Struvite precipitation as a method of liquid preparation before purification of post-processing liquid derived from hydrothermal carbonization of sewage sludge using membrane techniques

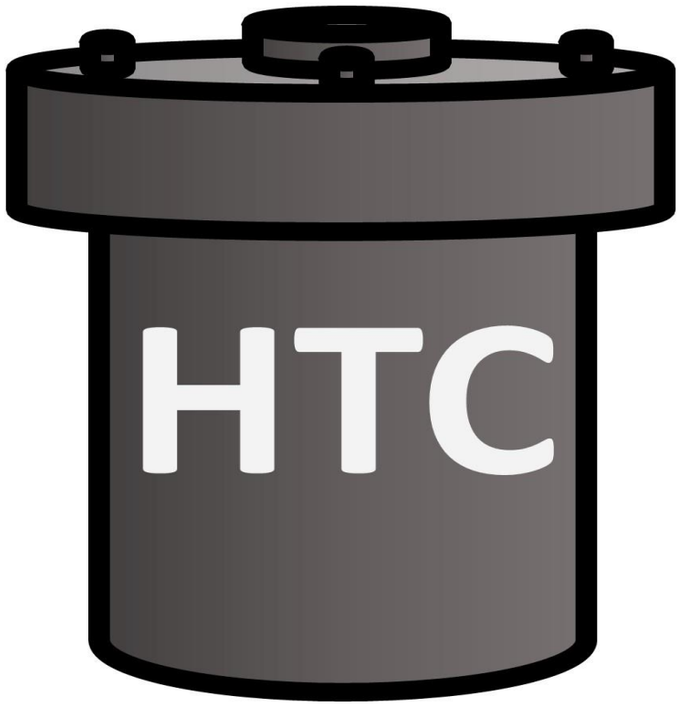
Klaudia Czerwińska[1], Agnieszka Urbanowska[2], Maciej Śliz[1], Izabela Kalemba-Rec[1], Małgorzata Wilk[1]

[1]AGH University of Krakow
[2]Wroclaw University of Science and Technology

Presentation plan

- Introduction: hydrothermal carbonization process of sewage sludge and liquid purification.
- Experimental procedures.
- Results.
- Conclusions.

What is the HTC?



The proces of converting wet sewage sludge into biofuel.

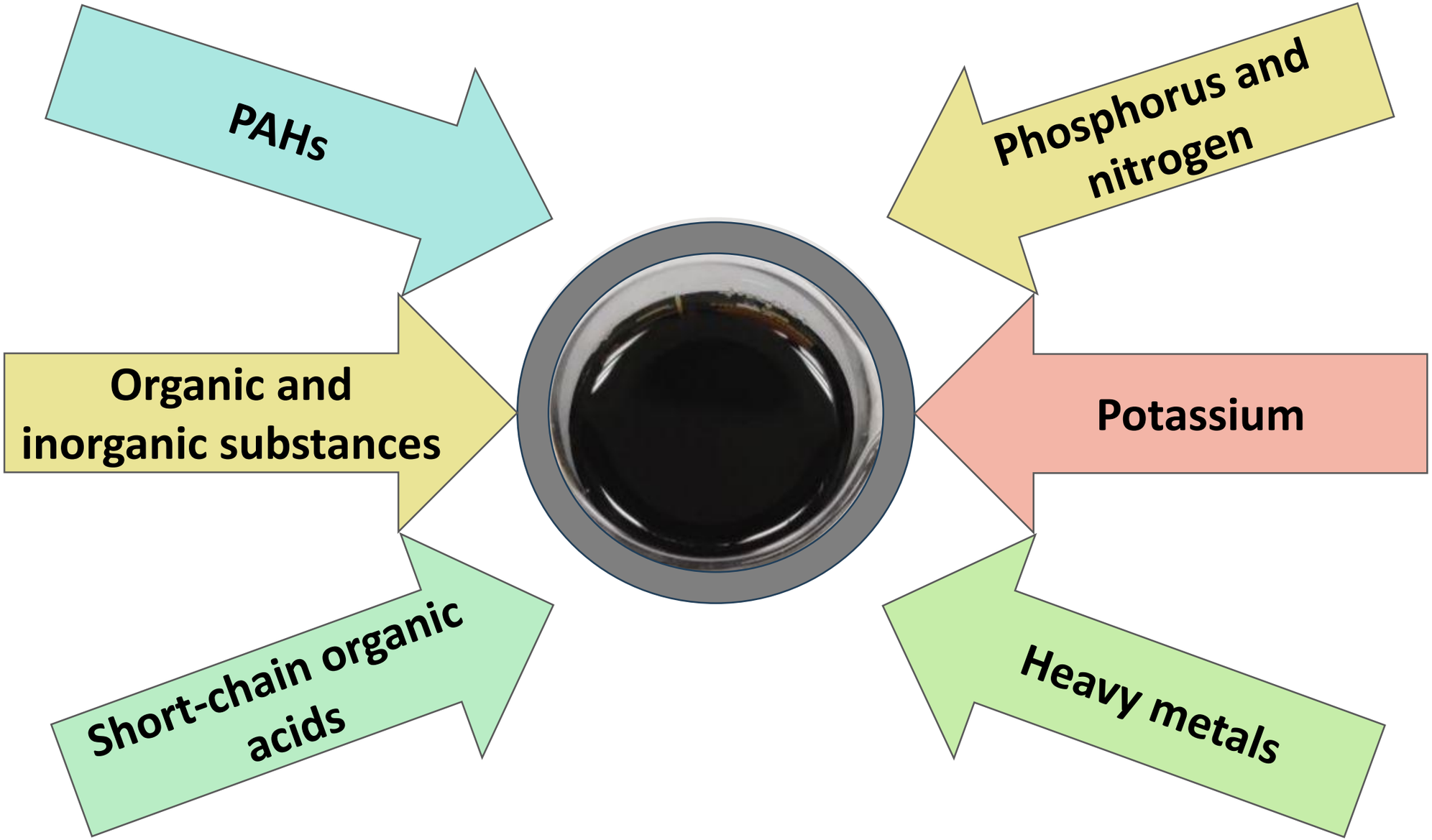
Process is caried out in an aqueous environment.

