Superheated Steam from Low-Temperature Waste Heat:

A Brief Technical Overview of The Open Oscillatory Approach

Presentation for

High Temperature Heat Pump Symposium

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Hydram Research

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Technology Outline

With Simplified Animation the System

Main characteristics

- Water as working fluid, oscillating up and down the system
- Boils water through pressure reduction – NOT heating
- Pressure reduction caused by the imbalance in water height
  - Large volume cavitation, leaving saturated steam in its wake
  - Steam generation cools the water (evaporated cooling)
- Steam is compressed to superheated conditions by the liquid piston (water) and subsequently ejected
- What does this mean?
  - Majority of the output energy is derived from the latent heat in the water
  - Only a small amount of work is required to maintain oscillation

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Current Prototype

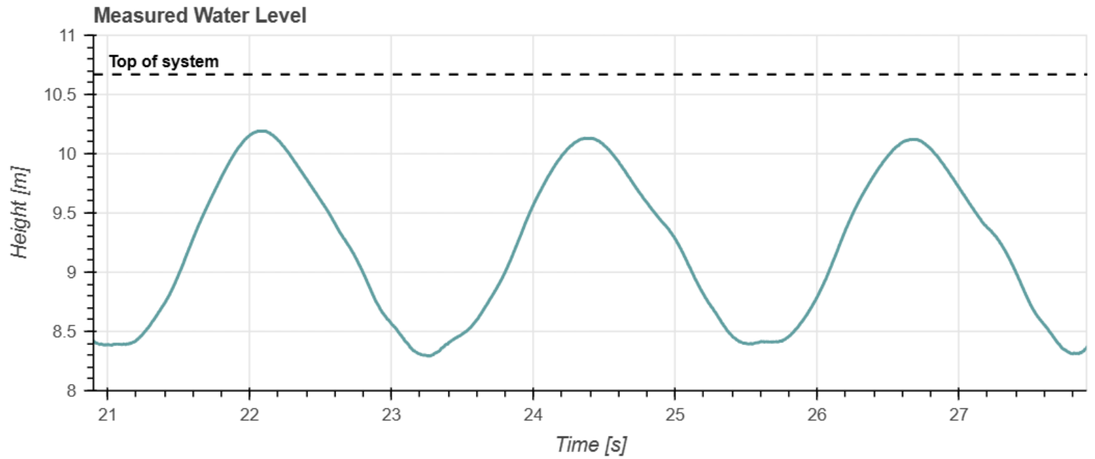
Specifications and Test Results

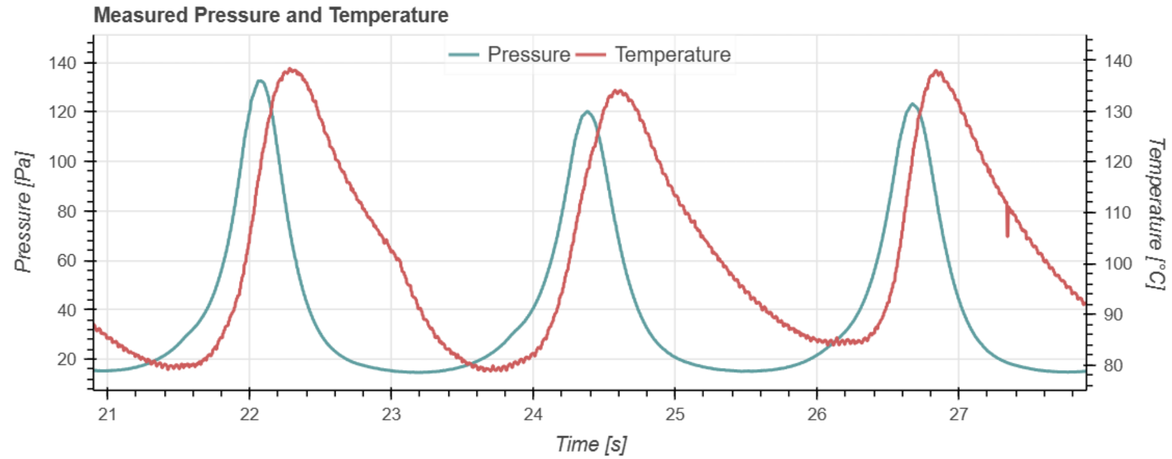
Prototype specification

- Height = 10.6m, Diameter = 0.4m
- Oscillations maintained by two pneumatic piston
- Source heat flexibility (20-95 Cº)
- Oscillation period between 2 - 3 seconds
- Theoretical power output of +100kWth
- Stable ejections achieved in December 2025

