Towards, Competitive, Reliable, Safe and Sustainable Concentrated Solar Power (CSP) Plants

DC6: Design, sizing, and analysis of molten salt heating systems as energy reservoirs

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Hussein Al-Saaidi

Dr. Cristina Prieto

Scope of a doctoral thesis: Electrification of thermal energy storage for the hybridization of CSP

1) Sensible heat

Modelling of Electrical Heater

2) Latent heat

Design and Sizing of PCM Storge Units

1) CFD Modelling of Electrical Heater

Utilization and advantage:

- Hybrid CSP with other renewable energy resources
- Increase the flexibility and dispatchability of power generation

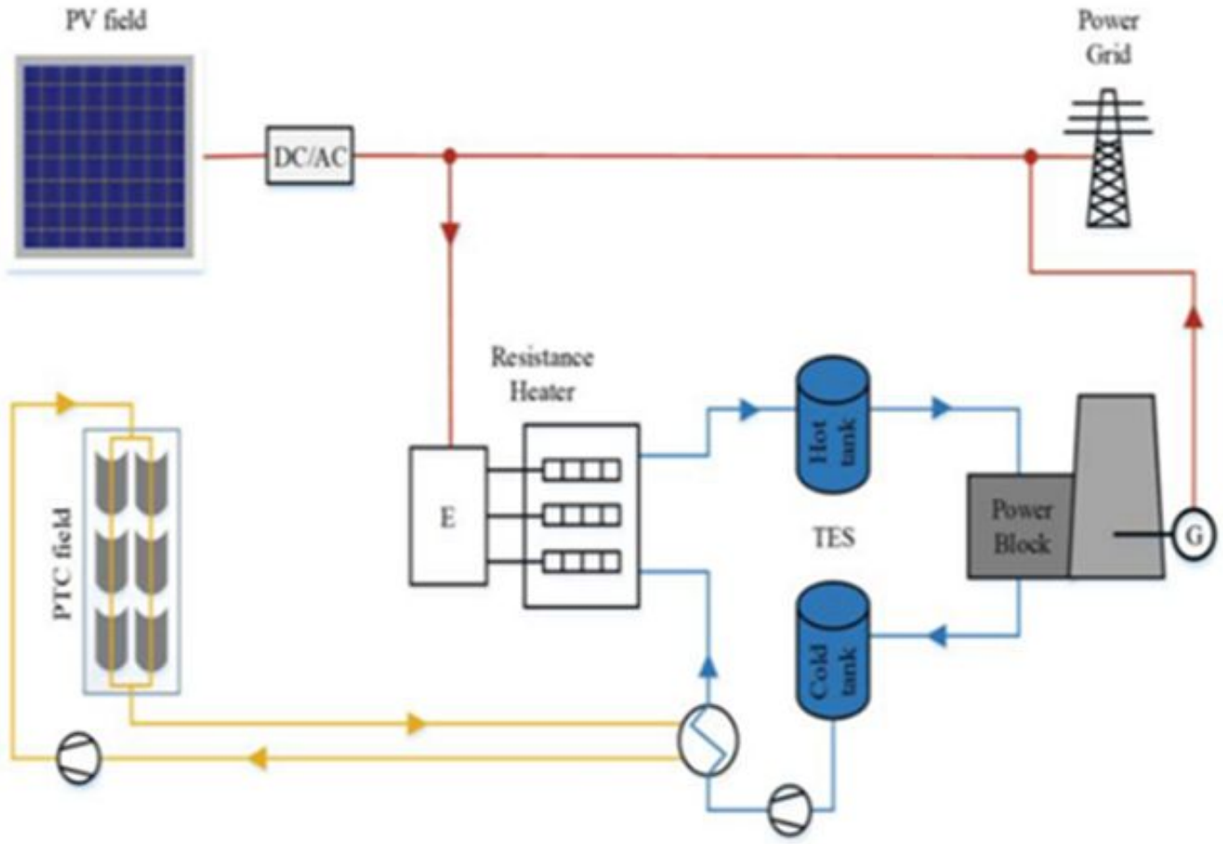


Fig 1. System configuration of a PV-CSP hybrid power plant together with TES and RH **Mahdi et al. (2022)**

1) CFD Modelling of Electrical Heater

- SpaceClaim
- ANSYS FLUENT 2023R2
- HTF (Molten Salt)
- Temperature 180 to up 400°C
- Mass flow rate 5.04 k/s

