Research Challenge 3

Advance performance of energy transformation technologies

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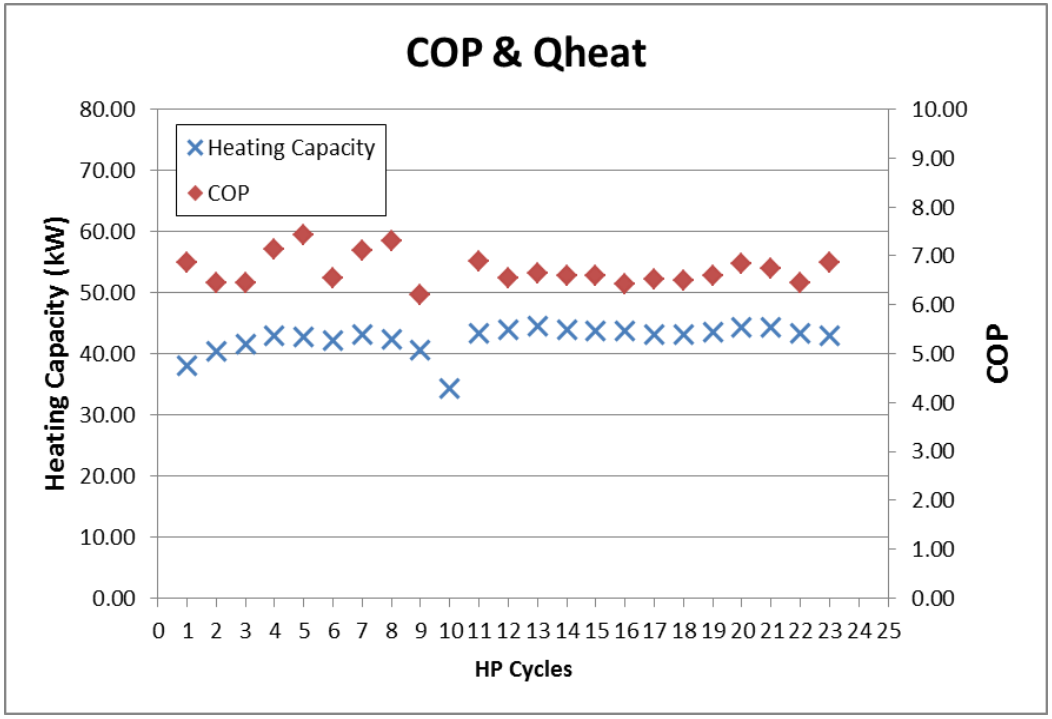
3.1 Low temperature lift, high COP heat pump

HP operation	November
Average Tamb (Low/High)	1°C/5°C
No of Cycles	24
Average operation time/cycle	36 minutes
Superheat setting	8°-12°K
Subcooling	11.3°K
STES Average temperature	34.8°C
Max. HP Water Outlet	52°C
Average Heating Capacity	43kW
Average COP	7.43



