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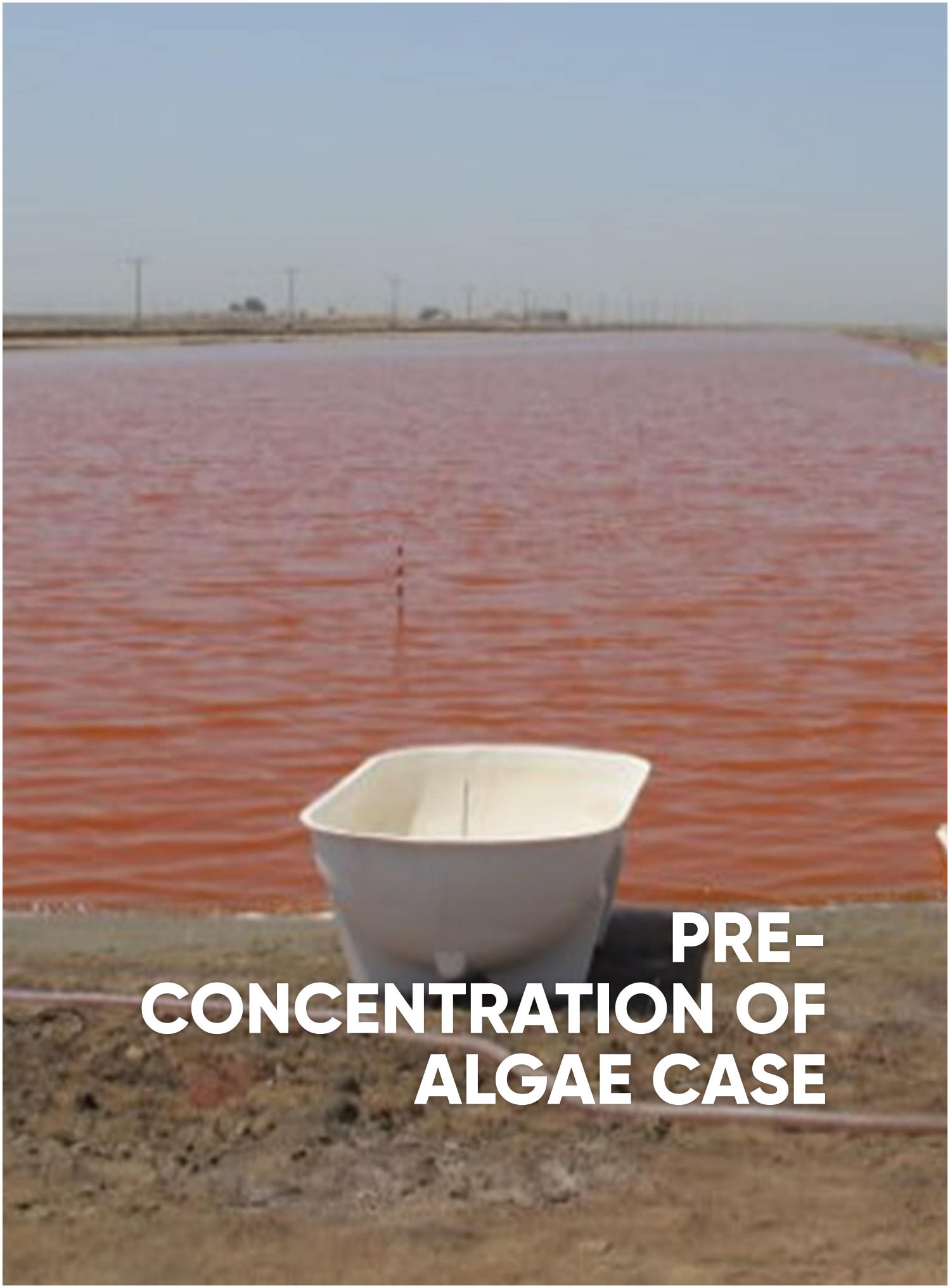

PRE-CONCENTRATION OF ALGAE CASE

Filtration Of Dunaliella Algae With SiC Ceramic Membranes

Algae For Food and Feed Production

With an increasing world population of more than 60 million people per year, the demand for sustainable and efficient food and feed production is receiving more and more attention. The demand for food is increasing the strain on agricultural systems and this puts food security and food supply on the agenda. Food security is considered by many to be one of the major threats to mankind in the future.

