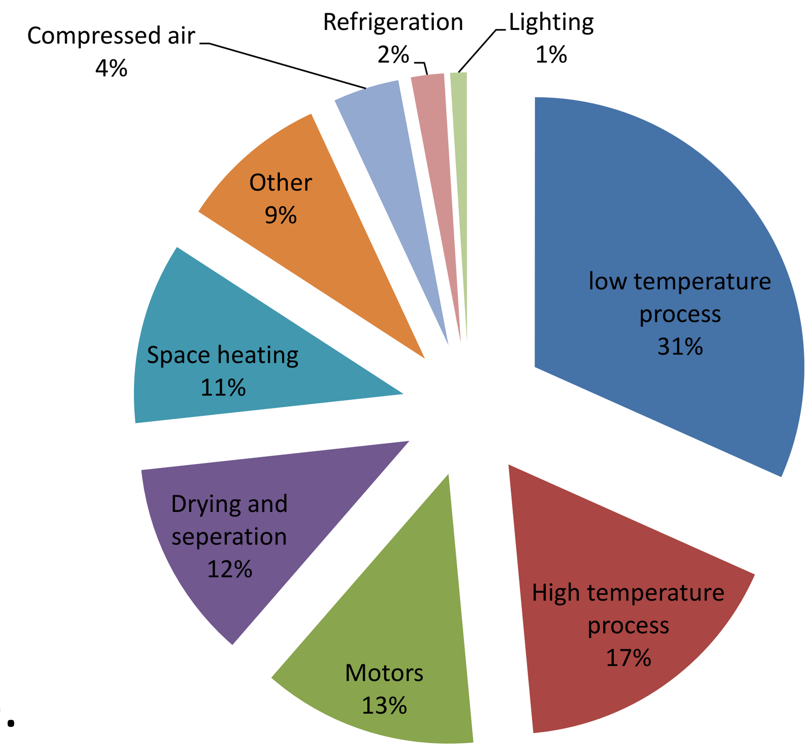
Interdisciplinary centre for Storage, Transformation and Upgrading of Thermal Energy

Thermal Energy Storage with PCMs for Medium Temperature Industrial Process Heat

Why industrial process heat under 200 ^{o}C?

1. The industrial sector accounts for 20% of final energy demand;
2. Heat is responsible for 70% of final energy demand in industry;
3. Over 30% of this is for low/medium temperature processes;
4. 75-85% of all process heating, cooling and inter-process heat transfer applications take place in the temperature range from ambient up to 200 ^{o}C;
5. All of the heating processes come with surplus heat.



What to do with the industrial waste heat?

1) Heat recovery; 2) Heat storage; 3) Heat transportation; 4) Heat reuse: on site or off site.

My research?

Latent heat storage by Phase Change Materials (PCMs) with melting temperatures around 200 ^{o}C to address the discrepancy between heat supply and heat demand in industrial process heat applications.

What is latent heat storage?

In a latent heat storage system, the heat is stored or released as heat of fusion/ solidification during phase change processes of the storage media. It provides a high heat storage density and has the capability of storing a large amount of heat during the phase change process with a small variation of volume and temperature.

The PCMs in this research?

Binary eutectic systems of $LiNO_3$-NaCl and $LiNO_3$-$NaNO_3$.

Advantages: Sharp melting temperature and high volumetric thermal storage density.

Disadvantages: Lack of currently available test data of thermo-physical properties.

Compound	Melting temperature ^{o}C	Latent heat kJ/kg	Thermal conductivity W/m^{2}K	Density kg/m^3
$LiNO_3$+$NaNO_3$ 0.57+0.43	193	248		
$LiNO_3$+$NaNO_3$ 0.49+0.51	194	265		
$LiNO_3$+NaCl 0.87+0.13	208	369	0.7	2355

To be delivered?

1. The thermal properties and chemical stability of $LiNO_3$-NaCl and $LiNO_3$-$NaNO_3$ binary salt combinations;
2. The thermal stability and performance of a $LiNO_3$-NaCl or $LiNO_3$-$NaNO_3$ binary salt combination used in a laboratory prototype medium temperature latent heat storage system;
3. Assessment of the potential and technological requirements for medium temperature latent heat storage in industrial waste heat utilisation;
4. Parametric analysis of factors including, flow rate, inlet temperature, fin and coil sizes, to optimise the system;
5. Long-term operational stability and economic analyses of the binary eutectic systems for industrial process heat applications.

