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Phase Change Slurries for Cooling and Cold Supply Networks

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Content



Source: Fraunhofer UMSICHT

- Introduction
- Material properties of PCS
- Economical comparison
- Environmental characteristics of PCS
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Introduction

Phase change material (PCM) latent energy storage material

Paraffin $\text{CH}_3-(\text{CH}_2)_n-\text{CH}_3$. The melting of the $(\text{CH}_2)_n$ chain adsorbs a large amount of latent heat.

Tetradecane: $\text{CH}_3-(\text{CH}_2)_{12}-\text{CH}_3$

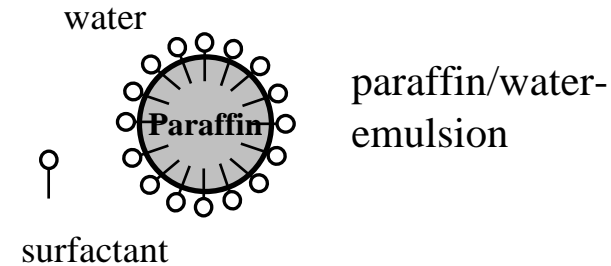
Melting point	Heat of fusion	Spezific heat capacity	State at room temperature
5.8°C	227 kJ/kg	2,18 kJ/kg°C	liquid

Introduction

Phase Change Slurries (PCS) heat carrier, which consist of a liquid and a phase change material

