Smart Solar Tanks with Variable Auxiliary Volume

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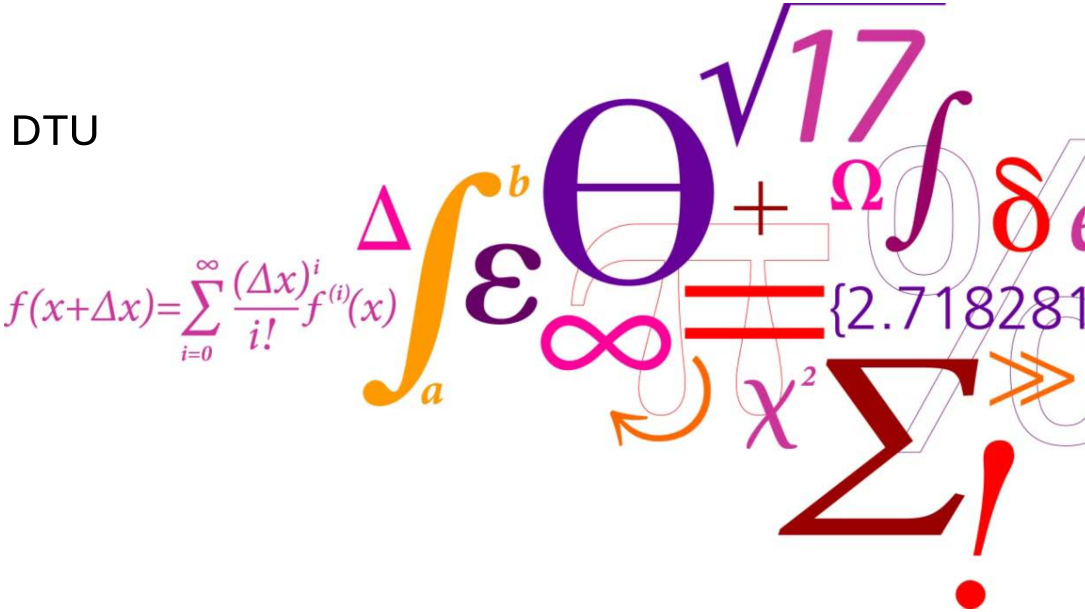


Smart Solar Tanks with Variable Auxiliary Volume

Content

- Why smart solar tank?

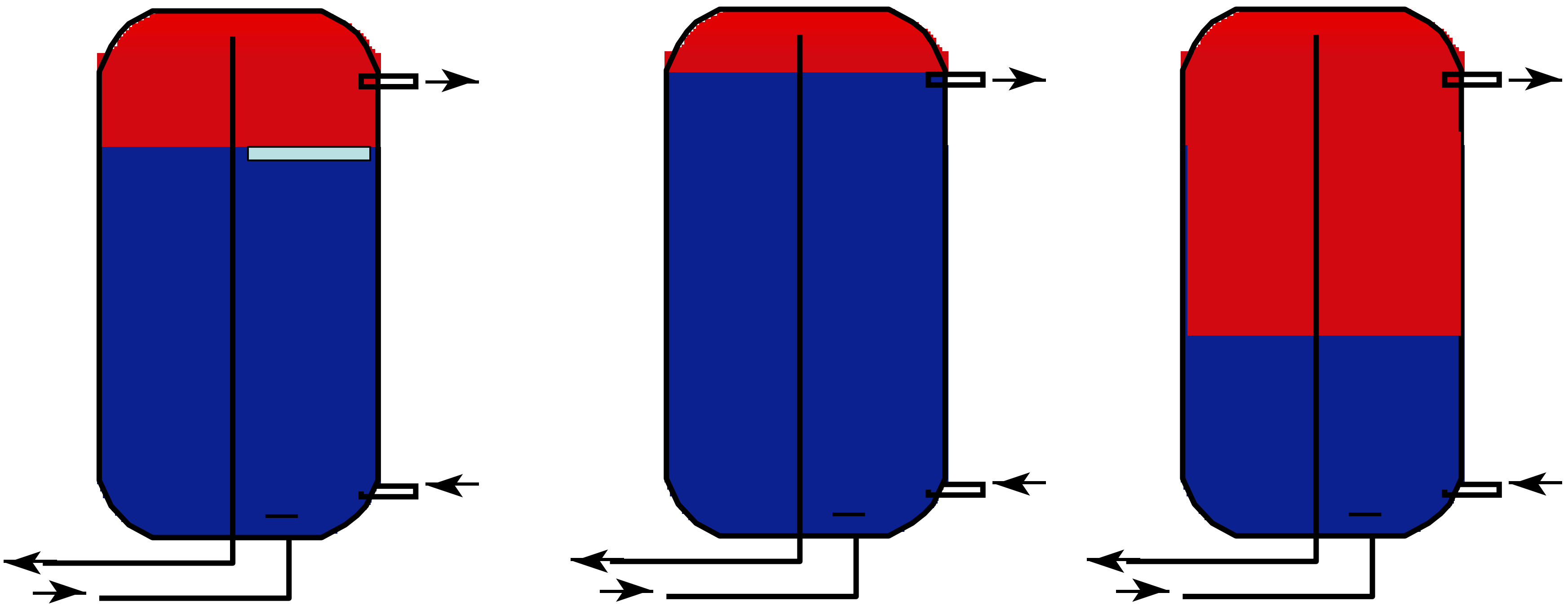
- How does a smart solar tank work?
  PIV (Particle Image Velocimetry) measurement
  CFD (Computational Fluid Dynamics) simulation

- Preliminary conclusion and future plans

Why smart solar tank?

