EMUG 2022 meeting

Analysis of nodalization effects on thermal stratification of a suppression pool

Sara Ojalehto

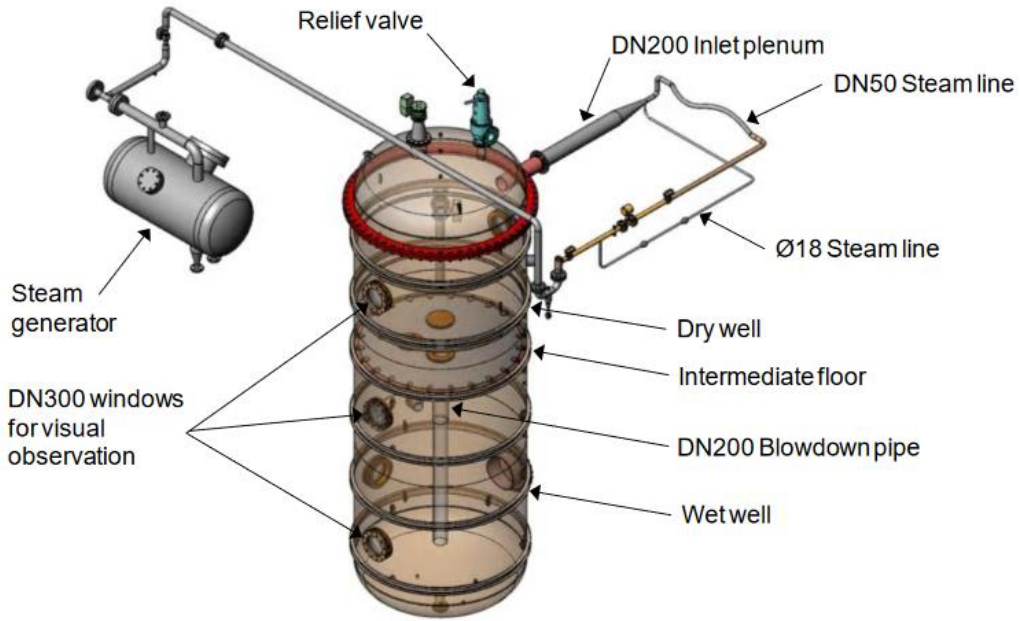
Objectives

- Study the effect of nodalization on the thermal stratification of a suppression pool by simulating PPOOLEX STR-11 experiment with different nodalizations.

PPOOLEX facility and STR-11 experiment

PPOOLEX test facility

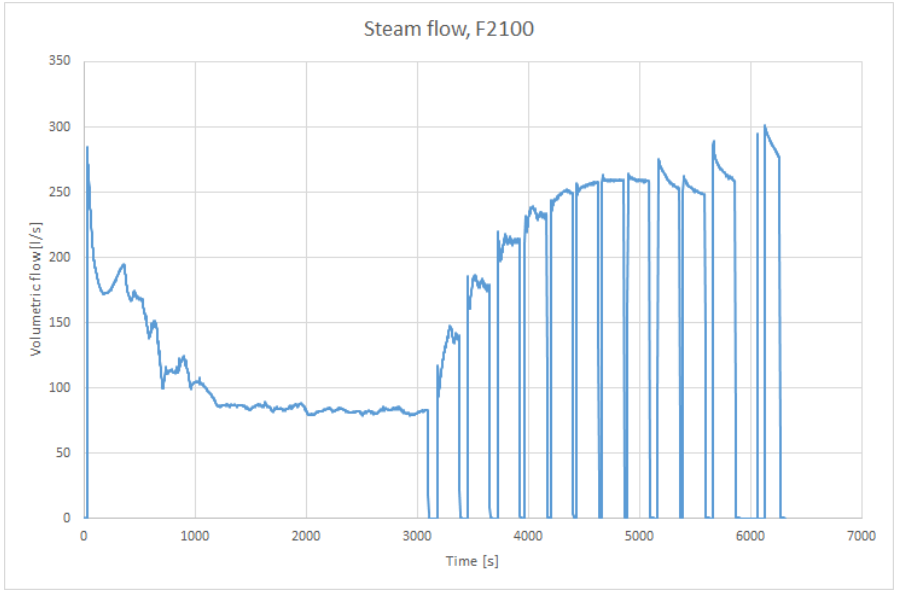
- Located at the Lappeenranta University of Technology (LUT) in Finland.
- Successor to the POOLEX facility.
- Used for BWR containment condensation studies.
- The dimensions of the cylindrical test vessel:
  - Height 7.45 m
  - Diameter 2.4 m
  - Total volume 31 m^3 (dry well volume 13.3 m^3 and wet well volume 17.8 m^3)
- Dry and wet well compartments volumetrically scaled to match the relative volume of the corresponding compartments found in Olkiluoto 1 & 2 containments.