investigated PCS

- paraffin/water emulsion
- encapsulated paraffin/water suspension



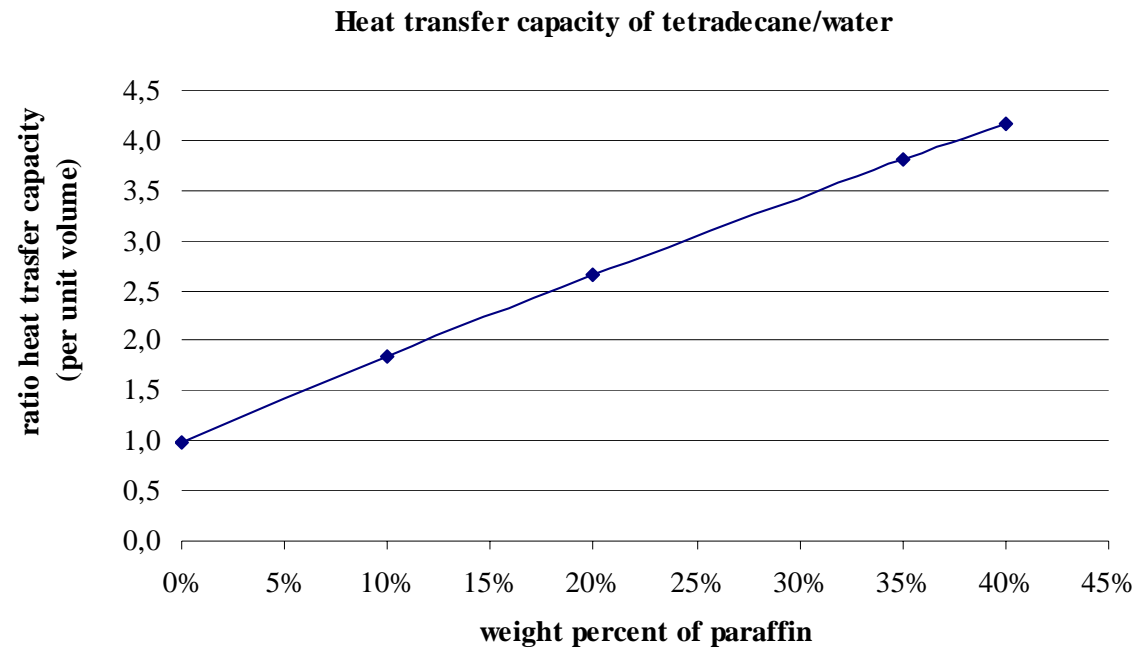
encapsulated
paraffin/water-
suspension



Material properties of PCS

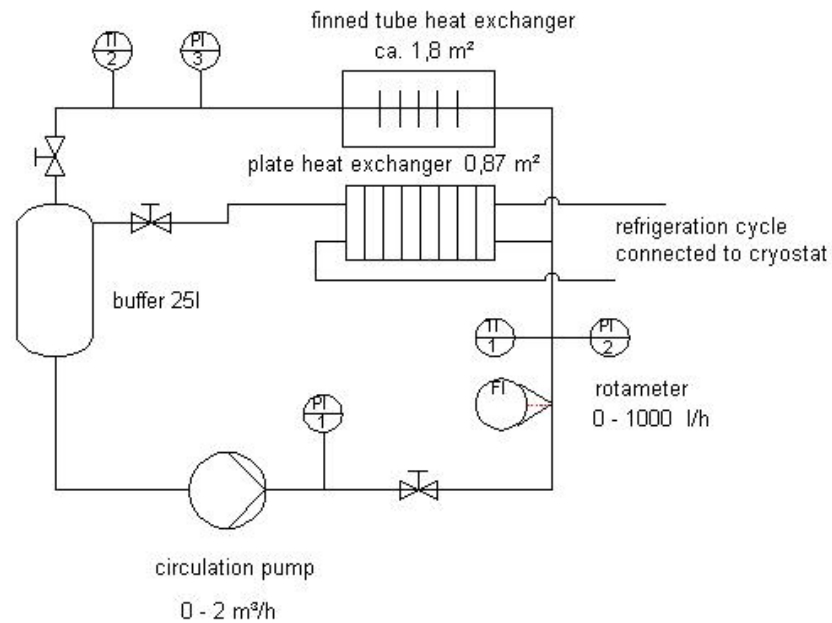
Heat transfer capacity

- heat transfer capacity of paraffin/water mixtures depending on the concentration of paraffin
- melting temperature range 8 –14°C for comfortable cooling



