SECONDARY-SIDE OPTIMIZATION OF DISTRICT HEATING CONNECTIONS

Summary

For the transition of the energy system to 100% renewable energy sources district heating systems play an important role, especially to enable heat recovery of industrial waste heat or large scale heat pump applications to use excess electricity from PV or wind power to be stored as heat. The basis for an efficient district heating network is lowest possible return temperature and high temperature spread for low heat losses and high heat transport and storage capacity. The return temperature is mainly determined by the quality of heat consumption of the heat consumers. Standard return temperatures are around 50°C to 55°C, very often much higher up to 70°C but in principle easy to reach 40°C and less as also examples in Scandinavia show. Examples from on-site investigations combined with system simulations show huge potentials of easy to reach “low hanging fruits” of secondary side optimization measures. Practical examples of monitored improvements show results of successful simple measures in practice and further potentials by means of simulations.

Keywords: district heating networks, return temperature, consumer optimization

Field of application for the findings: Sustainable and Efficient District Heating

Addressed audience: researchers, technical office experts, district heating operators

1. Introduction

The transition of the energy system to 100% renewable energy sources means, among other things, utilizing or recovering as much as possible of the energy that has already been used through a cascade of processes. To a very large extent, recovery is only possible through the use of waste heat. This requires efficient and flexible heating networks to transport waste heat from where it is generated to a potential consumer and, where possible, to balance out any time lag between heat supply and heat demand. The basis for a district heating network that operates efficiently and thus economically (low heat losses, high transmission capacity, low flow rates, etc.) or that can efficiently absorb waste heat (as directly as possible or via heat pumps) is the lowest possible return temperature from consumers and the highest possible temperature spread respectively. Low system return temperatures are also essential in order to make the highest possible heat capacity of storage systems available to the district heating network.

Since the return temperature is determined solely by the heat consumer of a district heating network, it’s internal hydraulic system, and it’s control system, it is of highest interest to motivate consumers to design and operate inside the consumer’s area of responsibility the heating system in best possible way.

2. Methods

Methodologically, existing operational data from the district heating network operator and, where available, from the customer are analyzed. Additionally, during site inspections, the current condition of the technical rooms, as well as the heating distribution systems and the hot water supply and distribution systems, is assessed both quantitatively and qualitatively. Based on this, optimization potentials are identified, evaluated in terms of implementation effort regarding possible control optimization, hydraulic balancing, or simpler and more complex hydraulic modifications, proposed, and implemented where possible. Additionally, the optimization potentials are modeled using Polysun system simulations to estimate the expected improvements. Furthermore, based on the monthly readings of the heat meters and the corresponding climate data (heating degree days), the actual maximum loads and the realistically required design-loads are determined.

3. Preliminary Results

As a result, the experiences and findings from over 20 system analyses to date can be presented. For example, connection capacities were found to be oversized by a factor of 2 on average, with peak values reaching a factor of 4.

In a single family house the existing 50 kW district heating transfer station showed peaks of up to 45 kW in practice. The hydraulic adjustment of the domestic hot water charging loop into a 800 liter tank from 0.9 m3/h to 0.15 m3/h reduced the peak power including heating to 15 kW at coldest days in winter. The return temperature during domestic hot water charging could be reduced by about 10K to the same temperature level as space heating delivers.

In a 20 apartment multi family house the existing contract of a 130 kW district heating transfer station could be reduced to 60kW in practice without any comfort disadavantage.

A 64 apartment multi family house with original 54°C weighted return temperature (mainly in the range of 48°C to 60°C) just by optimizing pump flow rates with reduction s of about 50% to 60% showed 7K reduction to 47°C in return temperature in average. Some simple changes in the hydraulic layout to get a “cascade-concept” in the simulation study showes the potential of further 6K reduction to 41°C weighted return temperature.

The effect of correcting to the correct power values through secondary-side optimizations means not only a significant reduction in the power price for the district heating customer but also, from an operational standpoint for the district heating network operator, a significant reduction in power peaks and typically significant lower return temperatures.

In five buldings of the same owner with actual return temperatures clear above 55°C up to 65°C it is possible to save about 100,000 EUR operating cost annually according to the bonus malus contract with 5% additional cost above 55°C and 5% bonus when reaching less than 50°C. Such incentives make it attractive to do investments which pay back within just one or two years in many cases which were investigated.

Several further examples demonstrate that a common problem is the incorrect integration of a storage tank, which tends to increase power peaks rather than reduce them. Also several examples demonstrate how even a single consumer within a customer’s system can effectively act as a hydraulic short circuit, thereby massively and unnecessarily increasing the return temperature.

This article illustrates how such problems can be detected and often solved through quite simple measures, both by analyzing measurement data following potential optimization measures and through system simulation analyses.