A traditional tank with fixed auxiliary volume

Smart solar tanks with a variable auxiliary volume fitted to expected energy demand



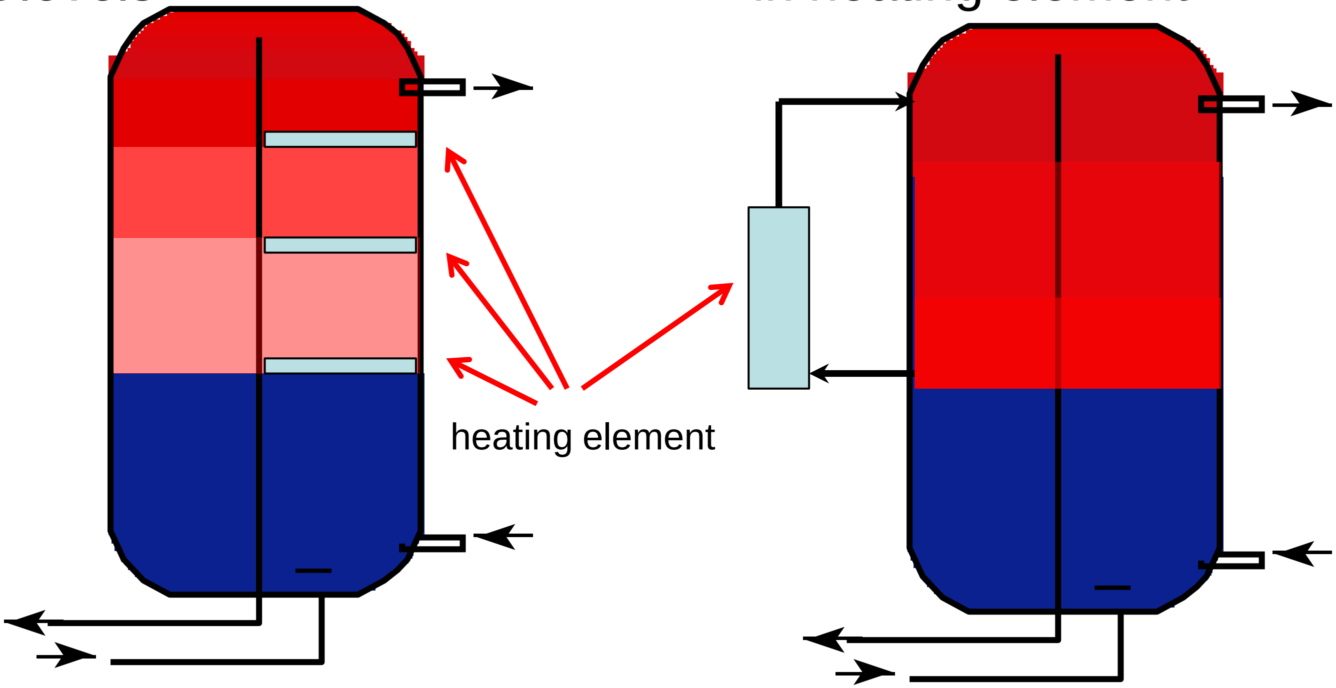
Advantages of a solar tank with a variable auxiliary volume

- lower heat loss from the tank
- higher system thermal performance

How to achieve a variable auxiliary volume?

A tank with internal heating elements at different levels

A tank with a side arm with a built-in heating element

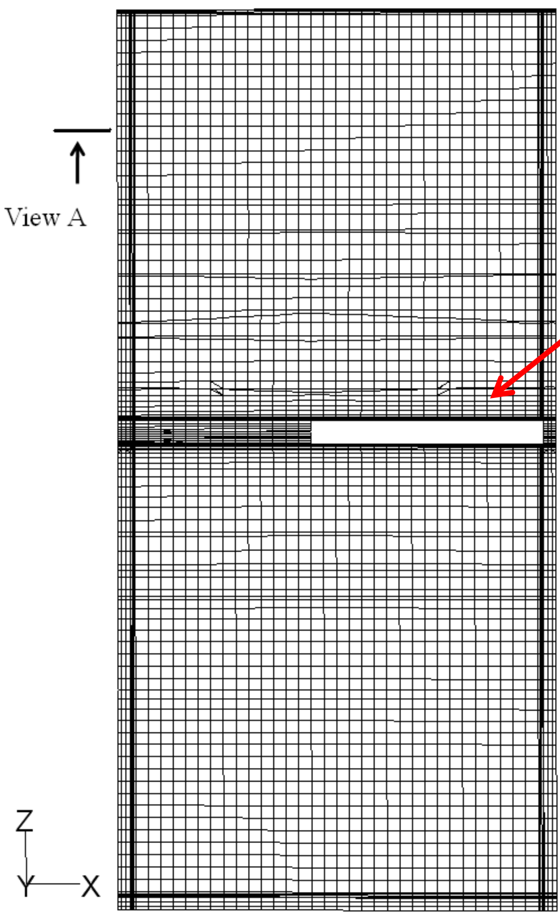


A variable tank volume is charged by the heating elements at different levels.

A variable tank volume is charged by the heating element in the side arm by means of thermosyphoning.