Current research

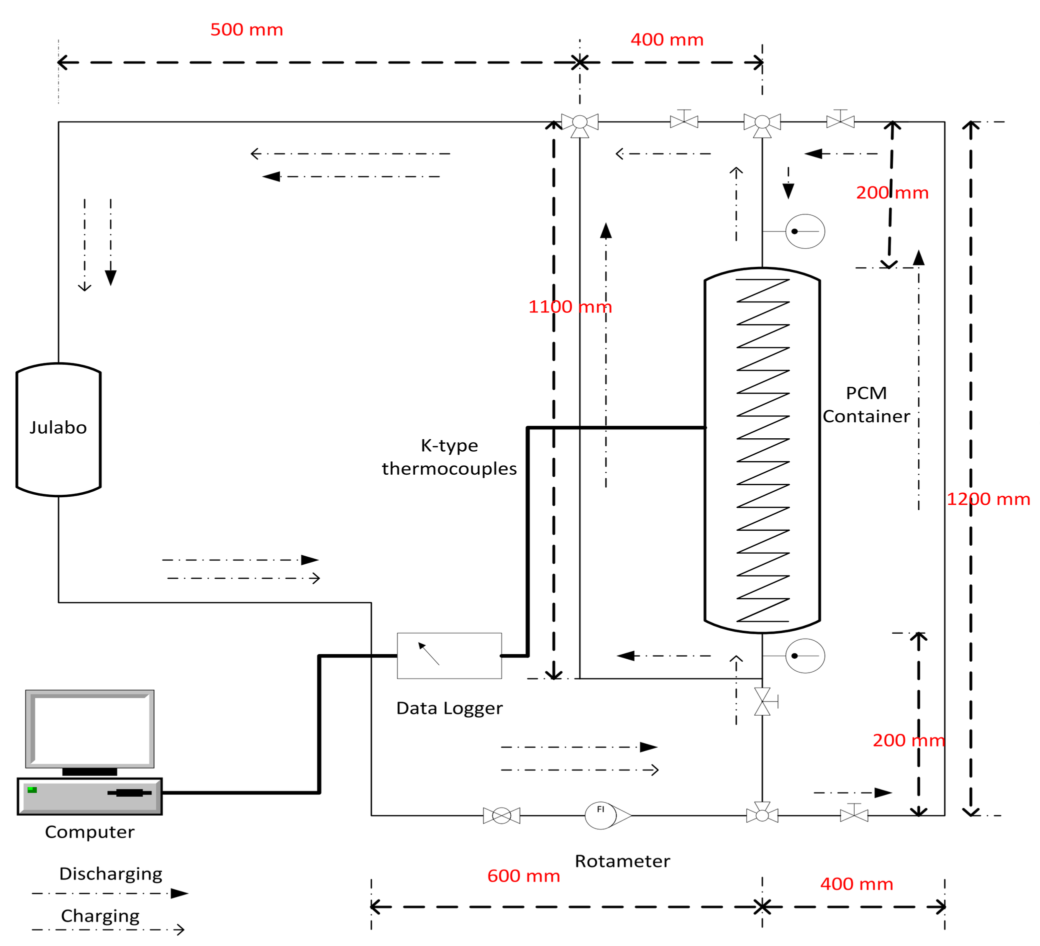
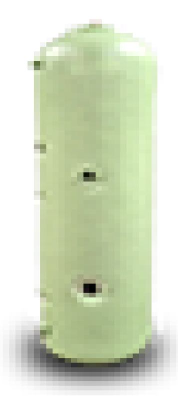


Figure 1: Schematic of experimental setup



Container: copper or stainless steel (depends on corrosion test); 66 litre, 800mm (height) × 350mm (diameter); maximum working head of 10m; a 3.24m² coil with 22mm connections.

Industrial Paddlewheel Series Flow Meter: Flow measurement range 6-60 l/min, operating temperature of 350 ^{o}C.

Panel Mount Flow Meter Indicator: output: Pulsed +4-20 mA+2 relays; communication: RS-422/RS485; power: 220VAC.

Multifunction Data Acquisition: 40 channels.

Highly Dynamic Temperature Control Systems: rapid cool-down and heat up; working up to 400 ^{o}C; using heat transfer fluid JULABO H350.

Mineral Insulated RTD (Pt100) Sensor with Pot Seal: probe diameter 3mm; probe length 250mm.

Figure 2: Some key experimental components.

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