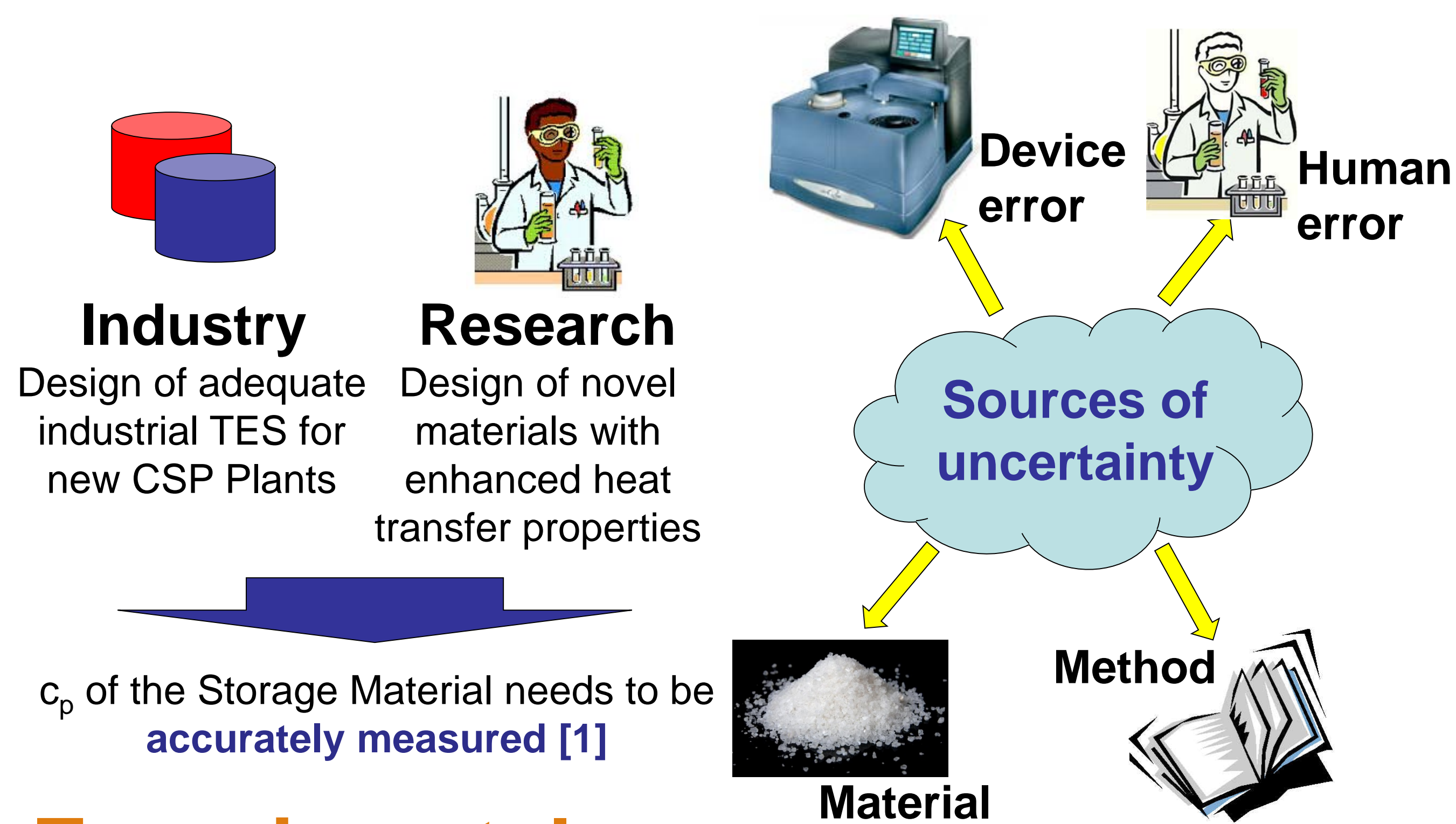


Round Robin Test on the Measurement of the Specific Heat of Solar Salt

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Introduction

Why a Round Robin Test on c_p of Solar Salt?



