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Methods of improving the performances of the low-temperature district heating system

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According to the energy guideline of European Union, the overall primary energy consumption needs to be reduced by 1/3 compared to the current, while the proportion of the renewable energy usage should be increased. The heating demand, which plays a role in the overall energy consumption, thus should be supplied more efficiently. With district heating, it is possible to aggregate large-scale excess heat from industry or waste heat for heating purpose. Nowadays, the district heating system are experiencing a transition towards the 4th generation district heating (low-temperature district heating), which will be operated mainly at 50-55 °C as supply temperature and 25 °C as return temperature[1]. That means more low-temperature renewable energy sources will be accessible. But how to provide sufficient heat without violating any comfort and hygiene requirements is crucial for the new generation district heating.

The local substation is used to harmonize the parameters between the primary side and secondary side. The optimization of the substation is helpful to remove the temperature or hygiene restrictions of low temperature district heating (LTDH), enhance the stability of the heat supply, and create synergy with the power grid. Considering the features of different district heating systems and building typologies, different methods to improve the performance of the district heating system are proposed.

1. Flat station for the newly-built buildings, LTDH can be used as heat supply. Since domestic hot water is produced locally, the hygiene risk of low DH supply temperature can be eliminated. Such type of substation has good energy and exergy performances.
2. Low temperature or ultra-low-temperature district heating with local supplementary heating devices is preferred for low-heat-density area due to lower relative system heat loss. Different heating devices can be considered for this combination, such as electric tracing, electric booster, electric micro tank concept. Their performances and comparisons have been studied in the authors' previous work[2]xi. Moreover, the low-temperature renewable energy sources can be beneficial with lower fuel costs. Thus, even excess electricity is consumed, it is still possible to achieve better performance compared to the conventional medium temperature district heating.
3. The optimized control method and design for the heating devices should be a general solution for the improvement in the substations. The over dimension and bad control of the equipment are the main problems. For example, an oversized charging flow of the storage tank will heat the storage tank frequently, which will result in too high district heating return temperature, especially during the period with low-tapping or non-tapping period. However, by optimizing the charging flow, the tank can be heated gradually during the day and the DH flow can also be cooled down efficiently. For the building with large domestic hot water circulation system, a more robust solution can be developed by installing a circulation heat pump between the storage tank and circulation circuit.

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