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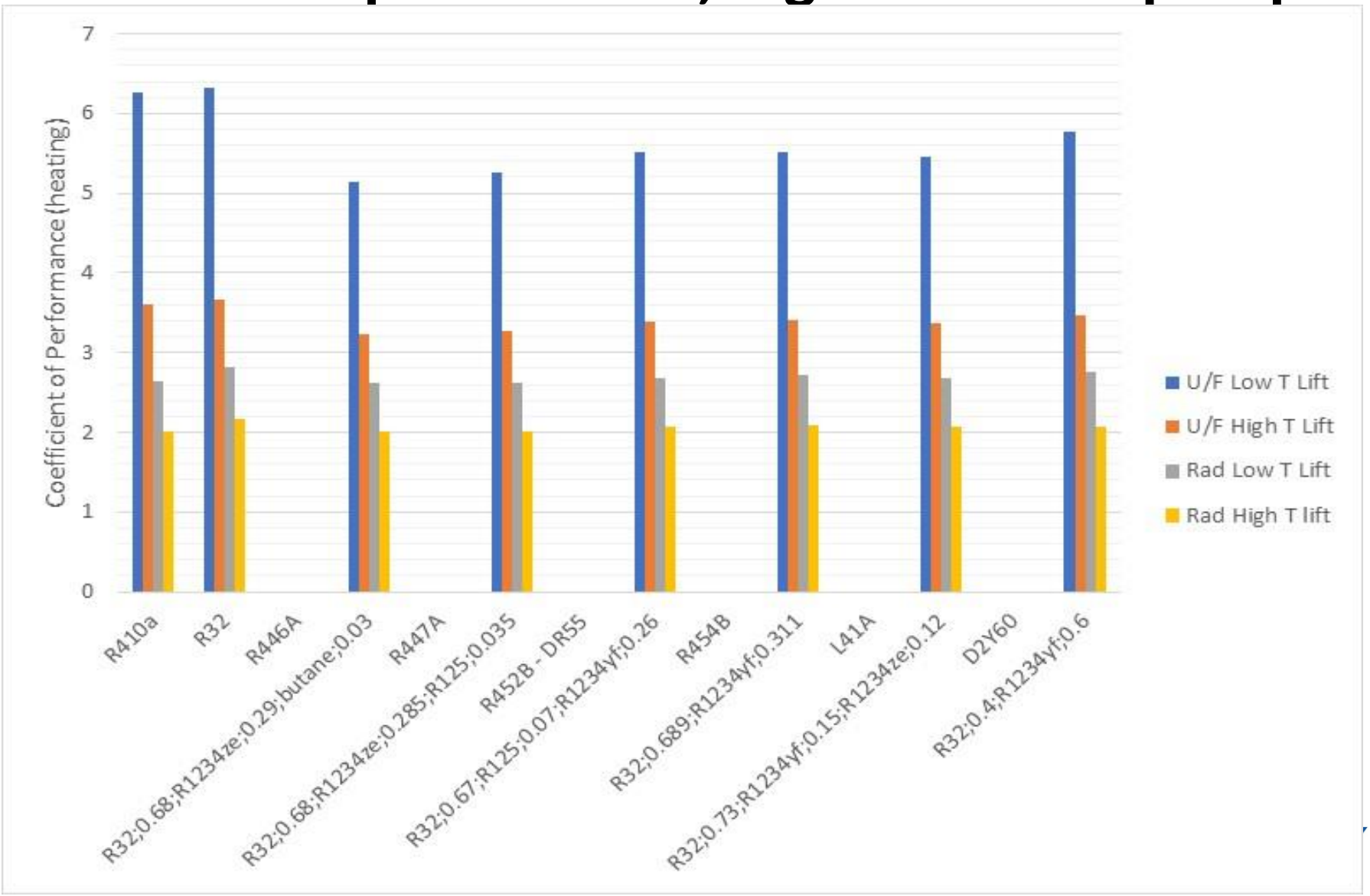
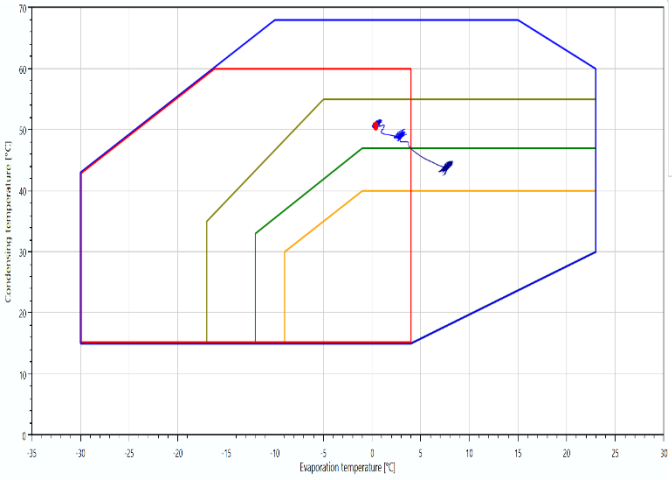
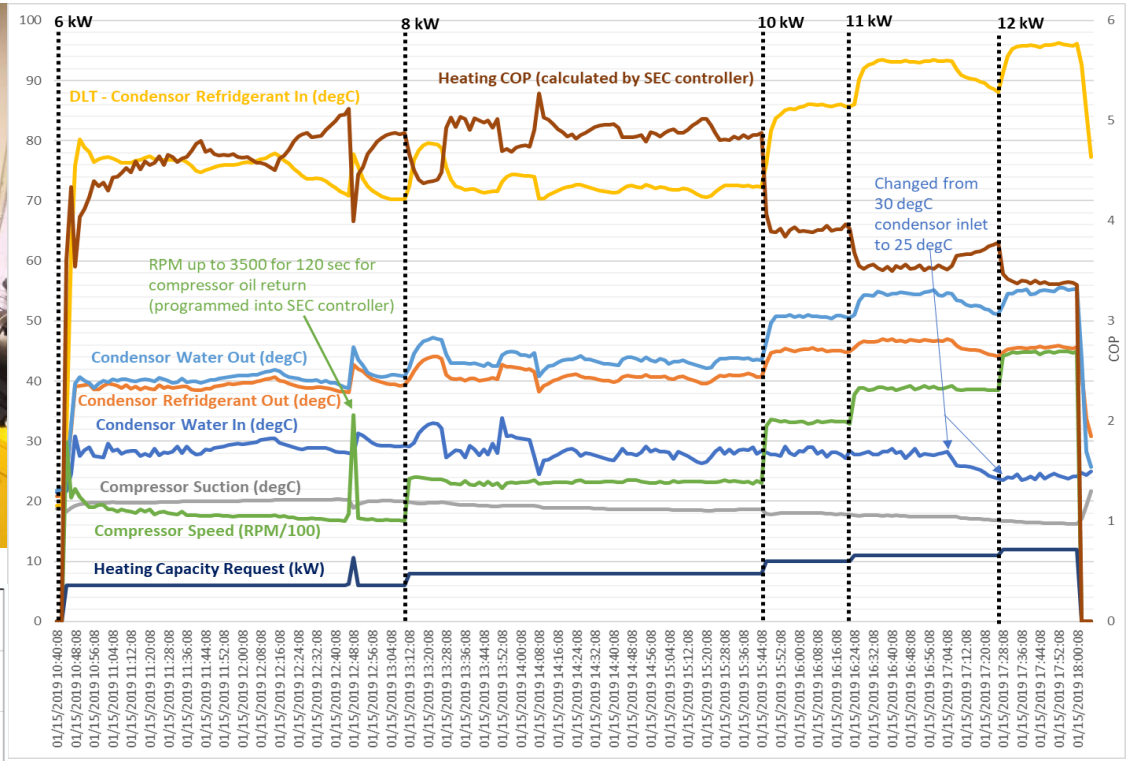
3.1 Low temperature lift, high COP heat pump