Process parameters: temperature, time, heating rate, B/W.

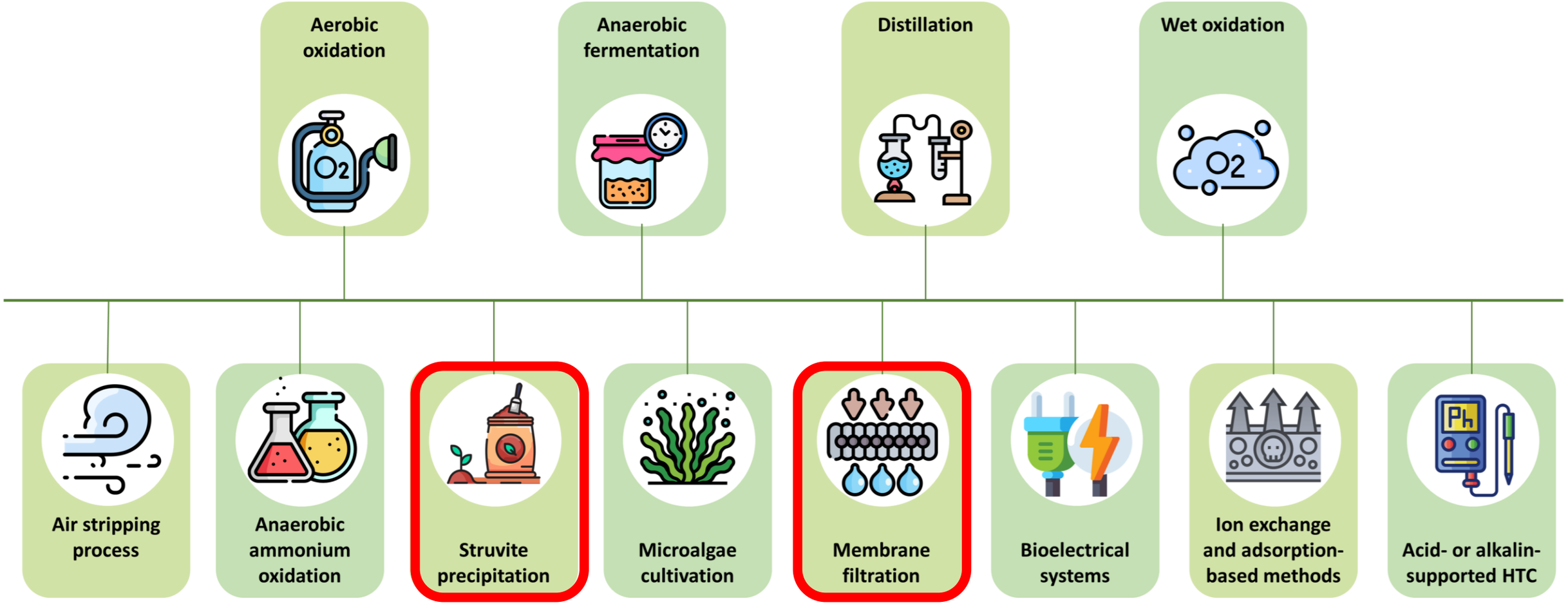
Research material: organic and inorganic material.

Reaction products: hydrochar, post-processing liquid and gas.