Highlighted Test Results

- Stable ejections of superheated steam over multiple cycles
- Max superheating recorded: 159C at 119kPa





Current Focus

Recent Developments and Next Steps

Test Setup

- Recent upgrades to our prototype grants us the ability to…
  - Perform much longer tests
  - Accurately determine the properties of ejected steam

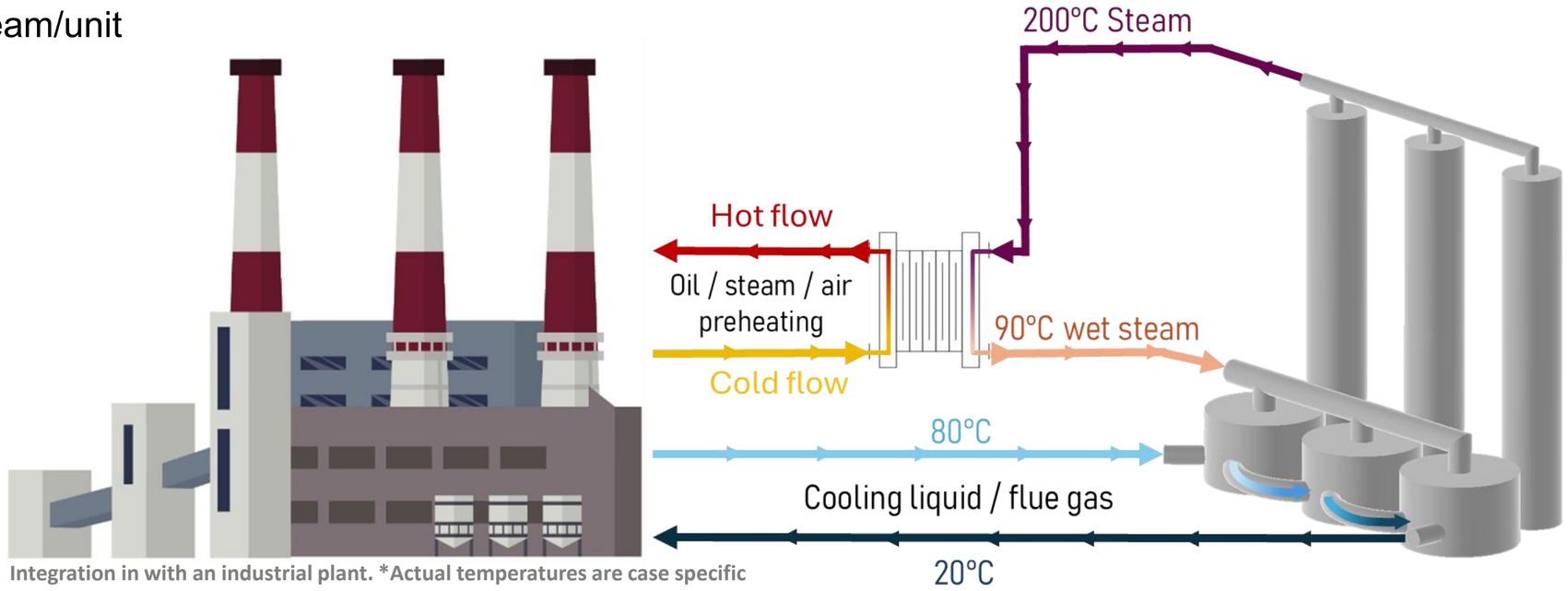
Computer Model

- Concluding upgrades to our python-based simulation model
- Speed up development and optimization
- Simulate real-world operating conditions

Summary

Highlighted Points

- Improved recovery of low temperature waste streams
- Clean operation – No combustion or toxic working fluids
- Powerful and scalable, +1MW-steam/unit
- Minimal space requirements
- Still early development (TRL 3-4)



Integration in with an industrial plant. *Actual temperatures are case specific

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