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Phase change dispersions for temperature-stabilisation

A glance at machine-spindle cooling

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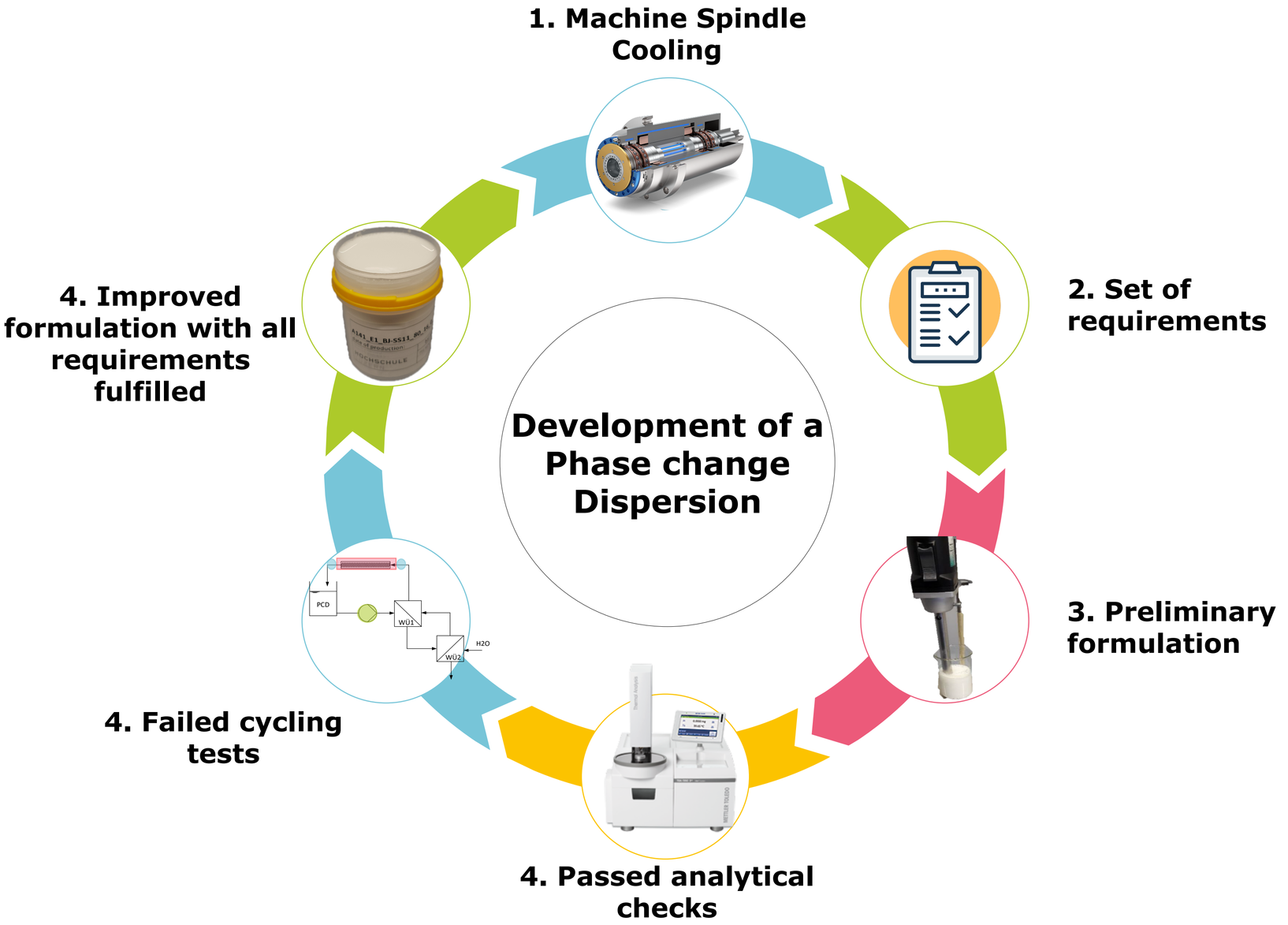
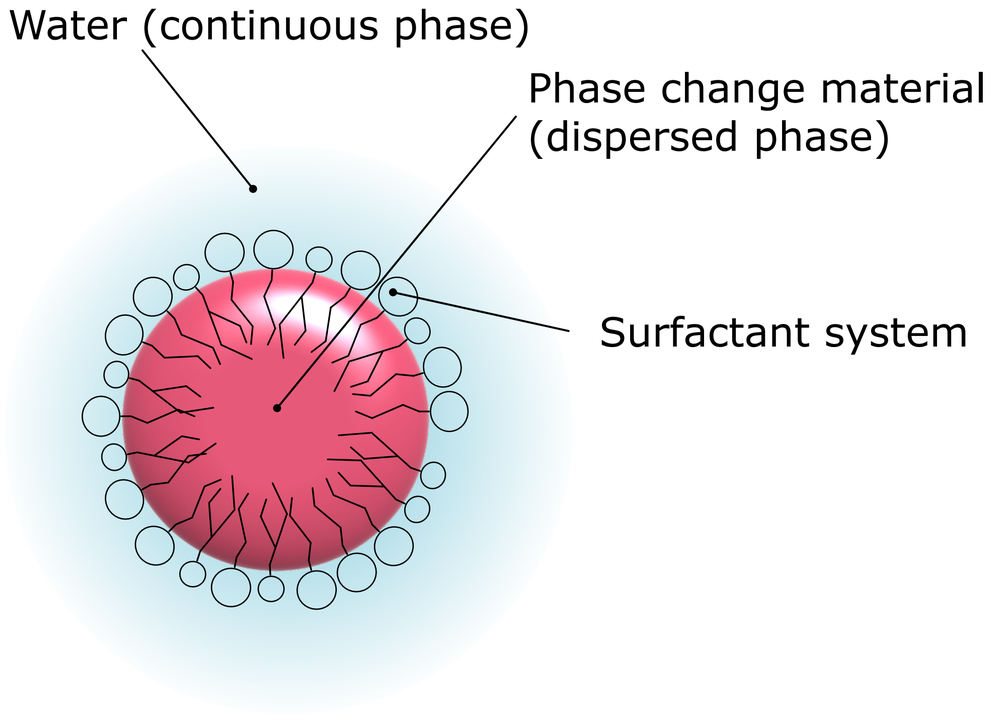
28.01.2022

