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Development of a sensor for the detection of the charge status of ice stores

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Objectives

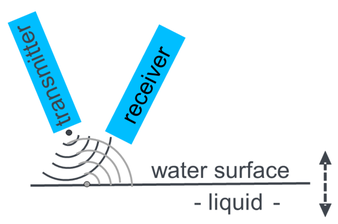
- Detection of the charge status of ice stores to maximize their efficiency and the use of the stores capacity
- Determination of the ice shield to protect the store tank and/or the heat exchanger from destruction

Within the joint project “Sol4City” integrated solar supply concepts for climate-neutral buildings for the "city of the future“ are being developed. The innovative concepts are based on an anergy supply network, also known as cold district heating network, which serves as a heat source for decentralized heat pumps. In combination with a central, seasonal low-temperature latent heat store with water as storage medium and an adaptive and predictive system control, the aim is to realize a highly efficient heating system using solar radiation and environmental heat as main energy sources. In order to control the system in an optimized way, the detection of the store’s charge status is of great importance. As an appropriate sensor is not available up to now the development of such a sensor is a key project goal. This poster presents a model ice store and a real-scale ice store with 12 m³ volume, newly installed at IGTE as well as the working principles of the most promising sensors and their accuracy and suitability compared with the vertical radar or ultrasonic sensors used to date.

Most Promising Sensors

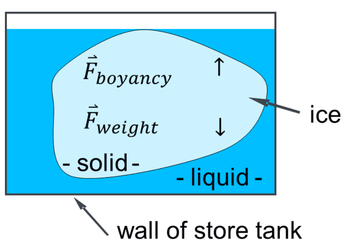
Vertical Ultrasonic Sensors (state of the art)

- Point measurement of the percentage of ice only
- Falsification of the measurement result due to water inlet/outlet



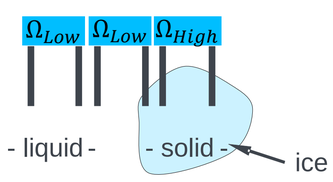
Buoyancy Force Sensors

- Measurement of the percentage of ice possible
- No direct determination of the ice shield



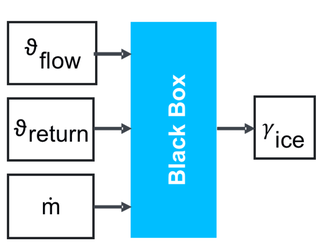
Electrical Conductivity

- Point measurement only (3D measurement possible depending on sensor arrangement)
- Homogeneous ice formation not determinable



Energy Balance

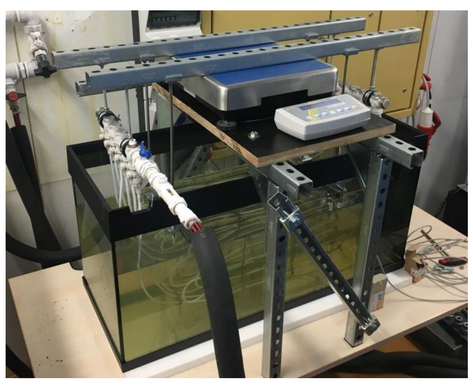
- Measurement of the percentage of ice possible
- No direct determination of the ice shield



Model Ice Store

Sensors are tested

- for their general suitability
- for their measurement uncertainty



Real-Scale Ice Store 12 m³

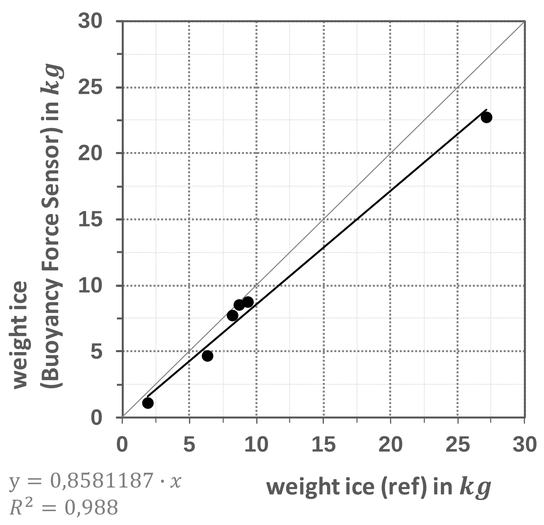
Sensors are tested

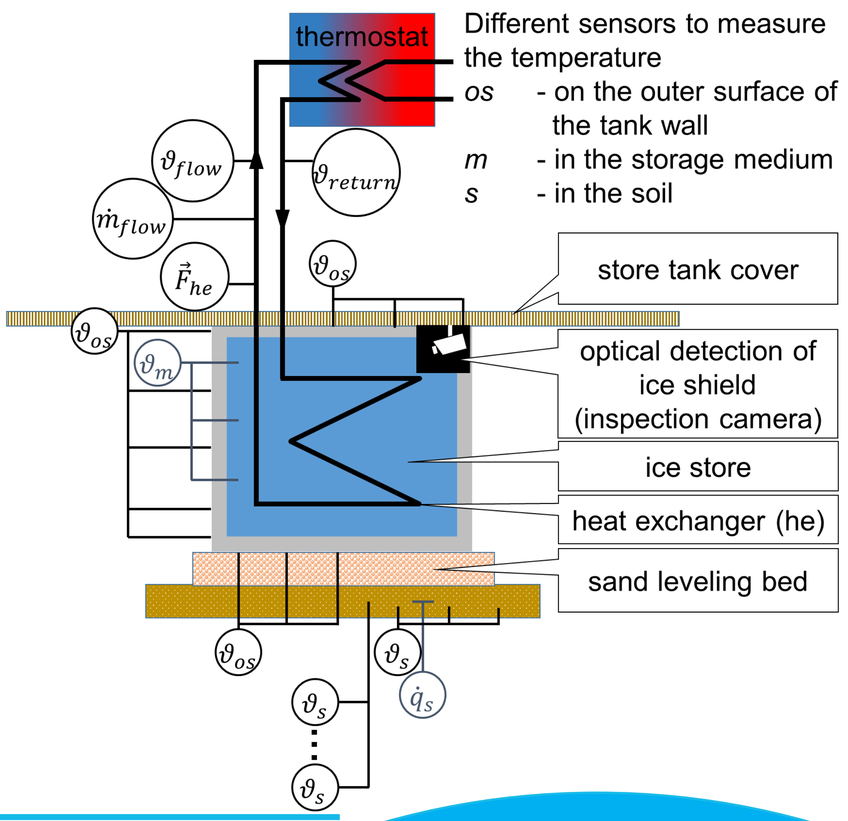
- under real operation conditions
- for their long-term stability

First Results

Buoyancy Force Sensors

- Measurement uncertainty u = 0,783 kg (10,4 %)





Preliminary Conclusions

In order to achieve both goals, the determination of the charge status and the detection of the ice shield for protection against destruction, based on the current research results a combination of two sensors turns out to be the most suitable sensor technology at present. While the measurement of electrical conductivity can be used in particular as a punctual safety sensory at the edge of the store tank, the buoyancy force sensor, among others, is suitable for making a statement about the charge status of ice stores. The further metrological investigation as well as a final evaluation of the sensors will take place in the further course of the joint project “Sol4City”.

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