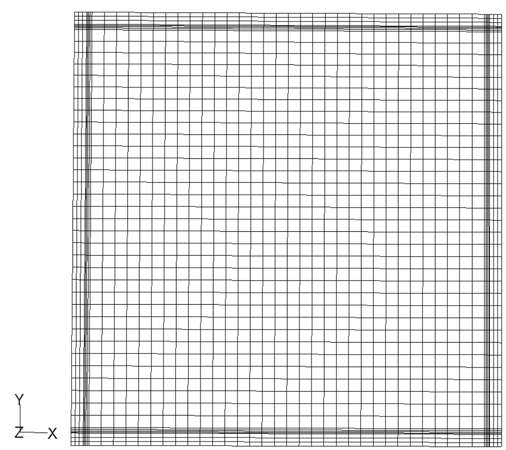
Does it work and how it works?
CFD model of the tank with an internal heating element

For the purpose of model validation

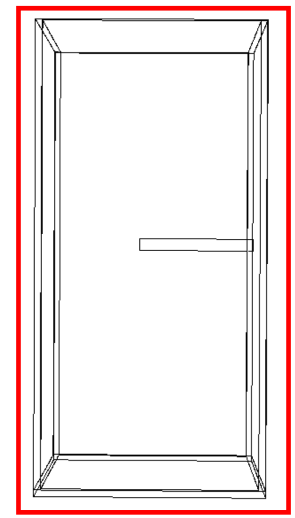


Electric heating element

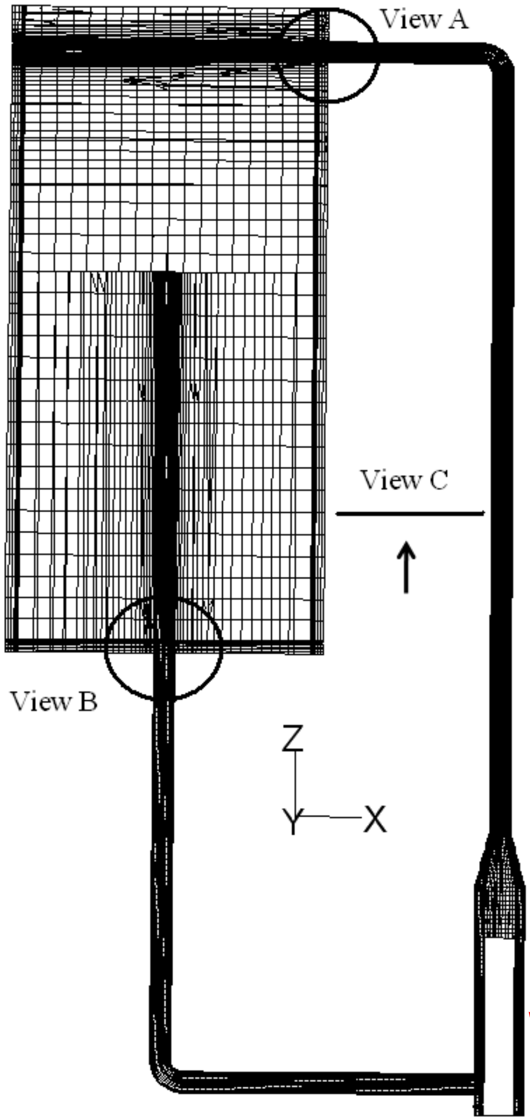
View A



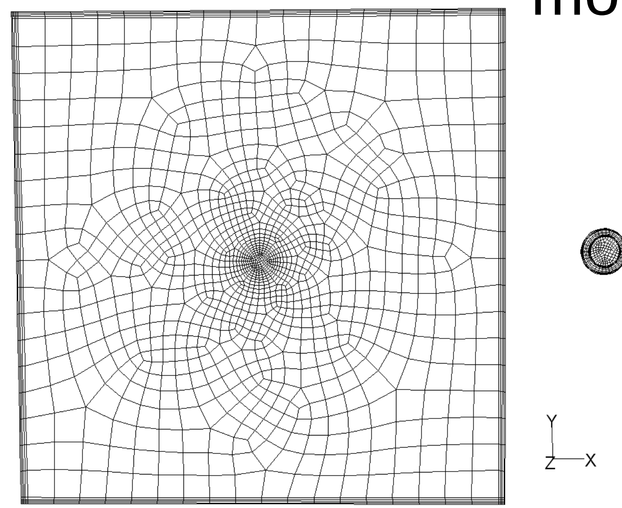
Tank design



Does it work and how it works?
CFD model of the tank with a side arm