Overview


1. Machine Spindle Cooling
2. Set of requirements
3. Preliminary formulation
4. Passed analytical checks
4. Failed cycling tests
4. Improved formulation with all requirements fulfilled
Development of a Phase change Dispersion
PCD
WU1
WU2
H2O

Background : Phase change dispersions

What is a phase change dispersion?

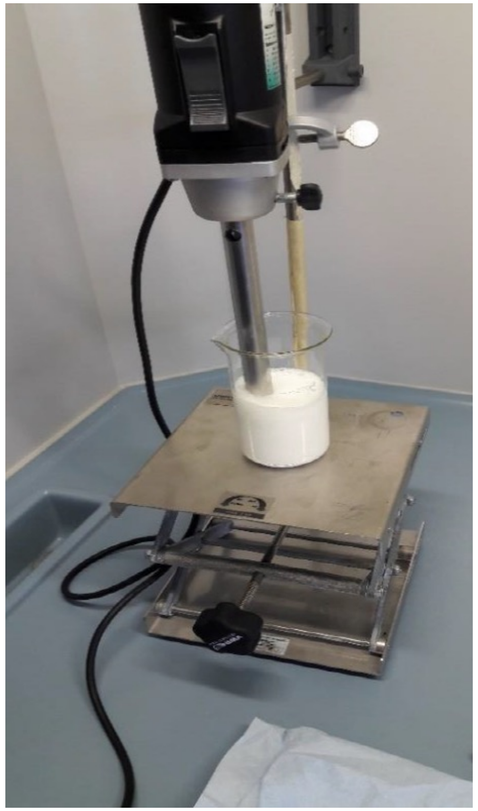


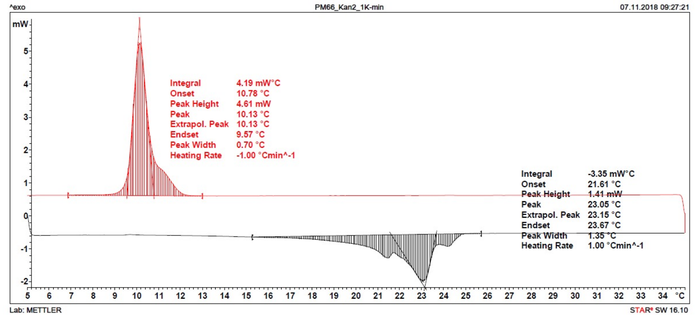
DeltaZero Objective

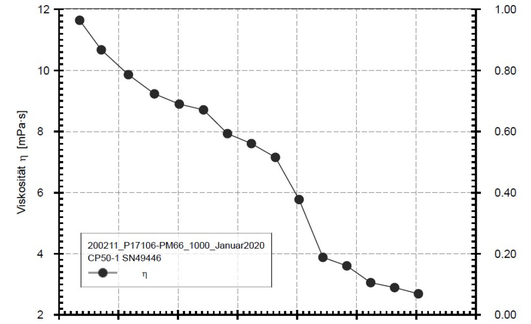
Formulate and test a novel phase change dispersion which fulfill the following requirements

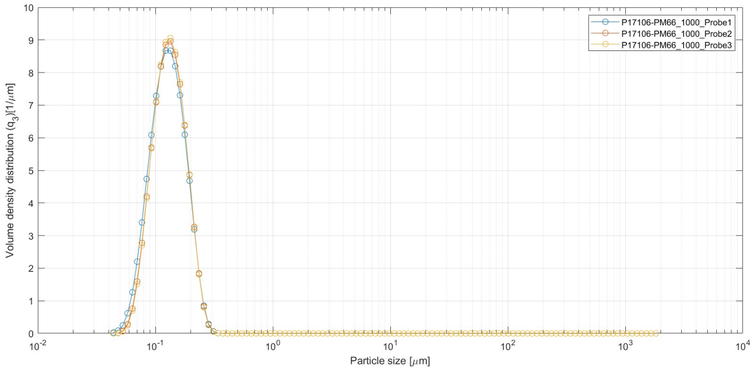
Requirements:

- $c_p \geq 8$ kJ kg^{-1} K^{-1}
- Low viscosity (μ)
- Low supercooling
- Thermal stability
- Mechanical stability
- Storage stability
- High heat transfer rate