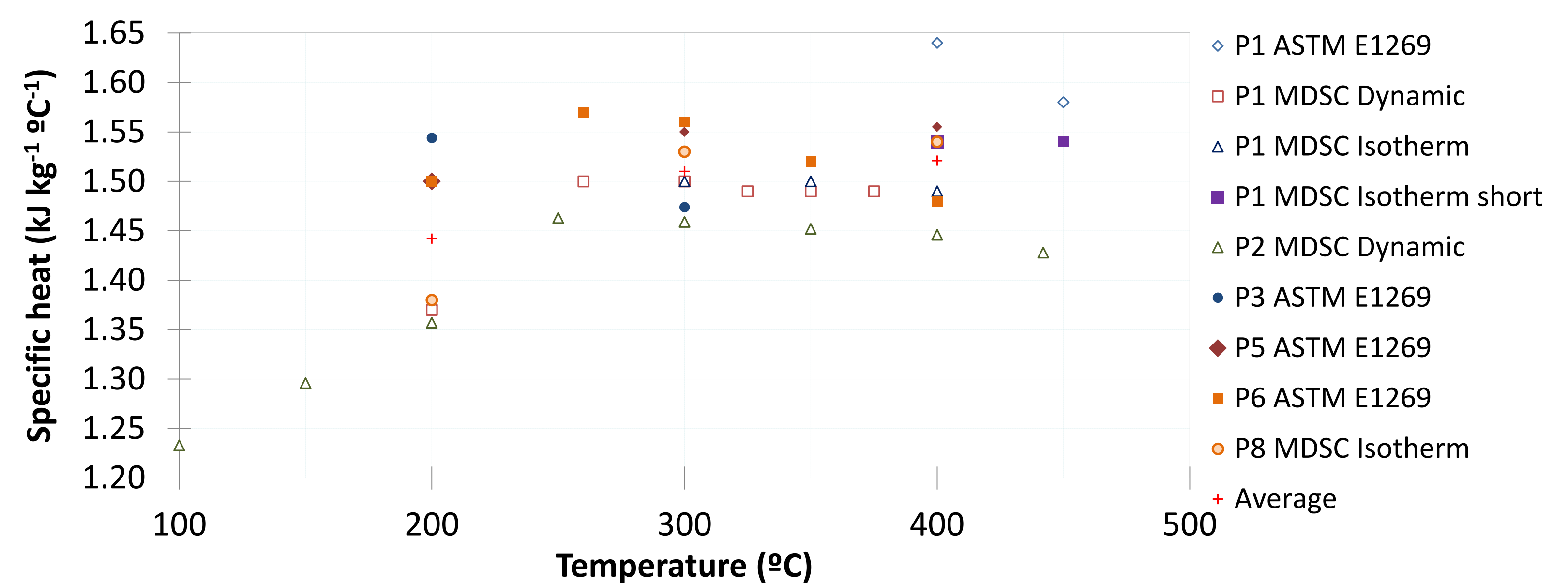
Nine partners involved



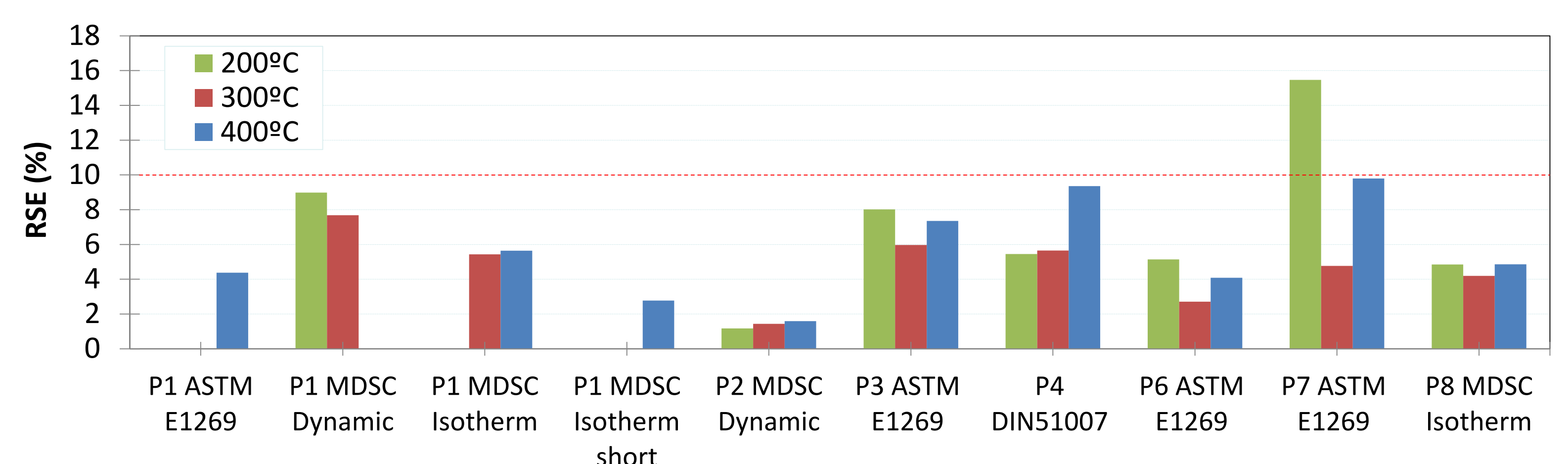
Assessment



Results



Results reported by partners. P7 and P4 were removed for high dispersion of results and high deviation from the average respectively



Relative Statistical Error (%) for each partner. RSEs (%) lower