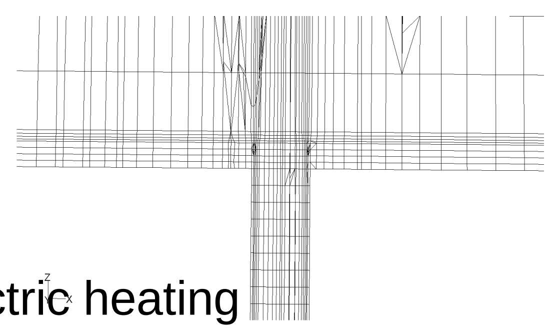


View C

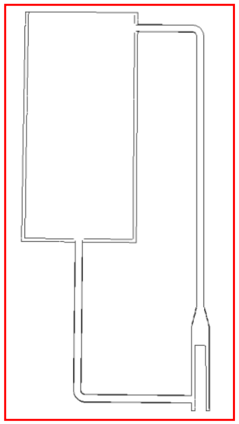


For the purpose of model validation

View A and B



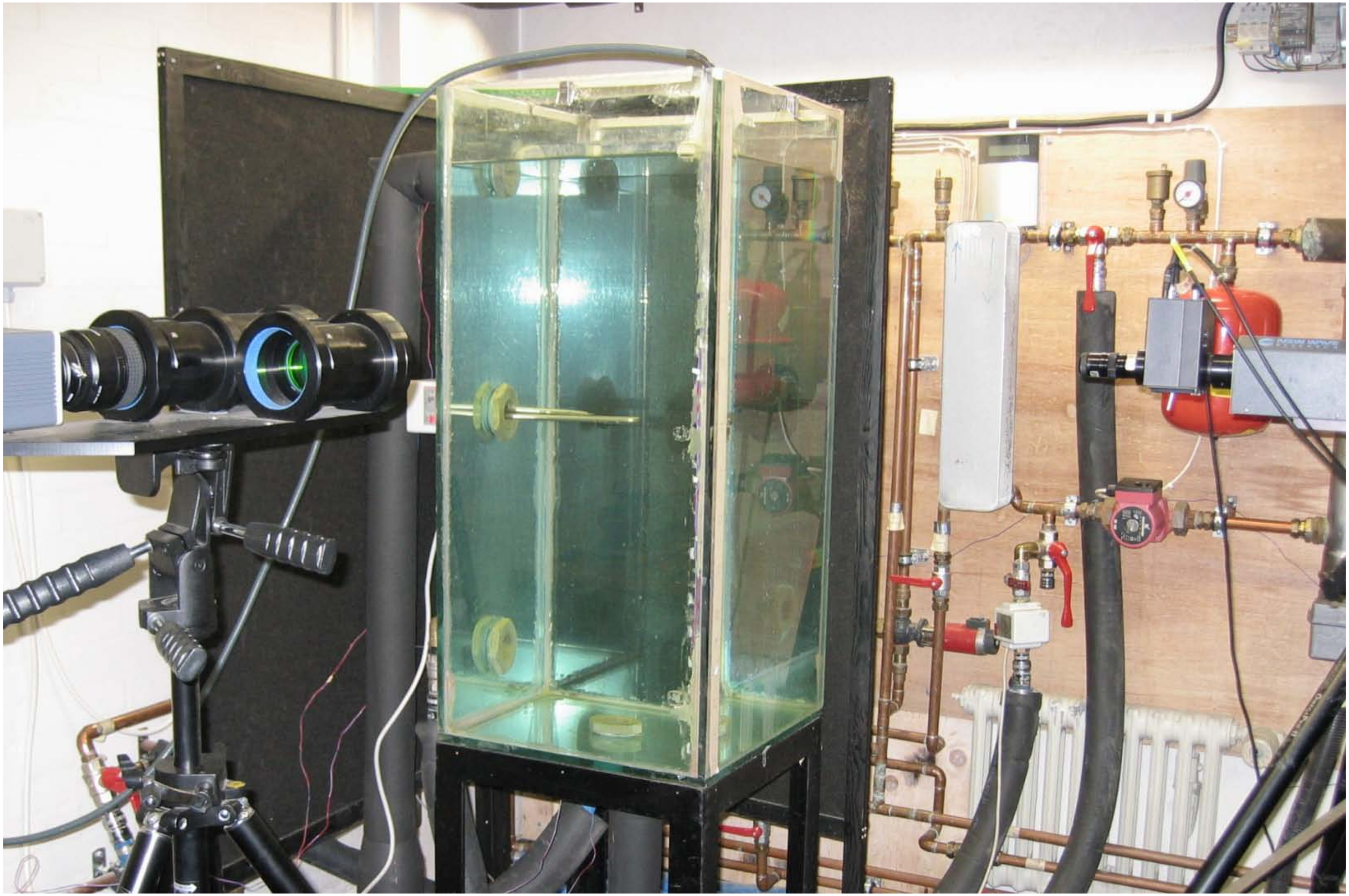
Tank design



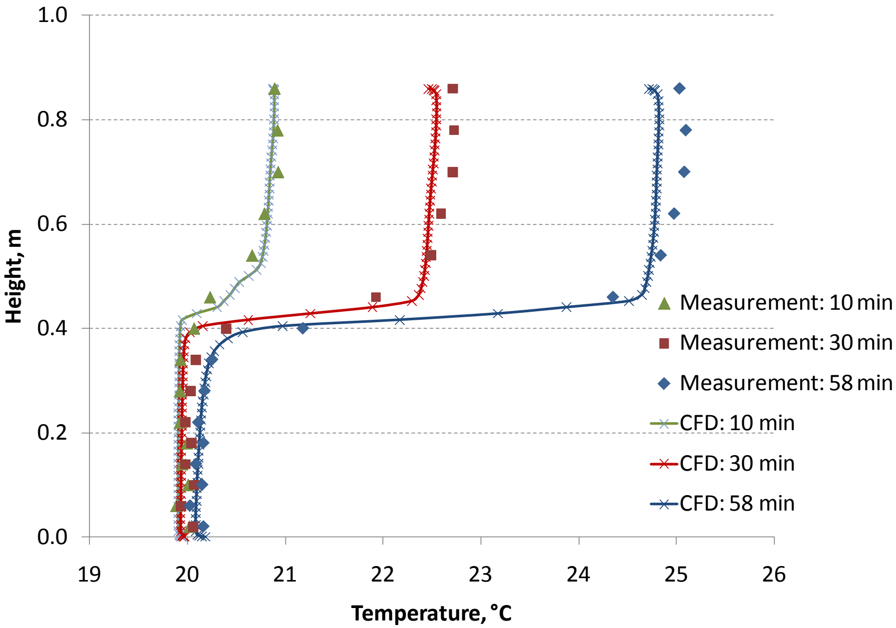
Electric heating element

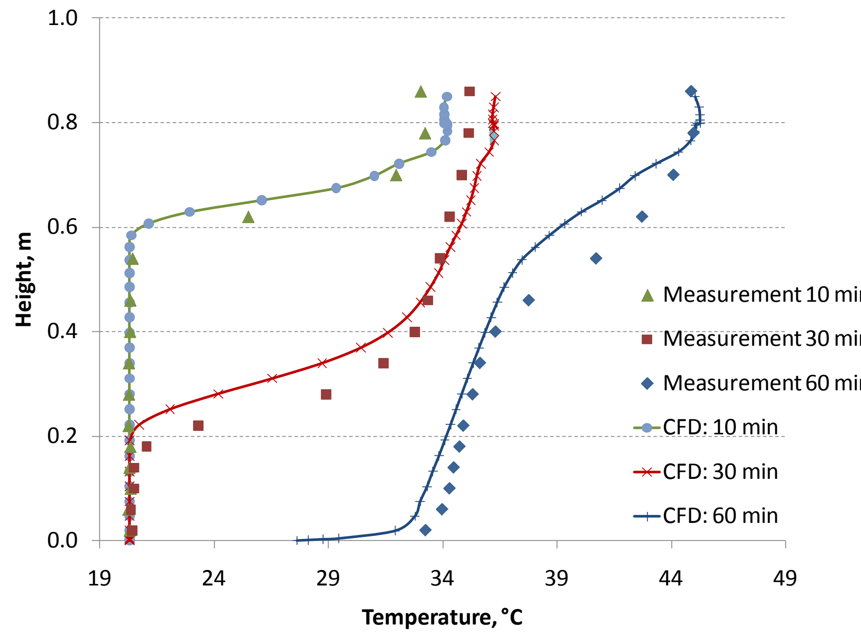
Does it work and how it works?
Fluid flow and temperature measurement

PIV=Particle Image Velocimetry

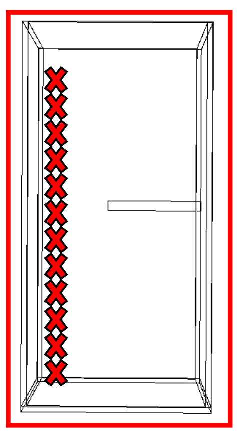