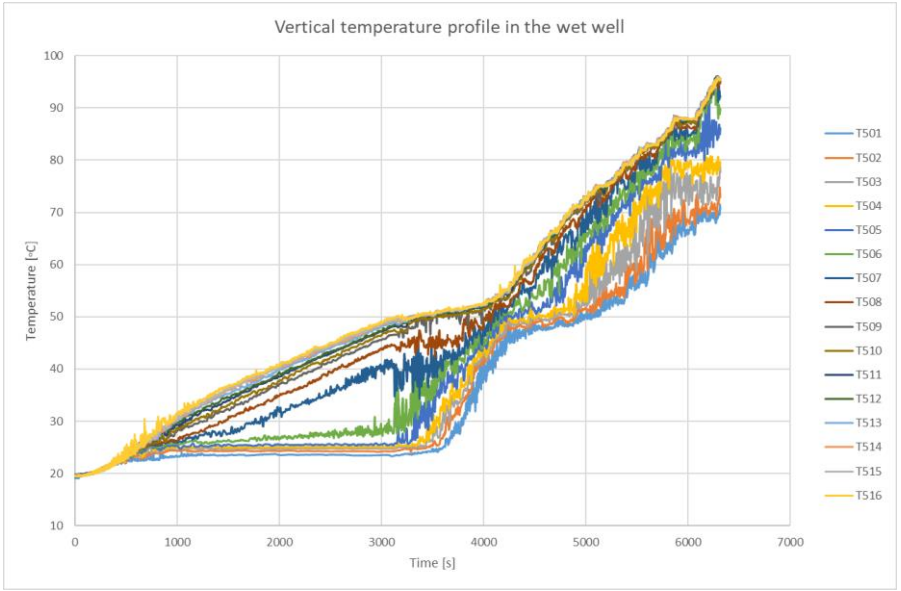


STR-11 experiment

- Part of a 5-part series of thermal stratification and mixing experiments.
- The purpose of the experiments was to study thermal stratification and its effect on thermohydraulic loads on wet well structures. Additionally, the experiments were used to provide validation data for computer codes.
- Test initialization:
  - The dry well structures were heated.
  - The wet well was filled with 20 C water up to level 1.47 m (total height of the pool being 2.14 m).
- The test procedure consisted of two parts:
  - Thermal stratification period (up to 3100 seconds)
    - Constant low steam flow ~100 g/s.
  - Mixing period (3180 s ->)
    - Step-wise increased steam flow 120 – 780 g/s.

Steam flow and the pool temperature during the experiment





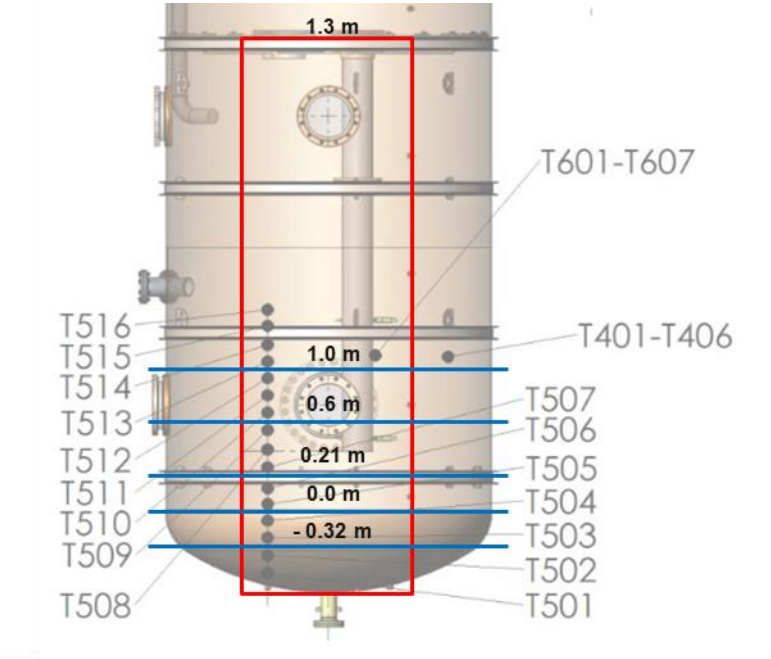
MELCOR model

MELCOR model

- The MELCOR model includes the inlet plenum, dry well, blowdown pipe, wet well and heat structures.
- Boundary conditions:
  - The pressure and the flow rate of the incoming steam were obtained from the measurement data.
  - Dry well completely insulated.
- Calculations were run for 6500 seconds.
- 7 cases were run with the number of nodes ranging from 1 to 12.

