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# Exergy Analysis of a Water Heat Storage Tank

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## Introduction

**Combined Heat and Power (CHP) Plant:**

- Higher overall efficiency than conventional power plant + separate heating device
- Heat storage tank enables decoupling of electricity and heat delivery

**Exergy:**

•Work potential of a given amount of energy (“valuable fraction” of energy)

•Exergy of storage tank:

$$W_{ex} = \iiint_{V_{\mathrm{hst}}} \rho_{\mathrm{w}} c_w \left[ (T - T_0) - T_0 \ln\left(\frac{T}{T_0}\right) \right] dV$$

## Numerical Simulations

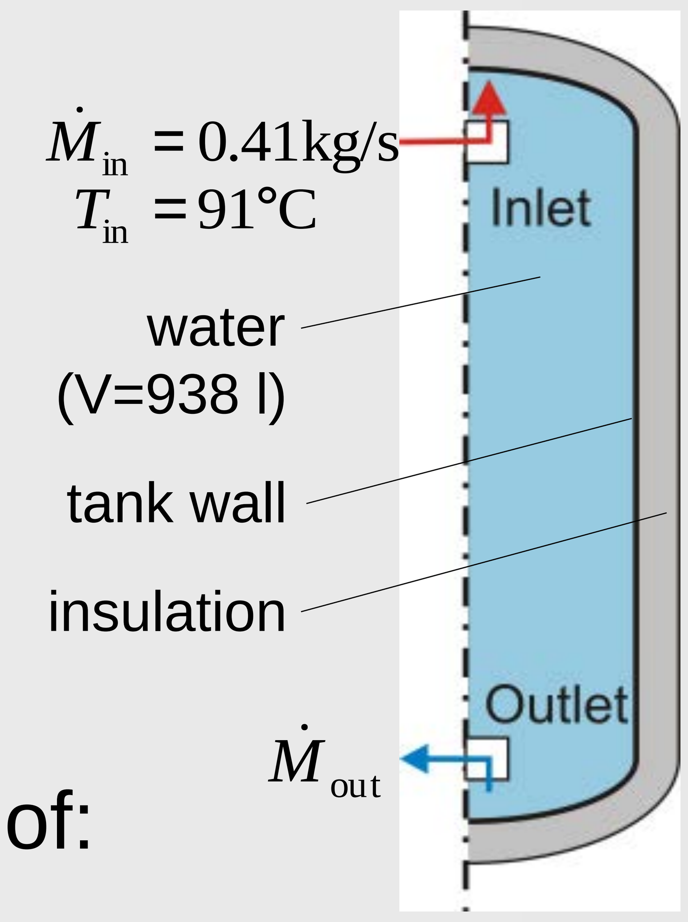
**Model A:** • Without wall • Adiabatic to env.

**Model B:** • Wall included • Adiabatic to env.

**Model C:** • Wall included • Heat loss to env.

Influence on overall exergy loss of:

- heat conduction in tank wall
- heat loss to environment




Charging (Model C)

