

How algae caused ultrafiltration fouling depends on type and growth phase of algae

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Introduction

Algae are globally abundant in surface waters like reservoirs, lakes, and seas. These algae-rich waters can cause challenges in water treatment. Ultrafiltration have been proven to reveal high retention for algae cells. However, severe fouling and cake deposition on the membrane was resulted due to the intensive accumulation of the algae cells and derived substances. This research work focused on the fouling mechanism of polyethersulfone (PES) capillary membranes by four types of algae (marine and freshwater) in relation with cell condition, "intact" (mostly present in exponential phase) and "lysed" (mostly present in death phase), and operating condition. Furthermore, the ability to restore the initial permeability was also investigated with different chemical cleaning protocols.

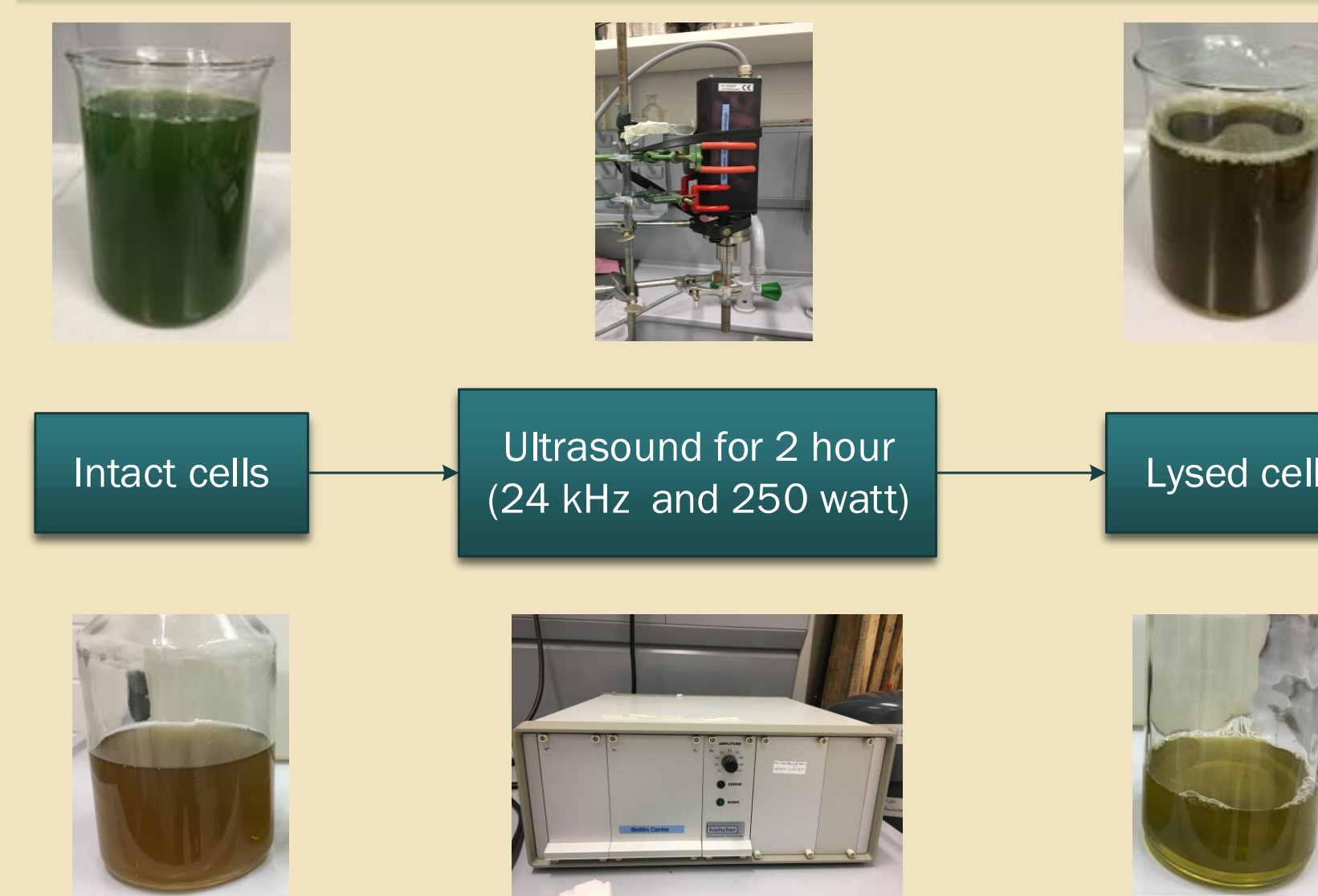
Objectives

- Differentiate the algae condition in intact and lysed.
- Description of the membrane filtration behavior of algae suspensions (various species, intact and lysed cells)
- Develop the effective cleaning sequence to cope the irreversible fouling due to the algae cells and by-products



Material & Method

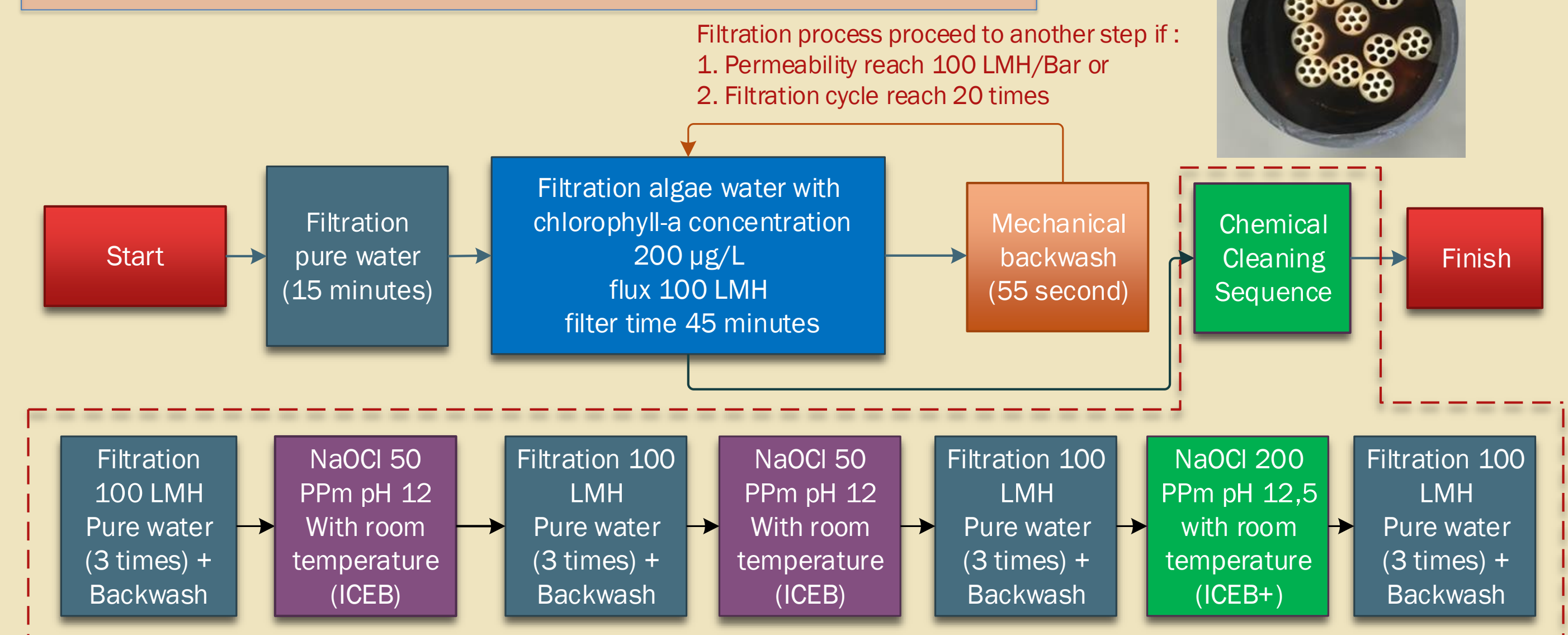
Preparation of intact and lysed condition



Membrane Characteristics

- Inge multibore®
- 0.051 m²
- Polyether-sulfone (PES)
- approx 20 nm
- Dead-end and inside-out filtration process
- Constant flux