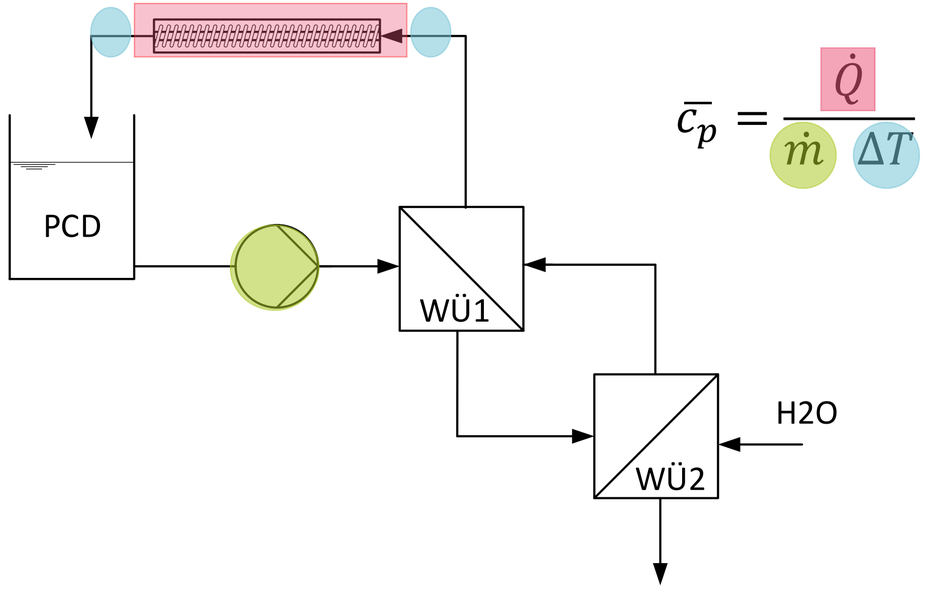








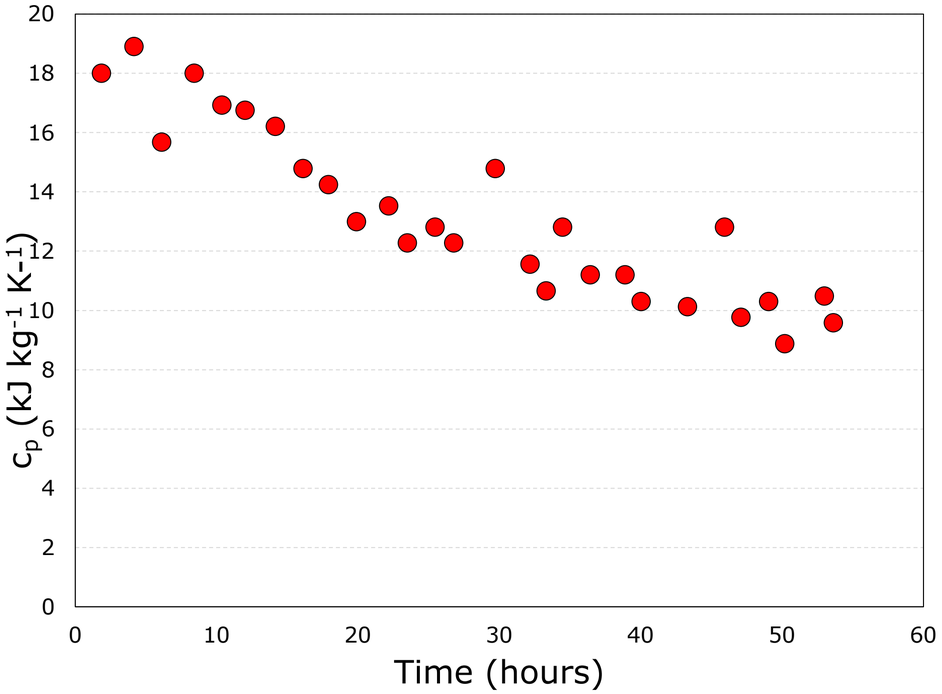
Methodology : Preliminary Phase Change Dispersion



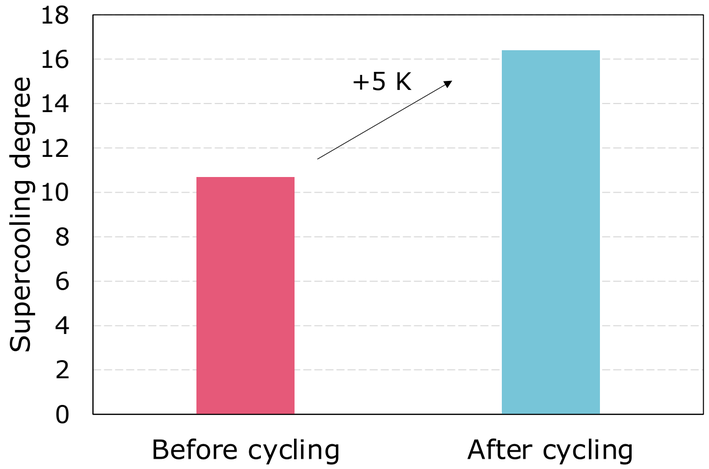
$$\overline{c_p} = \frac{\dot{Q}}{\dot{m}\ \Delta T}$$