than 10% were considered acceptable. RSEs (%) were not calculated for P5, as only 2 measurements were provided [4].

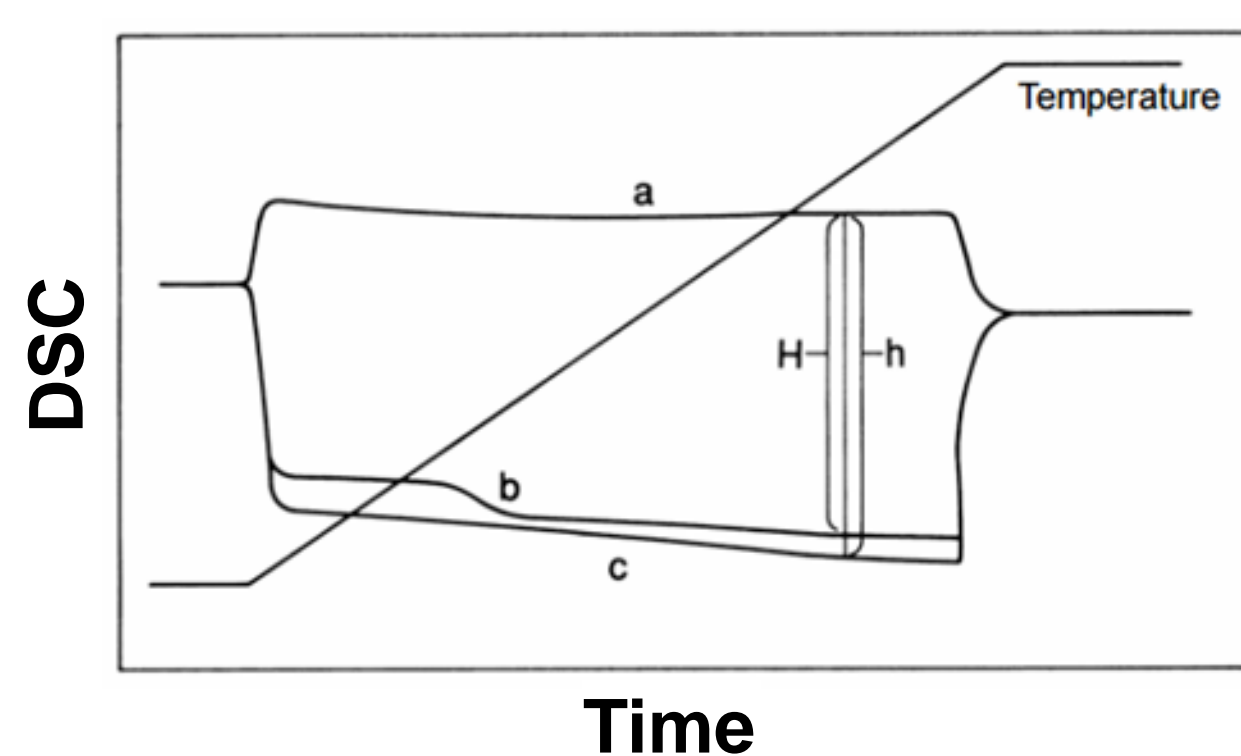
$$CI = \bar{x} \pm \Delta x = \bar{x} \pm t_{\alpha/2} \cdot \frac{SD}{\sqrt{n}} \quad RSE = \frac{\Delta x}{\bar{x}} \cdot 100 \quad \text{Confidence level} = 95\% [4]$$