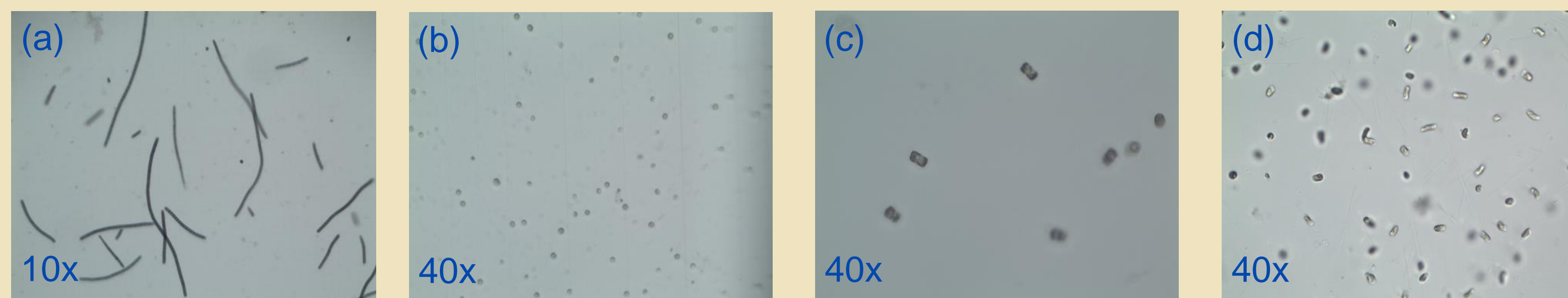
Ultrafiltration Experiment & Cleaning Process