Preliminary Phase Change Dispersion

1.Overall reduction in c_p over cycles

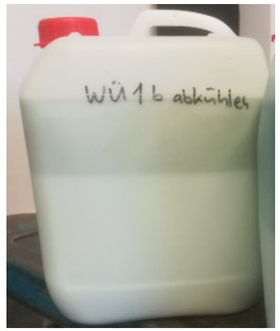


Increased degree of supercooling over cycles



PCM dispersed phase crystallising out onto HX & piping

8% lower PCM concentration



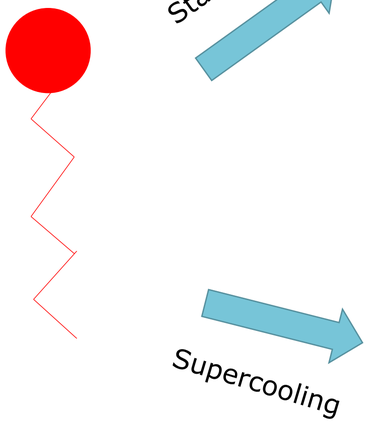
Materials & Methodology

A lot of formulations were made…

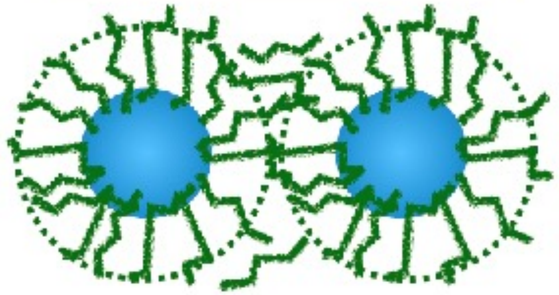
140

Materials and methodology : A novel approach

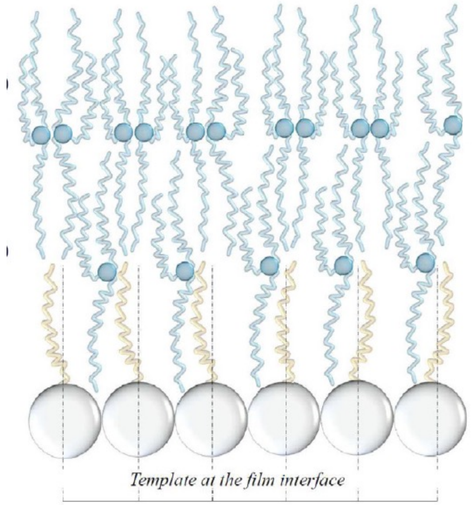
On ***formulation 141*** – we tried a different approach… *A modified surfactant system;* ***manipulating the interface***