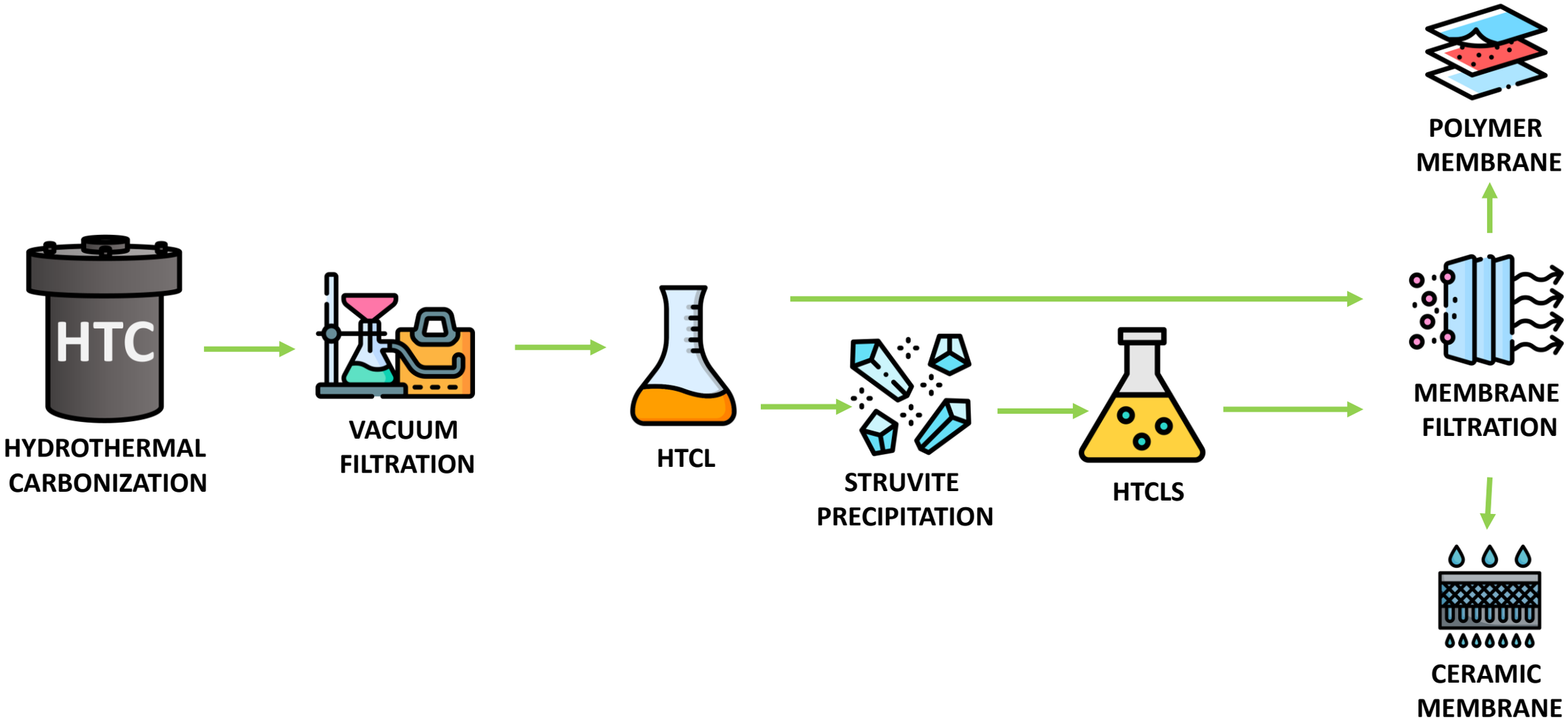
Post-processing liquid



Purification of liquids from the HTC

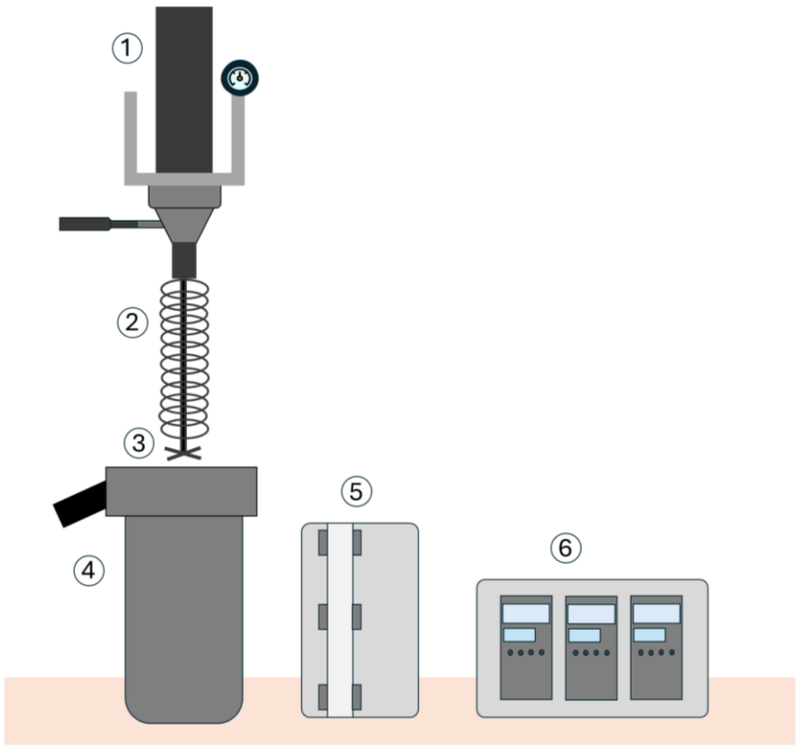


Experimental procedures



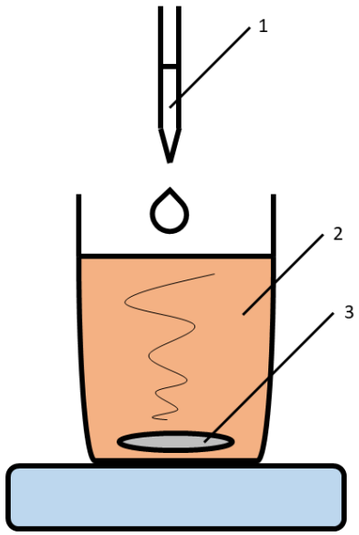
Experimental stations

HTC



1 – MagneDrive; 2 – cooling coil; 3 – mixer; 4 – reactor; 5 – heating jacket; 6 – control panel.