3.2 Heat Pump for Demand Side Management





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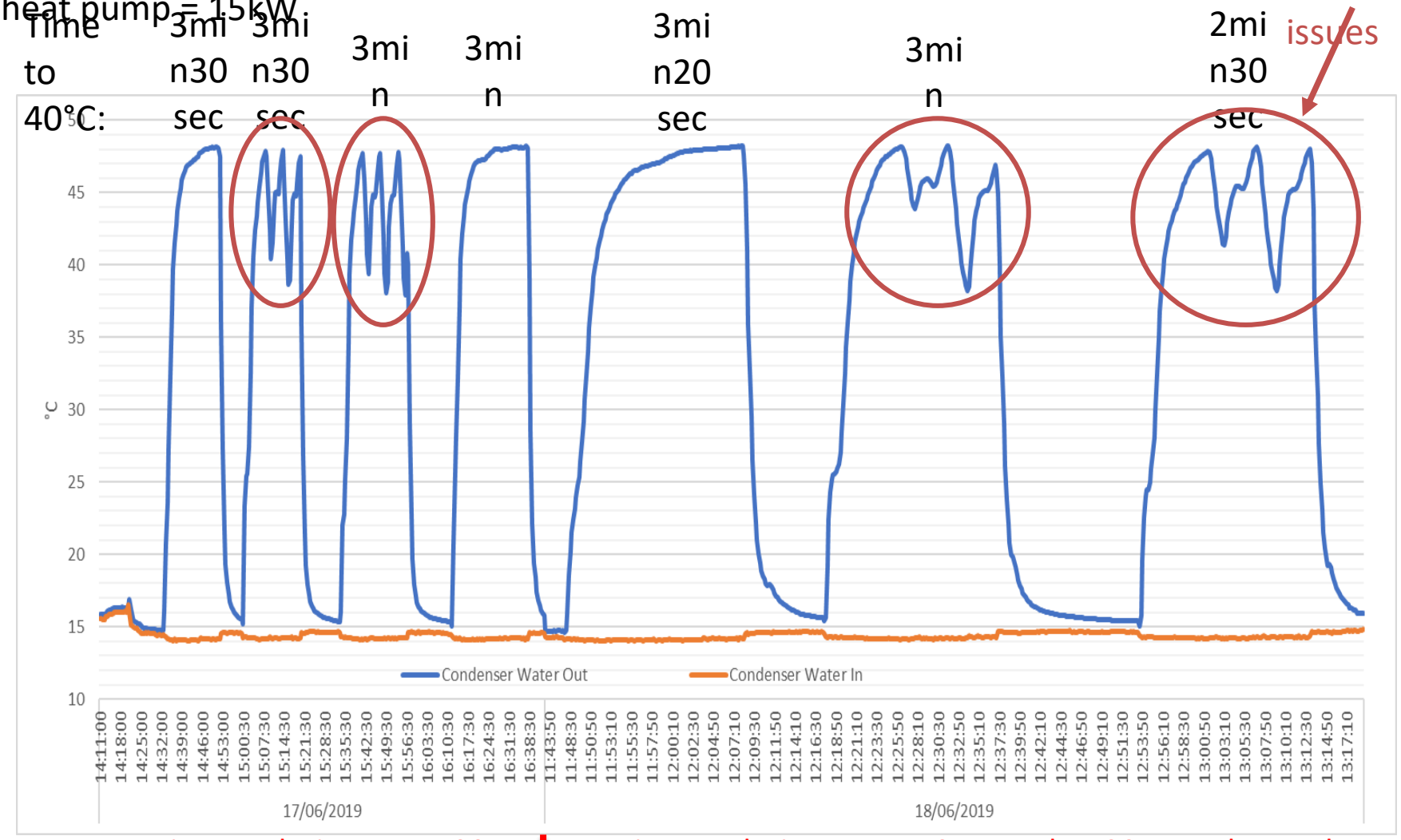
3.2 Heat Pump for Demand Side Management

- Test Chamber – Humidity and ambient temperature control

- HP and balancing rig moved to test chamber and plumbed in
- Sensor set-up and wiring completed for HP and test chamber
- PID control of chamber humidity reinstated

3.2 Heat Pump for Demand Side Management

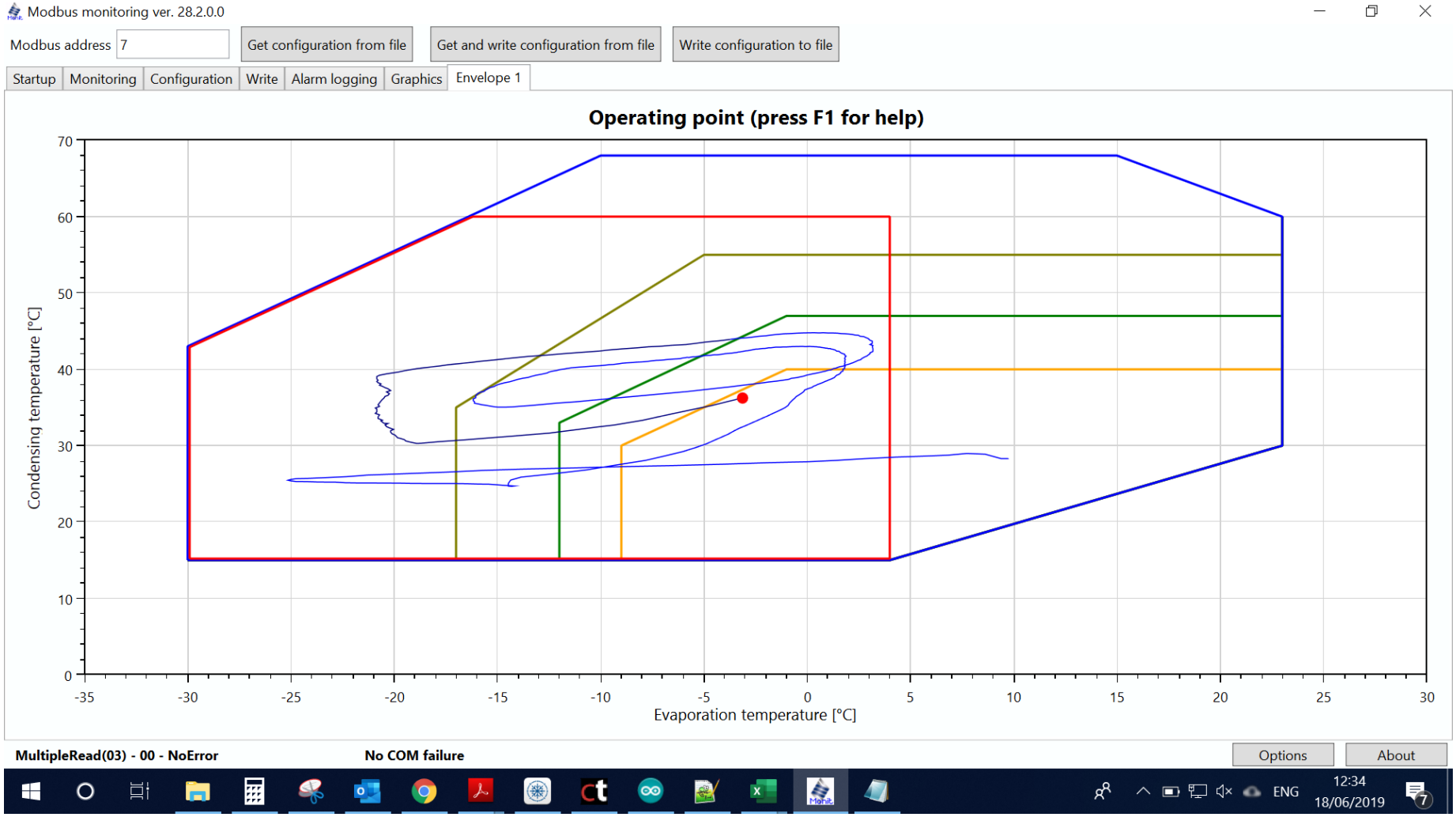
Chamber = 15°C/RH90%, water flow rate = 6l/min, heat demand requested from heat pump = 15kW