Model nodalization

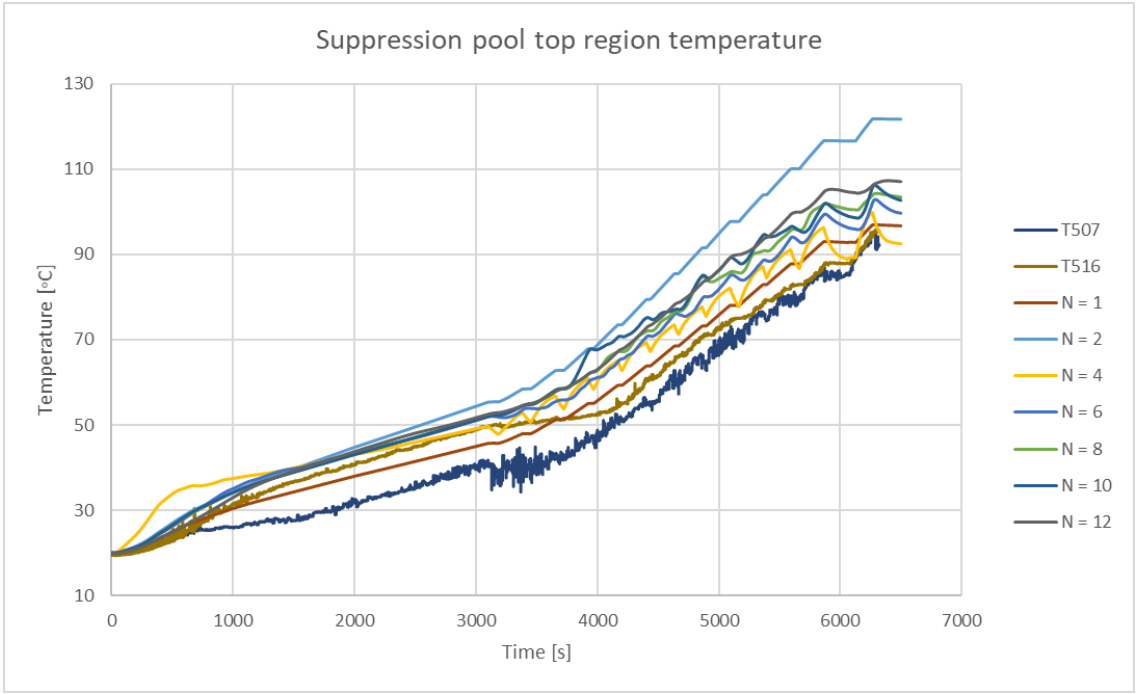
The number of nodes	Description
1	Wet well modelled as a single control volume.
2	Wet well divided into two parts below the blowdown pipe at z = 0.21 m.
4	Nodes divided once in radial direction. The diameter of the inner cylinder D = 1.3 m.
6	Wet well divided at z = 1.0 m.
8	Wet well divided at z = 0.0 m.
10	Wet well divided at z = -0.32 m.
12	Wet well divided at z = 0.6 m.