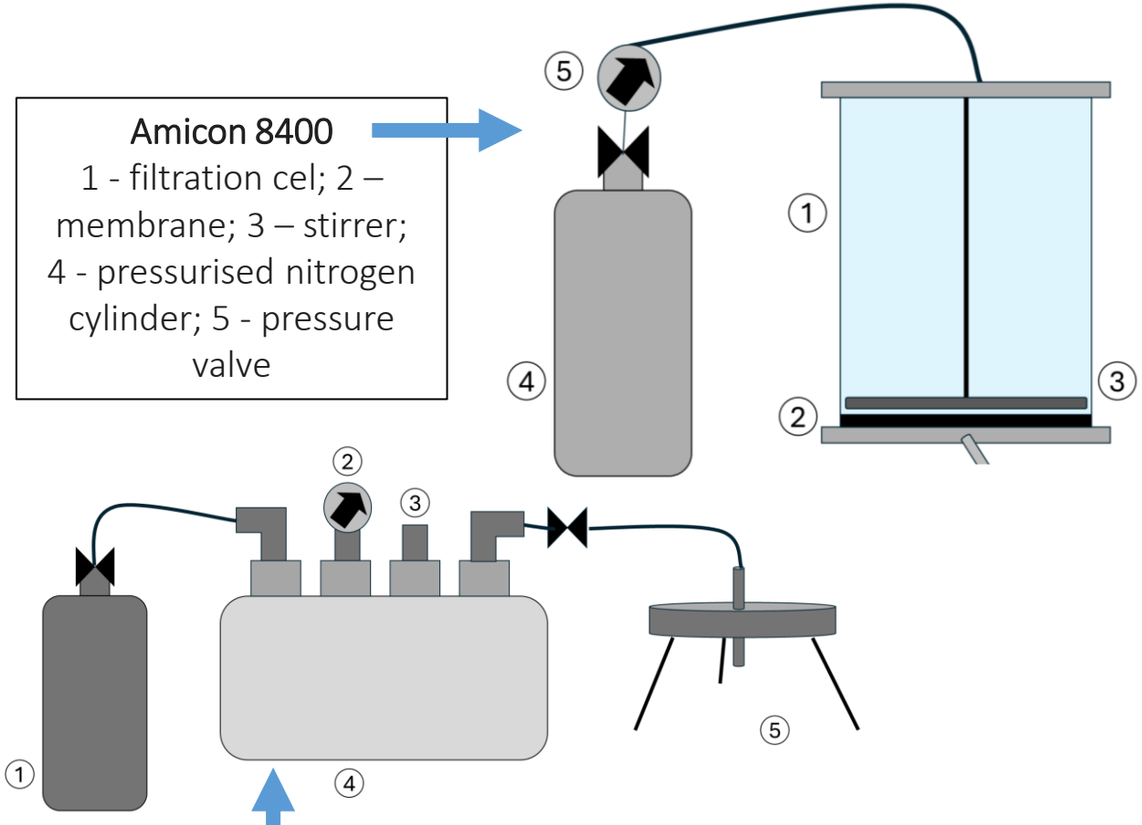
Struvite precipitation



1 – burette; 2 – solution with a specific ion concentration; 3 – magnetic stirrer.

Membrane filtration

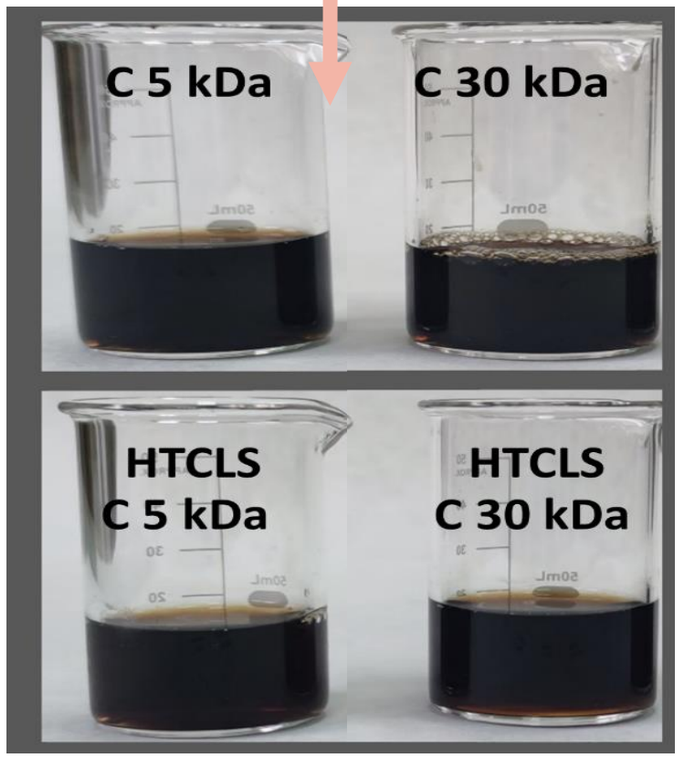
Amicon 8400
1 - filtration cel; 2 – membrane; 3 – stirrer; 4 - pressurised nitrogen cylinder; 5 - pressure valve



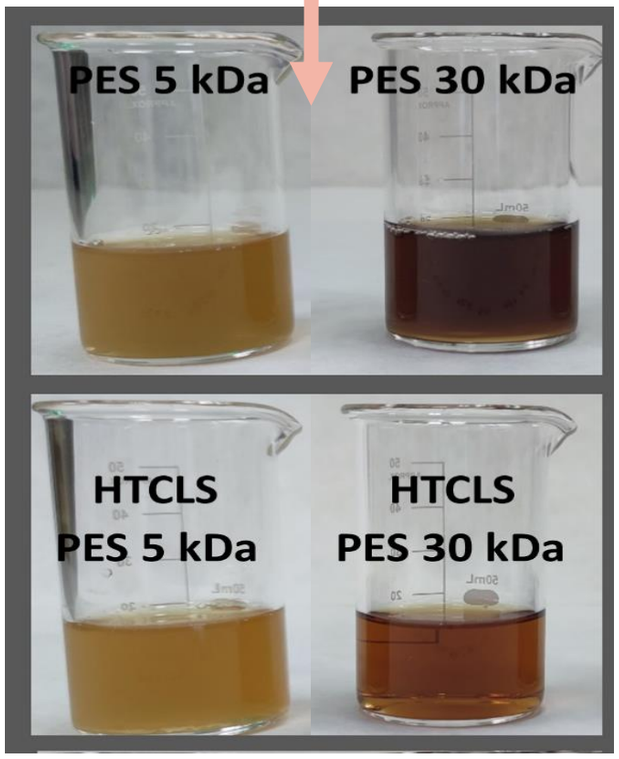
Sterlitech 316 SS
1 – pressurised nitrogen cylinder ; 2 – pressure gauge ; 3 – relief value; 4 – preassure vessel; 5 – filtration device .

