Study of a double subsurface snow-water utilization system for the melting of snow using the waste heat of urban sewage

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\textbf{ABSTRACT}

This study describes technology that melts snow using the waste heat of urban sewage and reclaims snowmelt on site using a double subsurface constructed snow-melting system, allowing the organic integration of snow utilization and landscape design in cities with long winters. This system highlights the thermal energy cycle, in which underground urban sewer pipes and the considerable amount of low-temperature waste heat that they contain are utilized along with a small-temperature-rise heat pump to ultimately melt snow. The temperature of sewage in the winter usually ranges from 4 to 10\degree C in cities, representing a high-value resource that can be developed and utilized. In this system, an indirect heat exchanger heat pump, which uses sewage as its heat source, is employed, and the heat is exchanged between the sewage and intermediary water in the heat exchanger. This is followed by heat removal and the emission of radiation into a working substance in the condenser and evaporator, respectively. Then, the water temperature in the assemblies of the heat pipes is increased, thereby increasing the coefficient of performance (COP) to 10 and achieving the concentrated reuse of the distributed waste heat. The double subsurface snow-melting system consists of snow-melting wells and double subsurface tanks. The surface plant residues and frozen layer constitute a natural insulation layer to maintain the water-purification activity of the lower-layer, low-temperature anaerobes. The removed snow is dumped into the snow-melting wells by workers and heated by the hot grate and pipes on the sidewalls and at the bottom of the wells. The snowmelt water flows into the pretreatment tank and grill, and then, it enters the lower layer of the double subsurface tanks. The lower-layer gravel fills are colonized by low-temperature oligotrophic bacteria. The removal of samples for the analysis of BOD\textsubscript{5}, COD, and SS is efficient, and the quality of the output thereby satisfies the standards for municipal water use.

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