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Experimental study of the performance of residential buildings utilizing potable water as a hydronic medium

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ABSTRACT

This paper describes an experiment performed to evaluate the use of potable water as a hydronic medium, a practice referred to as "open-loop heating/cooling", in a multi-unit residential building. This experiment employed a full-scale system with heating appliance, chiller, heat exchangers, and terminal units to simulate the operation of a multi-unit residential building with an open-loop heating system and an open-loop cooling system, one of the first to do so. While there have been numerous studies into the performance and modeling of individual appliances and system components used in HVAC applications, few have investigated the performance and modeling of complete functioning systems, largely due to the scale involved. This is the case particularly for multi-unit residential buildings. Based on the collected results it was determined that the steady state efficiency of an open-loop heating system could be predicted using linear modeling techniques developed to evaluate individual appliances, that the steady-state heating efficiency was not impacted by the occupant use of potable water, and that overall steady-state efficiencies of >90% were achievable using high efficiency appliances. The same was not found to be the case for an open-loop cooling system as the system was sensitive to occupant water use when inlet water temperatures were warmer than the intended distribution temperatures. This finding introduces regional performance implications on the use of open-loop cooling systems throughout large portions of North America as the service water temperatures at lower latitudes are too warm.

INTRODUCTION

The use of potable water as a hydronic medium has been a concept of interest for many years, originating as a technique for heating single family homes [1, 2, 3]. Numerous patents have been explored with the intent of reducing the amount of installed infrastructure necessary to satisfy the needs of building occupants, often looking for ways to use single piping systems for multiple purposes [4, 5]. While these systems have been proposed and are increasing in popularity [6], there are still many concerns in the industry regarding the implementation of such systems [7, 8] and there has not been an in-depth published review either of the effects of utilizing potable water as a