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Infrared Detection for Anti-Icing Systems in Ship Operations

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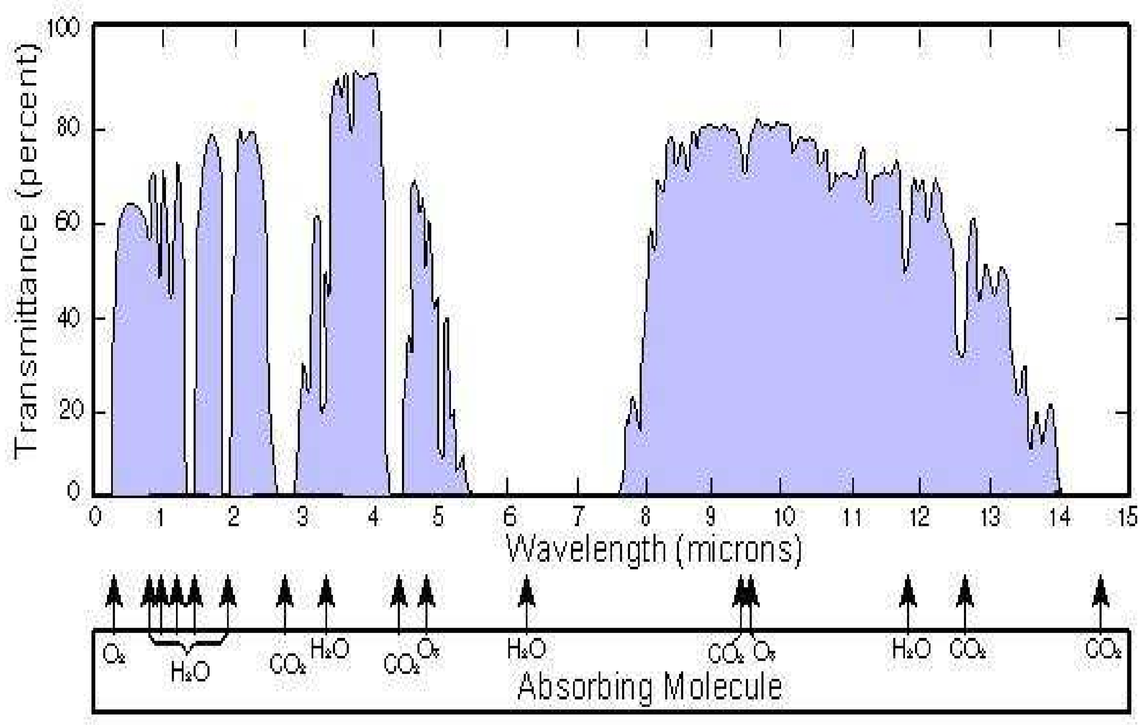
Abstract

The study is primarily based on the utilization of infrared sensing technique as an effective tool towards ice detection. The Infrared spectrum from 7.5µm to 13.5µm range is area of interest towards the particular observations and detection. Since temperature ranges of marine operations may vary but the study is focused towards the arctic marine operations (as low as -30 ºC). The infrared detection mainly relies on the emissivity of the material object. The typical ranges of ice and snow inclusive are experimentally known to be lying within 0.82 to 0.9. Smooth and rough ice is being close to 0.966 and 0.985; fine and granular snow close to 0.82 and 0.89 subsequently. The icing caused by sea spray can play major role in emissivity variation which can impact the reflectivity and absorption of the ice accretion over the ship deck and highly influenced areas of the ship. The thermal gradient in correlation with change in emissive values under certain circumstances can be visualized and analyzed by advanced forward looking infrared cameras available till date. The ice accretion and meltdown phenomena can be recursively observed to analyze the change in temperature and emissive values.

The study discusses the use of infrared techniques to solve energy efficient and cost effective anti-icing challenges faced in petroleum industry during exploration in arctic and Barents Sea.

Infra Red Spectral Behaviour

- ❑ Thermographic measurement consideration
- ❑ Atmospheric attenuation represetation
- ❑ Gases and Water vapour influence
- ❑ Areas under curve represent highest IR transmission



