

Basic Design of High-Temperature Sodium Thermal Energy Storage(TES) Verification Test Facility

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Introduction

- ✓ Recent growth of renewables inevitably causes perturbation → One of effective solutions is to store energy → The most cost-effective way is TES
- ✓ Issues on commercial TES based on molten salts: (1) long-term operation, (2) cost of material, (3) high-temperature application
- ✓ Liquid sodium-based high-temperature TES development and verification activity

Design Requirement

➤ Functional Requirement

- Main function : To simulate cycle operation including charging, holding, and discharging → Charging/Discharging rate is at max 10 hrs

➤ Main Design Requirement

- Heat capacity : 1.25 MW(th)
- Medium : Sodium
- Design temp : 650°C & 200°C (Hot & Cold)
- Nominal power : 125 kWt
- Nominal flowrate : 0.2 kg/s
- Structure material: SS316L & SS304
- Target heat loss : less than 5% for 6 days
- Design pressure : 5 bars

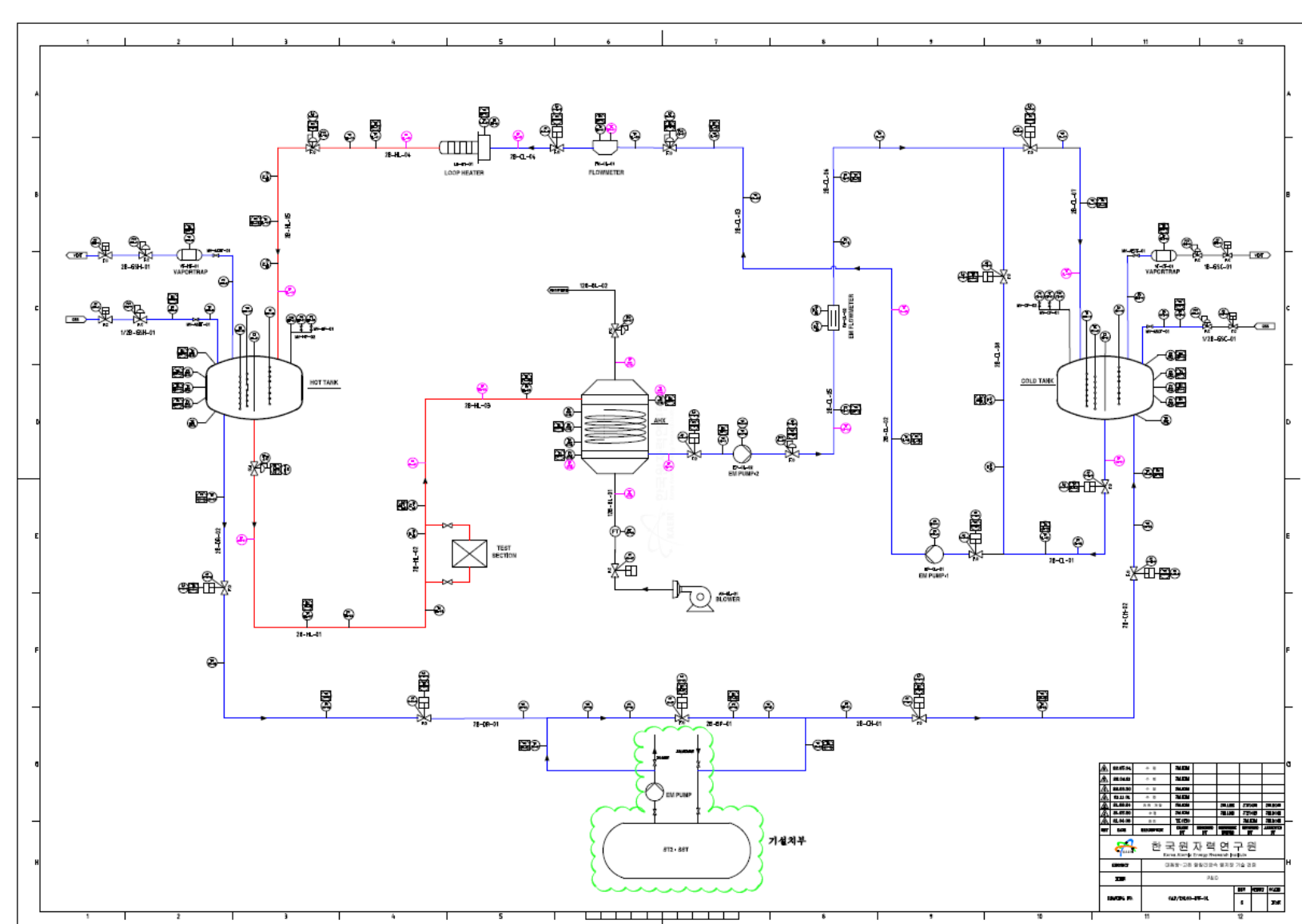
➤ System Arrangement Requirement

- 2 electro-magnetic pumps & 2 Coriolis flowmeters should be installed in cold legs
- All horizontal piping should be slanted by min 3% for drain
- Valve location is recommended in horizontal piping