Power 1.5 MW

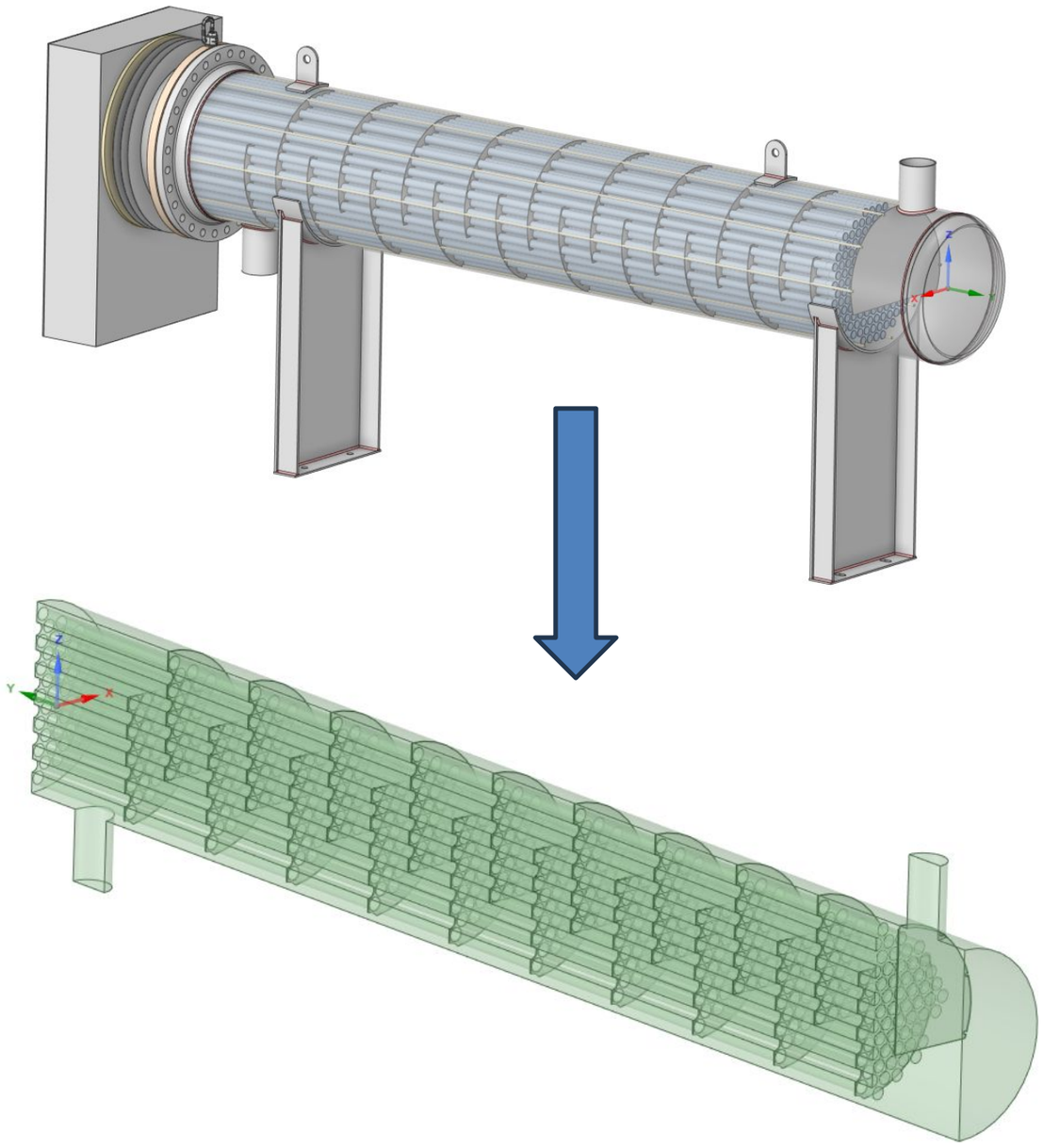
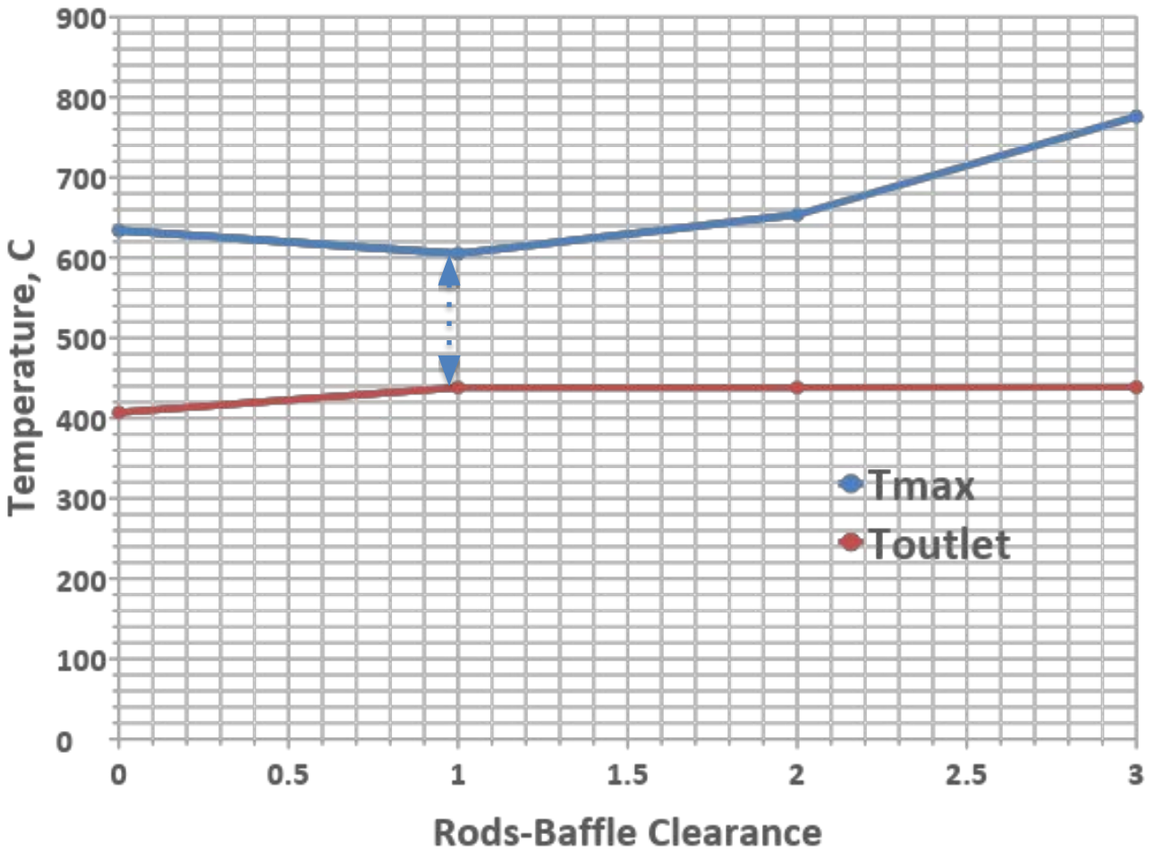


