Applying Passivhaus Experience to Archive Buildings

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Introduction

A previous paper describes the design of the passive paper archive for the Imperial War Museum [Clarke, Grant, Jarvis 2018]. This paper presents the environmental conditions and energy performance for this building during the first year of operation and compares the reality with the modelled predictions.

The building was designed by Passivhaus architects Architype with construction detailing and energy strategy by Elemental Solutions and M&E design by E3. The building has a floor area of 1,365m^2 and volume of 5,500m^3. Whilst benefitting from Passivhaus experience, the approach is really inspired by the work of the late Tim Padfield and his colleagues in Denmark.

Method

The building was originally modelled in PHPP with the assumption that it would be heated to maintain a minimum winter temperature of 13 °C. As the design progressed the brief changed to require 'as low a temperature as feasible without the use of active cooling'. For this approach the PHPP was modified to model a free-running unheated building with ground coupling using the summer sheet to predict monthly temperatures.

The low winter temperatures avoid the need for humidification. There is no dehumidification of the air in the building, instead supply air dehumidification is used to pressurise the building with fresh air of a fixed dew point. The minimum winter temperature of about 11 °C allows us to maintain the RH comfortably below 60% using chilled water rather than the more usual desiccant dehumidifiers.

This open loop approach avoids the need for RH sensors for control. Indeed no building management system is required as the only control is the chilled water temperature. The plant comprises a package water chiller with integral controls, a cooling coil and a Zehnder Q350 domestic MVHR unit used to pre-cool the incoming air. This reduces chiller energy use as it basically only meets the dehumidification load, with minimal reduction of supply air temperature. Heat from the chiller is rejected to atmosphere as we do not want to add heat to the store during the summer.

Results

The completed building achieved an n_{50} result of 0.03 h^{-1} and a permeability of 0.055 m/h at 50Pa. Prior to moving in the collection during summer 2019, the building was heated and dehumidified to dry out the masonry to around 65% RH. Ideally the building would have been drier but there was pressure to move the collection.

We expect the building to take a few years to fully settle down but initial results show extremely stable conditions. The graph shows the temperature and RH in the stores to date. Six ground temperatures are also being logged to check the accuracy of the modified PHPP ground model over the next few years.

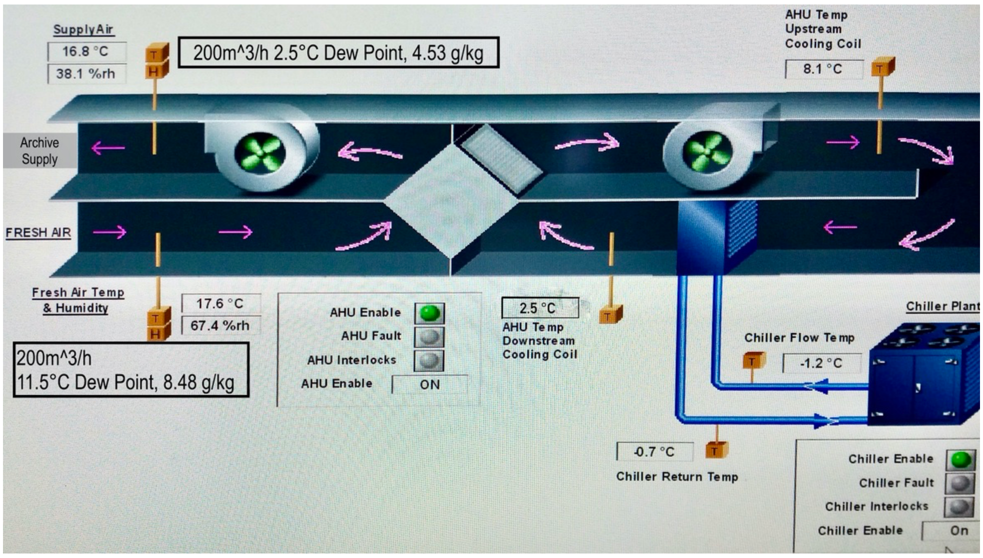

Figure 1: BMS screen shot 2/6/2020 showing the supply air dehumidification.