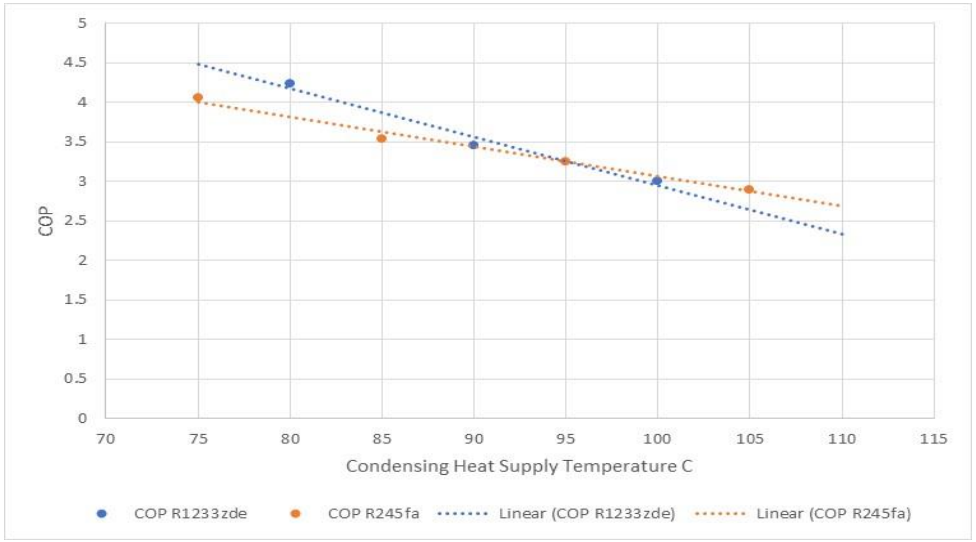
Logging resolution every 30 seconds

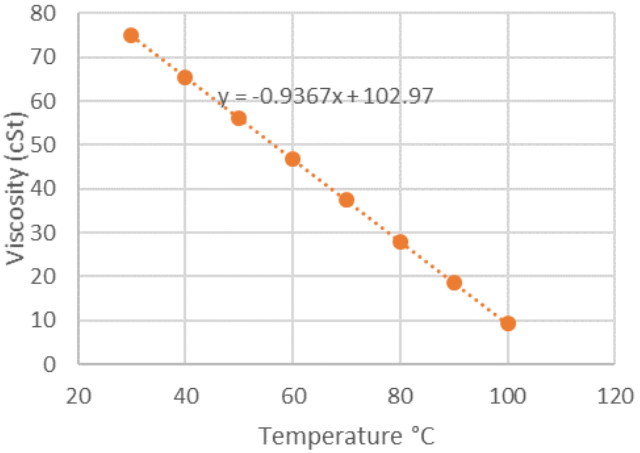
Logging resolution every 10 seconds – 30seconds too short to see difference

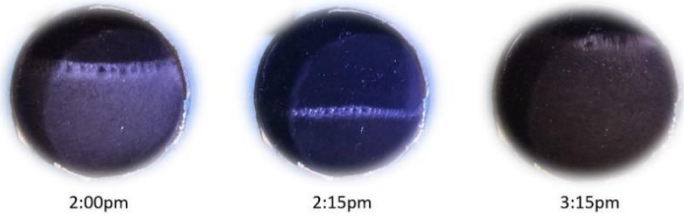
3.2 Heat Pump for Demand Side Management



3.3 High temperature heat pumps







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3.3 High temperature heat pumps

3.3 High temperature heat pumps

- **Expansion valve – failure** $>100°C$.
  - Upon investigation the stepper motor had failed.
- **Compressor oil shaft seals failed –** (Between compressor and motor)
  - High oil temperature may be responsible.
  - Some wear on internal parts evident on sump plug.
- **Oil sump temperature**
  - Increases above >90°C Condensing temperatures.
- **Start-up Issues**
  - Liquid refrigerant in suction line.

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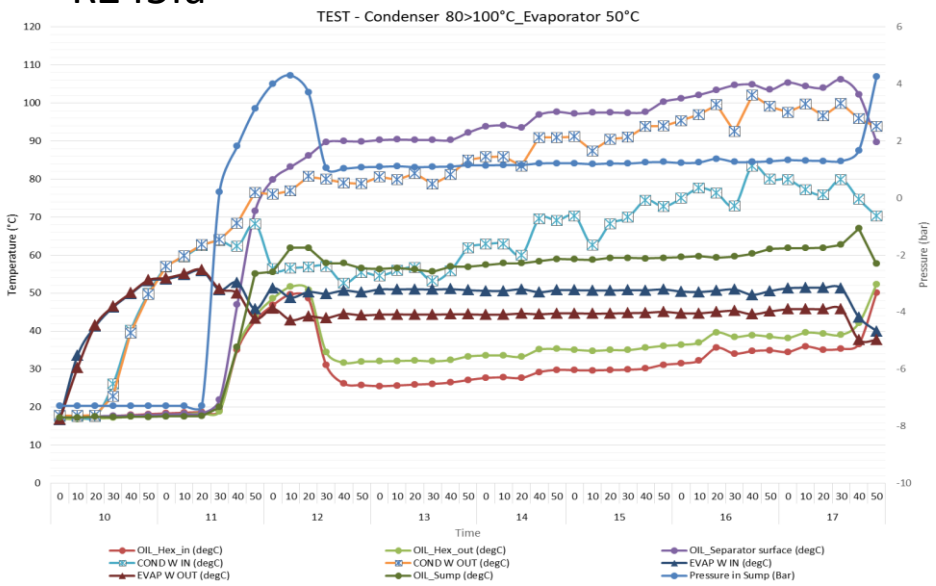
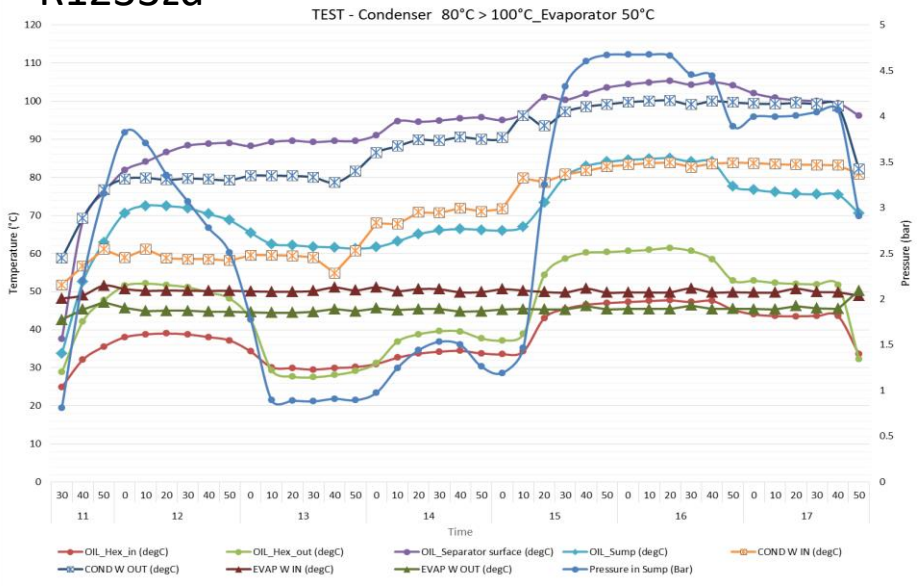
3.3 High temperature heat pumps