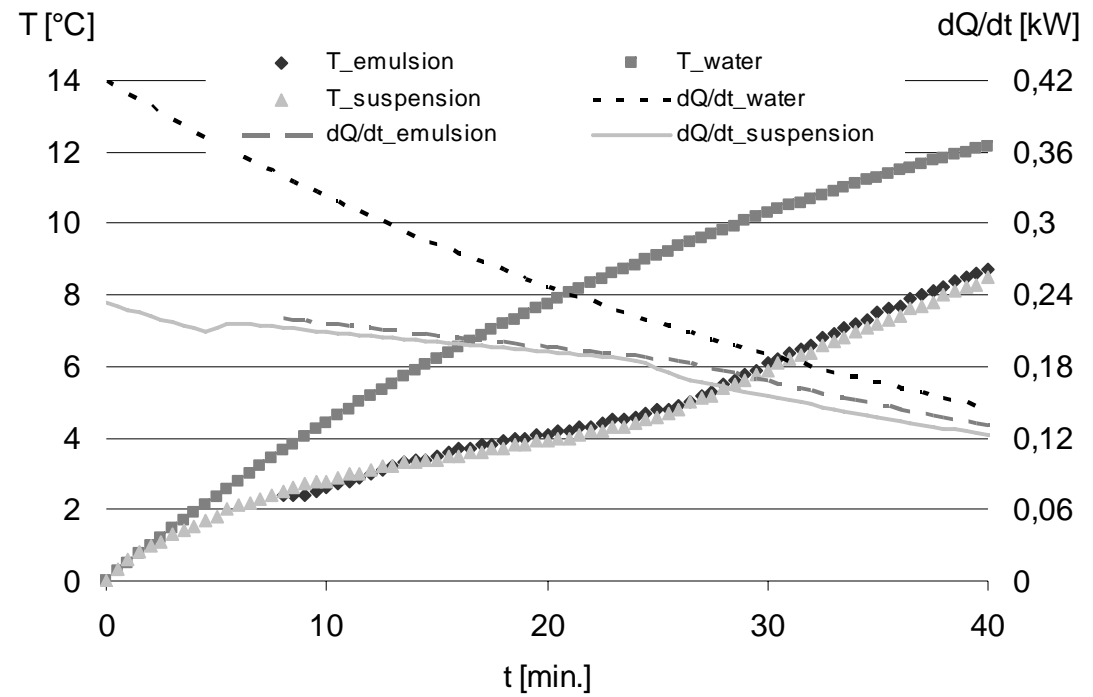
Material properties of PCS

Test rig for paraffin/water mixtures



Material properties of PCS

Temperature change and cold power output



Material properties of PCS

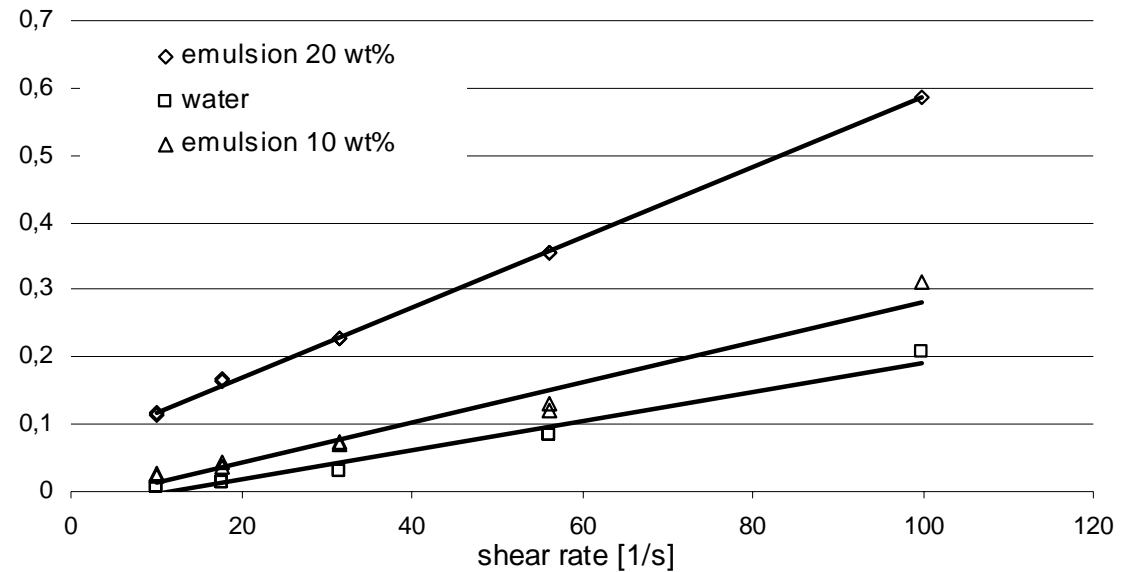
Rheological characteristics

Viscosity of paraffin/water emulsion:

Newtonian behavior

$$\tau = -\eta \cdot \dot{\gamma}$$

shear stress [Pa]