**Governing Equations:**

•Navier-Stokes-equations
- laminar flow
- Boussinesq approximation

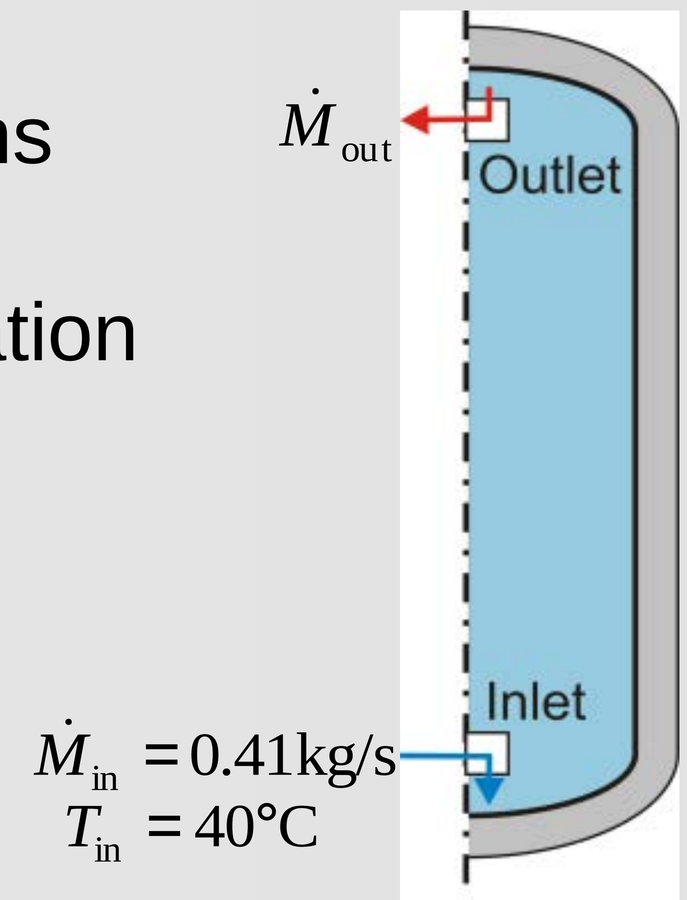
•Energy equation

**Initial conditions:**

$T$=40°C, **u**=0

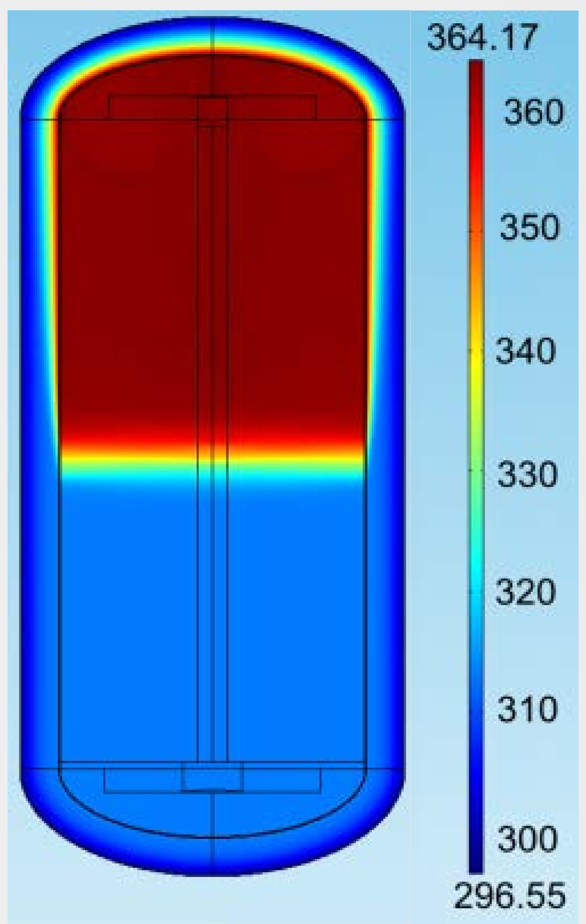
**Simulation steps:**

•charging (20 min)
•holding time (up to 10 days)
•discharging (20 min)