R245fa



R1233zd



20cST is the target at operation points.

Suggestions: Fuchs RENISO TRITON SEZ320 (POE).

POE suitable with HCFO and miscible.

Other potential oil:

PAG but not tested for long terms performance, miscibility, acidity, corrosivity etc

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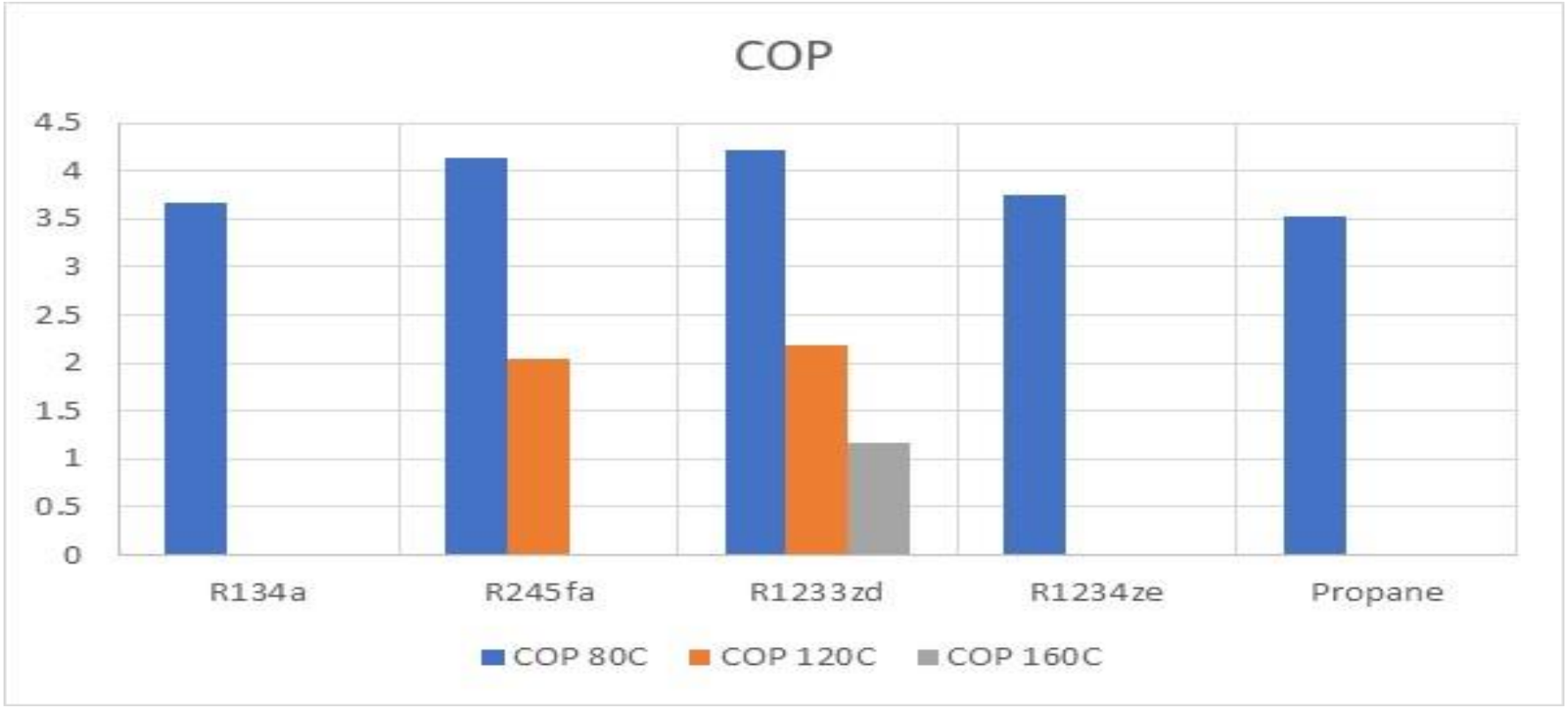
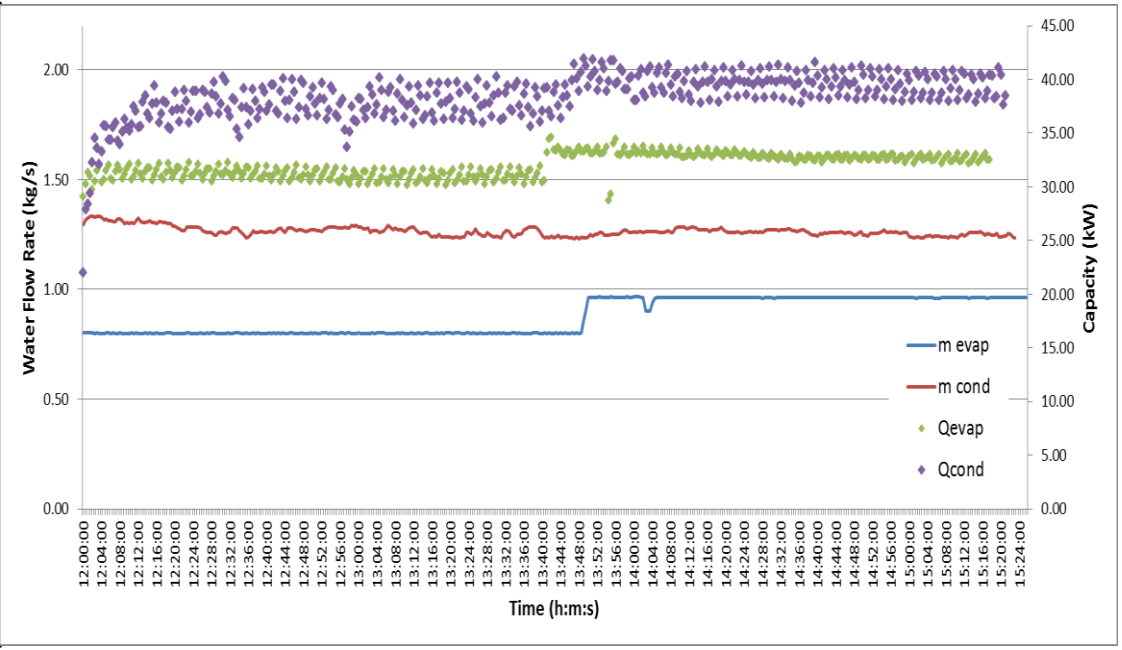
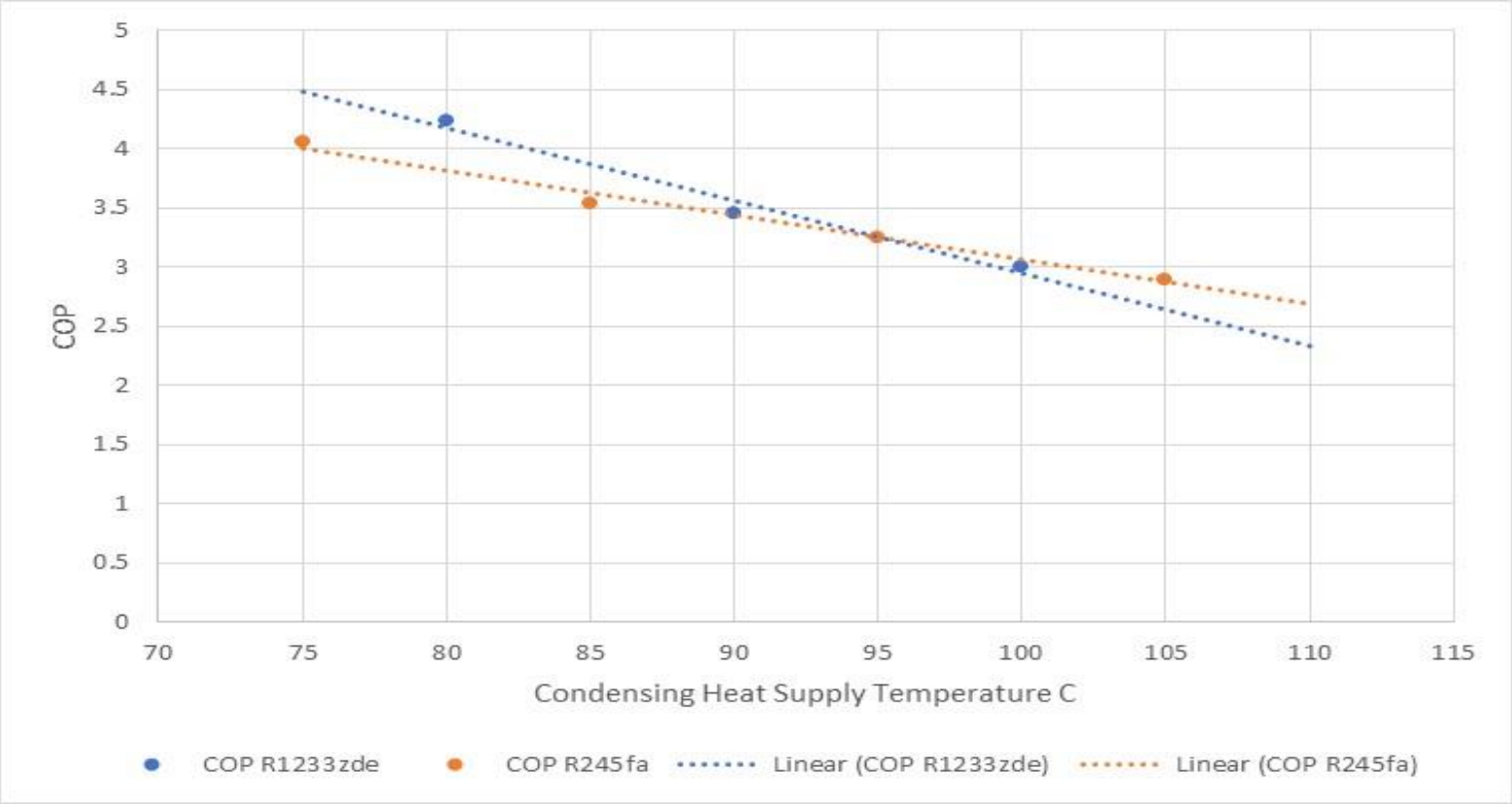
Replacing R245fa