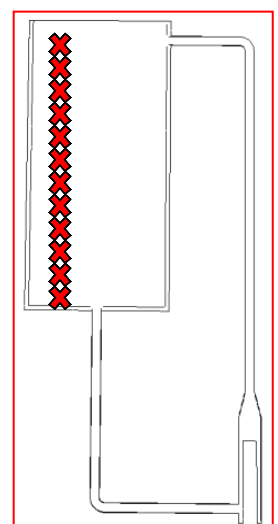
Thermal stratification in the smart solar tanks during charging





A tank with an internal heating element
Charging power: 0.5 kW

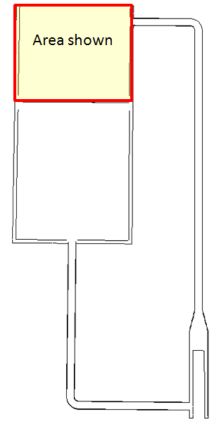




A tank with a side arm
Charging power: 3 kW

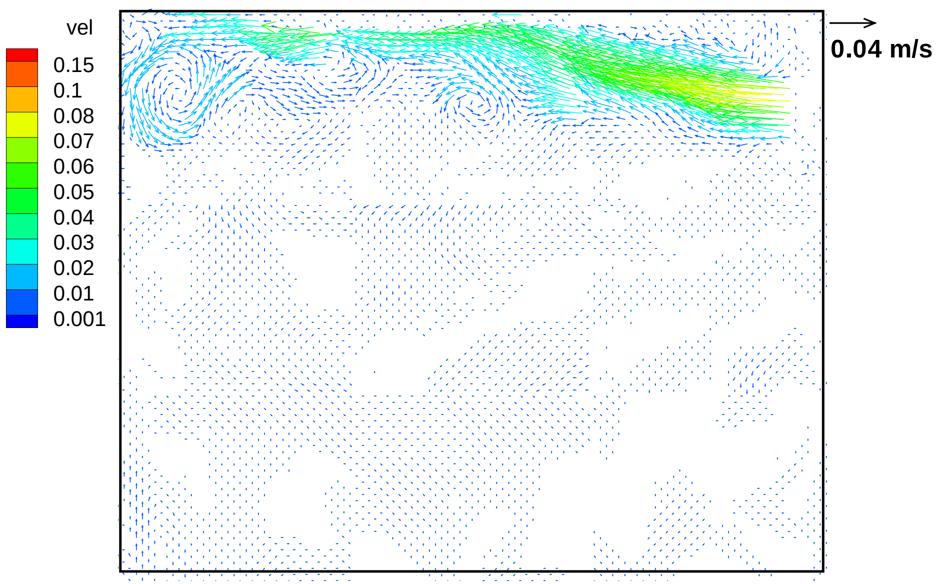
temperature sensor

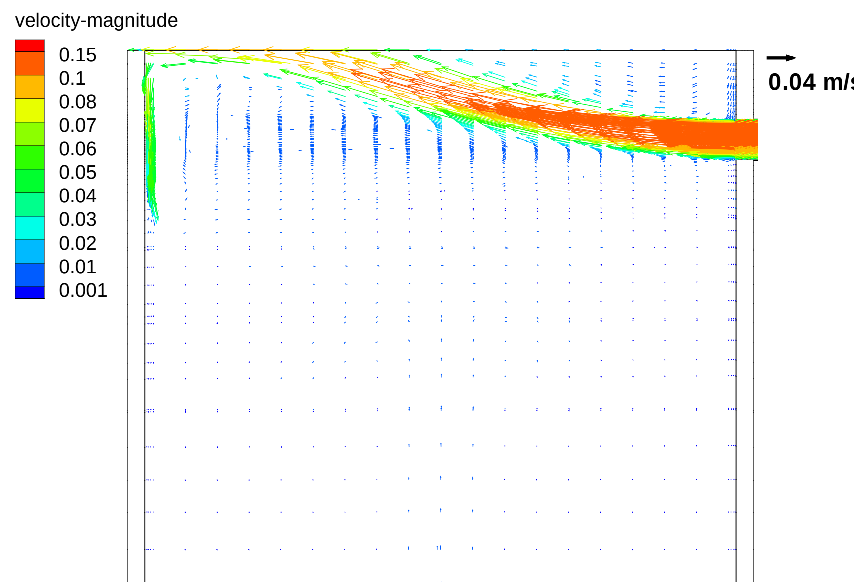
Flow field comparison between PIV and CFD



