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Research Article

Building Systems and Components

Developing new components for variable flow distribution system modelling in TRNSYS

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Abstract

This study attempts to fill the existing gap in the simulation of variable flow distribution systems through developing new pressure governing components. These components are able to capture the actual ever-changing system performance curve in variable flow distribution systems together with the prediction of controversial issues such as starving, over-flow and the lack of controllability on the flow rate of different branches in a hydronic system. The performance of the proposed components is verified using a case study under design and off-design circumstances. Full integration of the new components within the TRNSYS simulation package is another advantage of this study, which makes it more applicable for designers in both the design and commissioning of hydronic systems.

Keywords

hydronic system,
variable flow distribution system,
building simulation,
variable speed pump,
TRNSYS

Article History

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1 Introduction

Heating, ventilation, air conditioning and refrigeration (HVAC&R) systems account for more than 60% of the total building energy consumption in the UK (DECC 2010). Meanwhile, heating and cooling distribution systems are the most common parts of HVAC&R systems, which account for a significant portion of energy used in HVAC&R processes. For instance, in office buildings, the distribution systems account for more than 20% and 30% of the energy consumption and CO_2 emissions of HVAC&R systems respectively (ECG-19 2000; CIBSE 2004). Therefore, an accurate design and a precise performance evaluation of distribution systems are essential to achieve energy efficiency in HVAC&R systems.

In HVAC&R systems, heating/cooling could be distributed using water or air as a carrier fluid. To narrow down the scope of work, the water distribution system (hydronic system) is the focus of this study. The most challenging issue in the modelling of the variable flow hydronic systems is to find the actual operating point (Petitjean 1994; Parsloe 1999; ASHRAE 2008). This is a unique point, at which the pressure and flow rate of the hydronic system and the circulation pump are exactly identical.

2 Problem statement

The literature reveals two dominant approaches for the modelling of hydronic systems (Gamberi et al. 2009; Klein et al. 2009; EnergyPlus 2011; IES 2011). The first approach is based on using a pre-set operation point, whereas the second is to find the operating point according to the intersection of predefined system and pump performance curves.

Under a constant flow regime using a single speed circulation pump, the first approach is able to simulate the actual performance of hydronic systems as long as an accurate pre-set operating point is defined. Due to the complexity of the process of finding the actual operating point, the second approach automates the process. This is achieved through a successive mathematical operation to find the intersection of pump and hydronic system performance curves (EnergyPlus 2011).

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