Replacing R245fa - Baseline



R1233zd(e) Performance



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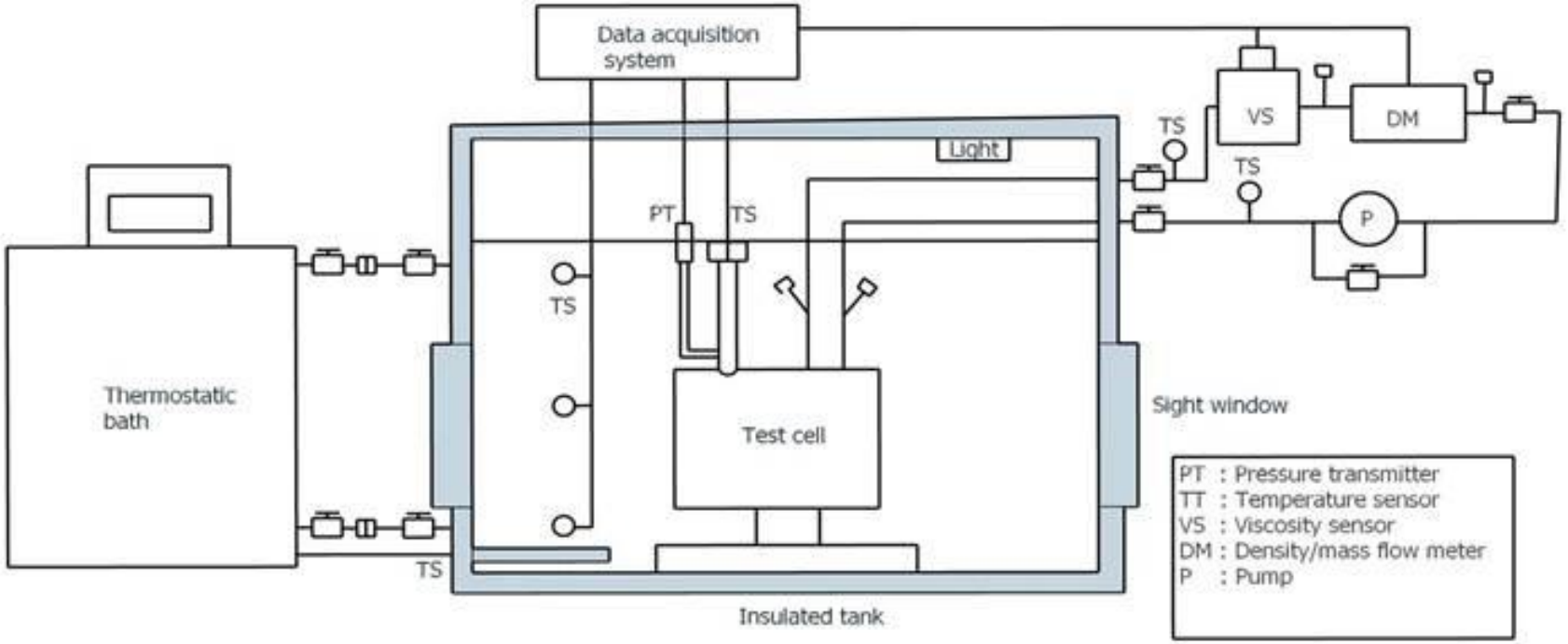

Schematic of the test equipment

Viscometer Test Rig

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3.3 High temperature heat pumps

Viscometer Test Rig

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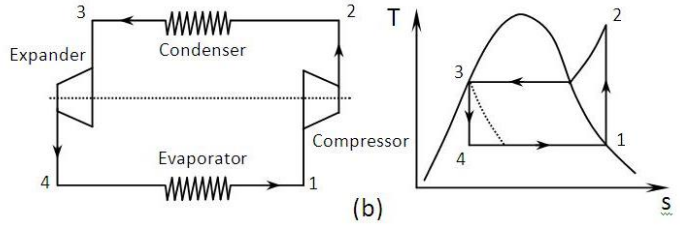
3.4 Combined heat pump/ORC

- Industrial applications may want to generate power from excess heat in two systems
- Stage 1 – Expander



- Stage 2 – Compressor as a Pump?

- Stage 3 – ORC/Heat Pump

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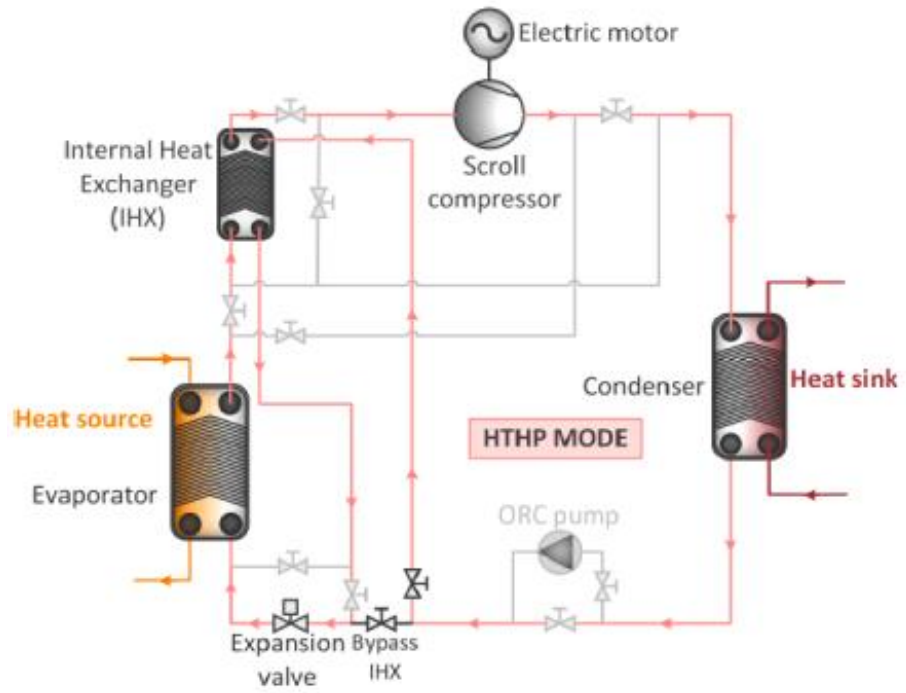
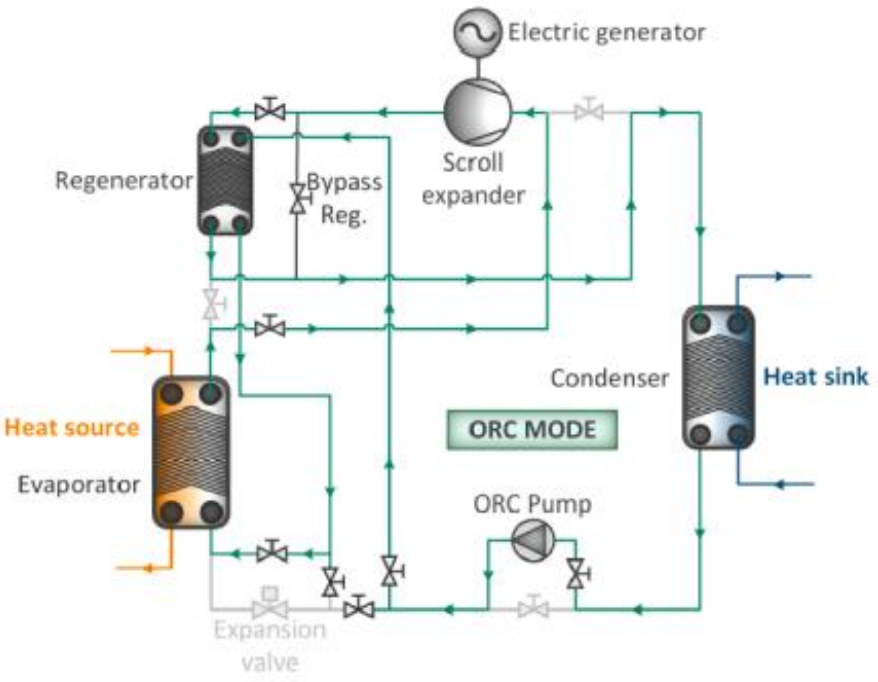
3.4 Combined heat pump/ORC