Characterization Intact and Lysed Algae

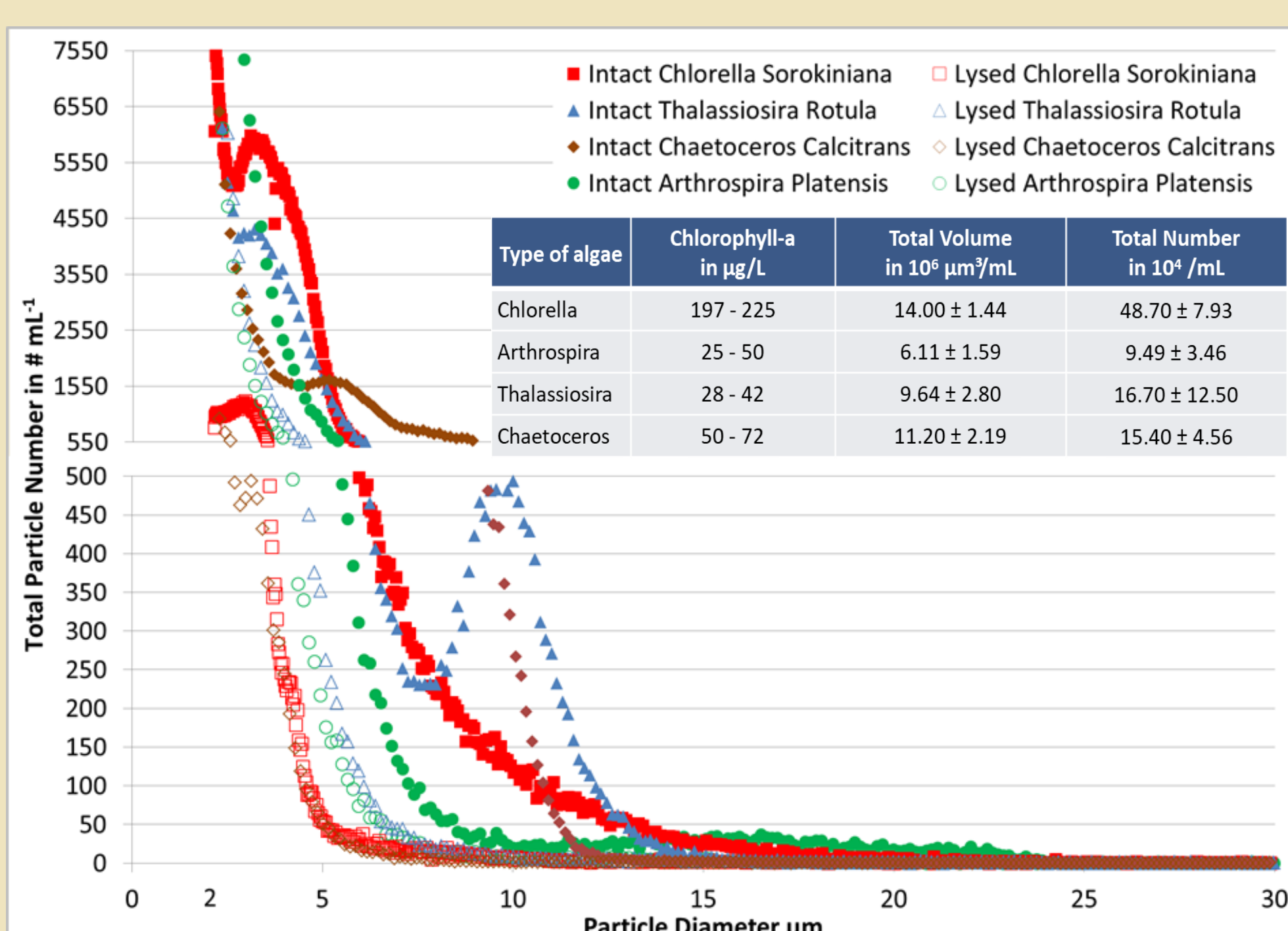