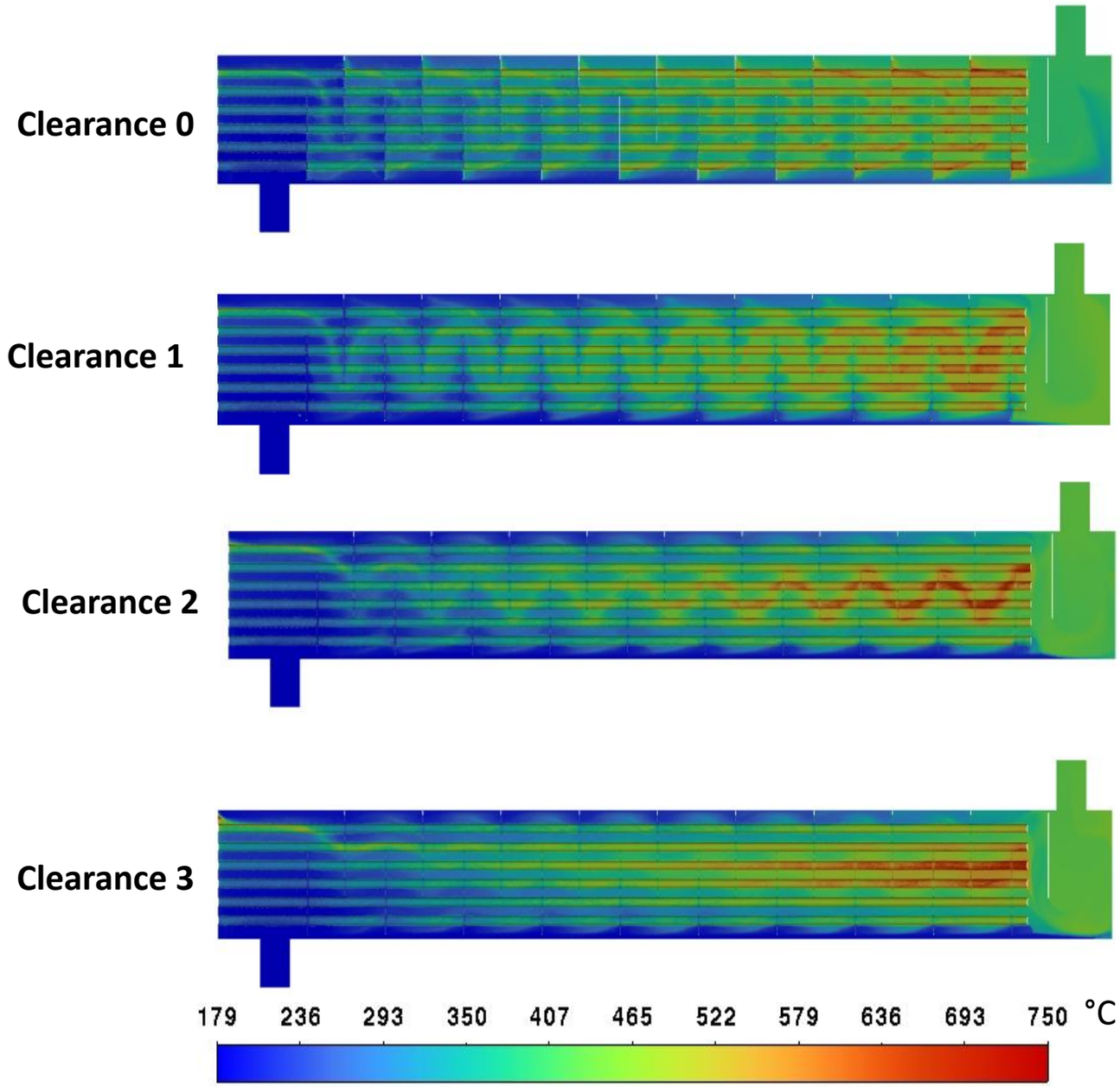
Table 1. Design parameters

parameters	number	Length (mm)	Diameter (mm)	Inlet outlet Diameter (mm)
Shell	1	5483	789	184
Rods	99	4900	54	
		Thickness (mm)		Holes Diameter (mm)
Baffles	19	5	784	54-58

1) CFD Modelling of Electrical Heater

❑ Effect Rods-Baffles Clearance





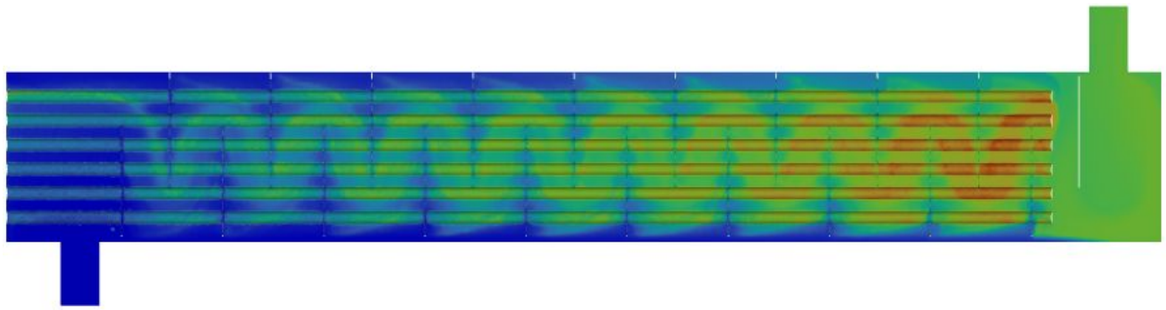
1) CFD Modelling of Electrical Heater

❑ Effect Heat flux

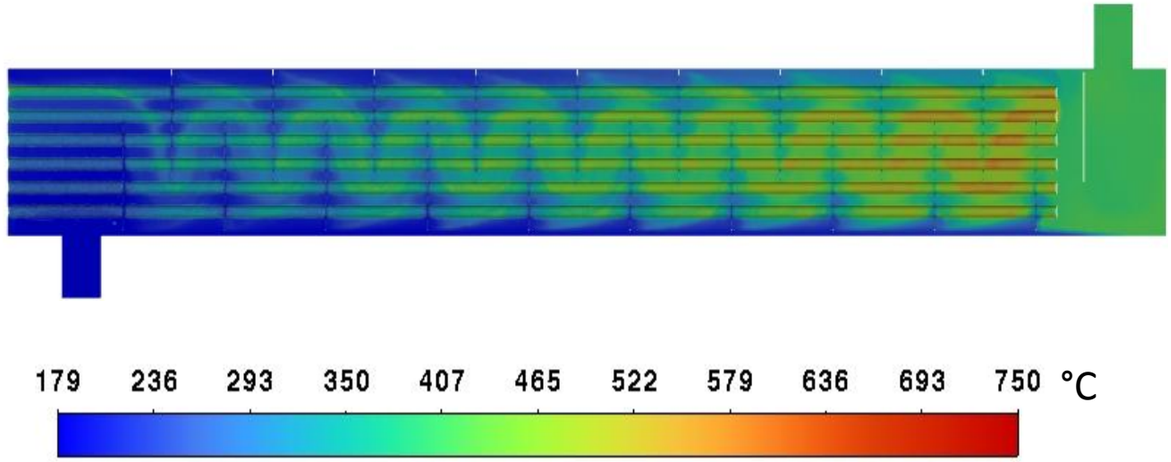
- Molten Salt
- Tmax –Toutlet = minimum

Heat flux W/cm^2	T_{max} molten-salt	T_{outlet} molten-salt	T_{max} E-rods	Tmax-T outlet
2.2	607	438.4	717	168.6
2	569	414	677	155