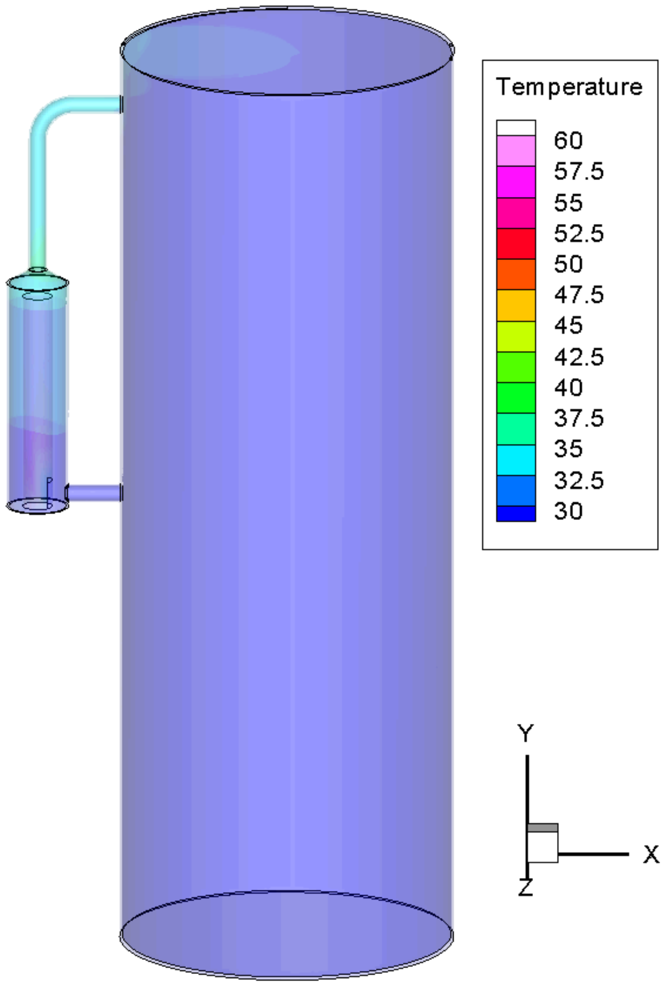
PIV

CFD

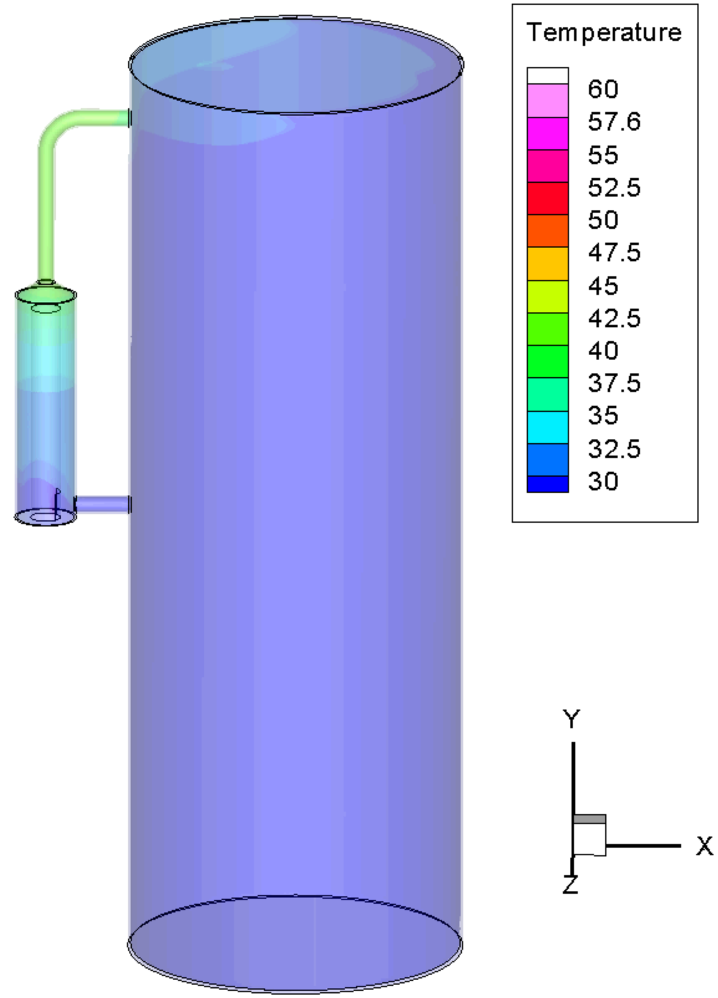




Influence of charging power on thermal stratification in the tank

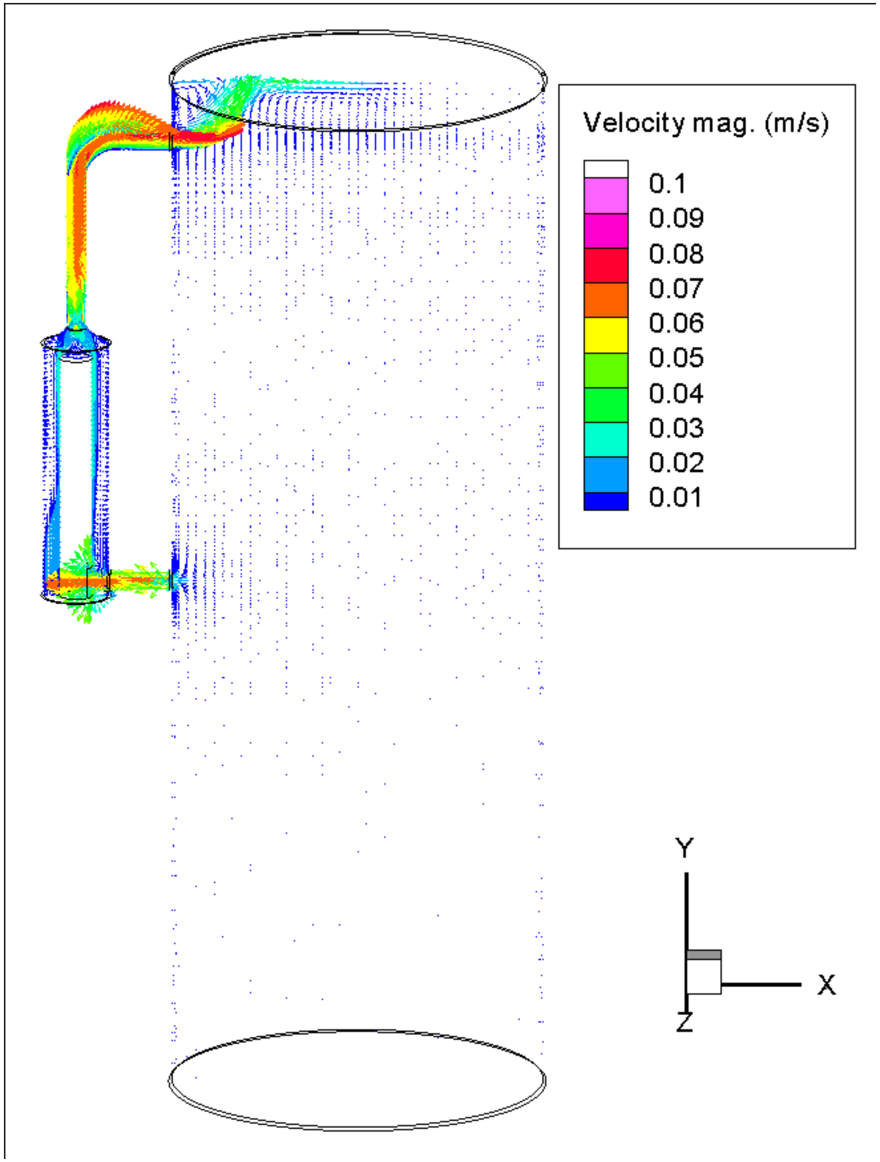


Charging power 1 kW
Duration: 30 min

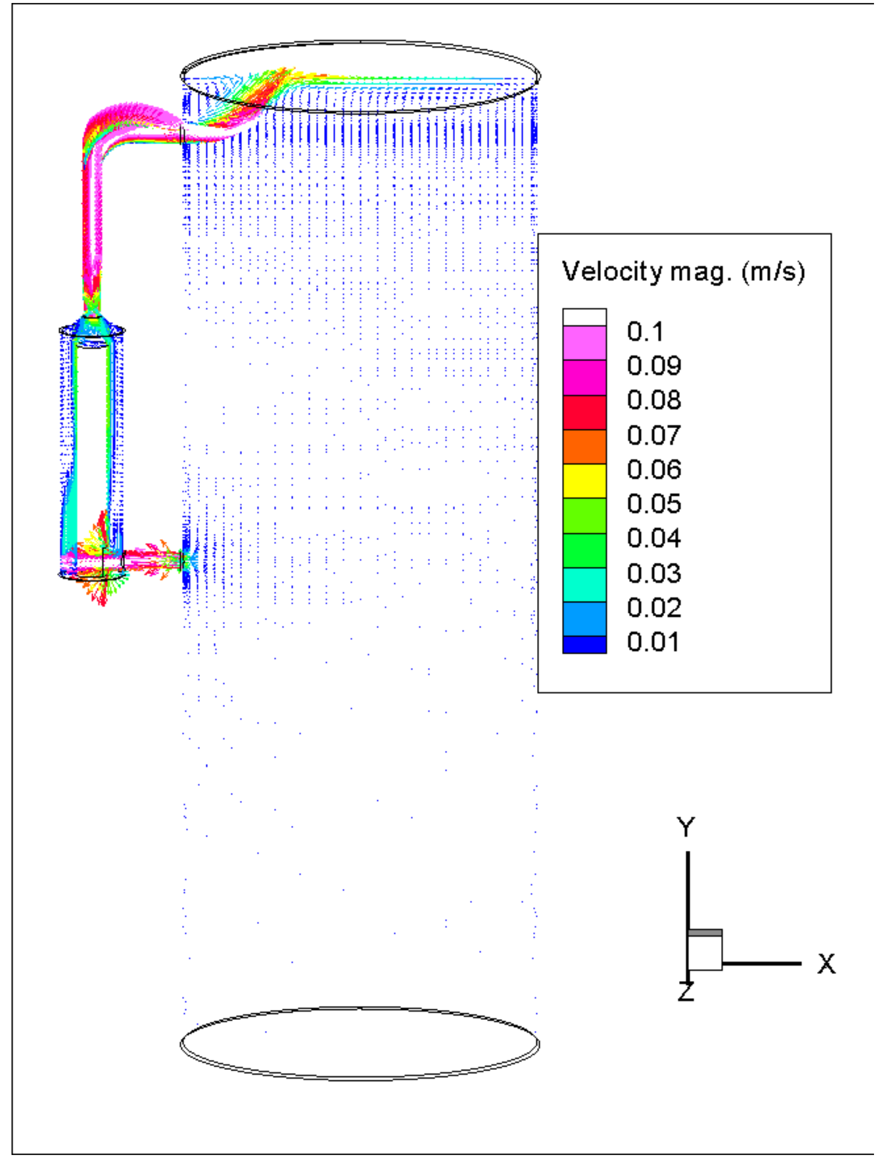


Charging power 3 kW
Duration: 30 min

Influence of charging power on flow circulation in the tank



Charging power 1 kW, Duration: 30 min



