DESALINISATION OF SEAWATER THROUGH CRYSTALLIZATION

BY J. ANTHOON, E. BOUCHERON, T. COUTURIER, L. MASSCHELEIN, P. NIJSEN EN A. SERGOORIS

INTRODUCTION

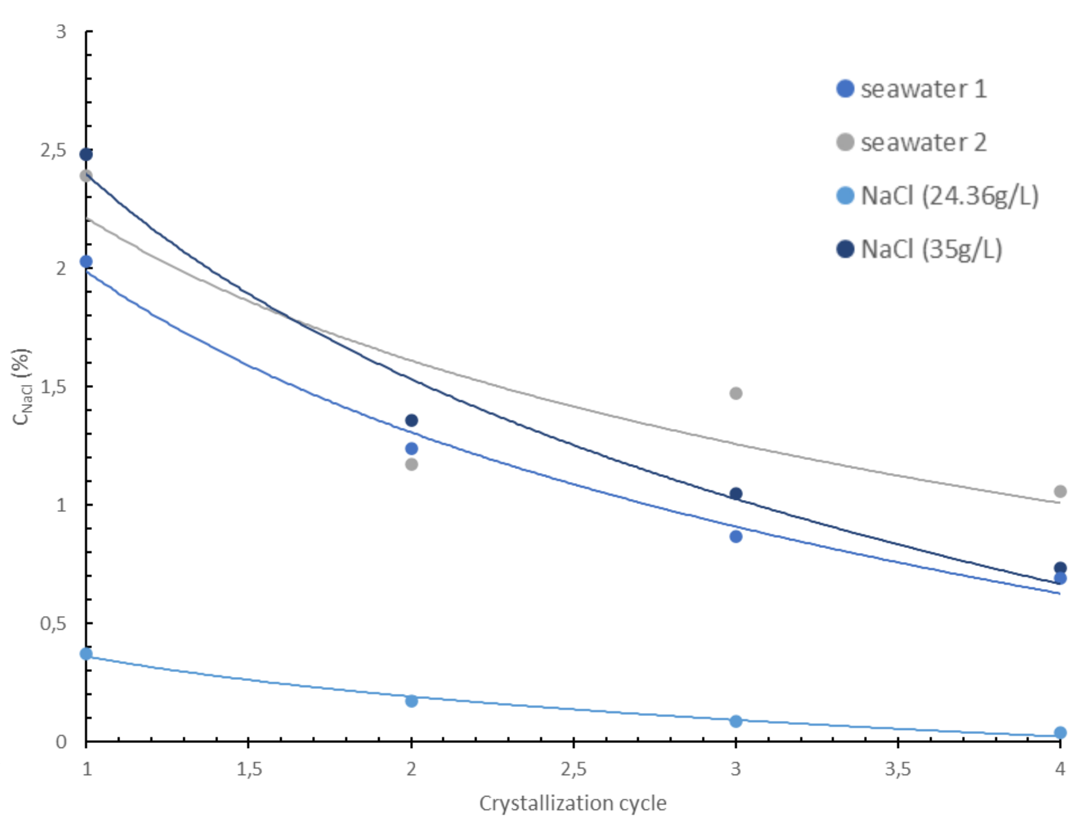
The main task during this project is very simple: Can seawater be transformed into drinking water through crystallization? Research shows that seawater has a total salt concentration of 3.5%w/v, with most of it being NaCl. The concentration of Na+ and Cl- ions in the sea is 10,56 g/L and 18,90 g/L. To get drinking water, these concentrations ideally need to be below 0,2 g/L and 0,250 g/L. What is the most effective method to crystallise the seawater? How low are the concentrations after multiple cycles? How can the progress and change in concentration be measured accurately? "Models" with different salt concentrations will be compared with seawater through atomic emission spectroscopy and conductometry. To compare the energy cost of crystallization with other methods, the energy usage of the process is also calculated.