A

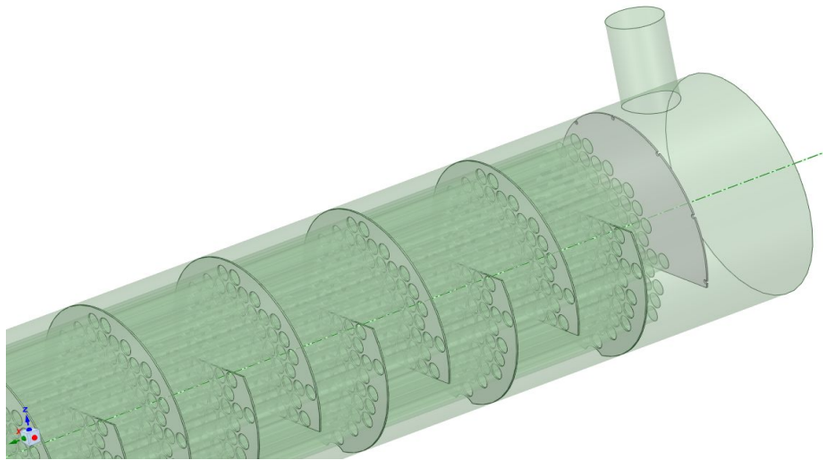


B



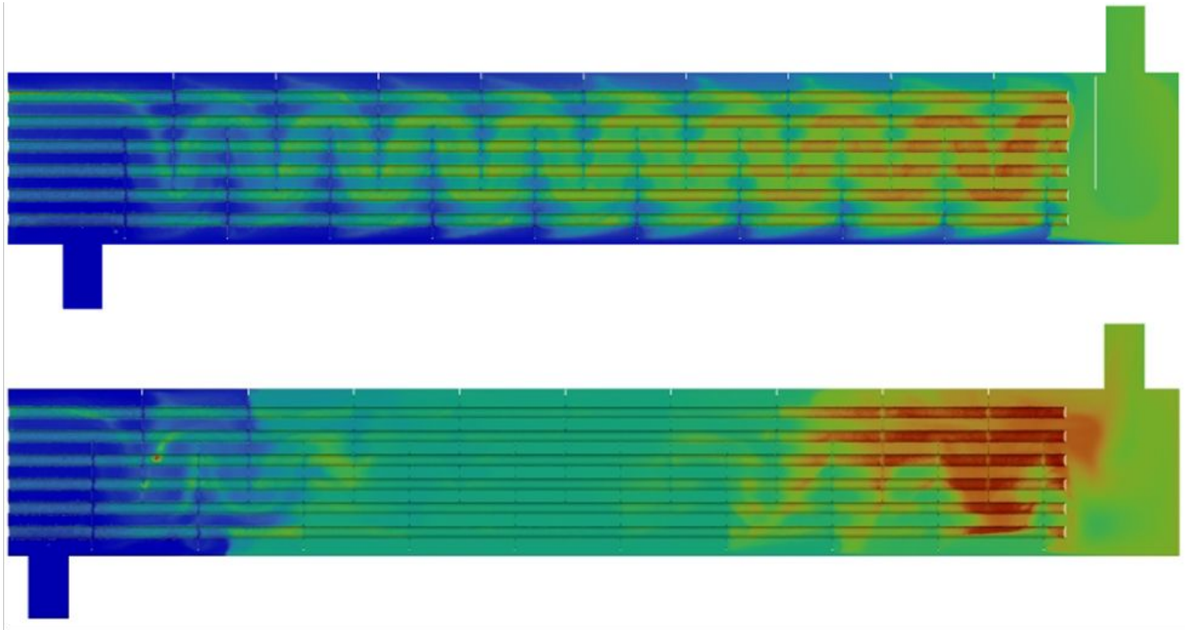
1) CFD Modelling of Electrical Heater

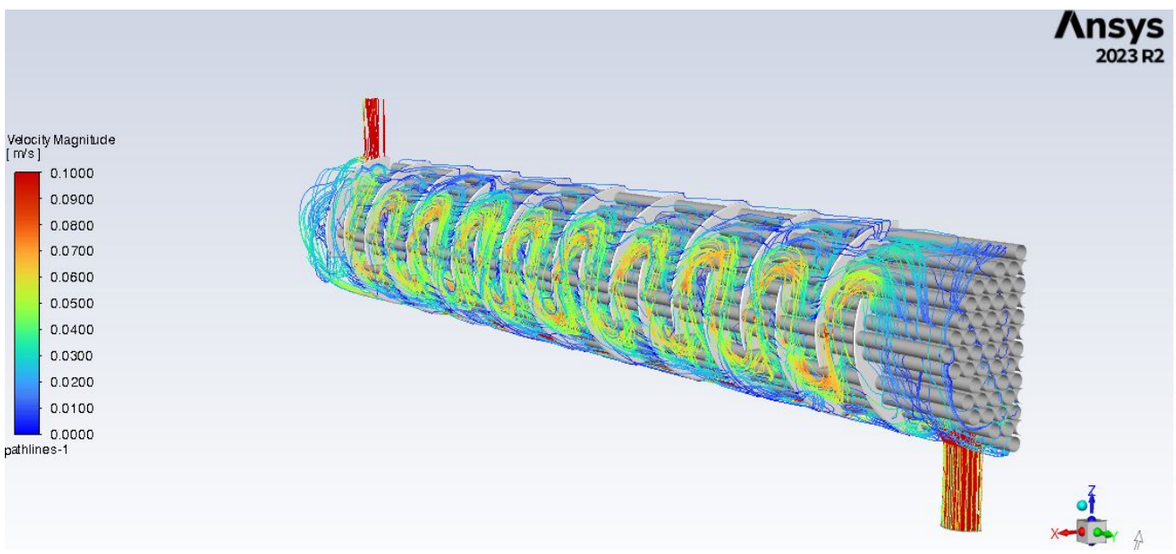
❑ Effect Plate after end of E-Rods