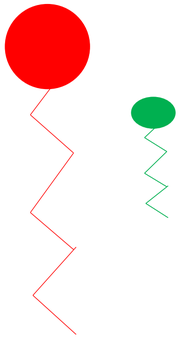


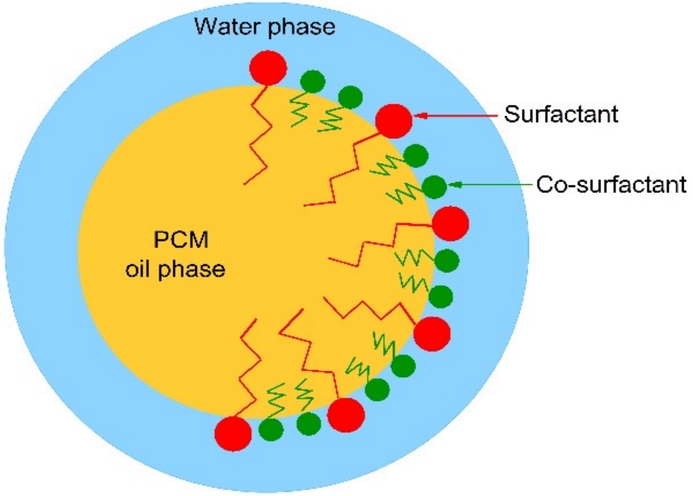
Steric stabilisation



Templating

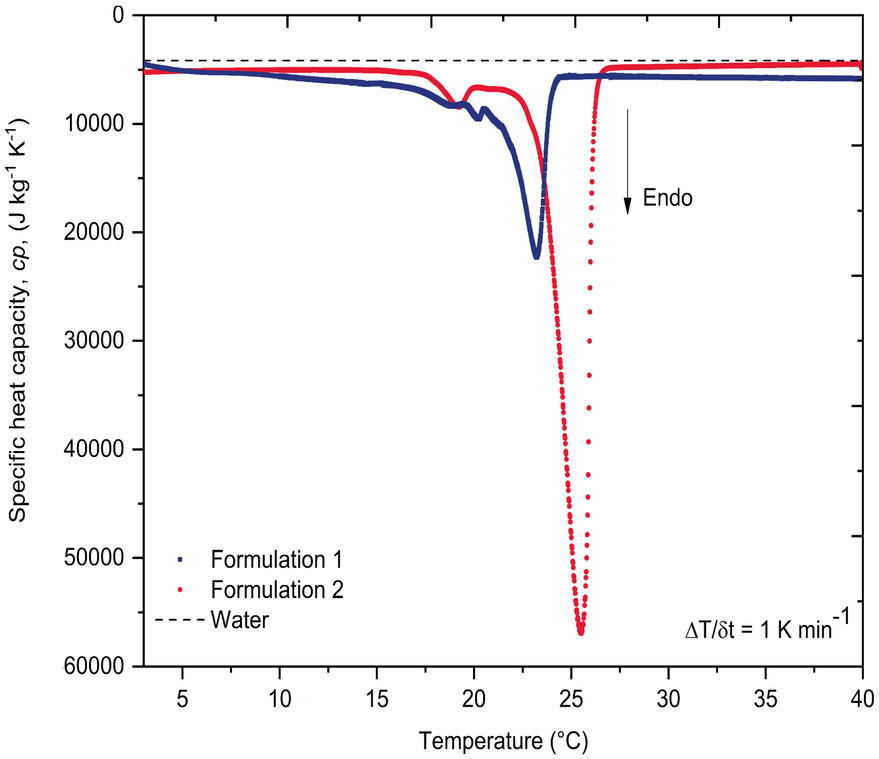


