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Introduction

Decarbonization of domestic heating sector is crucial to fulfill the UK 2050 climate commitment by replacing the fossil fuel-based heating system with more efficient, renewable energy devices. The air source heat pump (ASHP) system has shown good potential for demand side response and meeting the house heating load. Capacity modulation via compressor speed is essential to efficiently meet variable heating loads in domestic buildings and hence investigated in this PhD project.

Objectives

- The aim of the project is to assess the performance of 9kW domestic heat pump (HP) system for retrofit application. The variable speed HP developed at Ulster University have been tested under the laboratory conditions.
- The HP performance tested at different heat loads have been evaluated and simulated against the house heat demand (both for domestic hot water and space heating).
- To investigate the potential for meeting the typical Irish household heat demand, and demand response
- The establishment of the compressor operating map through experimental results and impact of the varying frequency operation, ambient temperature and water supply temperature on the overall system performance;

Methods

In this study, the performance of variable speed ASHP system (Fig. 1) was investigated at steady state conditions in the lab as per BS EN14511 standard by fixing the load at 18kW, 15kW, 12kW, 9kW, 6kW, and 3kW, with ambient temperature conditions of -2 °C, 2 °C, 7 °C and 15°C, and water supplying temperatures (WST) of 30 °C, 35°C, 40 °C, 45 °C, 50 °C, and 55 °C. The heating capacity (HC), ambient temperature conditions, WST, depending on the operating frequency (f), were responsible for the system performance (COP) at all tested conditions, as discussed in Abid et al. [1,2]. The testing results for 9kW, 6kW, 3kW, have been presented in the results section, showing COP values and the frequency of operation required.

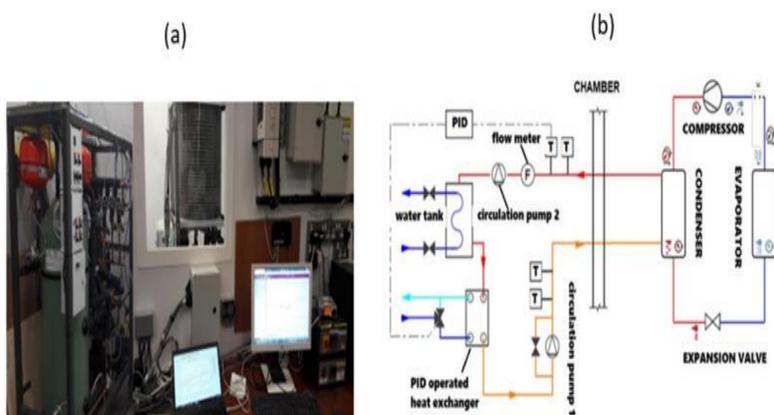


Figure: 1 Experimental setup a) pictorial view, b) simplified schematic diagram for the HP system

Results

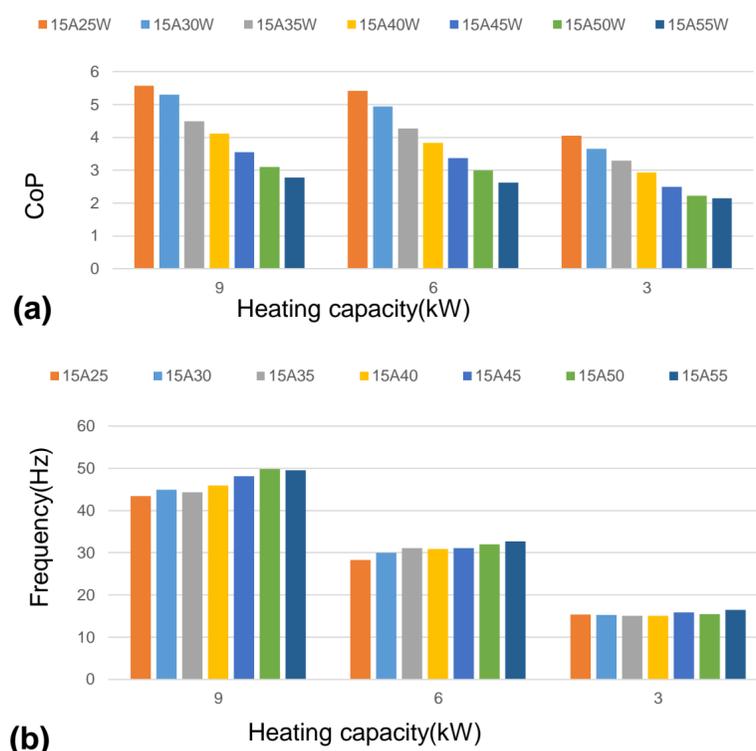


Figure: 2 Experimental results at ambient conditions of 15 °C and with varying WST, a) Co-efficient of performance, b) Frequency of operation

Conclusions

- The maximum CoP values was found to occur when operating the system near the nominal value of 60Hz.
- The frequency of operation is approximately proportional to heating capacity at constant load/source side conditions.
- The frequency of operation requirements increases for constant heat load, and WST while reducing ambient temperature conditions.
- The frequency of operation requirements increases/decrease for constant heat load, ambient temperature conditions according to the increase/decrease in WST.

References

- [1] M. Abid, N. Hewitt, M.J Huang, C. Wilson, and D. Cotter, "Experimental Study of the Heat Pump with Variable Speed Compressor for Domestic Heat Load Applications", submitted to the conference of "Compressor Engineering, Refrigeration, Air-Conditioning, and High-Performance Buildings" to be held in May 2021 at Perdue (under review).
- [2] M. Abid, N. Hewitt, M.J Huang, C. Wilson, and D. Cotter, "Heating Capacity Modulation Impact on the Performance of Variable Speed Compressor based Domestic Heat Pump" in progress