Retro-Commissioning and Improvement for District Heating and Cooling System Using Simulation

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Abstract: In order to improve the energy performance of a district heating and cooling (DHC) system, retro-commissioning was analyzed using visualization method and simulation based on mathematical models, and improved operation schemes were proposed according to simulation analysis results. The first part of this paper describes the system performance through visualizing the current operation modes. The second part introduces the retro-commissioning analysis for the system using mathematical models of each component. The third part studies the energy and cost performance of several improved operation proposals using simulation. The results are as follows.1) The carpet plots of current operation modes can be generated automatically and they are useful to check whether the operation is proper or not. 2) The total system simulation model was constructed. The simulation error of the total energy consumption was 1.5% and the percentage of root mean square error (%RMSE) was 16.3%, which show that the simulation is accurate enough to study the performance of proposed operation.3) System simulations for proposed operation schemes were performed. The simulation results show that the system operation with the optimal temperature set point of cooling water at 22oC can improve the total energy coefficient of the heat pump and cooling tower by 2.2 %. Another proposal is that if the return water temperature from users can be kept at the designed value, which is 13±1□ compared with the current average value of 10.5□, the total energy consumption can be reduced by 9.5%, and energy cost can be reduced by 11.6%.

1. INTRODUCTION

District Heating and Cooling system have been applied since 1970's because it can reduce harmful waste exhaust and improve energy efficiency compared with traditional local heat and cooling system. However it is reported that the system Coefficient of Performance (COP) is often less than 1 because of delivering energy consumption, equipments oversize etc. which make high energy efficiency cannot be achieved[1]. Therefore, it is important to operate a DHC system reasonably or optimally. So it is necessary to develop enhanced operation mode to improve energy efficiency as well as keeping the heating and cooling operation normal.

In order to apply the Retro-Commissioning for an existing DHC system, firstly, the simulation model of each component was developed and the simulation accuracy was verified using measured data. Secondly, the model of each component and control model were connected to form the simulation model of the whole heat source system. Finally, several proposals for reducing the energy consumption were analyzed using simulation.

2. PROFILE OF THE DHC PLANT

The DHC plant is located in Osaka, Japan. It is in charge of heating and cooling an office building and a building with welfare facilities since November 1992. Figure-1 shows the system diagram of the plant. Table-1 shows the profile of main equipments. The required supply temperature of chilled water is 6±1°C and the design value for return temperature is 13±1°C. The average system COP in 2004 was 1.89, which is a common value of most DHC systems[2].

The total electric consumption, water temperature, flow rate, and pressure, etc. are measured by the Building Energy Measurement System(BEMS) once one hour. Because these data are not enough for developing models, 9 points of the electric power of heat source equipments and variable water volume pump, 20 points of the current of