Results

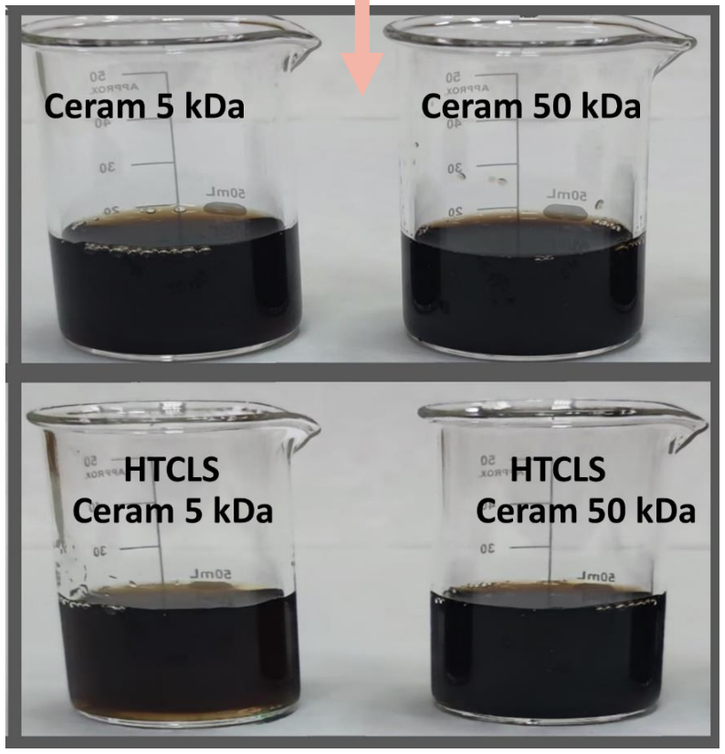
Regerated Cellulose Membranes



Polyethersulphone Membranes

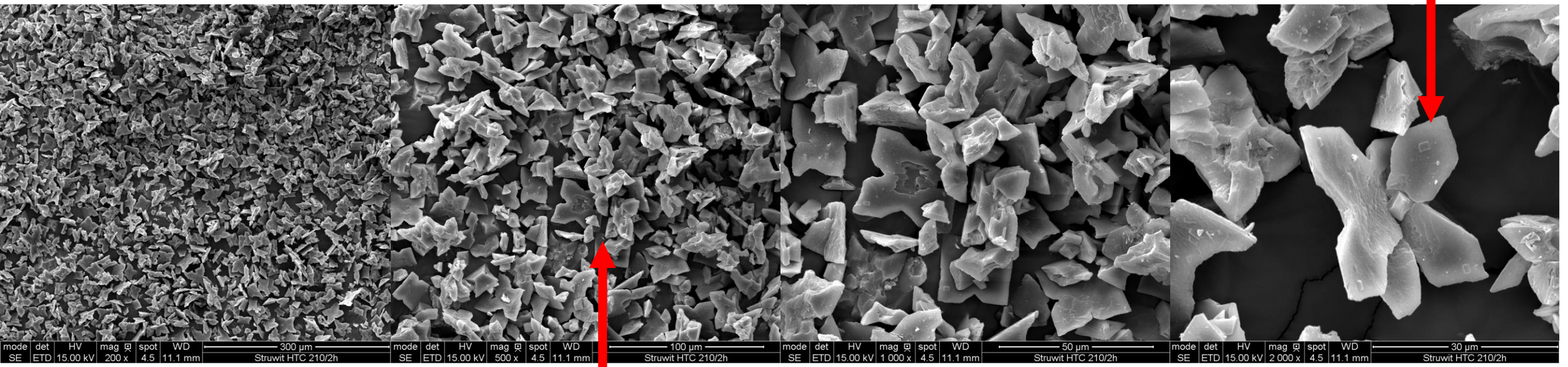


Ceramic Membranes



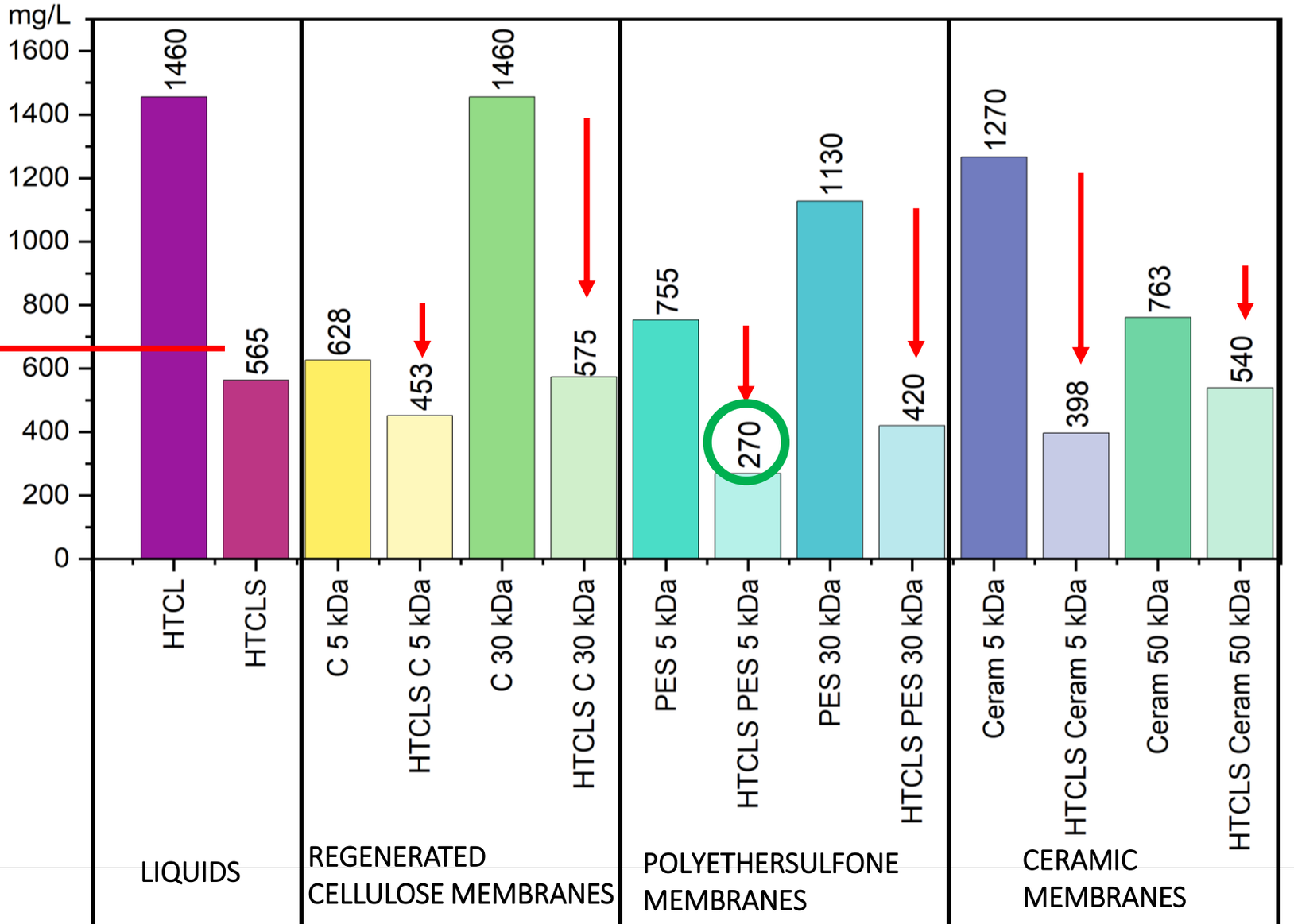
Results – struvite

STRUVITE with „X" structure