System Design & Layout

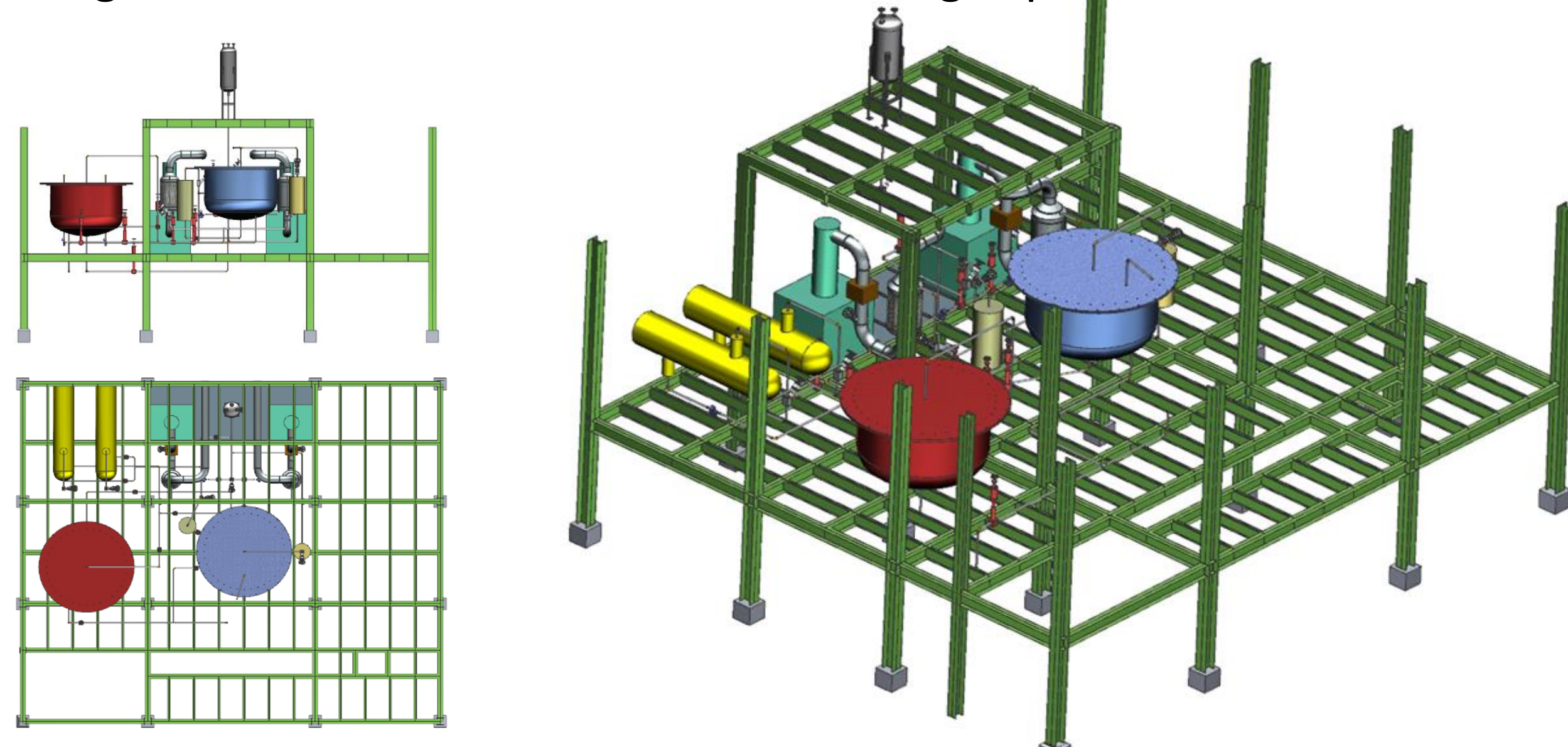
➤ System P&ID

- Main sodium line
 - Red (700°C), Blue (200°C)
- Auxiliary systems (not shown)
 - Purification system
 - Ar gas & Comp air supply
 - Na handling & transport
- Mother loop connection



