SophiA
Sustainable Off-grid solutions for Pharmacies and Hospitals In Africa

Self-sufficient cascade system in combination with a thermal energy storage charged by a two-phase thermosiphon

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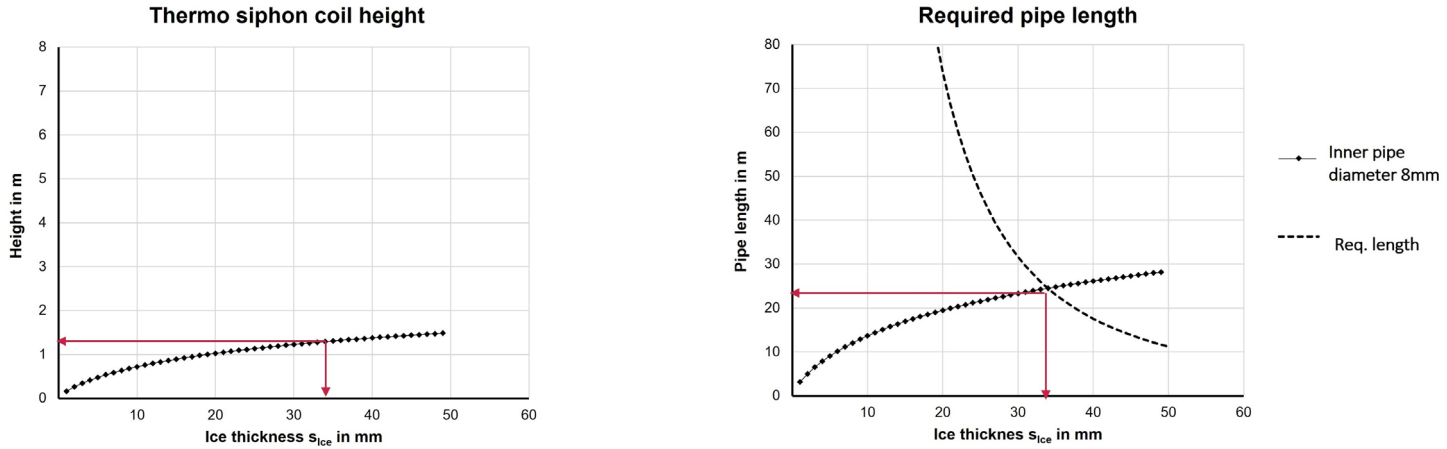
SOFACT N°4

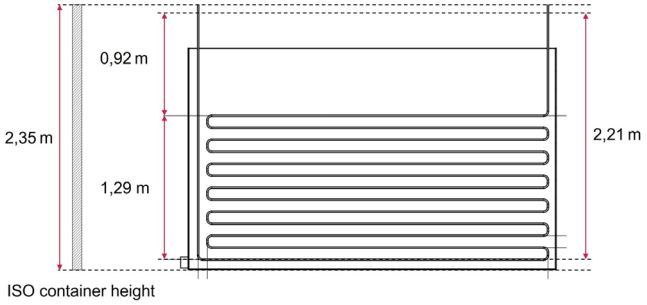
The PV panels of the SophiA cooling container supply electricity. A storage capacity is necessary to bridge nights and days when the electricity production is insufficient. In this paper, the construction of the TES is explained and its charging and discharging process is described.

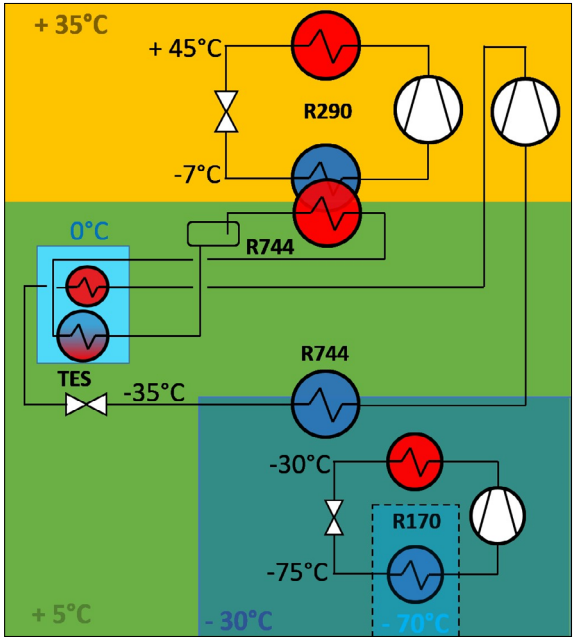


Simulation results - pipe length and heat exchanger height

Since the heat transfer coefficient deteriorates as the ice layer on the waterside in the ice storage tank increases, a simulation of the ice layer thickness was performed for the designed pipe diameter.

The simulation showed that the evaporator coil results in a height of 1,3m and a liquid column in the inlet of the thermosiphon of 0.92 m is required to overcome the pressure loss when evaporating in the 24,5m pipe length.





Principle structure of the SophiA refrigeration technologies

A thermal energy storage (TES) is implemented in the propane-CO_2 cascade. The TES is charged by a two-phase thermosiphon and discharged using a separate coil. The additional coil works as the heat sink for the -30°C CO_2 loop.

The total height of the ice storage tank with two-phase thermosiphon would theoretically fit into a 40-foot container and the experimental results of the preliminary test show that the operation of the two-phase thermosiphon works. However, the geometry of the natural circulation evaporator should be adapted according to the height occupied by the high-pressure receiver and insulation thickness.

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