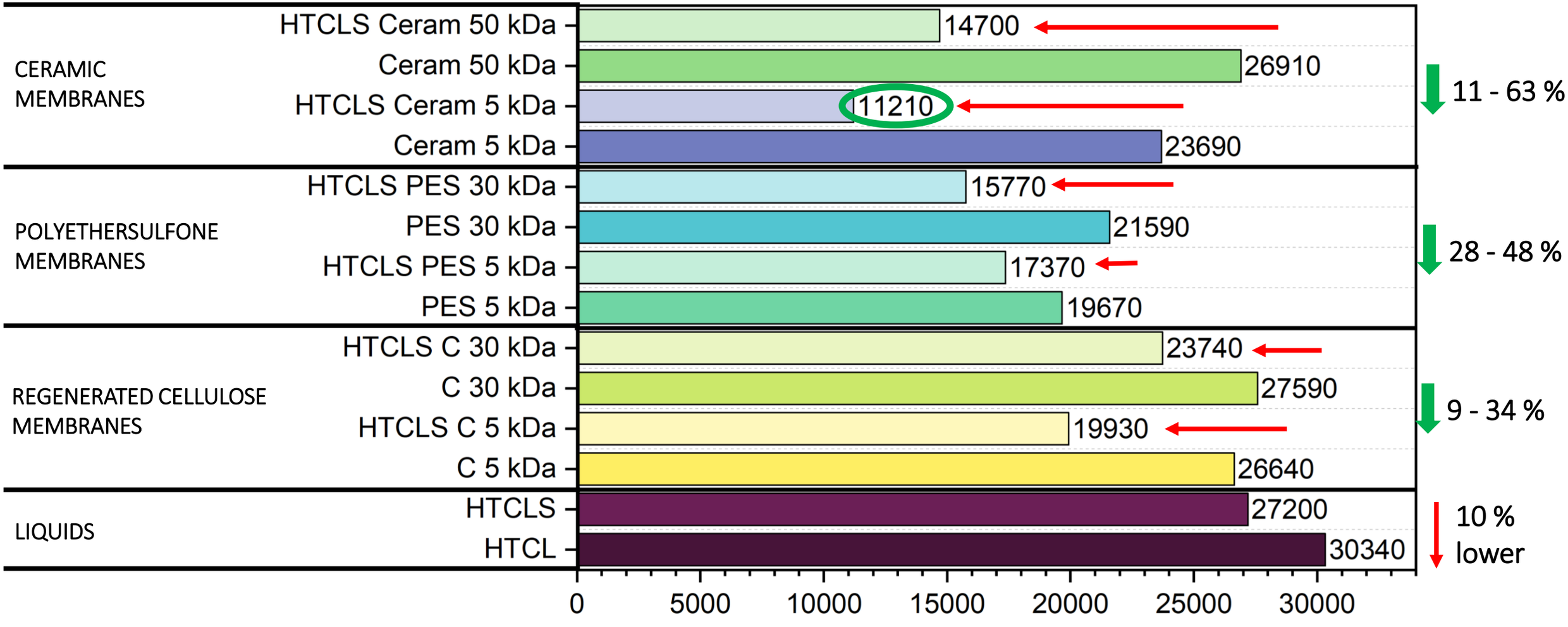
Tendency to agglomerate

Results – PO_4^{3-}

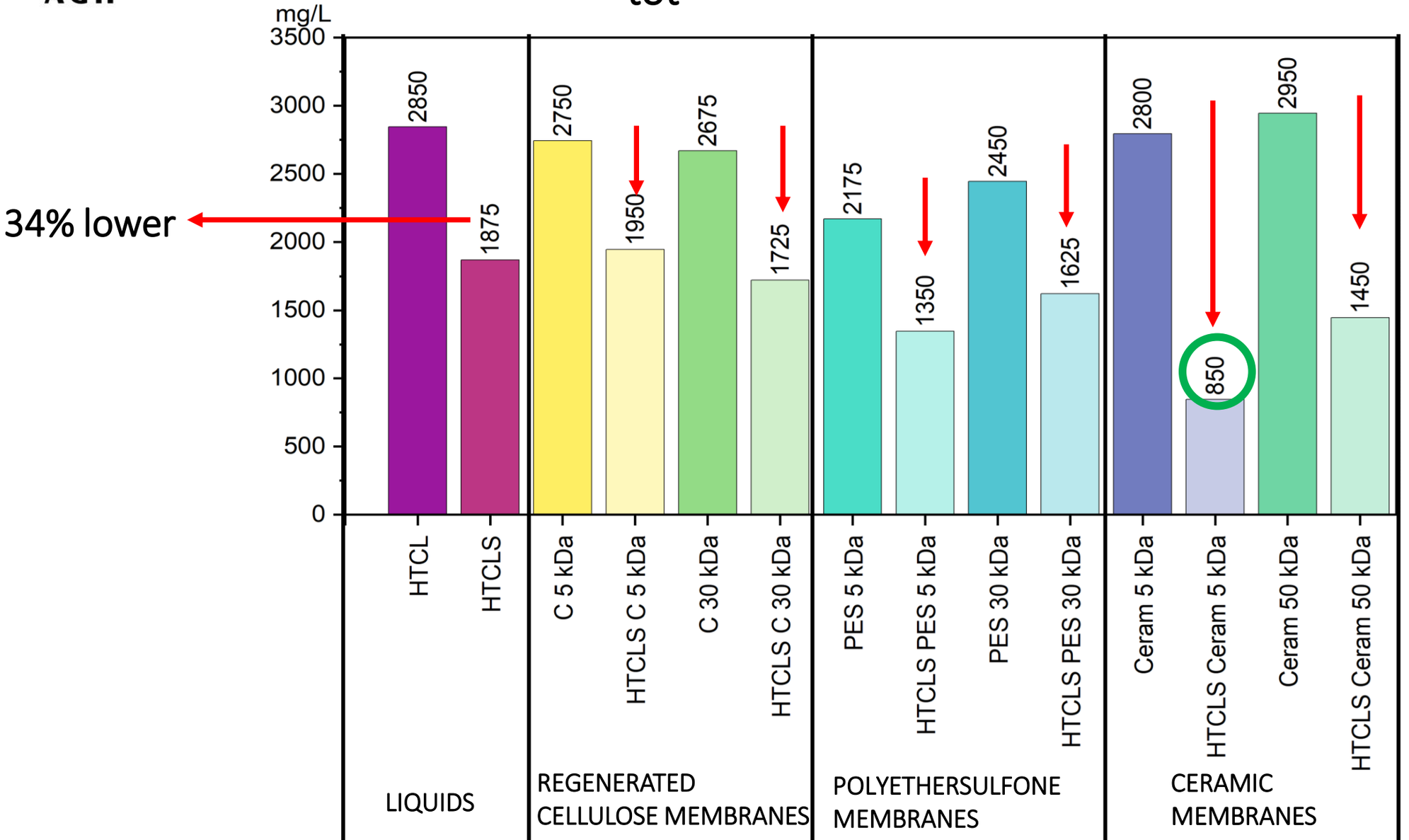


60% lower

Results - COD


CERAMIC MEMBRANES
HTCLS Ceram 50 kDa
14700
Ceram 50 kDa
26910
HTCLS Ceram 5 kDa
11210
Ceram 5 kDa
23690
11 - 63 %
POLYETHERSULFONE MEMBRANES
HTCLS PES 30 kDa
15770
PES 30 kDa
21590
HTCLS PES 5 kDa
17370
PES 5 kDa
19670
28 - 48 %
REGENERATED CELLULOSE MEMBRANES
HTCLS C 30 kDa
23740
C 30 kDa
27590
HTCLS C 5 kDa
19930
C 5 kDa
26640
9 - 34 %
LIQUIDS
HTCLS
27200
HTCL
30340
10 % lower
0
5000
10000
15000
20000
25000
30000