➤ System 3D Layout

- Designed not to interfere and to have enough space for maintenance



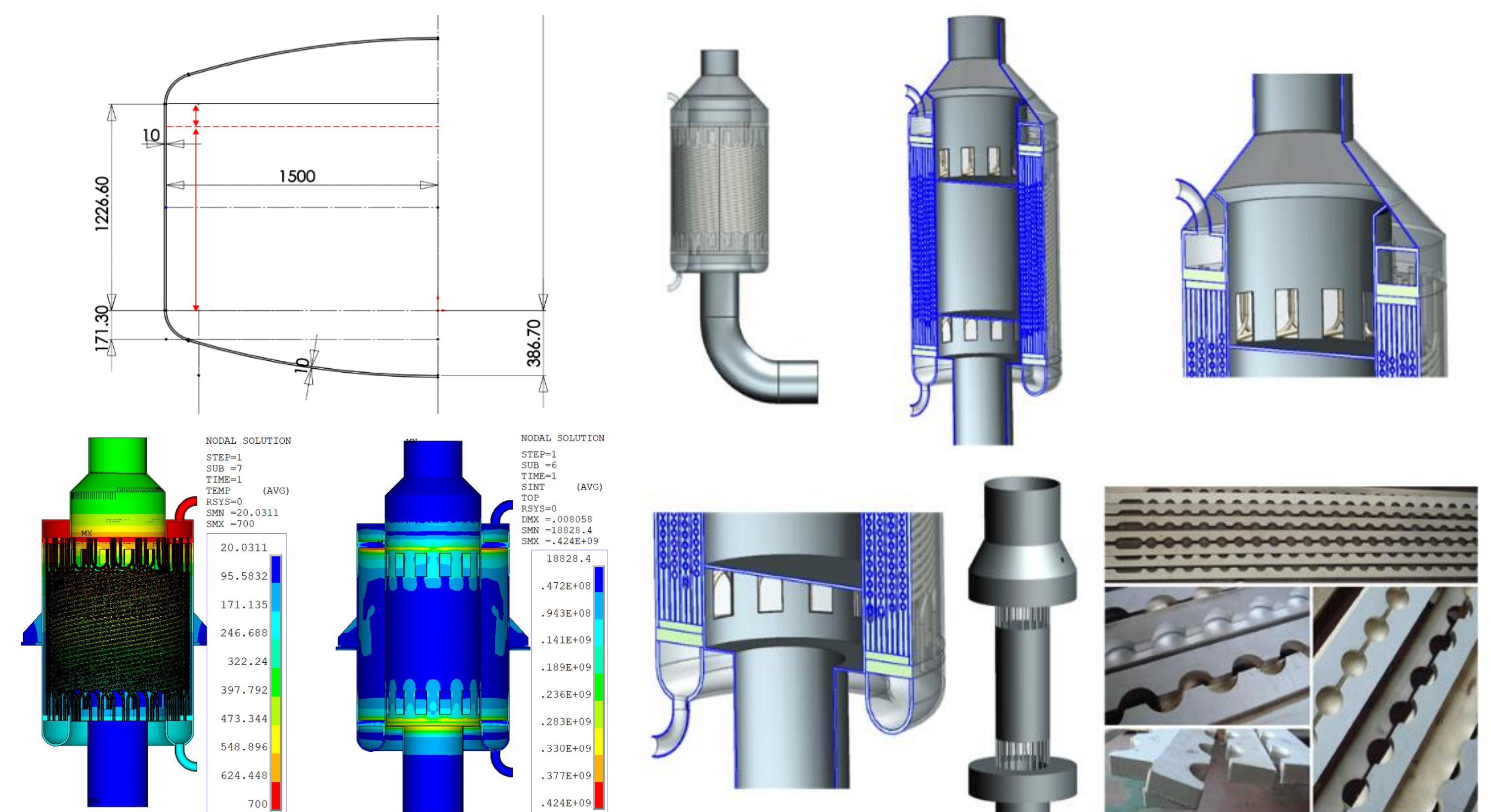
➤ Main Component Design

• Tank

- Diameter : 3,000 mm
- Height : 2,000 mm
- Thickness : 10 mm
- Material : 316L (Hot) / 304 (Cold)

• Heat exchanger

- Heat transfer rate : 125 kW
- Overall heat trans. coeff. : 49.36 W/m²K
- Effective tube length : 3.723 m
- No. of tubes : 60
- Tube ID/OD : 0.0114/0.0138 m



Summary & Future work

- ✓ For the performance verification, an experiment activity with large enough scale is necessary to simulate and to identify unexpected practical issues
- ✓ Key of this research is to investigate the effectiveness of 316L for high temperature structure and to enhance the thermal insulation practically
- ✓ According to construction schedule, the specific design will be carried out in this year and test matrix will be determined