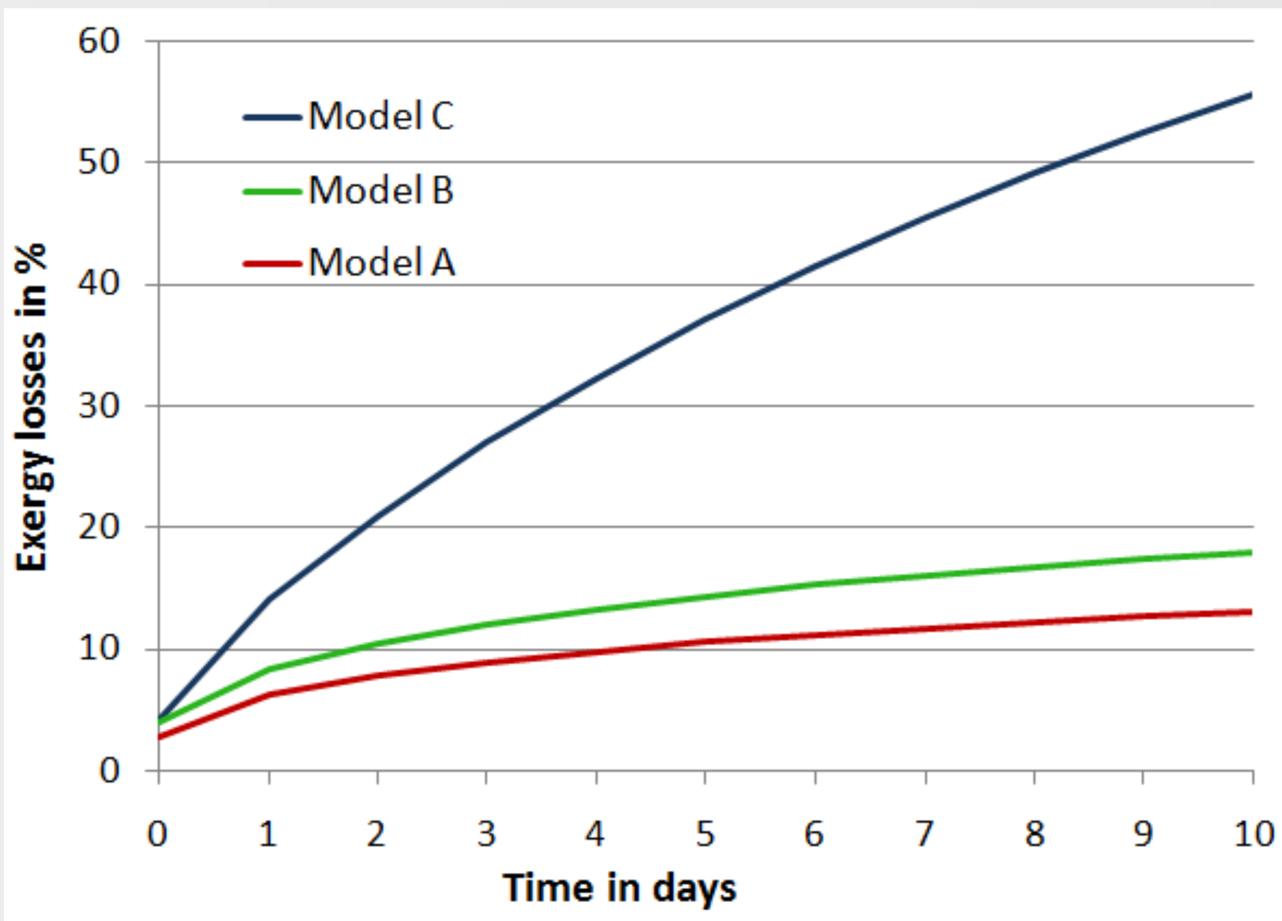



Discharging (Model C)