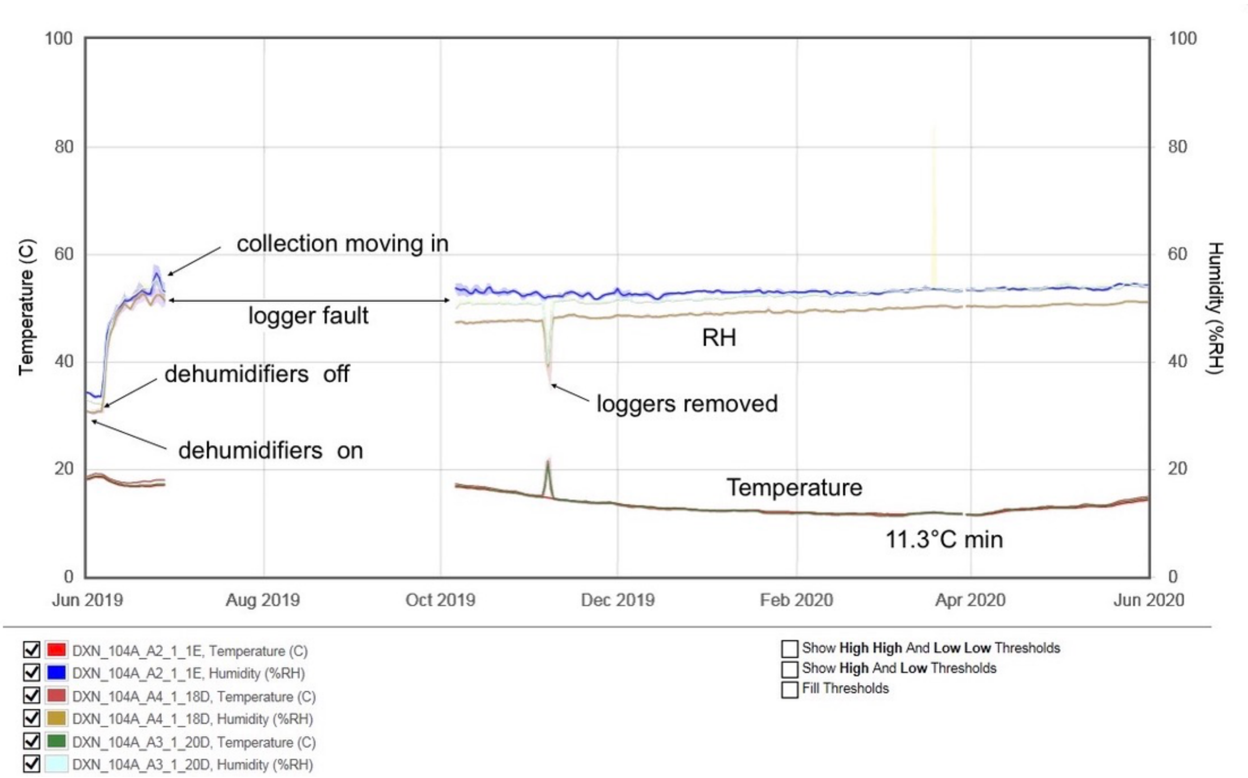

Figure 2: First year environmental monitoring.

The target energy use for conditioning the space is <1 kWh/m^3.a. Initial results are over 3 kWh/(m^3.a) but is expected to reduce as the building dries out and the plant is optimised.

References

[Clarke 2018] Clarke, A.; Grant, N. and Jarvis, A.: Next generation Passivhaus Archives: Proceedings of the 22nd International Passivhaus Conference 2018 in Munich. Passive House Institute, Darmstadt, 2018. https://bit.ly/3dk1COJ