Waves to Watts : Transforming Energy Harvesting

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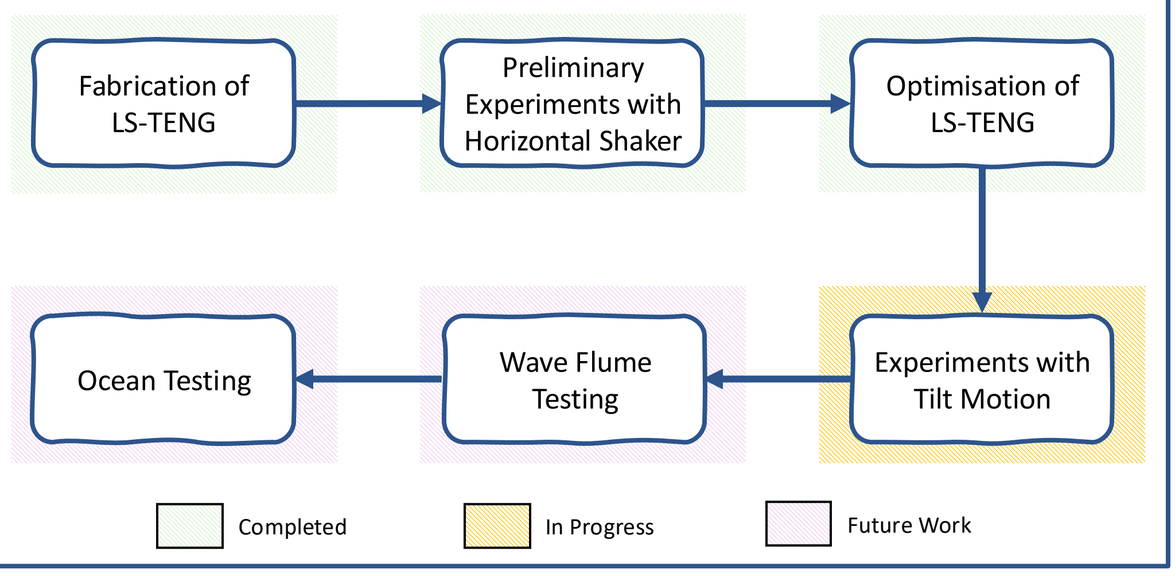
INTRODUCTION

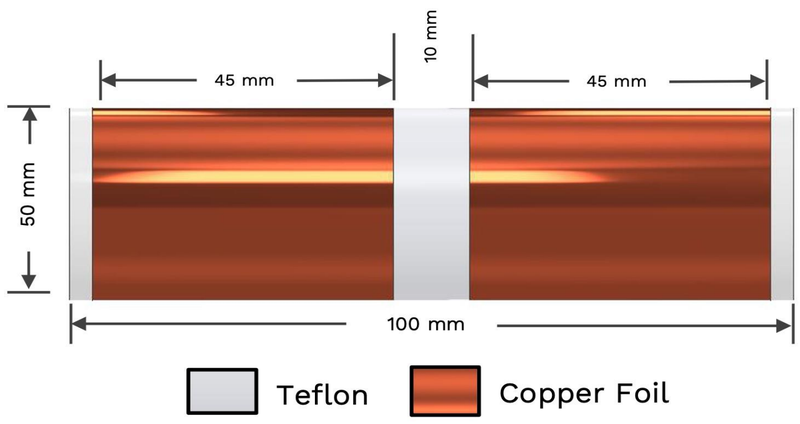
- Wave energy is a promising renewable energy source with abundant reserves.
- The primary challenges of wave energy converters are its low conversion efficiency and high costs[1].
- Triboelectric nanogenerators (TENG) are an emerging simple, low-cost solution that converts low-frequency ocean waves efficiently[2].
- TENG converts mechanical energy into electrical energy by coupling electrostatic induction and triboelectric effect[3].
- As such, a novel tubular liquid-solid TENG (LS-TENG) is proposed for wave energy harvesting.

