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SFERA-III

Final Event

December 13, 2023 | Madrid, Spain

Thermal storage systems: closing the missing gaps

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SFERA-III on TES: Improving Services

Storing Materials

feasibility as storage media
(sensible, latent)

Structural Materials

dynamic corrosion

Testing Procedures

Prototypes

Reliable procedures,
Key Performance Indicators

Solar Salt equipment

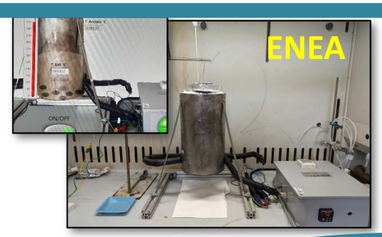
Flowmeters, Valves, Pressure Sensors,
Heating Elements, Flexible Joints

SFERA-III on TES: Improving Infrastructures

Storing Materials

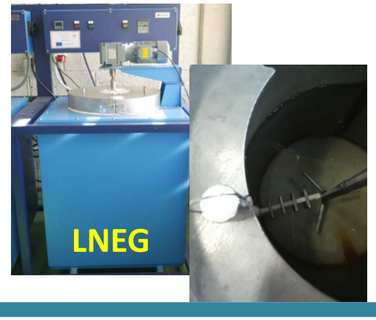
Sensible: MS+ S filler compatibility
- ENEA: Static Tests
- UniEVORA: Dynamic Tests

Latent:
- CEA: $NaNO_3$ & structural materials
- UniEVORA: Adipic acid
- CIEMAT



Structural Materials

LNEG, CIEMAT, ENEA



CIEMAT

Solar Salt equipment

Fraunhofer-ISE, CIEMAT, ENEA, CYI, UniEVORA

TES Prototype Testing

- **KPIs validated with experimental data** of different types of thermal storage devices:

  Sensible heat
  - FRAUNHOFER's molten salt thermocline
  - CEA's rock/sand-oil thermocline
  - ENEA's regenerative with concrete
  - CIEMAT's packed bed

  Latent heat
  - CEA's NaNO3

- Dedicated experiments for thermal losses assessment (concrete storage from ENEA)
- Special section added for particle storage

- **Close collaboration** ← Data exchanged

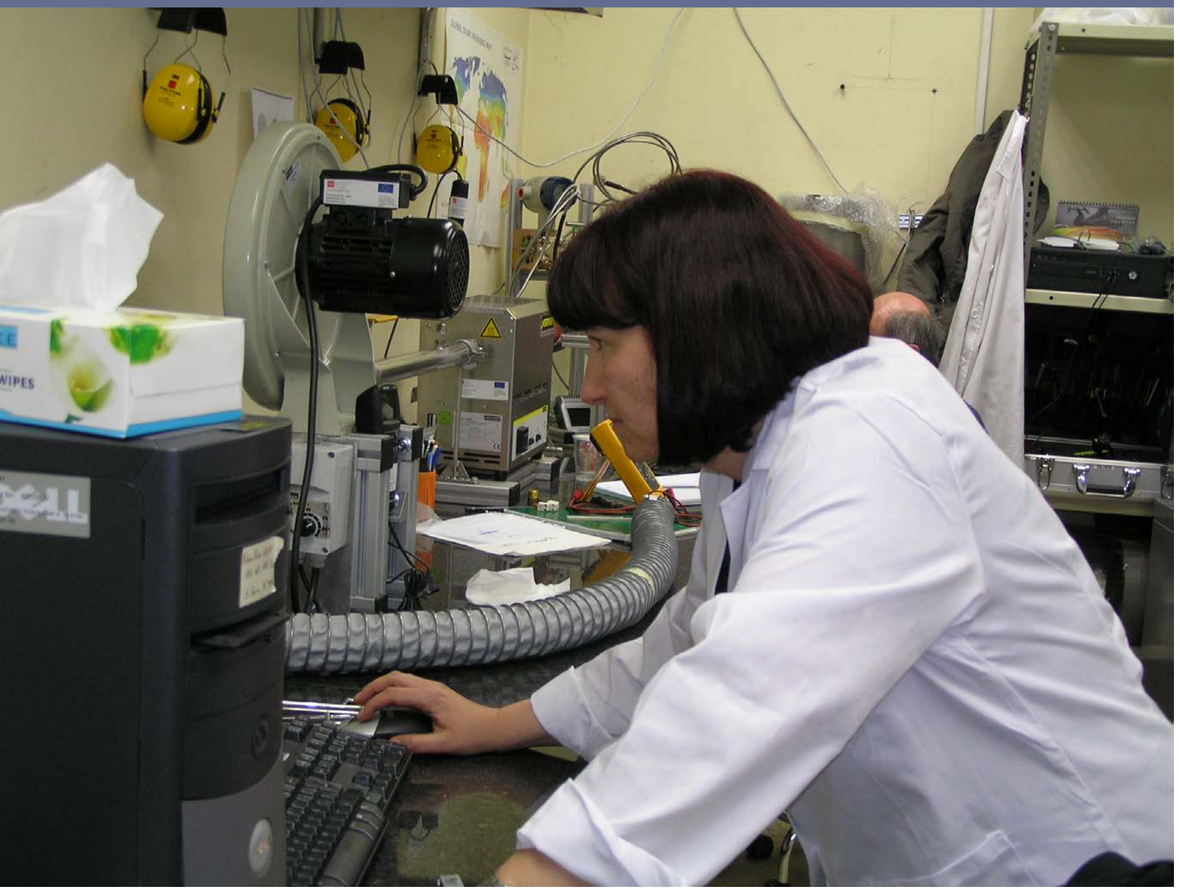
Available in close future in
https://sfera3.sollab.eu/deliverables/#

Key Performance Indicators

- Based on measurements done in HTF side
- Non homogeneous temperature considered

- **Discharging time**: by a enthalpy ouput threshold, input-output enthalpy difference, etc.
- **Storage capacity**: amount of thermal energy supplied by the HTF in a full discharge process
- **Utilization rate**: storage capacity to the theoretical storage capacity ratio.
- **Thermal losses**: 4 different methods proposed
- **Storage efficiency**: the energy provided by and released to the HTF in consecutive charge and discharge processes
- **Storage exergy efficiency**: the same as above but with exergy
- **Auxiliary power consumption**

From lab scale to prototype facility



Predicting PCM degradation

- Predicting long-term performance under conditions close the working ones.
- Based on life-time models obtained from the kinetic analysis of tests under stress conditions
  - TGA (small amount)
  - Oven tests (grams amount)

Studied Organic PCM ➔ fatty acids:

- Low temp: lauric, myristic, stearic
- Mid temp: **adipic (Tm=152°C)**
  - Evaporation is the main degradation process
  - Suggestion: closed containers

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Adipic Acid in SHIP facility (UEVORA)

Heat source: CPC field with thermal oil as HTF

Thermal Storage System (~32 kWh_{th})

- 500 kg of Adipic Acid
- Stainless steel tank (0.58 m^3)
- Helicoidal tubes for improving heat transfer

- ✓ Slight inert gas pressure can be introduced on top for avoiding to some extent the evaporation issues of PCM
- ✓ Tank commissioning expected for 2024

SFERA-III on TES: Improving services and Infrastructures

Close collaboration is the key

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Thank You

For Your Attention

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