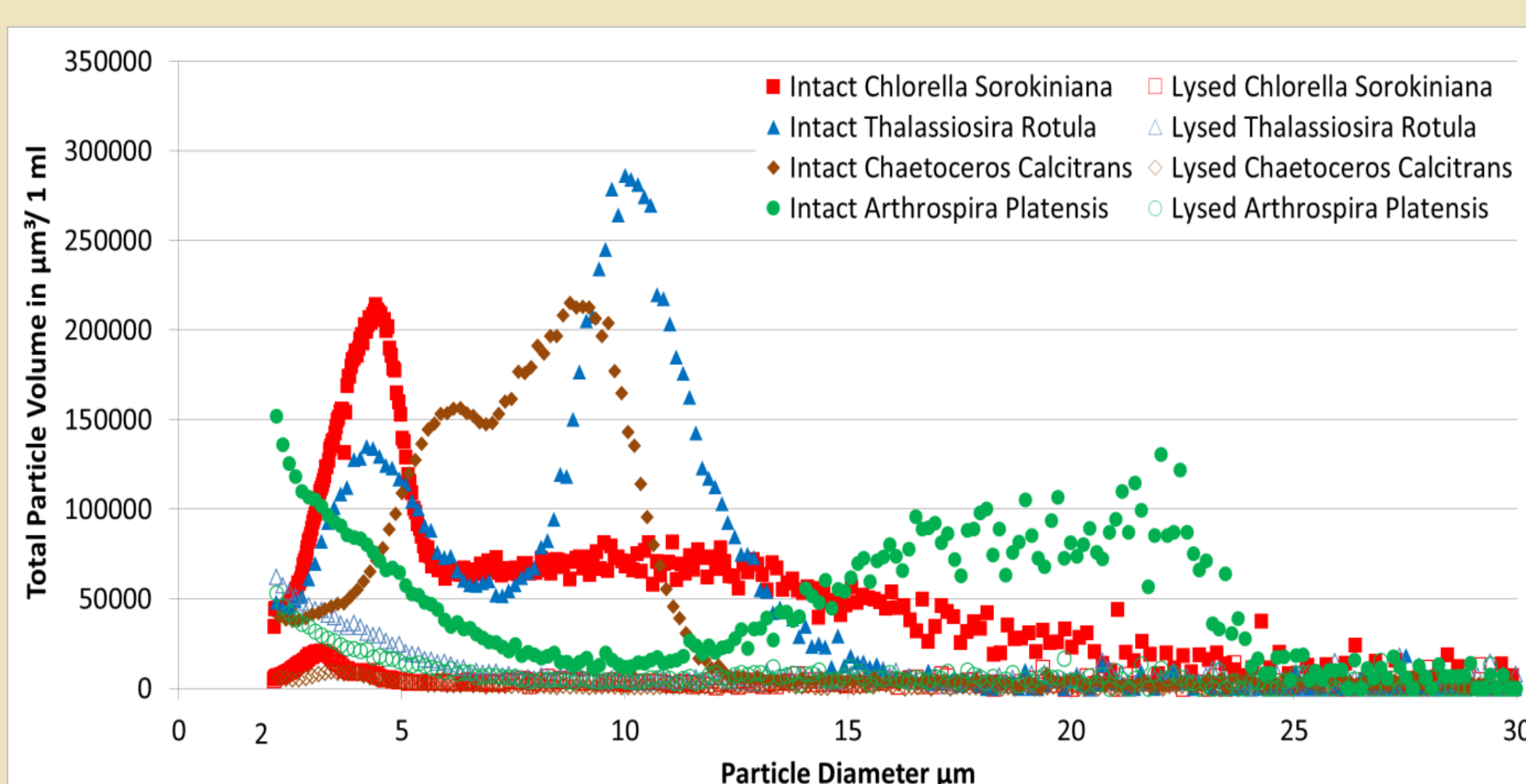
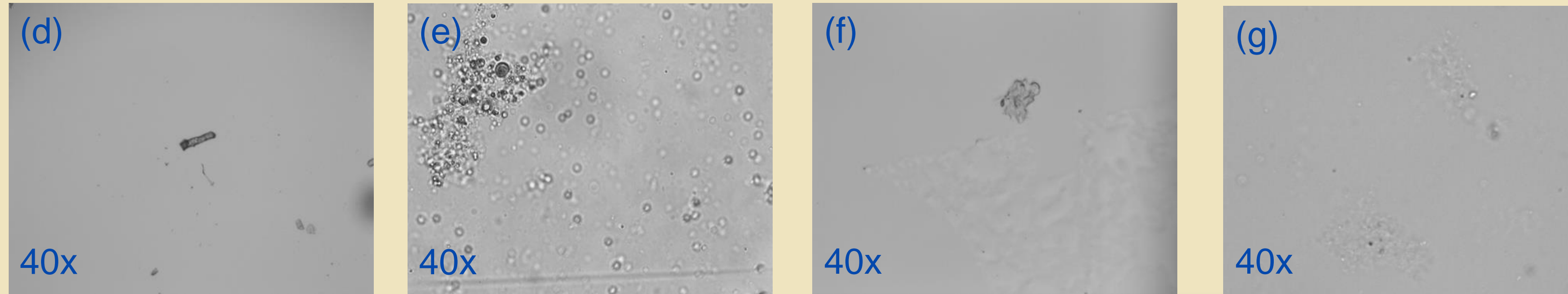
INTACT

