Abstract

Past research has been conducted to explore the feasibility of utilizing the exploding film phenomena to fracture ice in attempts to ease sea navigation in arctic regions [1]. This study enhances those past works by conducting experiments under conditions that more closely model the real-world conditions of the process. The exploding film phenomena was induced across an aluminum metallized polypropylene film (MPPF) while frozen in freshwater, and measurements were taken of the voltage and current waveforms. The experiments were then repeated replacing the freshwater with water containing salt at 35 parts per thousand [2]. This work presents the setup and comparison of the two sets of experiments.

Methods

A high voltage power supply was used to charge a 2 μF capacitor at 7.5 kV. An oscilloscope was used to monitor the voltage on the capacitor by means of a voltage probe. Once the voltage reached 7.5 kV, a switch was opened to disconnect the power supply from the capacitor to prevent damage caused by a back-feed current. A second switch was then opened allowing the capacitor to discharge across the MPPF. The current and voltage waveforms at the film were captured via a current transformer and voltage probe.

Results

Fresh Water

Salt Water

Results cont.

Fresh Water

Salt Water

Future Work

Although ice fracturing was observed in both fresh and salt water, moving forward more data from each test set will be taken to further solidify the findings. Afterwards, the volume of ice will be measured more accurately from each sample. Upon analysis the waveforms of each experiment set showed no distinguishable differences. The peak voltage, current, and power was different between samples that were tested appeared to fracture. In some cases it wasn’t until viewing slow-motion playback of the individual event that fracturing was realized. This is believed to be due to having some variation in volume of each sample. Upon analysis the waveforms of each experiment set showed no distinguishable differences. The peak voltage, current, and power was then tabulated and the average was taken. However, this also revealed negligible differences. The results indicate that inducing the exploding film phenomenon across an MPPF while frozen in either fresh or salt water, is an equally effective method of ice fracturing.

Conclusion

Early experiments conducted were unsuccessful in fracturing ice. To achieve ice fracturing the volume of ice used was lowered by a factor of 2, at which time both the fresh and saltwater samples experienced fracturing. However, during the experiments not all samples that were tested appeared to fracture. In some cases it wasn’t until viewing slow-motion playback of the individual event that fracturing was realized. This is believed to be due to having some variation in volume of each sample. Upon analysis the waveforms of each experiment set showed no distinguishable differences. The peak voltage, current, and power was then tabulated and the average was taken. However, this also revealed negligible differences. The results indicate that inducing the exploding film phenomenon across an MPPF while frozen in either fresh or salt water, is an equally effective method of ice fracturing.

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References

