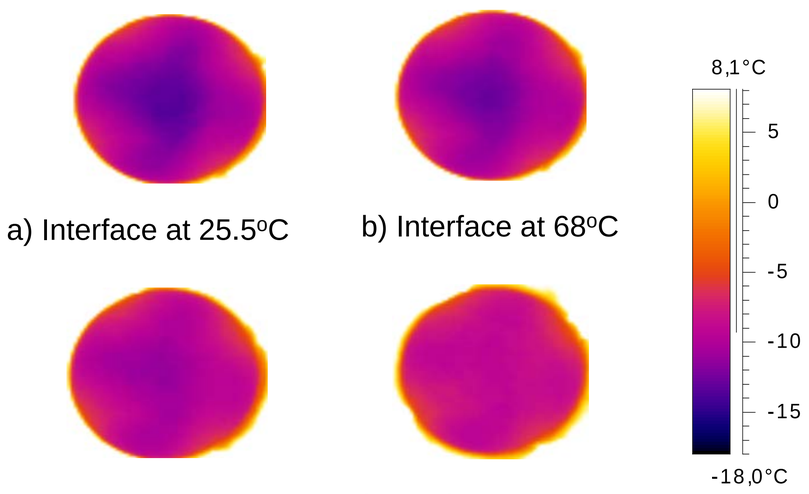
Ice accretion phenomena on ships (Makkonen 1987)

Ice Detection



IR Ice Detection Setup (Rashid et al. 2016)

Ice Samples Observed from IR Camera

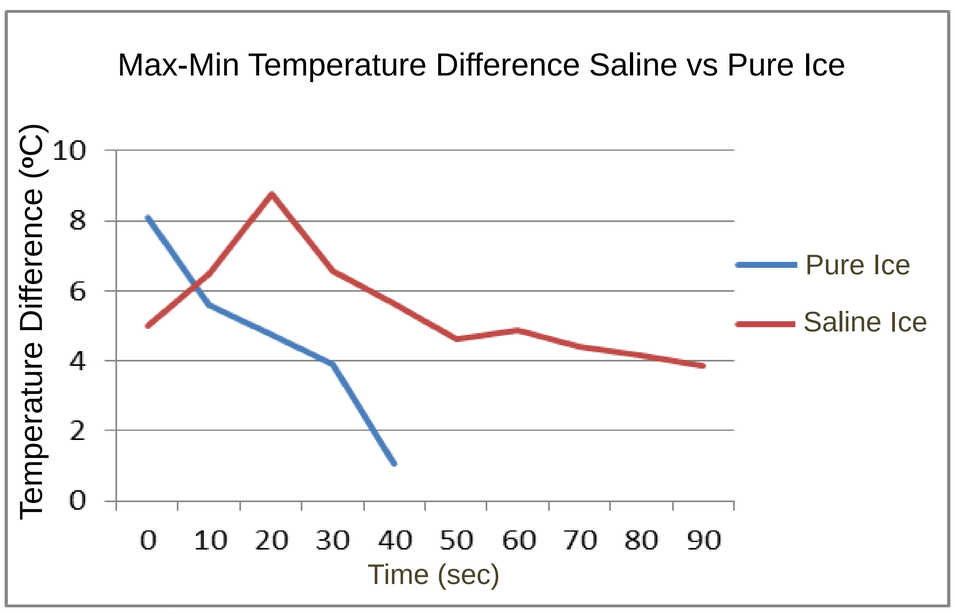


a) Interface at 25.5°C

b) Interface at 68°C

d) Interface at 115.2°C

c) Interface at 98.6°C



Pure and Saline ice block temperature profiles with time elapsed at room temperature

Abstract

The number of operations in cold regions due to oil exploration and other interests has increased. Severe ice accretion phenomena during marine operations are mainly caused by sea spray and atmospheric factors, with sea spray icing being a major contributor to icing on ships/offshore structures. The main source of sea spray icing is the spray generated by collisions between the structure and waves. Theoretical and experimental models for predicting the icing rate deal with the specific set of parameters in a particular environment, and, hence, they are difficult to generalise for all sorts of shipping platforms and sea conditions. It is suggested that no single methodology of anti-/de-icing can satisfy the entire ice protection requirements of a ship or an offshore platform.

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