

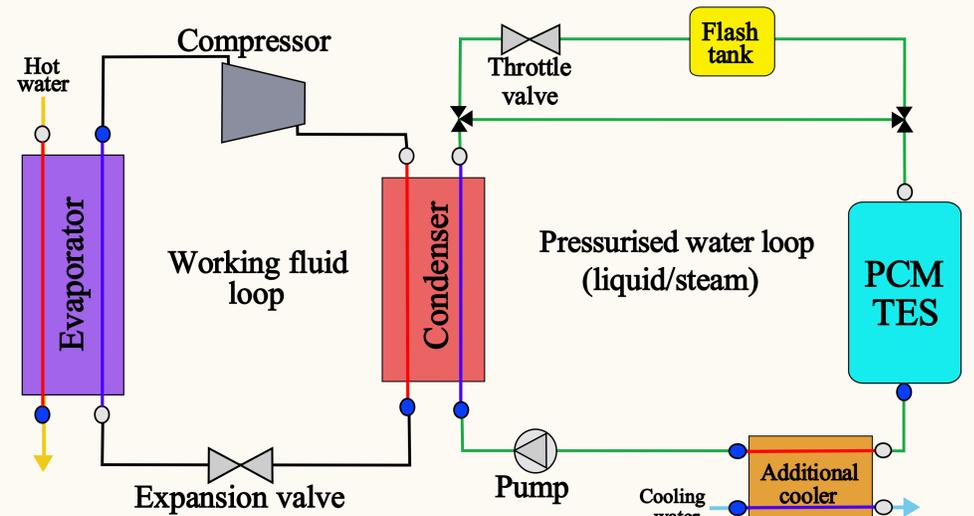
CONTEXT

Industrial waste heat can be recovered through Carnot Battery integration, improving efficiency and reducing greenhouse gas emissions.

The EU-funded **SEHRENE** project aims to develop a novel concept of **thermally integrated Carnot Battery** by modelling three use cases and prototyping a test bench.

The test bench will be separated in two: **High Temperature Heat Pump (HTHP)** connected to **latent Thermal Energy Storage (TES)** in Liège and Organic Rankine Cycle connected to TES at CEA Grenoble.

The objective of the test bench is to reach **125-130°C** of **condensing temperature** in the water loop to melt the **Phase Changing Material (PCM)** of the TES, with a **heat duty** of about **10kW**.



SYSTEM DESIGN

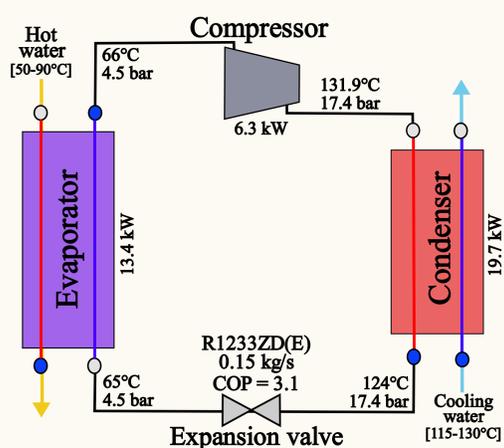
A **first simple design** of the HTHP was made.

Characteristics of the model:

- **Pinch point** for the plate Heat Exchangers.
- **Isentropic efficiency** for the piston compressor.

The model was implemented on EES.

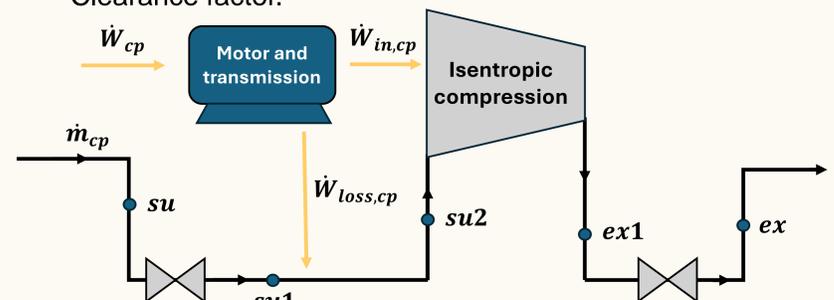
Parameter	$\Delta T_{pp,cd}$	ΔT_{sh}	$\Delta T_{pp,ev}$	ΔT_{sc}	$\eta_{s,cp}$	$\eta_{v,cp}$
Value	2	1	3	1	0.60	0.90
Unit	K	K	K	K	-	-



A **semi-empirical model** was then studied for the **piston compressor**.

Parameters of the model:

- Throttle areas for the throttle valves 1 and 2.
- Motor losses: constant, proportional to the rotational speed, proportional to the internal compression power $\dot{W}_{in,cp}$.
- Clearance factor.



The model was **fitting** the manufacturer's data provided by *Tecumseh* for \dot{m}_{cp} but **not** for \dot{W}_{cp} and $T_{ex,cp}$ [1].

Some discussions were started with the manufacturer to consider other hypothesis for the model.

RESEARCH DIRECTIONS

PCM-TES integration

Several ideas came up about the usage of the TES.

If the TES is used only in a water circuit, the PCM melting can be led:

- By circulating **pressurised hot water** in it. This hot water will be heated in the HTHP's condenser.
- By heating liquid water in the HTHP's condenser then **flashing** it to **study two-phase** fluids in PCM-TES.

The TES could also be used by circulating **working fluid (R1233ZD(E))** directly in it.

Compressor cooling

The *Tecumseh* compressor to be used in the HTHP is not designed to reach the required high temperatures (125-130°C).

Some parts of the compressor cannot withstand these high temperatures, so compressor cooling is necessary.

Different strategies were envisaged:

- Add an oil separator at the compressor's exhaust and **cool down the oil** before reinjecting it at the compressor's suction.
- **Blow** a large amount of **ambient air** directly on the compressor's shell.
- **Expand** part of the **working fluid** from the condenser's exhaust and **reinject** it at the compressor's suction.