Charging power 3 kW, Duration: 30 min

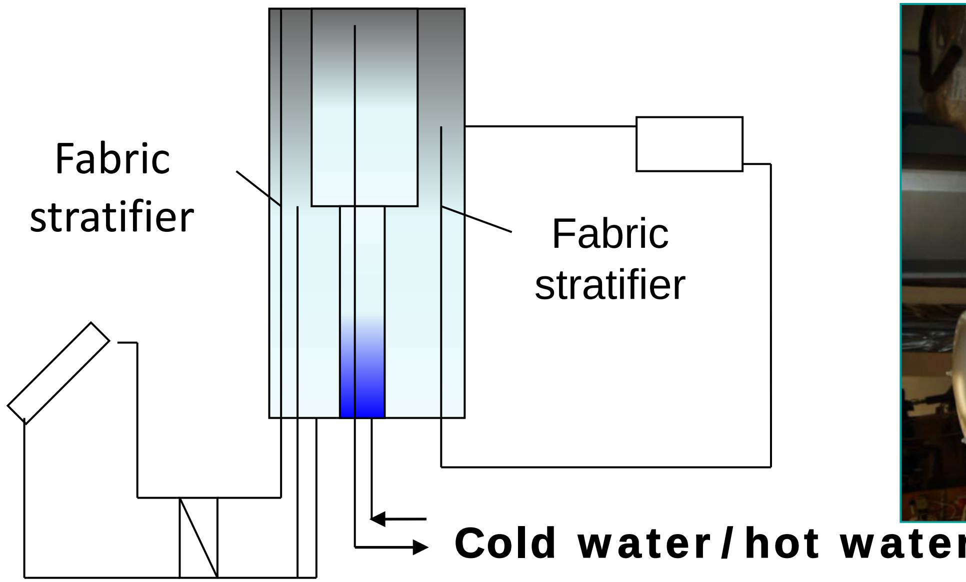
Preliminary conclusions

- CFD models have been created and validated for smart solar tank with an internal heating element and tank with a side arm.
- The validated CFD models will be used to investigate the influences of the following parameters:

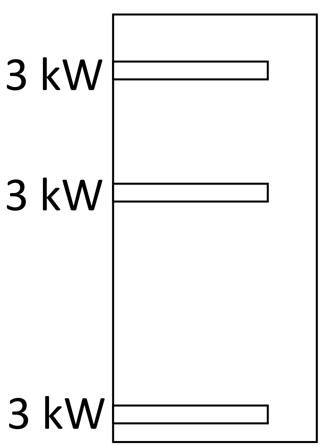