MATERIALS & METHODS

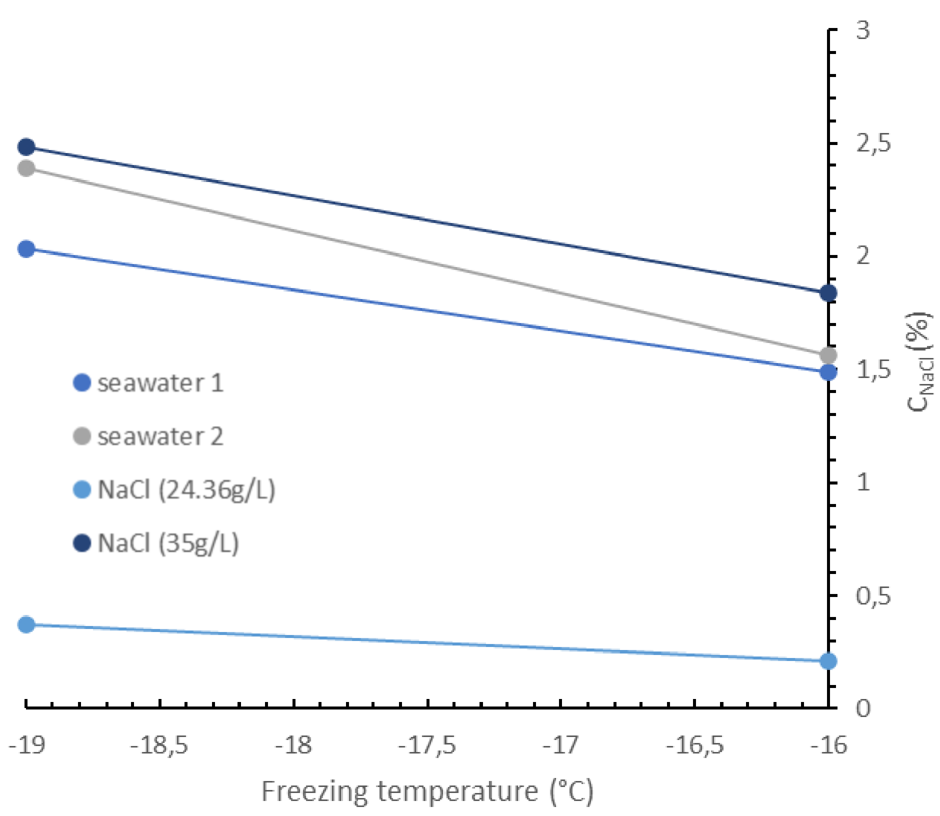
The seawater from Bredene first had to be filtered to remove the solids. Hereafter, the total salt content and the exact concentration of Na+-ions in the seawater were determined in order to make proxy solutions. This was done with a conductometer and a flame photometer. The concentration before and after crystallization of both beakers with seawater (two in case of an accident) and the different proxy solutions of NaCl could be determined by using a calibration curve for each of these methods.

NUMBER OF CYCLES

In a freeze-thaw cycle the pure water will crystallize first and be surrounded with a water-salt mixture that has a higher salt concentration then within the starting seawater which is called brine. With each cycle the mass of the ice was weighed and the yield was calculated. This is the amount purified water compared to the starting amount of seawater. After each cycle the conductivity of the purified water was measured and from that measurement we calculated the concentration of salt still present. After four cycles our salt concentration was still too high.



TEMPERATURE & VOLUME



The two seawaters and the two proxies are crystallised in beakers of 500 mL. Once at -16°C and once at -19°C.
Also three different volumes (125, 250 and 500mL) of both the two seawaters and the two proxies, are crystallised at -19°C.
After one crystallisation cycle, each time, the concentration of both the brine and the purified water coming from each pot, is determined conductometrically. In addition, the yield of the purified water is always determined.

CONCLUSION

During our research it was determined that the freezing temperature at which the sea water was cooled down has an impact on how much purified water was gained after 1 cycle of freezing. Freezing at -16°C has a higher yield compared to freezing at -19°C.

Furthermore, research was conducted to determine if the amount of seawater being frozen had an impact on the "yield". After conducting multiple experiments with different amounts of seawater, no conclusion can be drawn between the amount of seawater and the expected yield.

The energy cost is a big factor, if this separation technique is ever to be successful it needs to be very energy efficient. In our project, 0,2202 kW was needed to freeze 4 liters of sea water. This value though is not proportionate to the value for a higher volume of ice. The industry has the ability to use more expensive and thus more efficient cooling methods.

It can be concluded that it's possible to separate salts from water by crystallizing, possibly even up to drinkable water. But more research is still necessary.

Promotor research: Jan Willems
Faculty of Technology, campus Gasthuisberg, Herestraat 49, 3000 Leuven, Belgium.

UCLL HOGESCHOOL

MEMBER OF ASSOCIATIE KU LEUVEN