With Plate

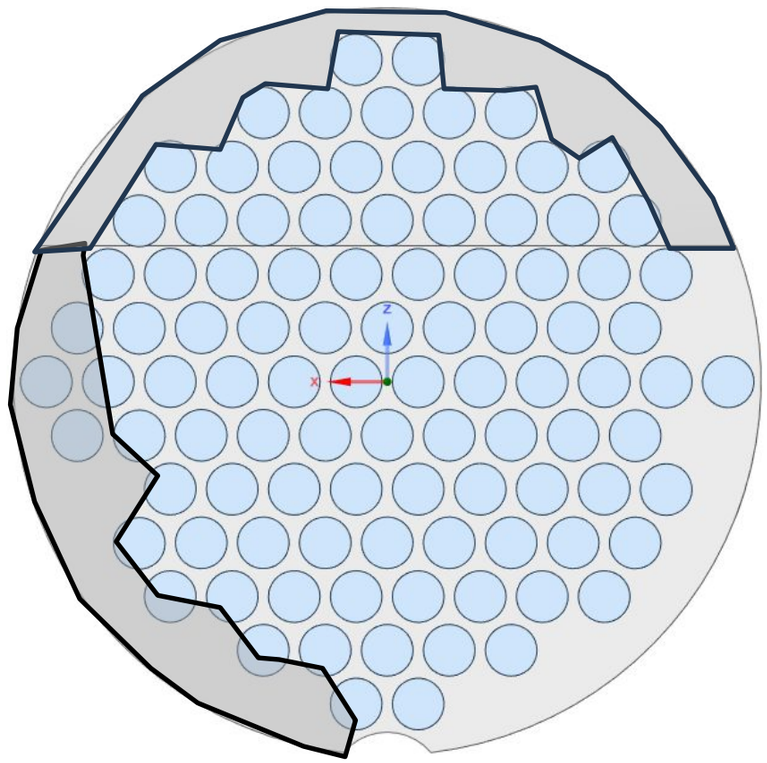
Without Plate



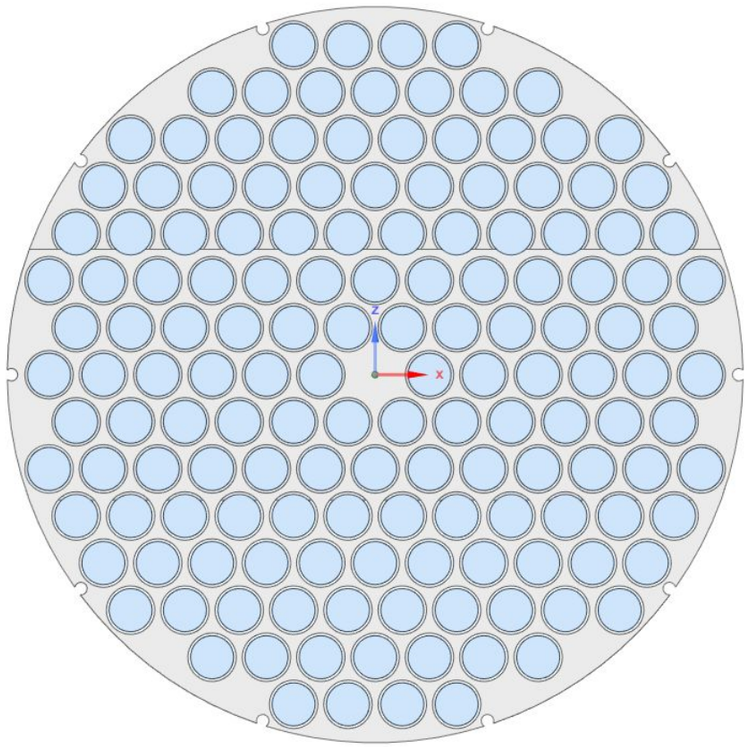


1) CFD Modelling of Electrical Heater

- **Next steps:New Configuration with power 2.25 MW and 150 e-rods**