One solution to the above is to increase the use of algae for food and feed production. By using algae there is no need to occupy fertile land. The advantage of using algae is that it grows incredibly fast and can grow in fresh, brackish, and even highly saline waters.

Today, different types of algae are already used for the extraction of fuels, oils, proteins, and food ingredients. However, the big breakthrough of using algae is yet to come. The reason for this is that one of the challenges with algae is the costs of the systems which are needed to cultivate it, harvest it, and extract the valuable ingredients from it.

Field Trial

LiqTech has on the request from an algae farm in the Middle East evaluated its SiC ceramic membranes for algae harvesting. The purpose was to harvest and pre-concentrate Dunaliella algae for the production of β-carotene, which is used as an ingredient for food coloring and various medical applications.

The Dunaliella algae is a green alga with no cell wall, thus it can easily break during filtration. The algae turn red and overproduce β-carotene when it is under stress conditions with high light intensity and nutrient starvation.

Field Trail Objectives

Product Criteria - Pre-concentrate the algae to dry weight percentage of > 10% - Zero dead/broken algae cells in concentrate - Zero loss of cells to permeate Operational Criteria - Sustainable production (stabile flux)

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- Pre-concentrate the algae to dry weight percentage of > 10%
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- Zero loss of cells to permeate

Operational Criteria

- Sustainable production (stable flux)

Field trial setup

The field trial was carried out with the use of LiqTech's MultiBrain pilot unit which is designed for field trials with LiqTech's CoMem Conduit OD146x865mm elements. The SiC membranes are produced with pore size from 40nm and up to 10 microns. Due to the relatively large size of the Dunaliella algae (see picture below) a membrane with nominal pore size of 1 micron as well as a 3 micron were used for the field trials.

Field Trail Results

From the field trial, it was concluded that a 1-micron membrane is an ideal choice, due to lower loss of algae cells in the permeate and more stable operation compared to a 3-micron membrane.

Cell loss

Cell loss to permeate was 3% for the 1-micron membrane and 9% for the 3-micron membrane. For future trials, a 0.5-micron membrane should be evaluated as it would reduce cell loss.

Broken cells

The amount of broken algae cells in the concentrate stream was measured to be around 9-10% for all experiments conducted. Several studies show that the Dunaliella Algae is hydrophobic thus it would be repelled by the hydrophilic surface of the SiC membrane. It is therefore believed that it is not the membrane causing the cell damage, but that the damage is caused by the centrifugal pump, and thus a different type of pump should be applied for a full-scale installation.

Dry weight

The results showed that it is possible to harvest and pre-concentrate the algae to a dry weight percentage of 7-11%. Higher concentration can be achieved but it would compromise the flux. For a second concentration step, LiqTech's flat sheet membranes are recommended (submerged outside-in filtration modules).

Flux

Flux rates on the 1-micron membrane were recorded up to 600 LMH, however this with a high increase in the TMP over time. During the fine-tuning experiments a stable flux with no TMP rise was found to be in the range of 200-250 LMH with a concentration factor of 6 (see graph 1).

It was also proved that the membrane can be effectively and easily cleaned with an alkaline cleaning solution.

Algae Pre-Concentration

TYPE OF MEMBRANE	COMEM CONDUIT OD146X865MM
Flow per membrane	2m³/h
Flux	200-250 LMH
Cell loss to permeate	3%
Broken algae cells in concentrate	<10%
Dry weight percentage in concentrate	7-11 %
Temperature	26-33C

Conclusion

The trials with LiqTech's SiC membranes were successful in terms of cell loss, dry weight percentage, and stable flux achieved.

Broken algae cells were approx. 9-10%, which could be assessed as being high. However, due to the fact that Dunaliella has no cell wall, it can easily break, and thus cross-flow filtration was proved to cause little damage to the cells. The damage is believed to be caused by the centrifugal pump.

Feed Tank Dunaliella Algae
Dunaliella Algae
Algae Filtration Results
Filtration of Algae
Algae Ponds

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