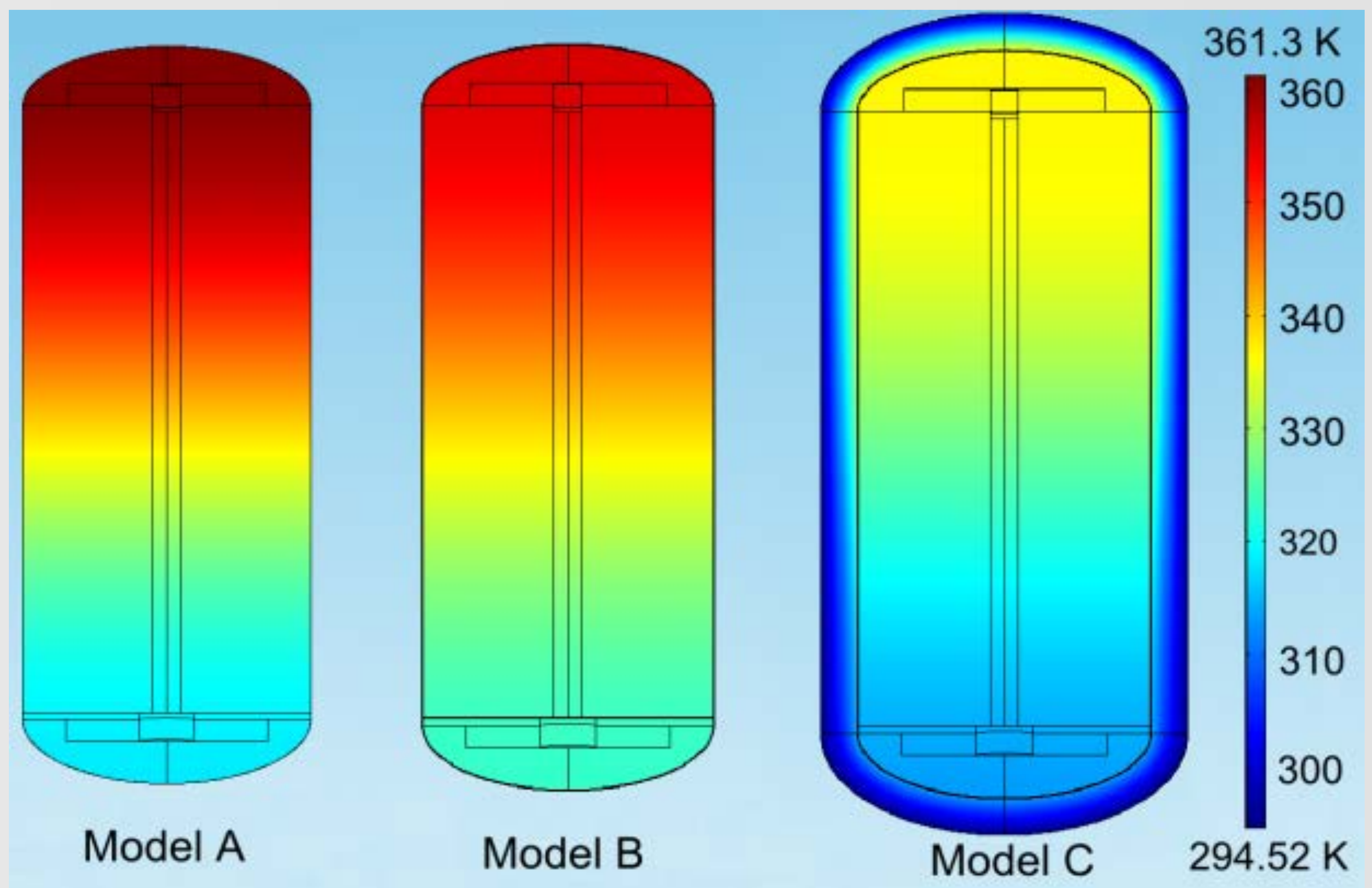
## Results



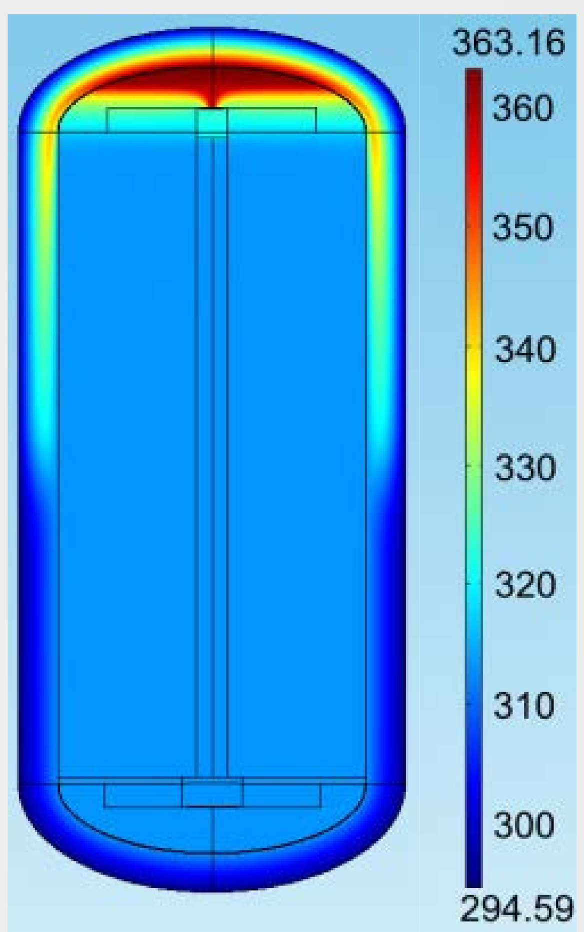

Temperature [K] at the end of charging (Model C)