(a) Arthrospira Platensis (b) Chlorella Sorokiniana (c) Thalassiosira Rotula (d) Chaetoceros Calcitrans



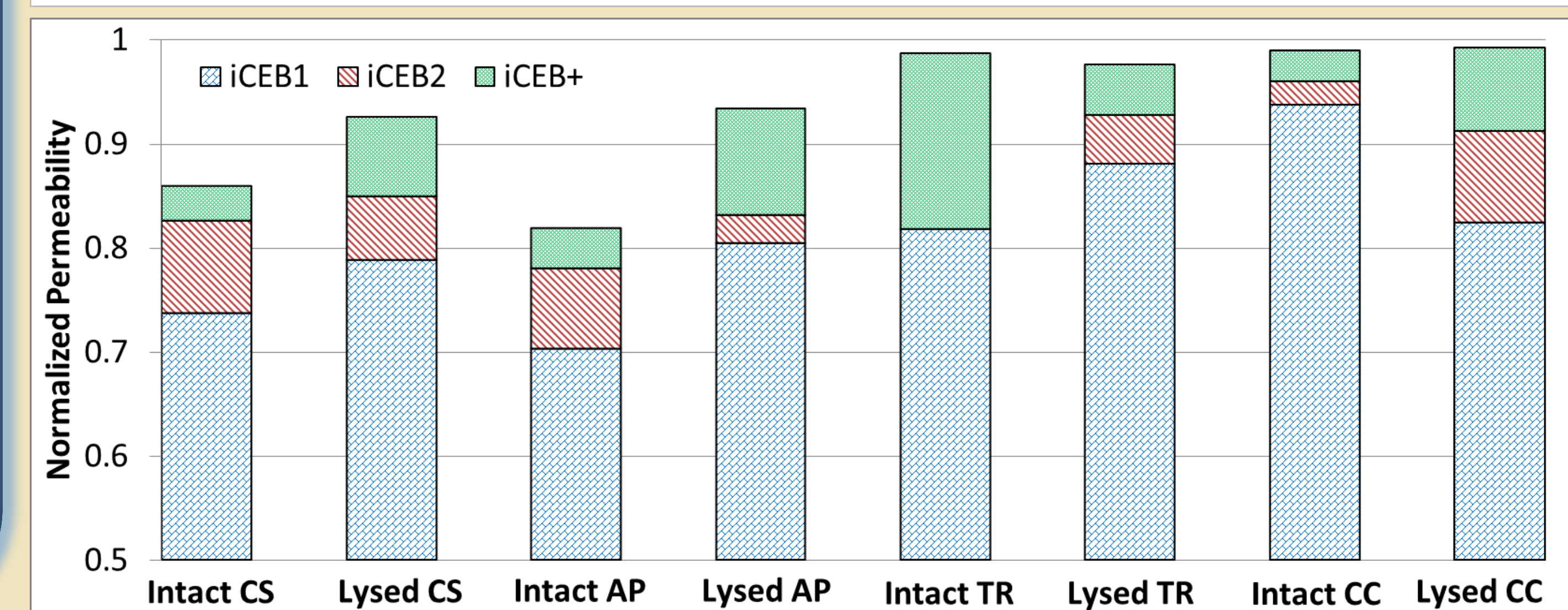
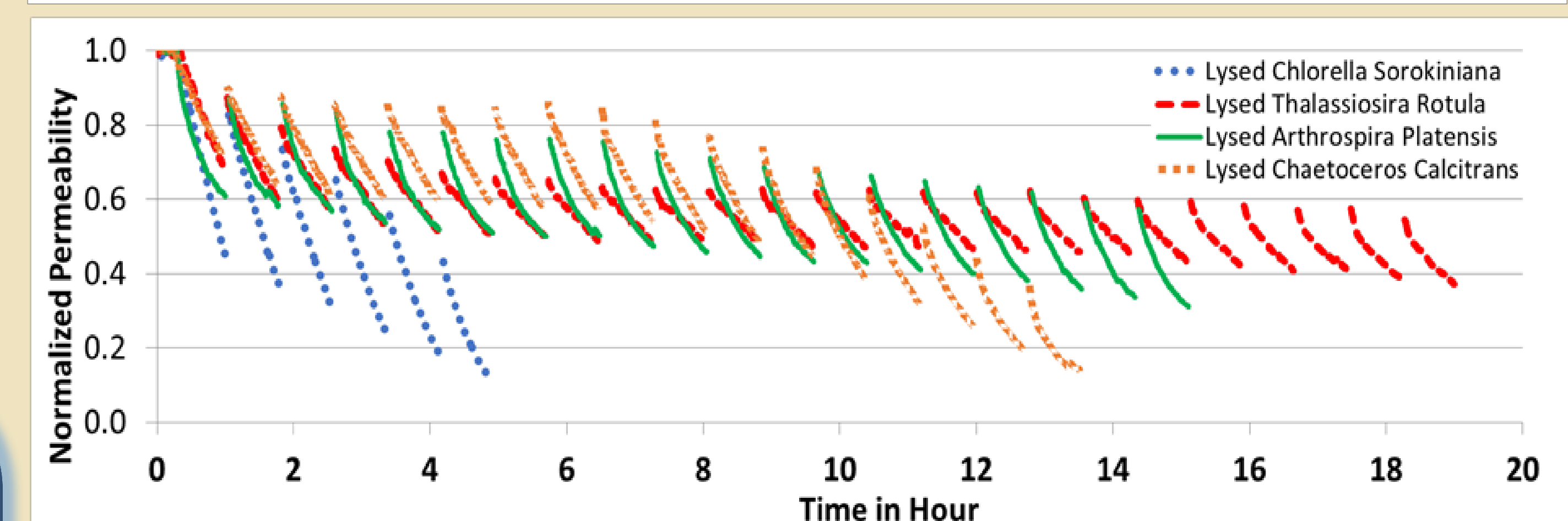
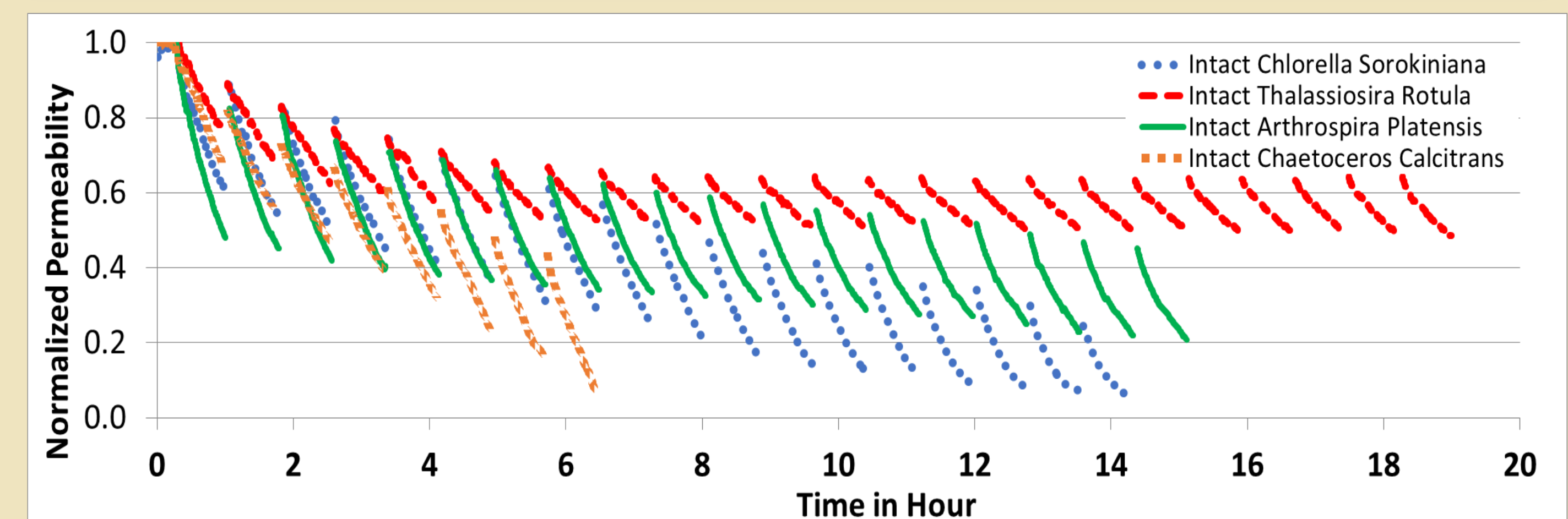
LYSED

