Analysis of ice build-up on the evaporator of an externally installed heat pump

Graduate

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Introduction: Ice on the evaporator of an air source heat pump leads to reduced efficiency. Ice acts as an insulator and impairs heat transfer between air and heat exchanger. At temperatures below 5°C and relative humidity above 50%, ice can form on the heat exchanger (see Figure 1). In this thesis, the behaviour of the ice build-up was investigated and various methods were analysed to measure the ice build-up. The methods based on enthalpy difference, pressure loss, air velocity and air volume flow were analysed and compared with the measured ice mass increase.

Approach: A measurement setup was constructed and implemented in order to carry out the comparisons. The heat pump was measured in the climate chamber with 44 test points. The test points differed in temperature and relative humidity of the environment, the heating capacity (set by the compressor speed), the water flow exit temperature and the defrosting time. Measurements were also carried out in part load operation. Over 120 ice build-up and defrosting cycles were recorded. Figure 2 shows an example of a test with the transient phase of the climate chamber at the beginning and then three frosting and defrosting cycles.

Conclusion: The measurement methods were compared based on their correlation to the ice-build up. The method based on pressure difference shows the best results. In figure 3, the mean values of different standard tests are shown. Up to 1 - 1.5 kg ice, a prediction can be conducted via the average pressure difference increase. After this, the fan enters the stall region and it is no longer possible to establish a clear dependency. In this work the main focus was on analysing the measurement data on the air side. Future investigations could benefit from examining the refrigerant side as well.

Figure. 1: Evaporator of the heat pump covered in ice
Own presentment

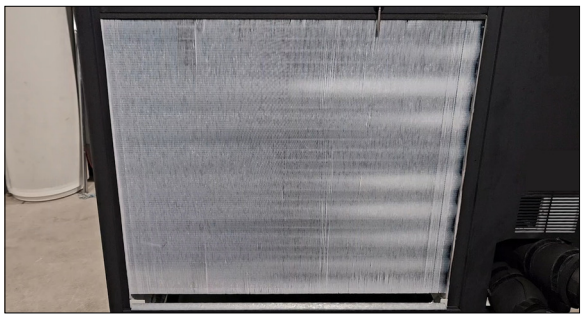


Figure 2: Example test with different cycles (transient a) and ice build-up cycle b))
Own presentment

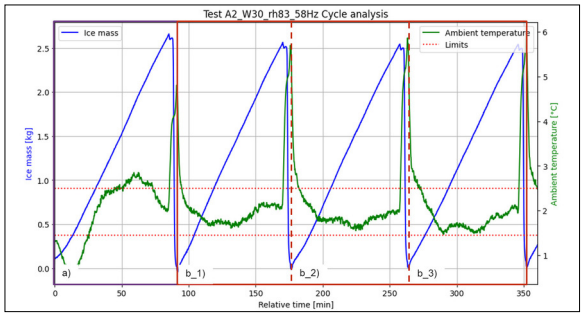
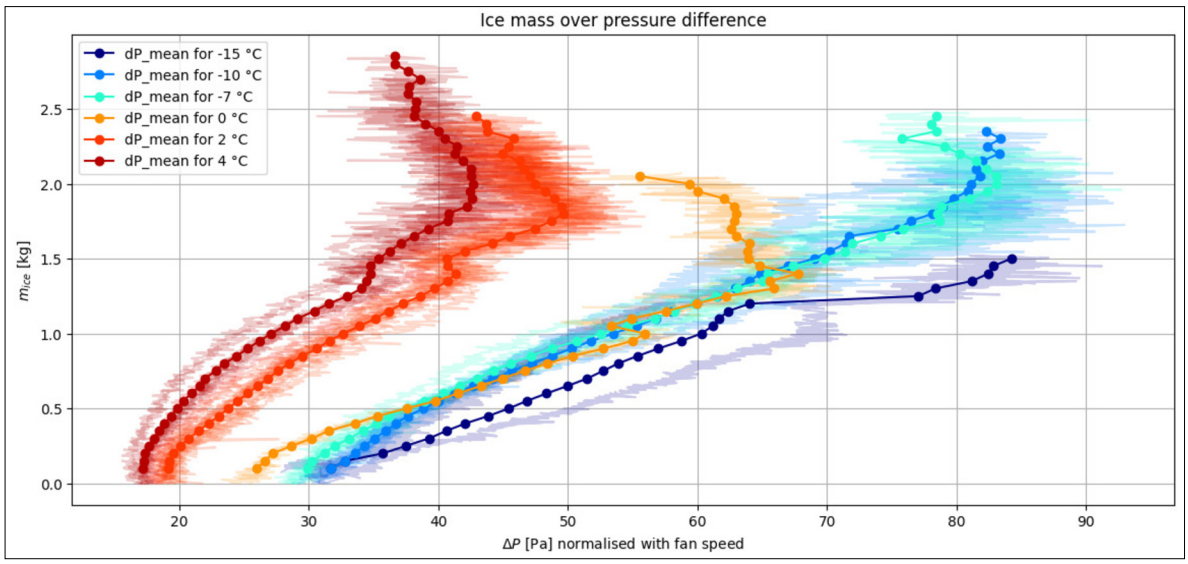


Figure 3: Comparison of pressure difference to measured ice mass
Own presentment



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