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Simulation-based Method for Optimization of Supply Water Temperature of Room Heating System

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Abstract

To reduce energy use for space heating, the optimization of operation of heating system has always been a key issue in north China. In this study, on the basis of field survey results, one existing regulation mode of supply water temperature and its effects on indoor environment and energy use were analyzed. Then the simulation-based optimization method of supply water temperature was pointed out by comparing the relationship among outdoor temperature, indoor temperature, room base temperature and supply water temperature. The optimization effects were presented by comparing room indoor temperatures and energy consumption before and after optimization. As a result, the simulation-based method proposed in this study was proved to be an effective way to optimize the operation of heating system, by which "excessive heating" can be significantly decreased, and average daily indoor temperature can basically be kept at its set point.

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Keywords: Room heating system; Optimization of operation; Supply water temperature; Simulation-based; Optimization effects

1. Introduction

In recent years, the rapidly growth of energy use in developing countries has raised global concerns over energy exhaustion and heavy environmental impacts. In china, the growing development of economy and society has inspired large of building energy consumption, especially in north china, heating consumption account for a great proportion in building energy utilization, which has caused heavy pressure on environment.

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Over the past 20 years, a large number of theoretical and practical works has been carried out to improve the thermal insulation performance of building envelope, which actually reduced the heating demand in north china [1]. However, the actual effect is not ideal: indoor temperature of heating room was generally high and in some households indoor temperature was even up to 25℃. Further analysis suggested that the unbalance between heating supply and demand was the main reason causing overheating. Accordingly, it's necessary to optimize the operation of heating system to make it adapt to the changes of heating demand.

Relevant research on optimization of heating system mainly focused on establishing the mathematical model between supply water and outdoor temperature. On this basis, the static and non-static compensation models are widely developed and applied in space heating system [2-5]. Yet, the excessive heating has not been effectively controlled [6, 7]. A relevant study indicated, the optimization of operation of heating system should not only consider the influence of outdoor temperature on heating effect, but also focus on the dynamic effects of internal heat disturbances and solar radiations across thermal inertia of building envelopes [7, 8].

This study tried to propose a simulation-based optimization method of operation of heating system, which considers the dynamic effects of both outdoor temperature, internal heat gains and solar radiations, expecting to balance the heat supply and demand and finally achieve energy saving. Moreover, one example room will be selected to analyze and explicate the process of optimization, and the optimization effects will be presented by comparing indoor temperatures and energy consumption before and after optimization.

2. Methods

2.1. Regulation and effects of heating system

The district heating system in this study serves for the heating of some dormitory buildings, office buildings, laboratory buildings and residential buildings in one university in Beijing, with a total heating area about 140000m^2. The heat source side (boilers) was connected with the end users (radiators) through plate heat ex-changer. The water in the primary pipeline was heated by boilers and then transported to the plate heat ex-changer by the primary pumps, where the heat was transferred to the secondary pipeline.

The system operation was implemented manually by professional operators. According to what the operators reported, the supply water temperature of primary pipeline was adjusted by regulating the gas consumption depending on the outdoor climate conditions, and then influencing supply water temperature of secondary pipeline and end users accordingly. Based on the field survey data, the relationship between average daily temperatures of supply water and the weighted outdoor temperature is shown in Fig 1.

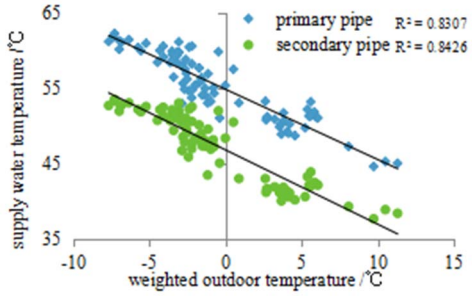

Fig.1. Relationship of supply water temperature with weighted outdoor temperature.

The supply water temperatures of both primary pipeline and secondary pipeline showed a strong linear correlation with outdoor temperature; and the relationship can be expressed in formula (1):