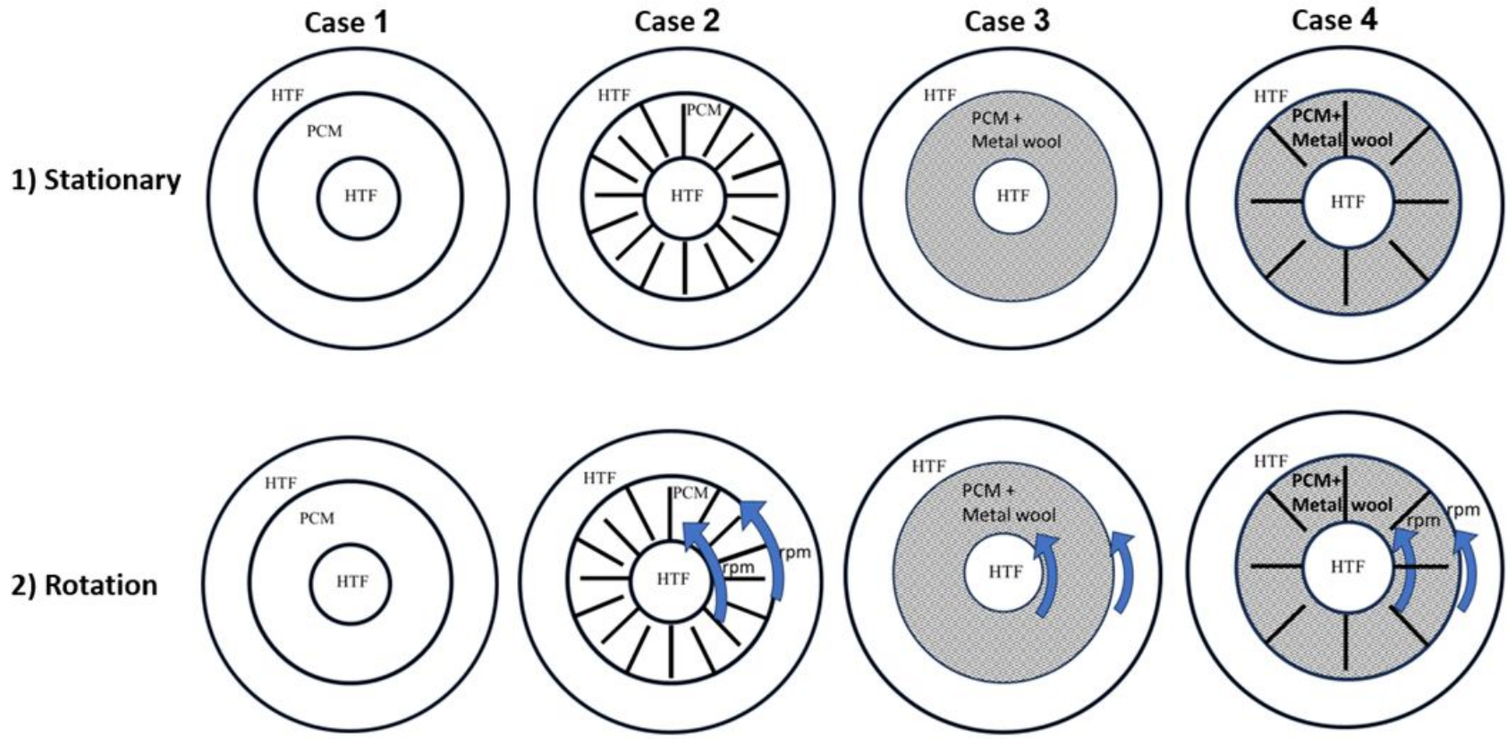
Old design

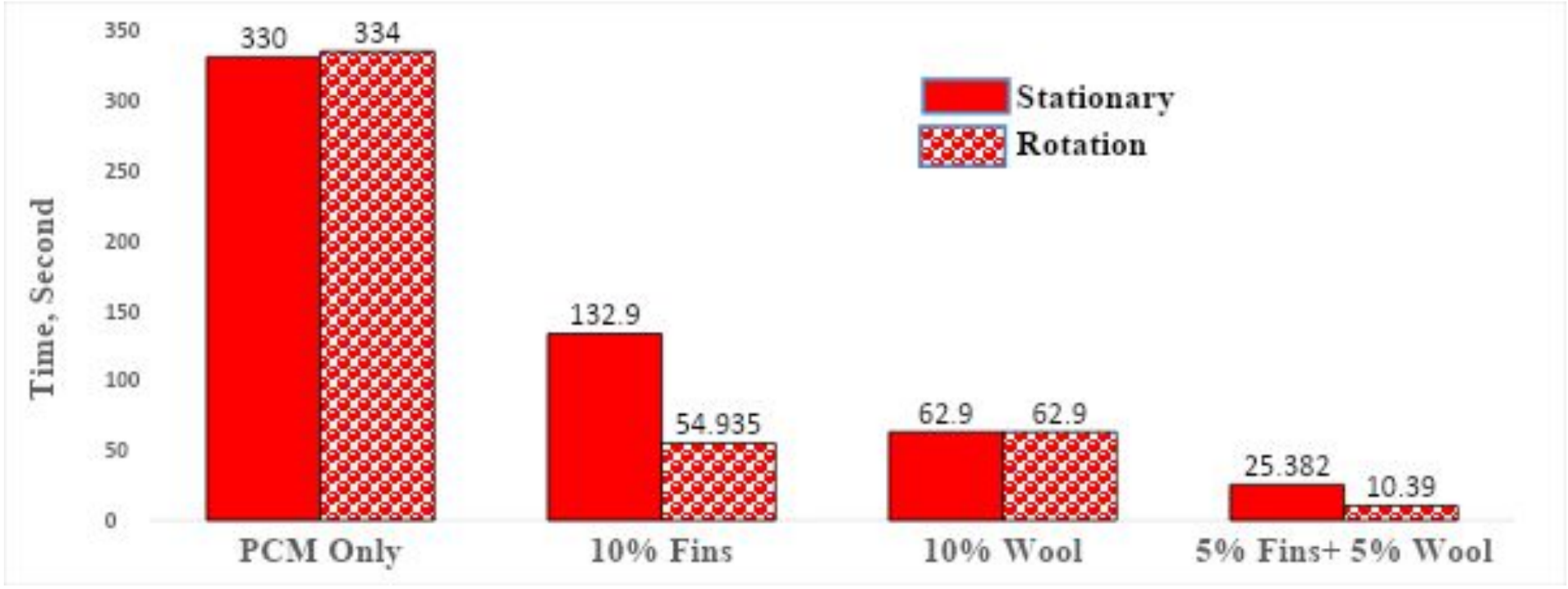


New design

2) PCM analysis

- **Effect of (Rotation + Fins + metal foam)**
  - For High temperature applications

