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The feasibility analysis for the concept of low temperature district heating network with cascade utilization of heat between networks

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Abstract

Recently, low temperature district heating networks (LTDH) have received attention in district heating and cooling market due to their benefits in terms of efficiency, greenhouse gas reduction, flexibility to use renewable energy sources and economic benefits. In this work, physical and techno-economical aspects of the new concept of cascade types with high temperature district heating (HTDH) return is utilized to supply heat at low temperature networks. The HTDH return water temperature is around 45°C and supply of LTDH can be set around 60°C. The return water temperature of HTDH return line at 45 °C can be raised to 60°C with the help of heat pump. A detailed study of major components, network design, pressure drop, heat loss and power consumption was performed to formulate an annual, hourly, based energy simulation to assess the techno-economic feasibility of the systems for different types of customers (residential & commercial) The economics were also analysed in terms of internal rate of return (IRR) and the results show that IRR for residential buildings varies from 14 ~ 17%. In order for the successful realization of the proposed system in the market new sustainable systems encouragement in government level is desired to be provided in the form of renewable energy target/certificates or CO2 reduction incentives especially at the initial stage of the commercialization of the model.

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Keywords: Low temperature district heating; heat pump; cascade heat utilization

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1. Introduction

District Heating (DH) is concerned with centralized production of heat and electrical power and its distribution in such efficient way that the production and maintenance cost incurred is lower than individual production of end user [1]. District heating network has evolved over time in terms of its supply temperature and efficiency. Fig 1 presents the evolution and enhancement of efficiency of DH network with respect to the supply temperature. It is evident that the low temperature district heating networks are the best in term of efficiency and will be sustainable alternative in future of DH technology.

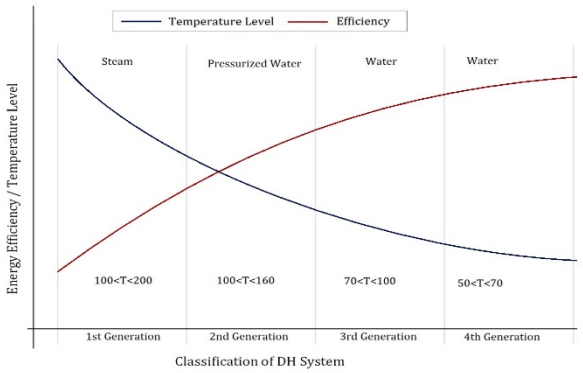

Figure 1. Classification of DH system based on temperature

The advantages of low temperature district heating include the following

- Reduced Network heat loss

  Decreasing the temperature of supply reduce the overall mean temperature difference between pipelines and ambient and thus heat loss is reduced without changing the insulation.

- Reduced Pipeline Thermal stress

  Using lower supply temperature, there will be less variation in supply temperature along the pipeline. The reduced risk of pipe leakages due to thermal stress and maintenance cost will be reduced. Furthermore, different material can be considered as candidates instead of steel or copper as in HTDH.

- Reduced Risk of boiling

  The Lower supply temperature reduces the risk of boiling as fluid temperature is far from saturation temperature.

- Renewable/Multiple heat source

  With reduced temperatures, it is not necessary to always use high exergy heat source. Renewable or multiple heat sources can also be used with ease.

- Greater utilization of thermal storage units

  Utilization of thermal storage units allow to handle the peak loads without greatly oversizing equipment and so reduce investment costs.

- Improved power to heat ratio in steam CHP system

  The efficiency of CHP unit is dependent on the condensing temperature of CHP unit. Low network supply and return temperature allow more power to be extracted from steam turbines. The reduction of the