METHODS



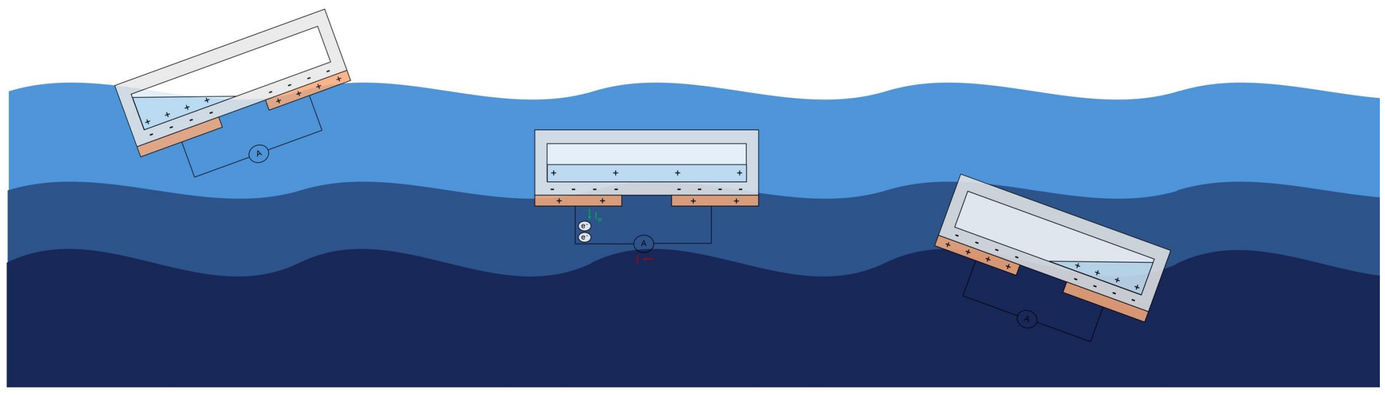
STRUCTURE AND WORKING PRINCIPLE

Schematic Diagram of LS-TENG



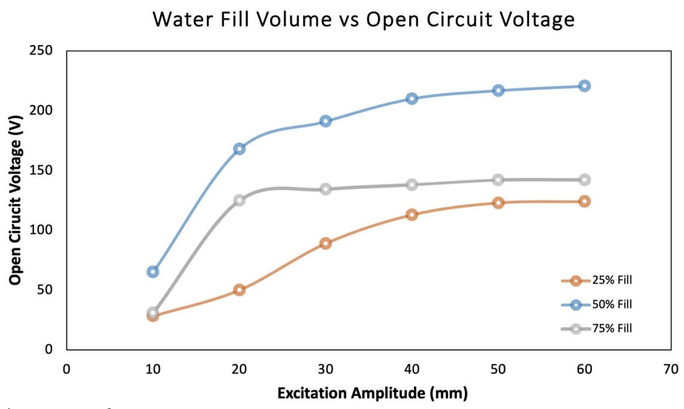
Wall Thickness of Tube: 1 mm

Working Principle of LS-TENG



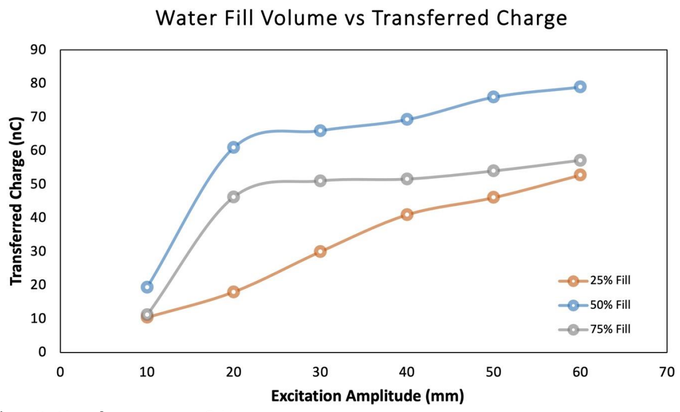
RESULTS

Optimisation of LS-TENG for Water Volume



*excitation frequency – 2 Hz

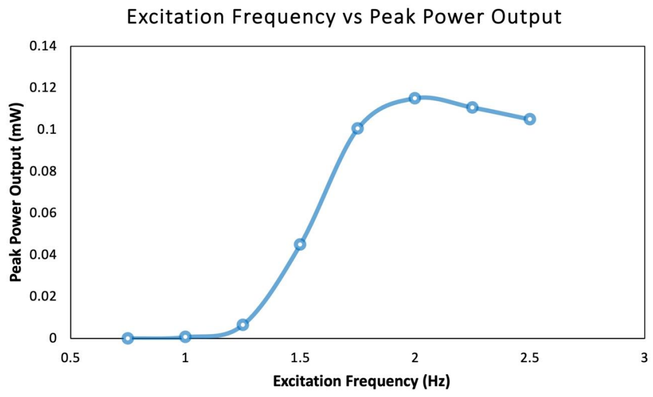
- 50% water fill level resulted in the highest output voltage.



- Highest transferred charge was observed when the tube was filled 50%.

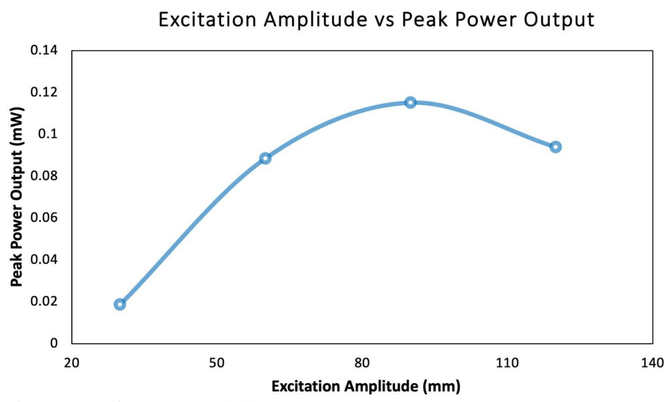
*excitation frequency – 2 Hz

Output of LS-TENG Under Surge (Horizontal) Excitation



*excitation amplitude – 90 mm

- Peak power output of 0.116 mW was obtained at excitation frequency of 2 Hz.



- Peak power output increases with increase in amplitude and then decreases.

*excitation frequency – 2 Hz

CONCLUSIONS

- LS-TENG overcomes the wear and tear associated with solid-solid TENG due to friction and has an increased lifespan. It is a simple, low-cost solution that is easy to manufacture.
- The optimal water level for LS-TENG was determined to be 50% of the tube's capacity, yielding highest output.
- LS-TENG yielded a peak output power of 0.116 mW under surge excitation.
- The power output of LS-TENG could be further scaled up and optimised for marine micro-power applications.

FUTURE WORK

- The power output LS-TENG will be analysed for tilt wave excitations.
- LS-TENG will be tested in wave flume to examine its performance under simulated ocean conditions.
- An array network for LS-TENG will be explored and subjected to ocean testing.

Experiment Video

[1] C. Song *et al.*, "Recent advances in ocean energy harvesting based on triboelectric nanogenerators," *Sustainable Energy Technologies and Assessments,* vol. 53, p. 102767, 2022/10/01/ 2022, doi: https://doi.org/10.1016/j.seta.2022.102767.
[2] Y. Li *et al.*, "High-efficient built-in wave energy harvesting technology: From laboratory to open ocean test," *Applied Energy,* vol. 322, p. 119498, 2022/09/15/ 2022, doi: https://doi.org/10.1016/j.apenergy.2022.119498.
[3] C. Wu, A. C. Wang, W. Ding, H. Guo, and Z. L. Wang, "Triboelectric nanogenerator: a foundation of the energy for the new era," Advanced Energy Materials, vol. 9, no. 1, p. 1802906, 2019.

Research Group

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