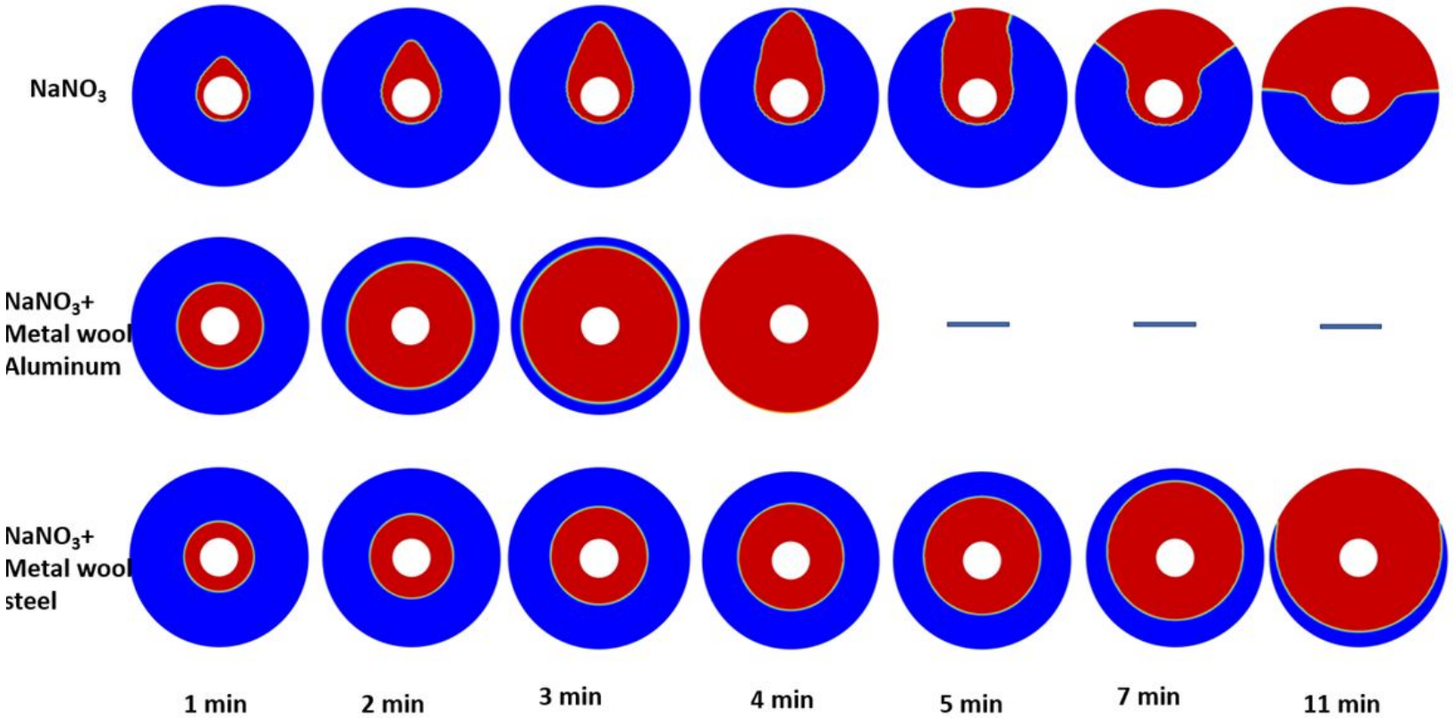


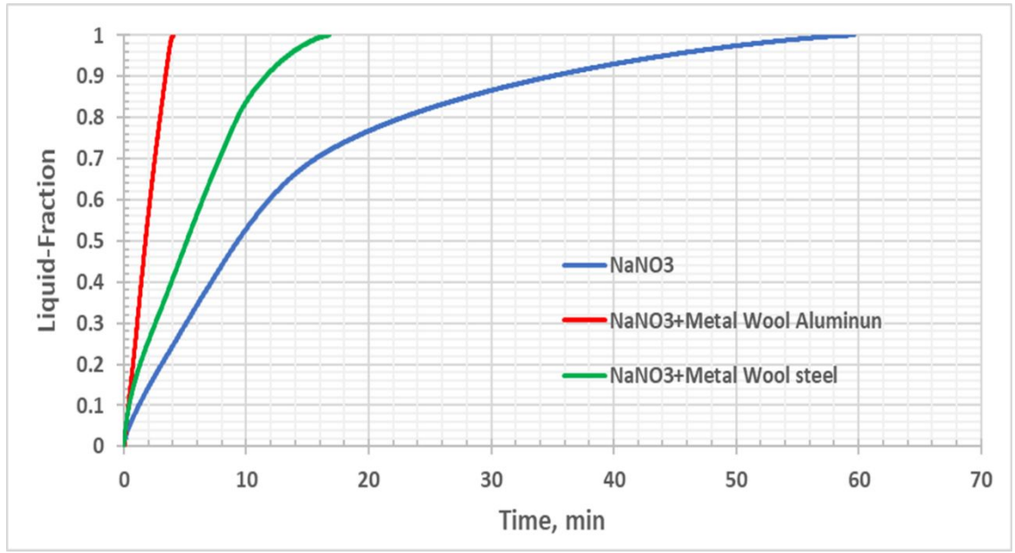


2) PCM analysis

❑ Select Materials for High Temperature Application

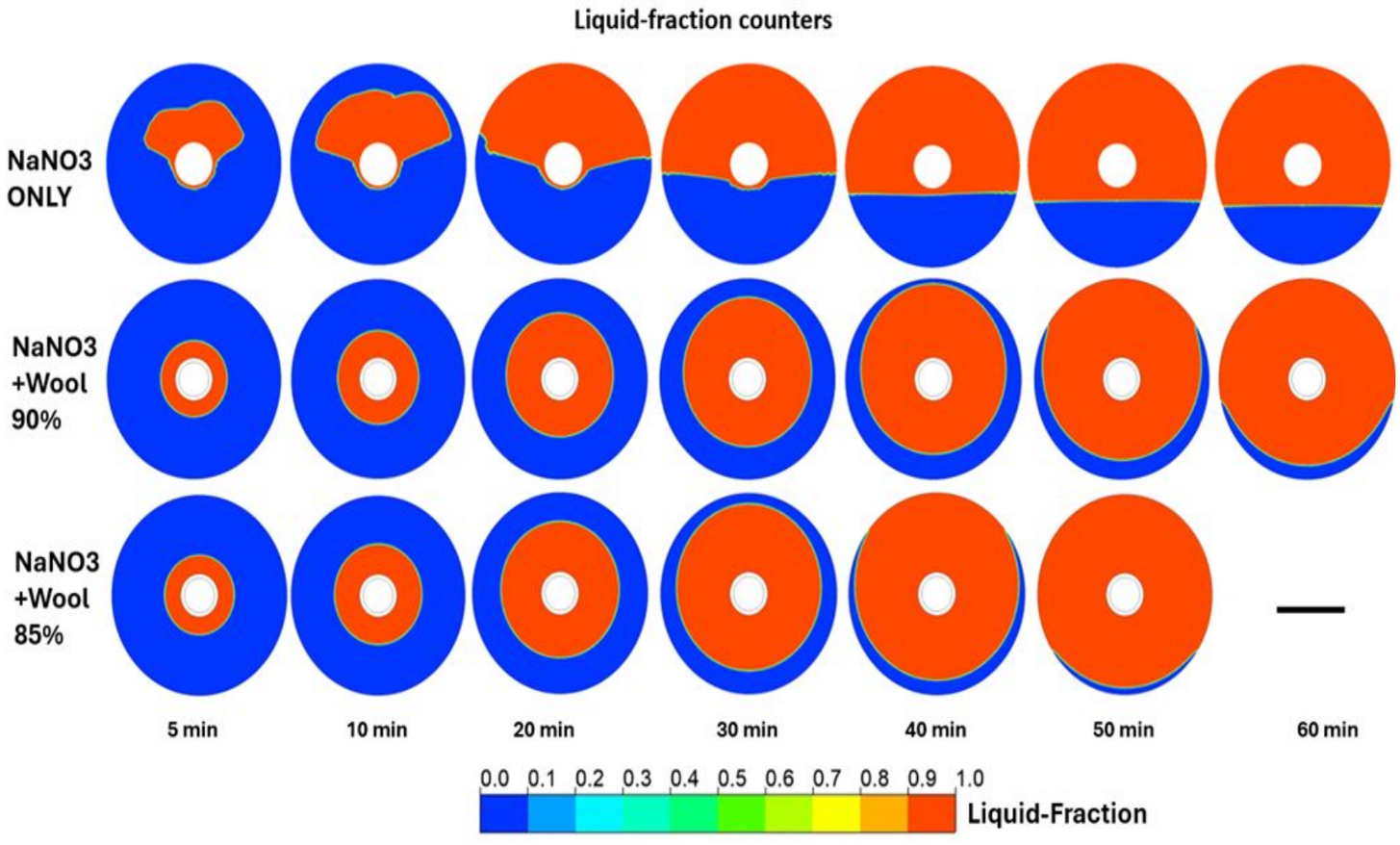
- Find Best Composite Materials for High Temperature Application