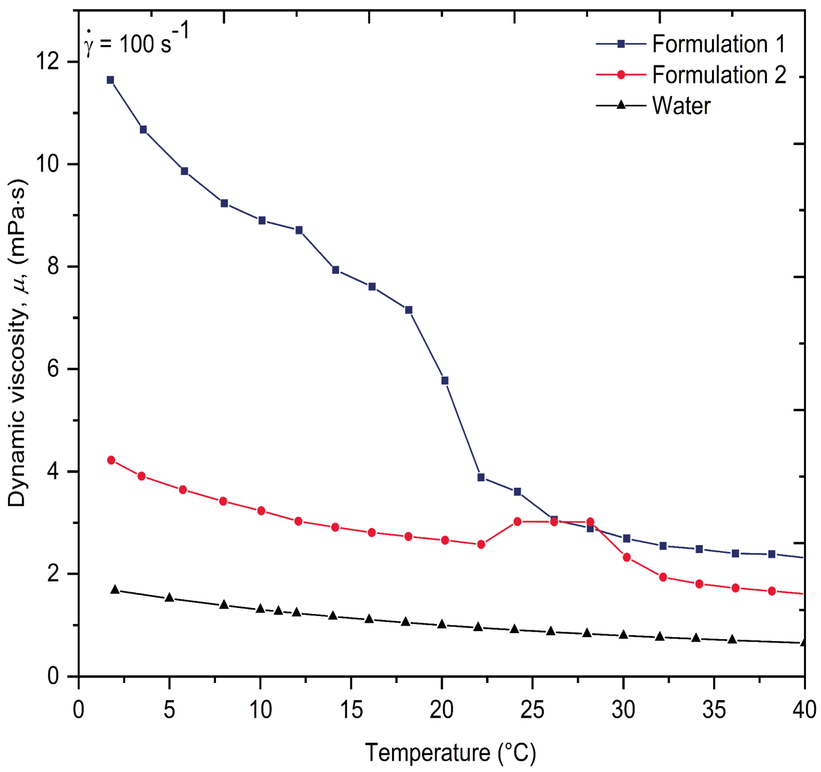


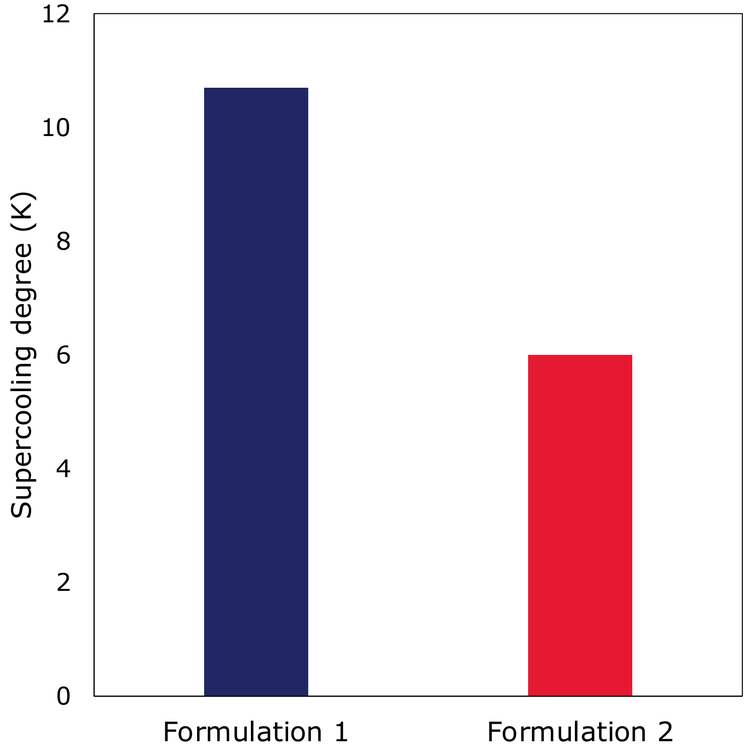


Mura & Ding, Adv. Colloid Interface Sci., (2021)