    charging power, diameter & location of the side arm, design and location of the heating element.

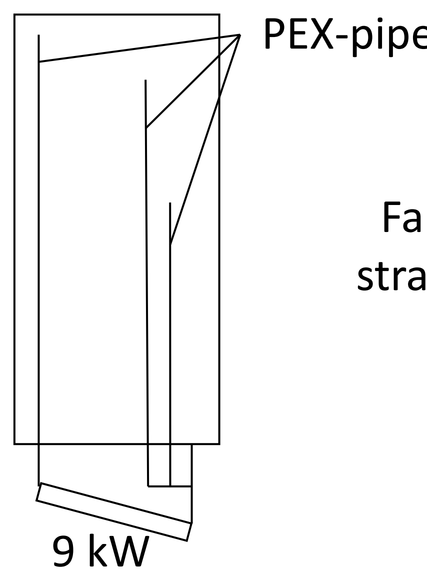
- The validated CFD models will be used to determine the optimal design of smart solar tank.

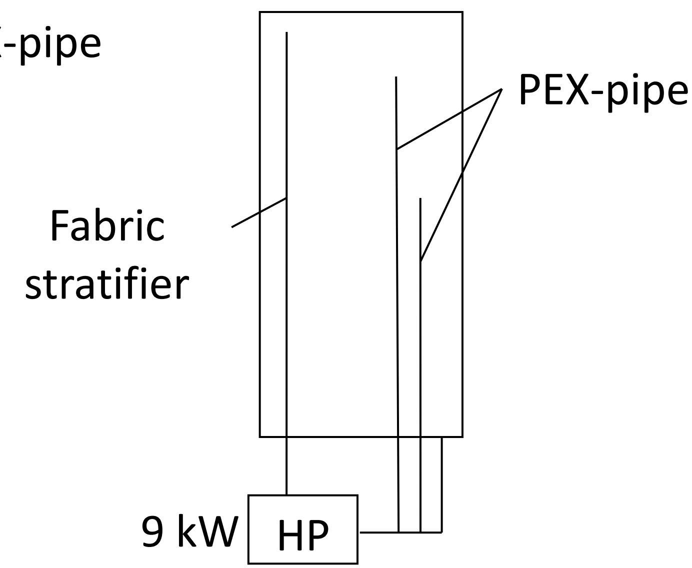
System sketch



Auxiliary energy – different ways of charging







Three solar combisystems with differently designed smart tanks will be tested in PTF.

Thank for your attention!