(d) Arthrospira Platensis (e) Chlorella Sorokiniana (f) Thalassiosira Rotula (g) Chaetoceros Calcitrans



- **Chlorella Sorokiniana (CS)** (Chlorophytes): spherical form of freshwater algae
- **Arthrospira Platensis (AP)** (Cyanobacteria): filamentous helical shape freshwater algae
- **Thalassiosira Rotula (TR)** (Diatoms): cylindrical shape sea water algae
- **Chaetoceros Calcitrans (CC)** (Diatoms): flat rectangular shape sea water algae

Filtration Results



Conclusion

- Physical appearance (total number and total volume) could differentiate between intact and lysed condition. Lysed condition have less number in total cells and volume due to shape deformation.
- The different size and shape of algae in "intact" condition resulted in different membrane fouling behavior
- A better performance of the membrane during filtration of Arthrospira Platensis and Chaetoceros Calcitrans in "lysed" condition, compared to the "intact" condition is found
- Moderate and severe membranes fouling during filtration of Thalassiosira Rotula and Chlorella Sorokiniana in the "lysed" condition compared to "intact" condition are found.
- A chemical cleaning procedure close to common chemical enhanced backwash is applied with which 85 to 95% of the initial permeability could be recovered for all types of algae in both "intact" and "lysed" condition.

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