Material properties of PCS

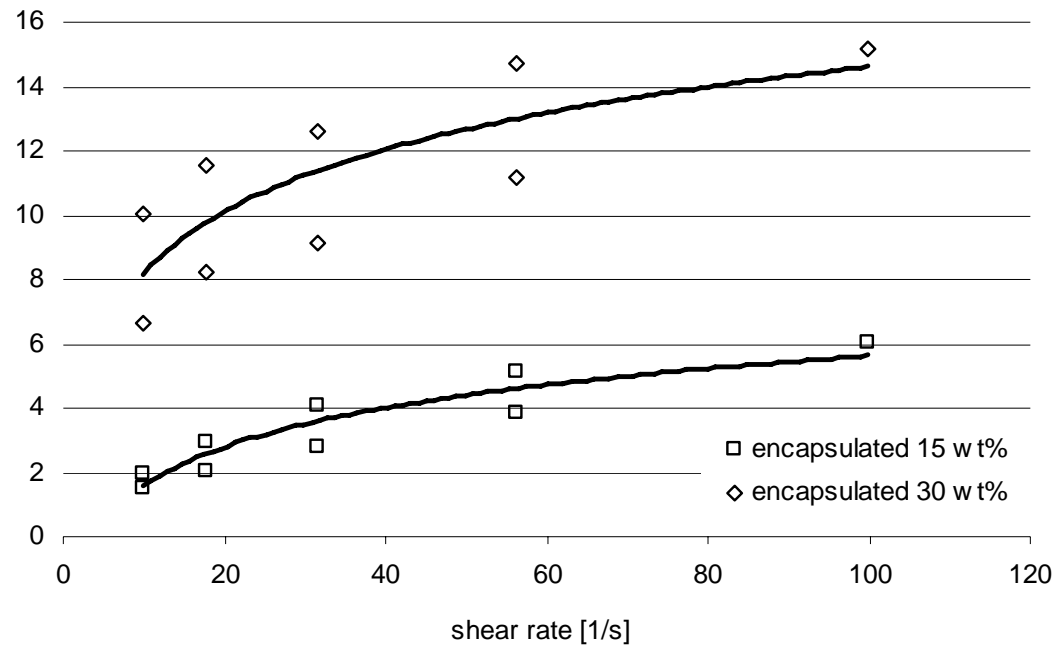
Rheological characteristics

Viscosity of encapsulated
paraffin/water suspension

Ostwald-de-Waele-fluid:

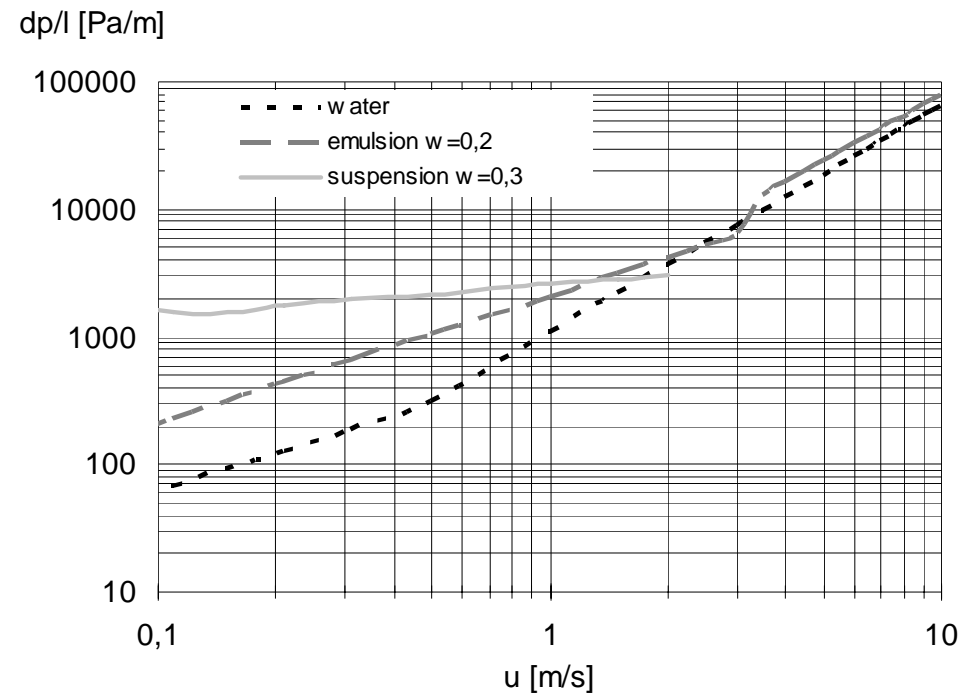
$$\tau = k \cdot \dot{\gamma}^n$$

shear stress [Pa]