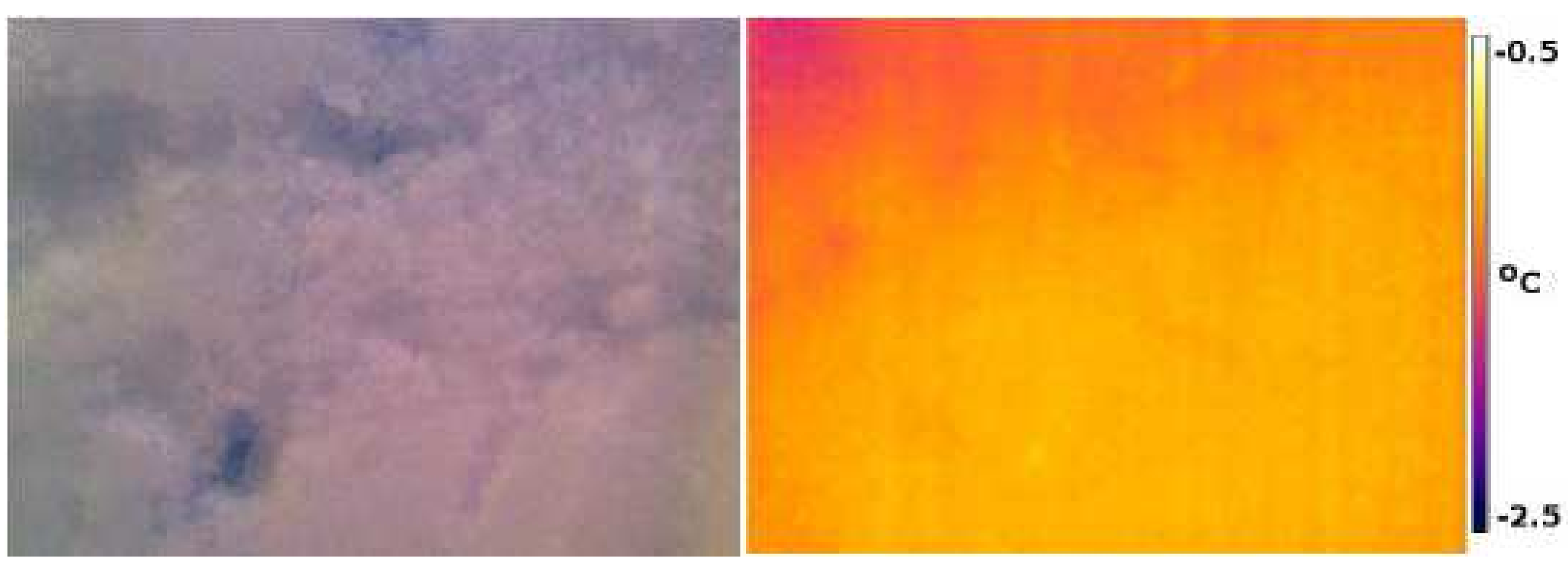
Emmision form the object $= \varepsilon \, . \, \tau \, . \, W_{obj}$

Reflected emmsion from ambient sources $= (1 - \varepsilon).\tau \, . \, W_{amb}$

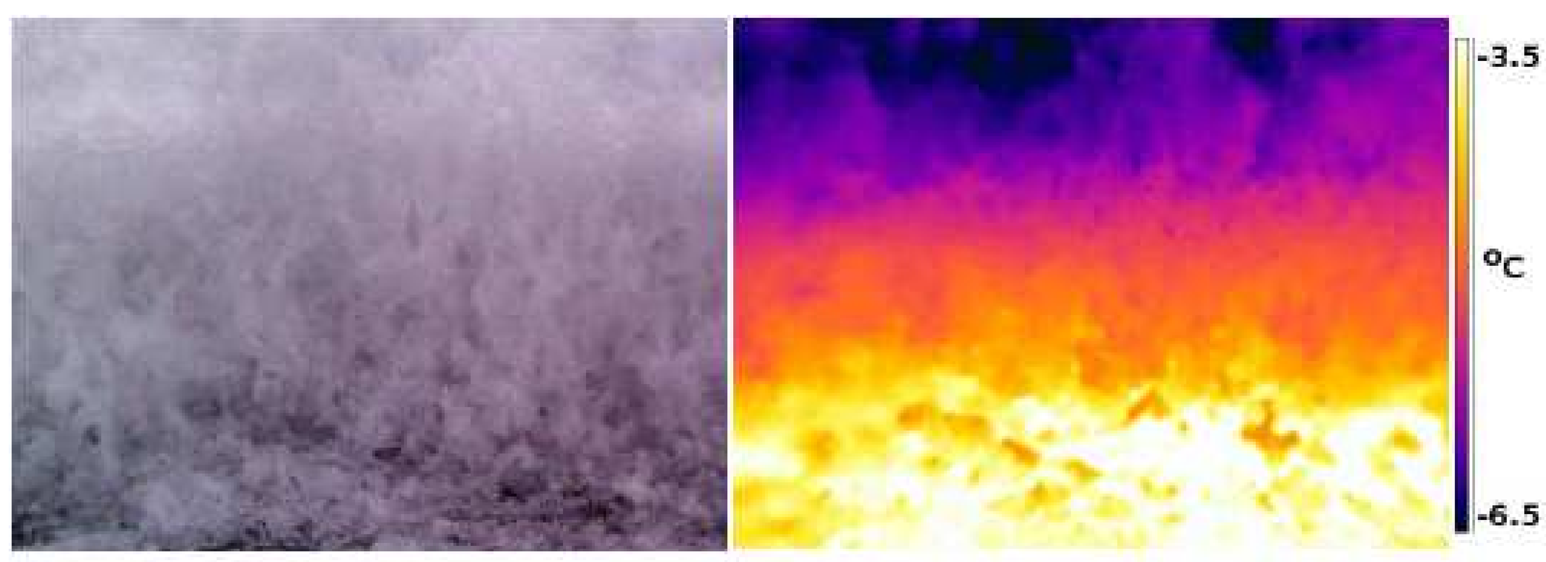
Emmision form the atmosphere $= (1 - \tau). \, W_{atm'}$

$$W_{tot} = \varepsilon.\tau.W_{obj} + (1-\varepsilon).\tau.W_{amb} + (1-\tau).W_{atm'}$$

Thermal Gradient of Ice/Snow



Thermal gradient distribution within delta -1.5 degrees



Thermal gradient distribution within delta -3.0 degrees

IR Imagery analysis with Complex Surface and Grain Qualities

Challenges

- ❑ Dealing with variable emissive nature
- ❑ *In situ* environmental conditions involving
  - o Brightness
  - o Temperature variation
- ❑ Sea spray cumulative effect towards ice accretion
- ❑ Calibration techniques followed

Conclusion

The infrared imagery analysis gives an insight towards the radiance of targeted area. This can be employed for ice accretion detection phenomena focused on the area for marine operations. The technique appears to be more suitable as compared point detection methodology that could be not feasible for the area observation for anti-icing system.

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