Multi-objective optimization of a novel reversible High-Temperature Heat Pump-Organic Rankine Cycle (HTHP-ORC) for industrial low-grade waste heat recovery

Energy Conversion and Management, Volume 197, 1 October 2019, Article 111908

Carlos Mateu-Royo, Adrián Mota-Babiloni, Joaquín Navarro-Esbrí, Bernardo Peris, Marta Amat-Albuixech

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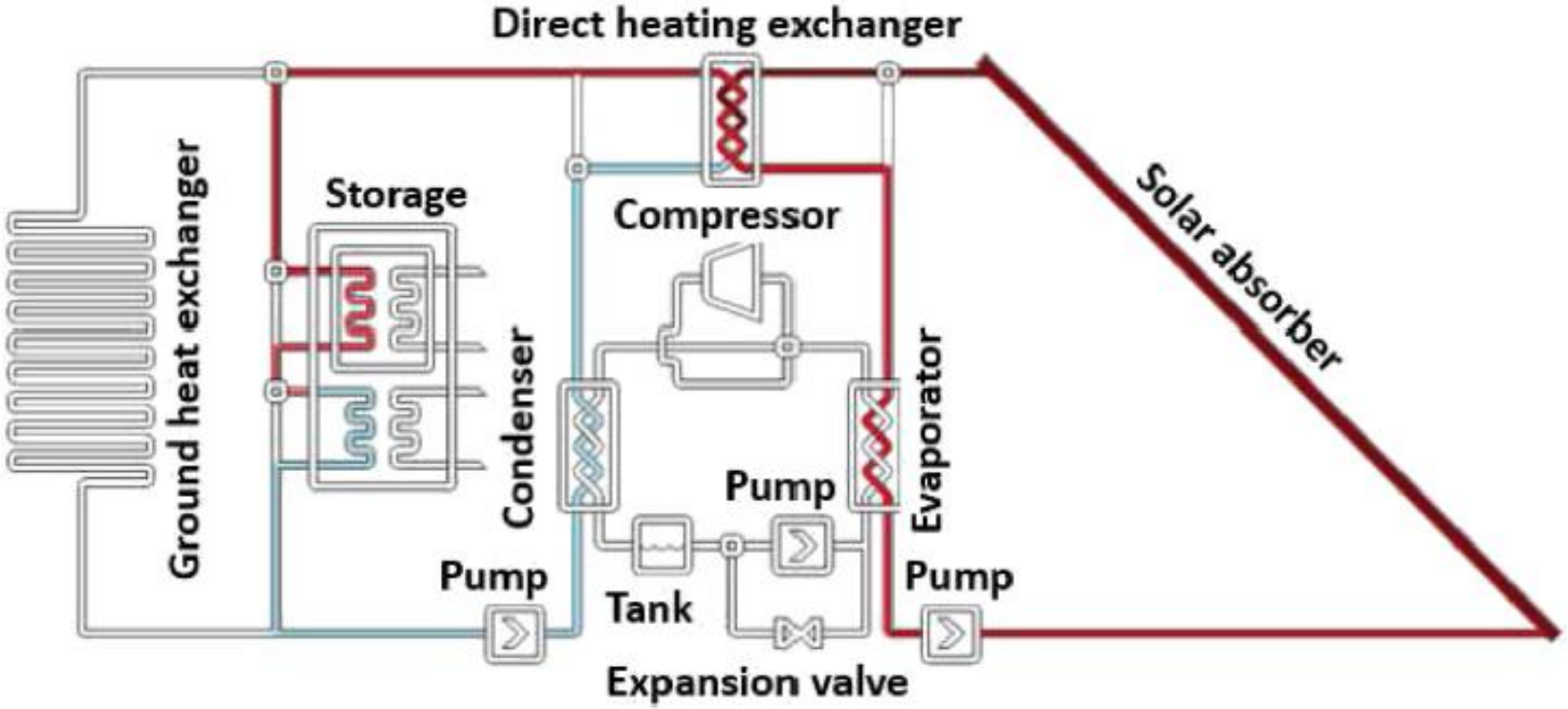
3.4 Combined heat pump/ORC



Experimental investigation of a reversible heat pump/organic Rankine cycle unit designed to be coupled with a passive house to get a Net Zero Energy Building
International Journal of Refrigeration, Volume 54, June 2015, Pages 190-203
Olivier Dumont, Sylvain Quoilin, Vincent Lemort

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Thank you.