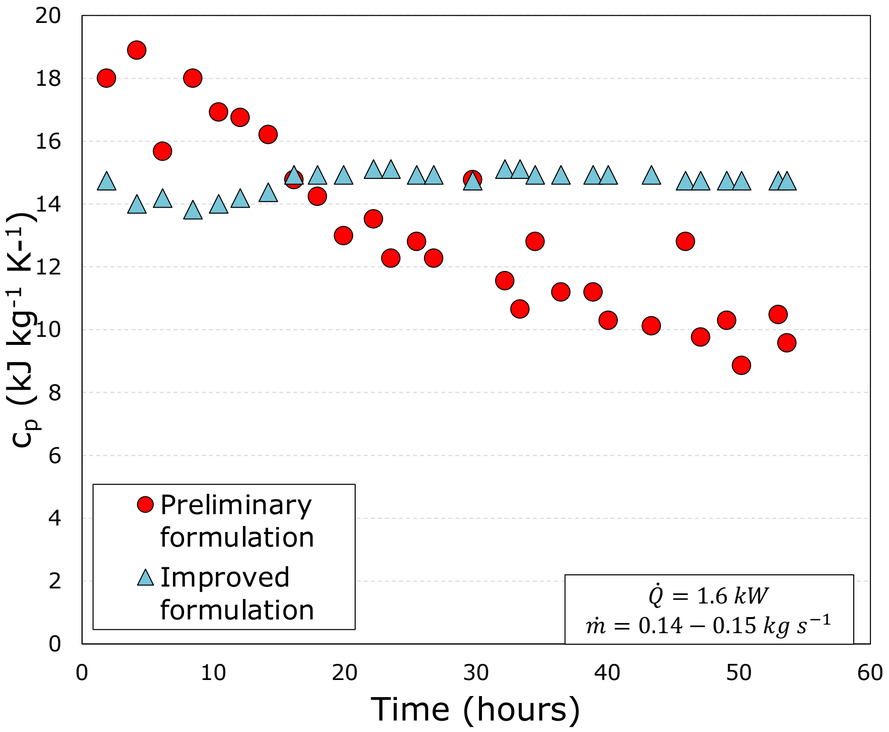
Results : New formulation

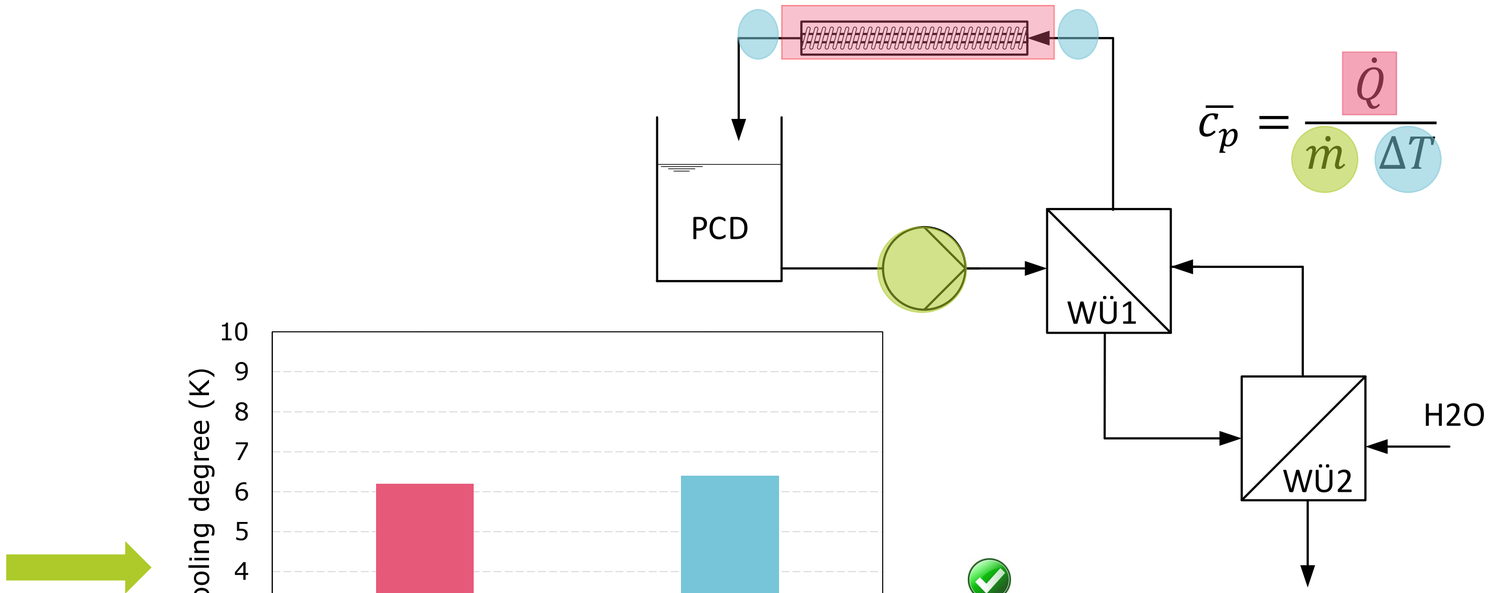


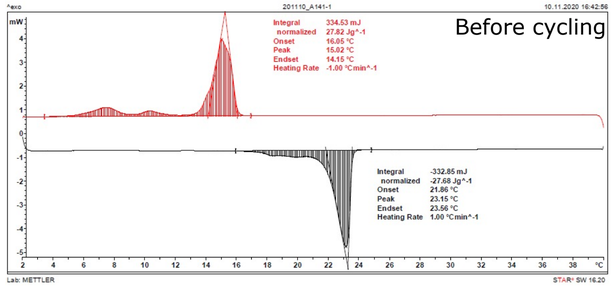


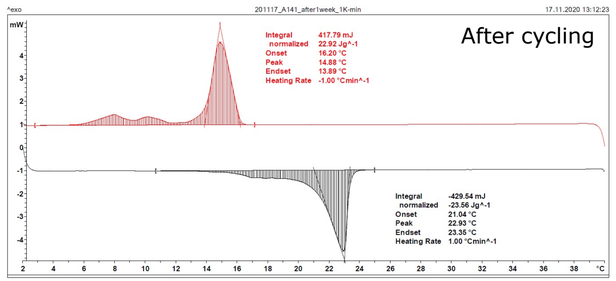


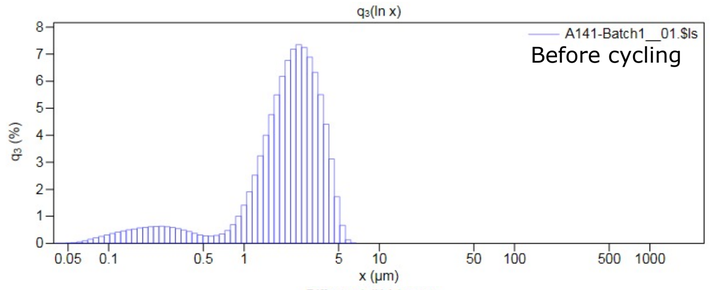
Results : New formulation

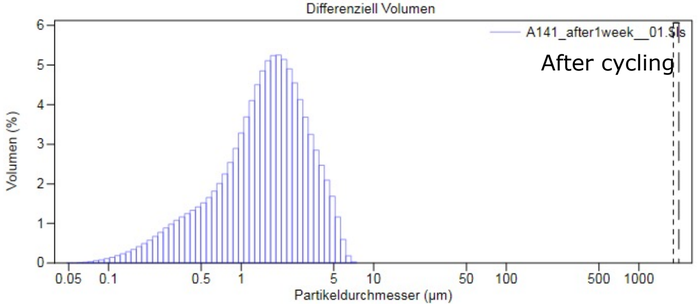












Future perspectives for phase change dispersions:

- Elucidate further **surfactant structure effects** to the reduction of **supercooling** and **thermophysical properties**

- Understand the the influence of **interface chemistry** on all the thermophysical properties of PCD

- **Apply the methodology** of PCD formulation to other temperature ranges/applications

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Thank you!

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