Results

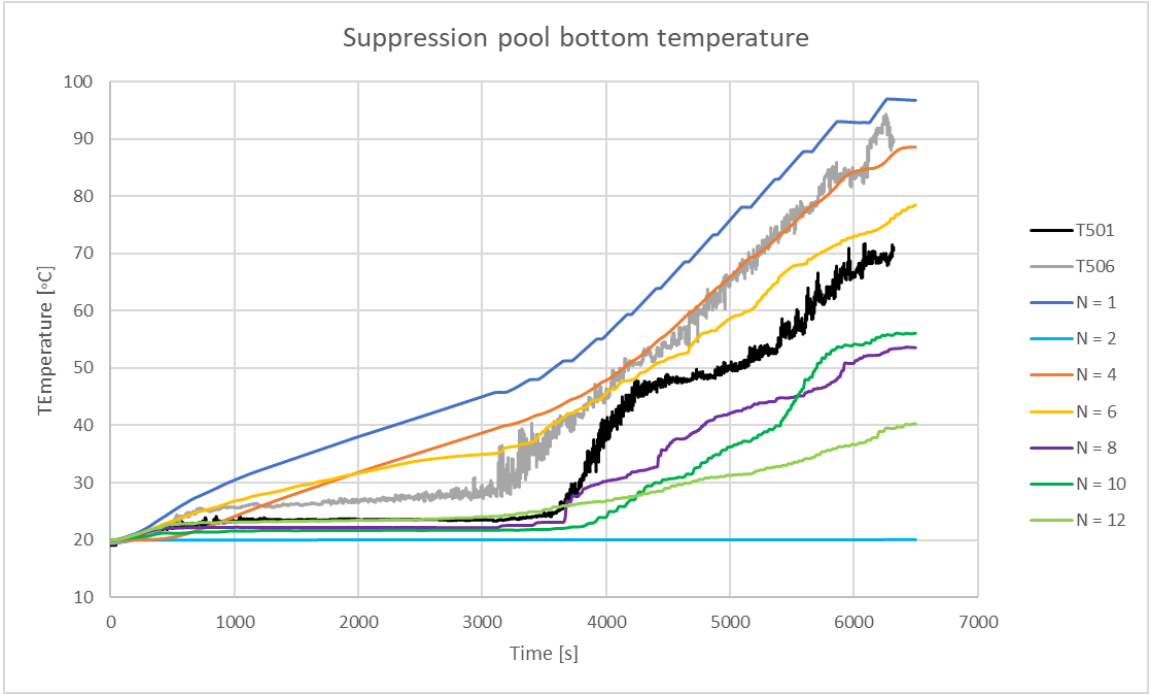
Pool top layer temperature

- Stratification period:
  - Temperatures seem to converge close to the temperature recorded by T516.
- Mixing period:
  - Higher temperatures.
  - No clear convergence.



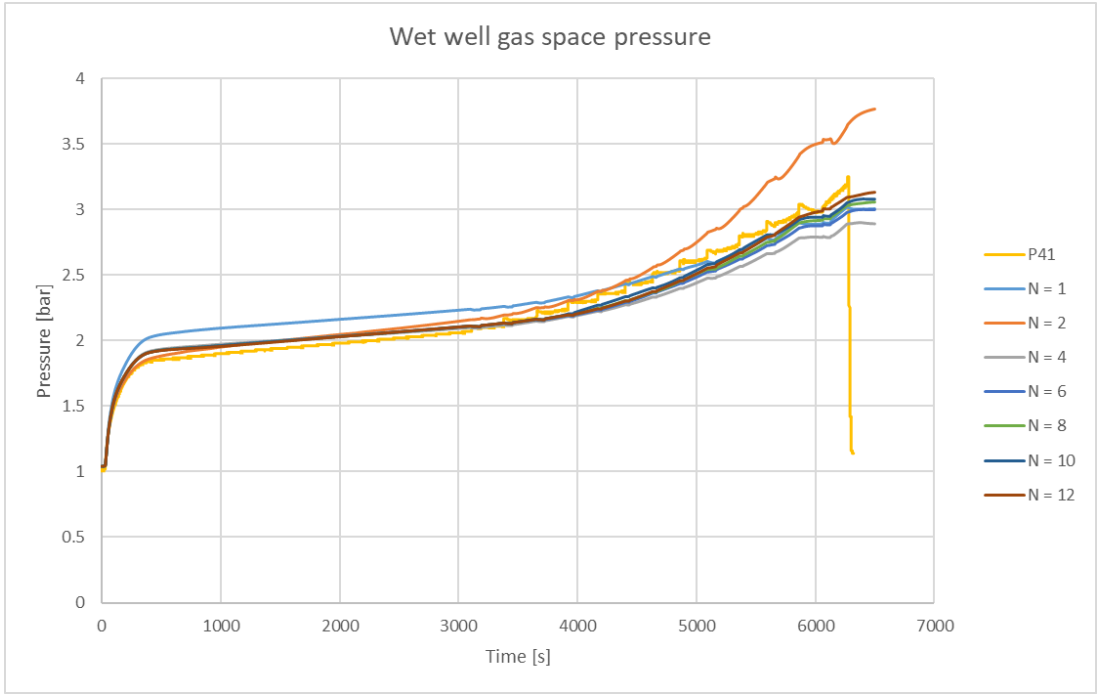
Pool bottom layer temperature

- Stratification period:
  - Good convergence in the results once the bottom half of the pool was divided into two or more nodes.
- Mixing period:
  - Significant divergence in the results.



Wet well gas space pressure

- Nodalization does not seem to have a significant effect on the wet well pressure.



Conclusions

- The model accuracy and the effect of nodalization differed between the experimental periods.
- During the stratification period the model was able to predict the pool temperatures with a good accuracy and the results seemed to converge as long as there were enough nodes (2 in this case) in the bottom half of the pool.
- The modelling of the mixing period resulted into divergence in the results. It seems that the usage of the single volume model might be more justified in cases with mixing.
- The nodalization doesn’t seem to have a significant effect on the pressure in the wet well gas space.

VTT

beyond

the obvious

Sara Ojalehto
sara.ojalehto@vtt.fi
+358405951507

@VTTFinland

www.vtt.fi