Experimental

General conditions

- All partners start from the same raw material:
 - $\text{NaNO}_3/\text{KNO}_3$ (60/40% wt.) mixture melted at 350 °C – ½ h
- The method of measurement was not imposed
- Three measurement temperatures: 200, 300 & 400 °C
- The delivered samples were stored under dried argon atmosphere
- Conditioning of samples: 1h at 100°C prior to measurement

ASTM E1269

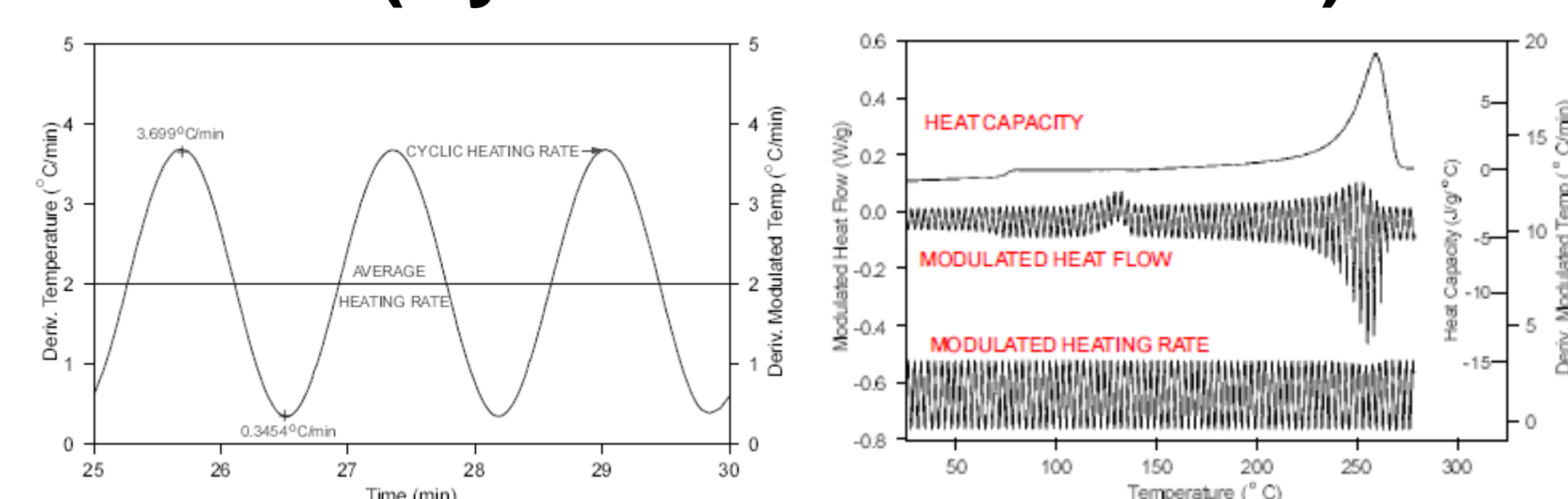


$$c_{ps} = \frac{H m_r}{h m_s} c_{pr}$$

c_{ps} c_p of sample
 c_{pr} c_p of reference material
 m_s weight of sample
 m_r weight of reference

a empty pan. b sample. c sapphire (reference material).
 H Difference of sample and empty pan heat flow signal
 h Difference of reference material signal and empty pan
 Measurement takes place during dynamic segment [2].
 Two isothermal segments are required for temperature stabilization

MDSC™ (Dynamic and Isotherm)



Modulated DSC™ (TA Instruments) [3] measures both heat flow and heat capacity in a single experiment by superimposing a modulated heating rate on top of a linear heating rate.

Conclusions

- The normalized method ASTM E1269 and MDSC™ are adequate for the measurement of c_p of SS in the range of temperatures between 200 and 400°C.
- Comparing the results sent by the partners, a maximum RSE(%) of 5.95% for the measurements of c_p at 200 °C (solid state) was found.
- The values of c_p at 200 °C reported by partners using MDSC-based methods were less dispersed than those obtained by the ASTM E1269 method.
- The average results were 1.442 kJ/kg⁻¹ °C⁻¹ at 200 °C (RSE, 5.95%), 1.510 kJ/kg⁻¹ °C⁻¹ at 300 °C (RSE, 2.32%), 1.521 kJ/kg⁻¹ °C⁻¹ at 400 °C (RSE, 3.35%)

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