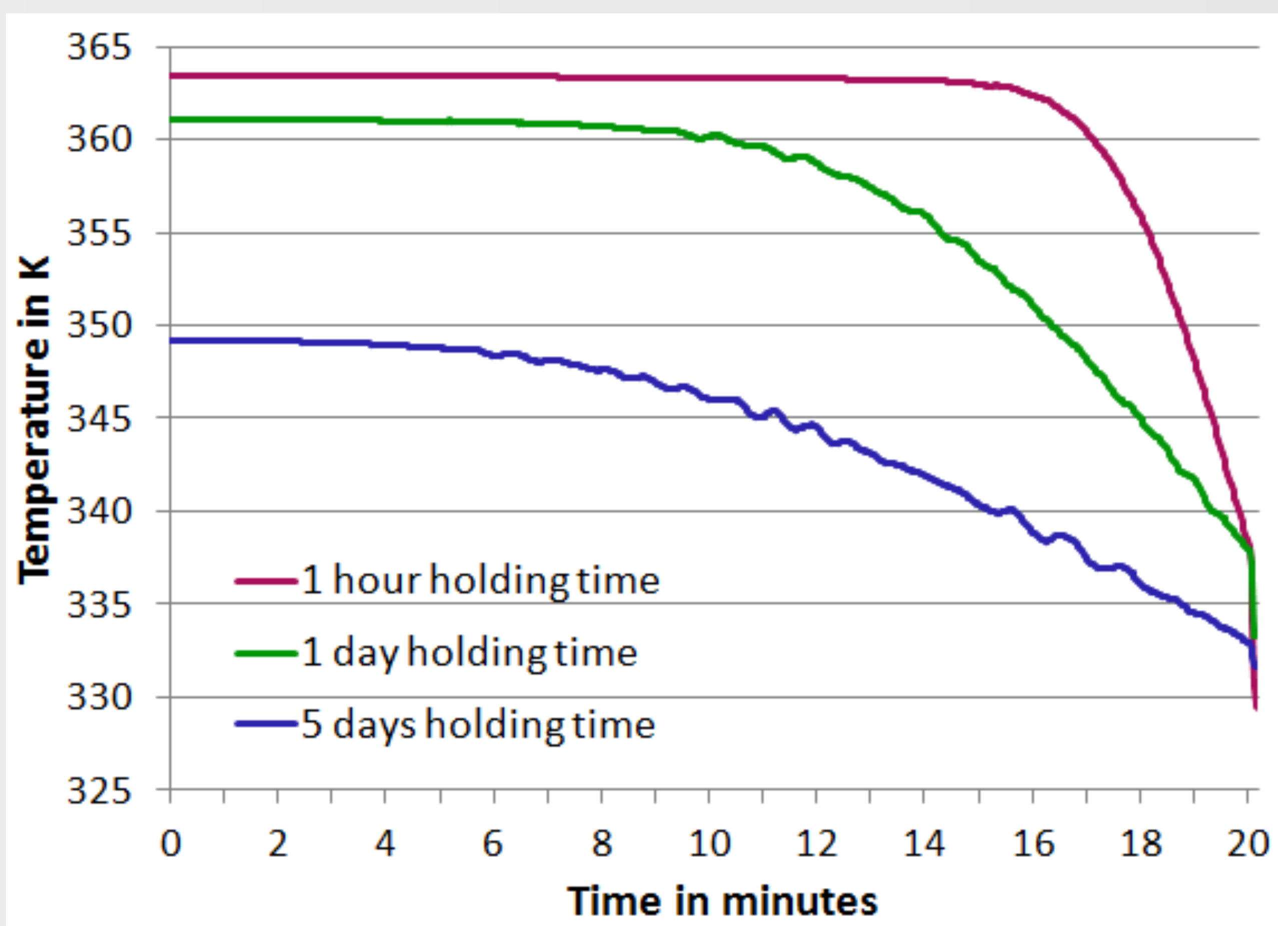

Exergy loss during holding time




Temperature Distribution after 10 days holding time




Temperature [K] at the end of discharging (Model C)




Outlet temperature during discharging

**Exergy losses are caused by:**

•Mixing during charging
•Heat conduction in tank wall
•Heat conduction in water
•Heat loss to environment
→ *dominating factor for long holding times*
→ *better insulation could improve overall efficiency*

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