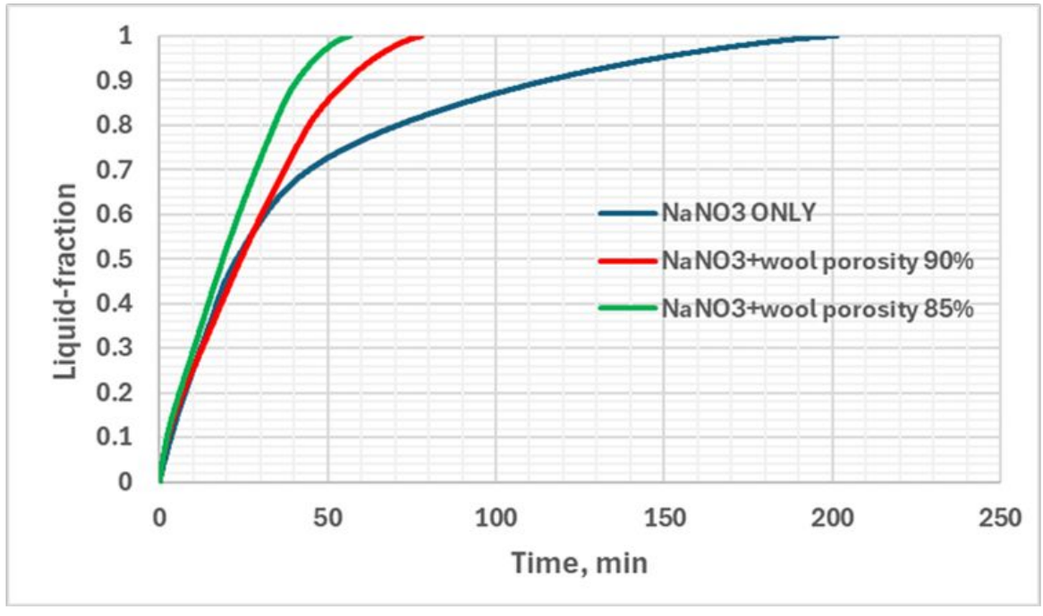




2) PCM analysis

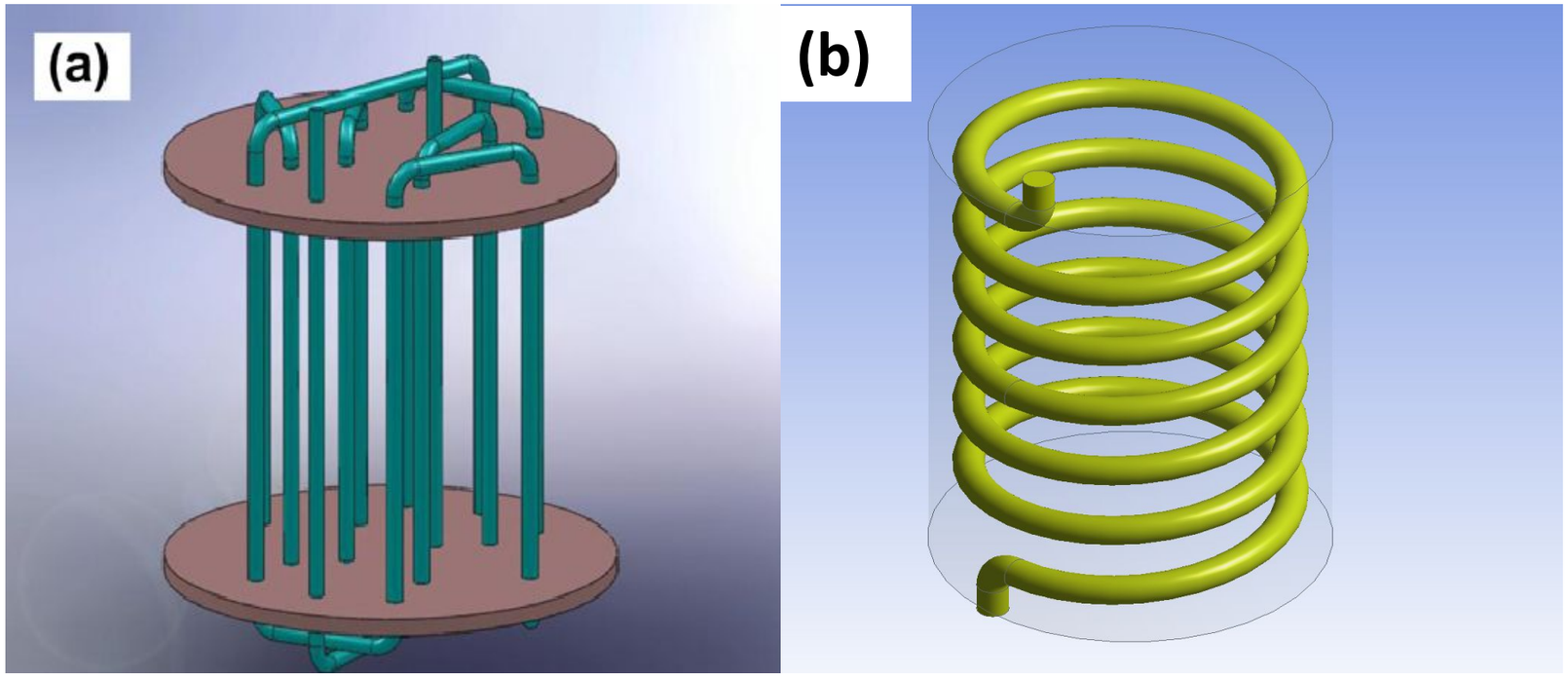
❑ Effect of porosity





2) PCM analysis

- **next step : Design and modeling best geometrical configuration**



Thank you for your listening

Hussein Al-Saaidi
Cristina Prieto
hibrahim@us.es