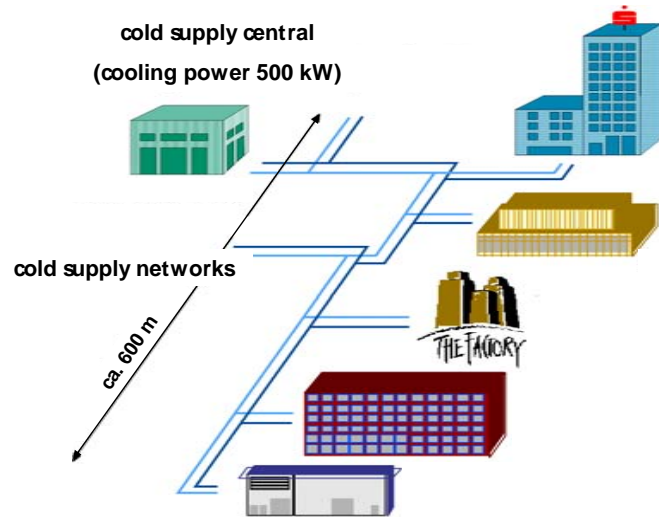


Material properties of PCS

**Pressure drop for water, tetradecane/water
emulsion and encapsulated tetradecane
suspension**



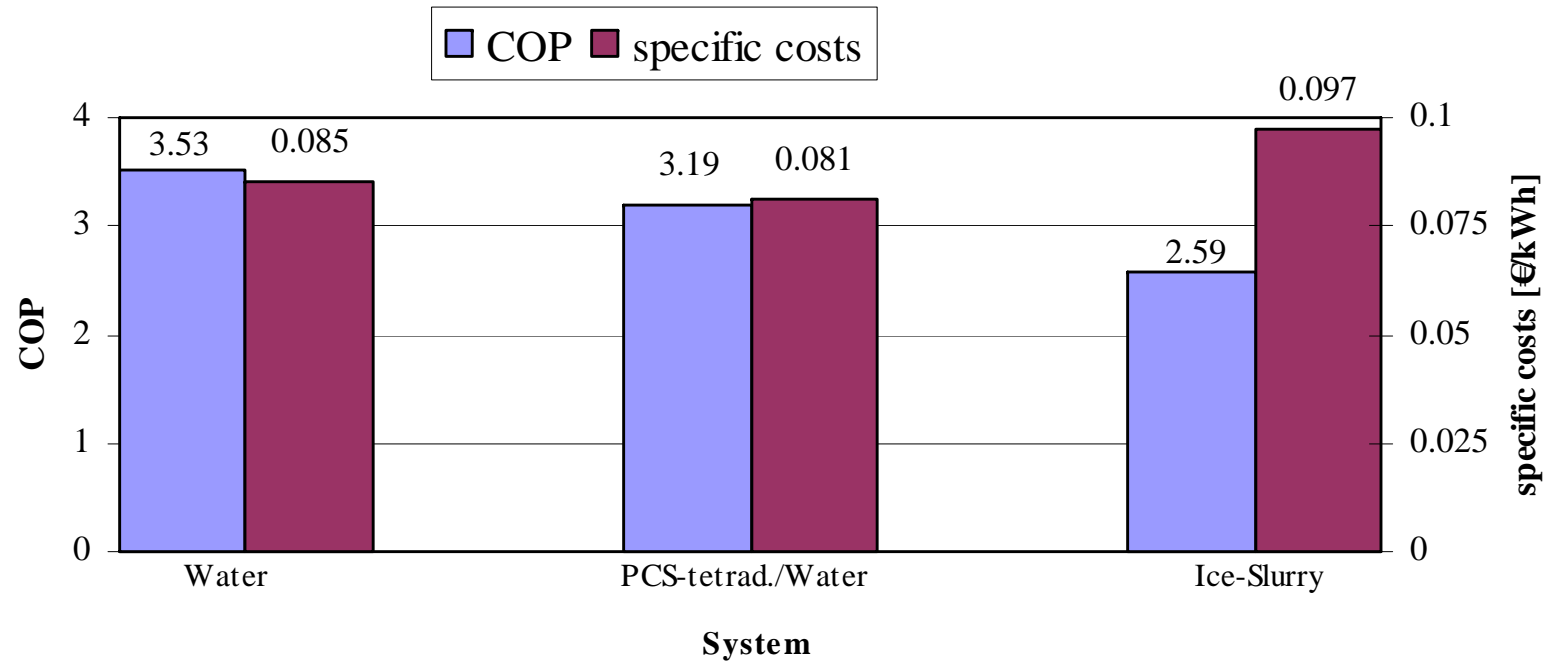
Economical comparison



- Comparison of a cold water, paraffin/water mixtures and Ice Slurries network
- Cooling power 500 kW and length of network 600 m
- Operating time 1000 hours per year
- PCM-concentration 20%

Source: Fraunhofer UMSICHT

Economical comparison



Environmental characteristics of PCS



- The investigated PCS-Systems (Ice slurries, tetradecane/water emulsion and suspension) have no hazardous or dangerous substances
- Due to German Water Management Act -> The investigated PCS-Systems are low water endangering and are classified to WEC 1

Source: Fraunhofer UMSICHT

Results



Source: Fraunhofer UMSICHT

- **Material properties**

- high storage density with small temperature change

- Rheological behavior:

- emulsion (<20%): Newtonian behavior

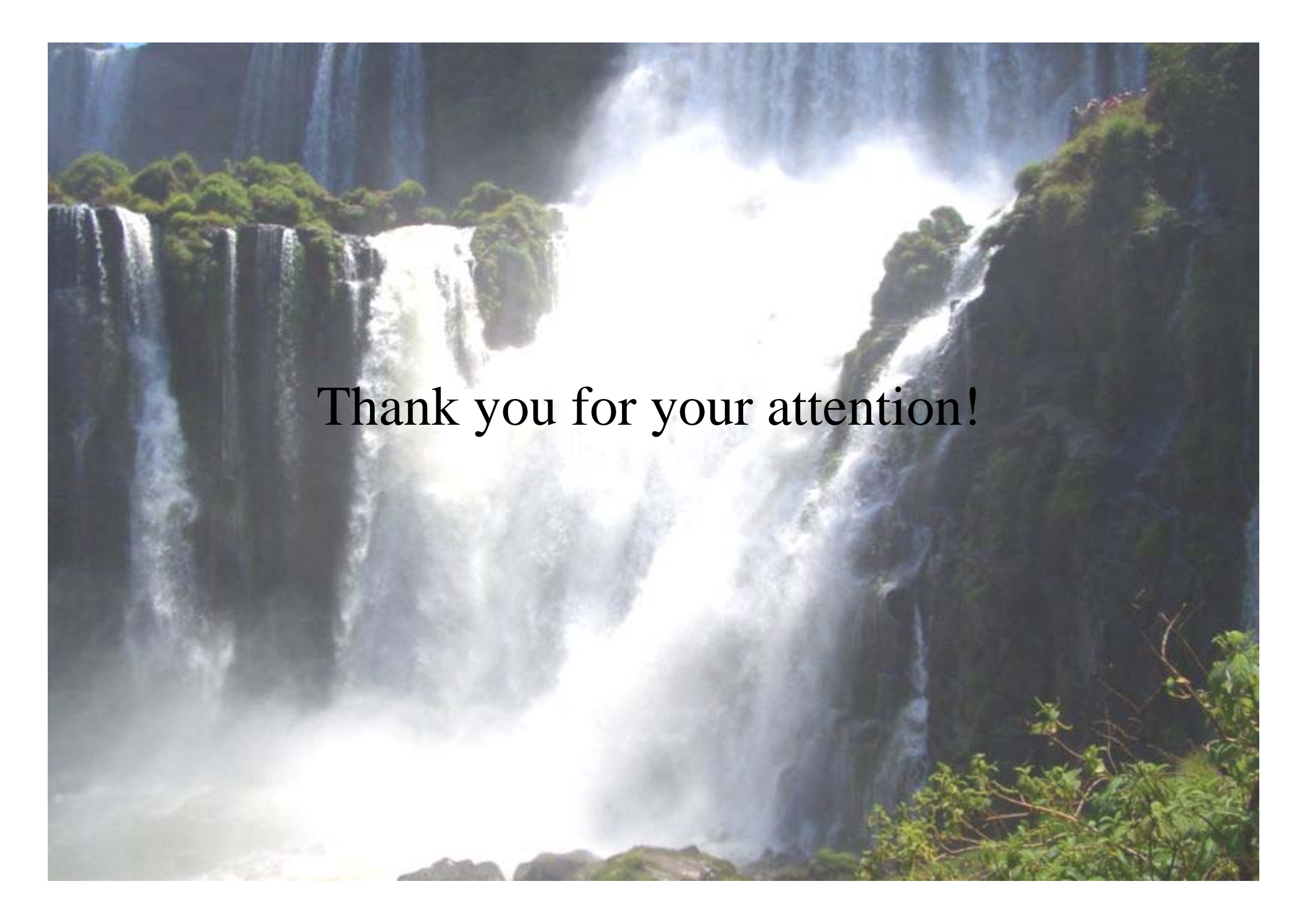
- suspension (<30%): Ostwald-de-Waele fluid

- **Economical comparison**

- paraffin/water: in temperature range over 0 °C in competition to chilled water

- **Environmental characteristics**

- no dangerous or hazardous substances



Thank you for your attention!