# INTISARI

Miniaturisasi perangkat elektronik dapat meningkatkan risiko kelebihan panas dan menurunkan masa pakai. Metode pendinginan efektif, seperti *pool boiling*, dihadapi kendala uap terperangkap, yang dapat memengaruhi nilai *Heat Transfer Coefficient* (HTC). Solusi diusulkan dengan menggunakan metode agitasi melalui getaran akustik pada variasi frekuensi dan waveform, diuji dalam kondisi subcooled 40 °C pada frekuensi 10 kHz, 20 kHz, dan 40 kHz, masing-masing diterapkan pada gelombang *square, sine*, dan *triangle waveform.*

Pada eksperimen, fluida kerja di dalam ruang pemanasan dipertahankan pada suhu saturasi dan tekanan atmosfer. Pemanas catridge terhubung ke termostat otomatis untuk menjaga suhu, sedangkan pressure transducer memantau tekanan. Tiga *Thermocouple* tipe K ditempatkan di pemanas utama, mengukur suhu benda uji dan suhu fluida kerja secara keseluruhan. Ketiganya terhubung ke sistem akuisisi data. Kamera digunakan untuk merekam pembentukan gelembung uap dan sistem penerangan memudahkan pengamatan proses *pool boiling*.

Pada variasi *waveform* (*square, sine, triangle*) dan frekuensi (10 kHz, 20 kHz, 40 kHz) di sonikator, terjadi pengaruh pada *pool boiling*. *Square waveform* memiliki *heat flux* dan HTC tertinggi, dengan peningkatan mencapai 2 kali nilai tanpa getaran. Frekuensi 40 kHz memberikan performa terbaik, diikuti 20 kHz dan 10 kHz, meningkatkan *pool boiling* secara keseluruhan. Peningkatan frekuensi menginduksi konveksi paksa, mengurangi lapisan batas termal, dan meningkatkan transfer panas. Hal ini meningkatkan peluruhan gelembung, mengurangi tegangan permukaan, dan mengakibatkan peningkatan nilai heat flux serta HTC, meningkatkan performa pool boiling secara keseluruhan.

**Kata Kunci:** *Pool boiling, HTC, Frekuensi, Waveform*

# ABSTRACT

*The miniaturization of electronic devices can increase the risk of overheating and reduce their lifespan. Effective cooling methods, such as pool boiling, face challenges related to trapped vapor, which can impact the Heat Transfer Coefficient (HTC). A proposed solution involves using agitation through acoustic vibrations at varying frequencies and waveforms. The experiments were conducted under subcooled conditions at 40 °C with frequencies of 10 kHz, 20 kHz, and 40 kHz, each applied to square, sine, and triangle waveforms.*

*In the experiment, the working fluid inside the heating chamber is maintained at saturation temperature and atmospheric pressure. A cartridge heater is connected to an automatic thermostat to control the temperature, while a pressure transducer monitors the pressure. Three Type K thermocouples are placed in the main heater, measuring the temperature of the test object and the overall working fluid. They are connected to a data acquisition system. A camera is used to record the formation of vapor bubbles, and lighting facilitates the observation of the pool boiling process.*

*In the sonicator, variations in waveform (square, sine, triangle) and frequency (10 kHz, 20 kHz, 40 kHz) influence pool boiling. The square waveform exhibits the highest heat flux and Heat Transfer Coefficient (HTC), with an increase reaching twice the value without vibration. The frequency of 40 kHz delivers the best performance, followed by 20 kHz and 10 kHz, enhancing pool boiling overall. The increase in frequency induces forced convection, reducing the thermal boundary layer and improving heat transfer. This leads to increased bubble nucleation, reduced surface tension, and results in an overall enhancement in heat flux and HTC, improving the overall performance of pool boiling.*

***Key word: Pool boiling, HTC, Frekuensi, Waveform***