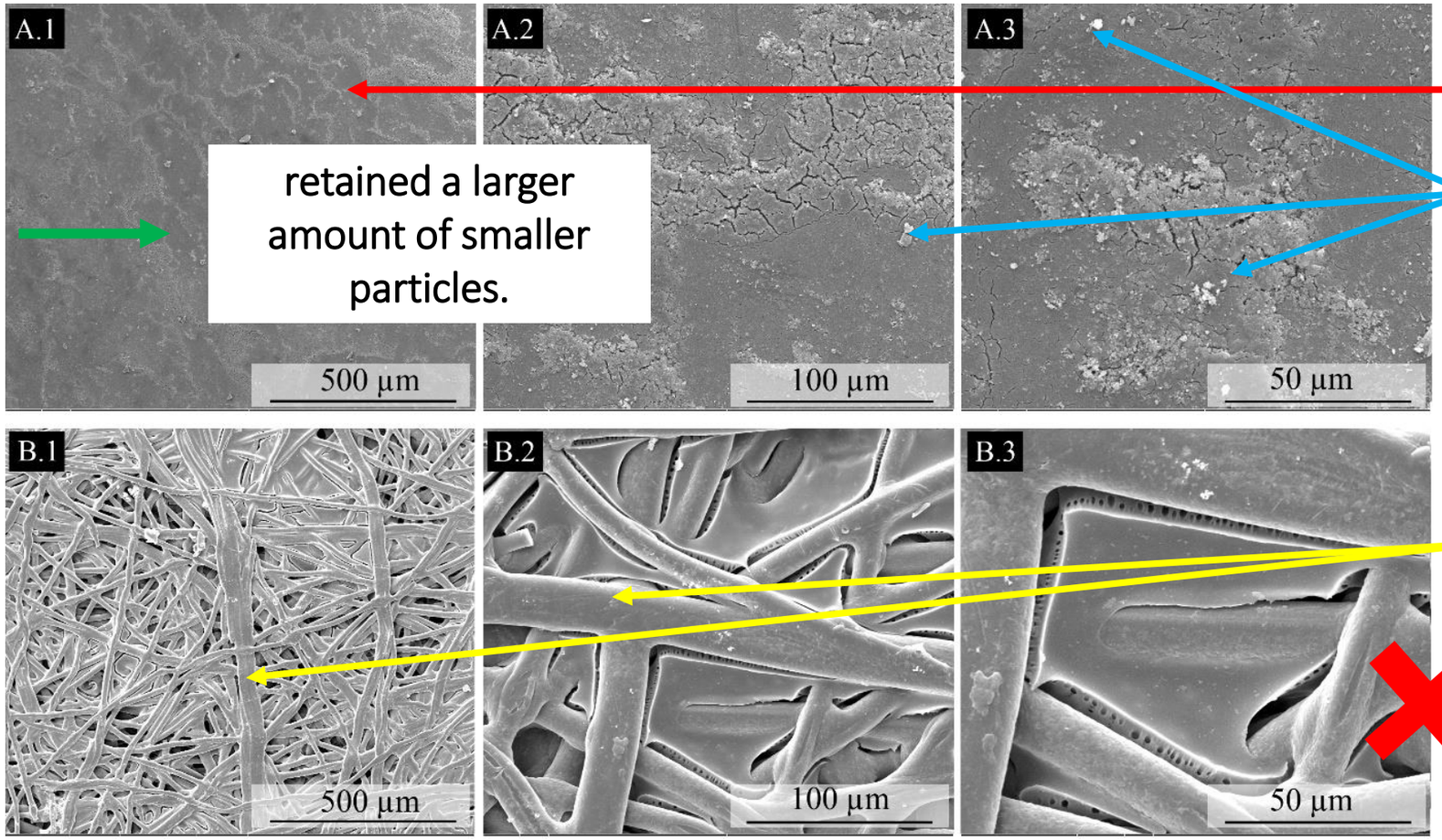
Results – N_{tot}



Results – membranes

C 5 kDa

PES 50 kDa



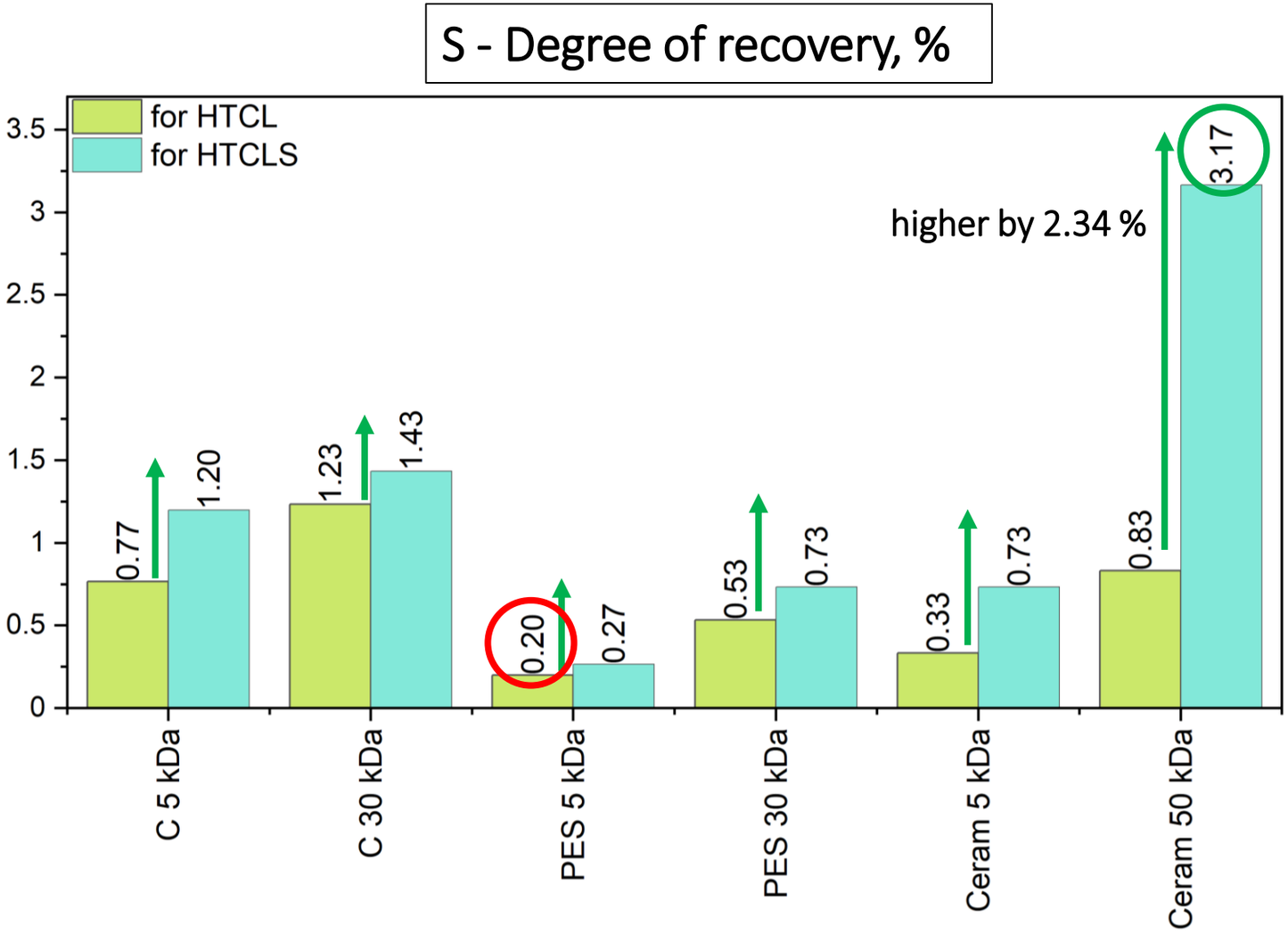
fouling phenomenon

single larger particles

membrane fibers

non large debris

Results – S parameters



Conclusions

1. Struvite precipitation caused the reduction of phosphorus compound, nitrogen and COD in the HTC liquid.
2. Membrane filtration was used to purify the liquid after HTC and the liquid from struvite precipitation.
3. Struvite precipitation caused higher retention of contaminants.
4. Struvite precipitation caused higher liquid recovery.

Acknowledgements

The research was funded by the National Science Centre, Poland under project no. 2021/41/B/ST8/01815 [OPUS21].

The authors would like to express their thanks to the proprietor of the experimental apparatus EKOPROD Ltd. in Bytom.

Thank you for your attention!