

Case | Brewery, Denmark

Process water reuse with onsite treatment.

“A dream to actually do this.”

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GRUNDFOS 

Possibility in every drop



Andreas Kirketerp, Manager of the Total Water Management plant at Carlsberg in Fredericia, Denmark. The facility treats and purifies the factory's process water, sending 90% of it back to be reused as process water.

The situation

Water is an essential ingredient to produce beer. No water, no beer. Most of the water used traditionally, however, does not end up in the beer. At the Carlsberg facility in Fredericia, Denmark, around 60-65% of the total water usage goes mainly to cleaning purposes. This includes everything from equipment, floors and surfaces to pipes and tanks to bottle and can washers and more, including cooling towers and boiler plants. This is called process water.

“Water consumption in breweries is related to the hygiene. Historically, there’s been a lot of emphasis to when you’re producing food, you need to do that with a lot of water,” says Søren Nøhr Bak, Expertise Director of Water in Food and Beverage at NIRAS,

Carlsberg’s engineering consultancy partner. “Actually, going back in time, brewers would be bragging about how much water they were using, because that was an indicator of how clean it actually was. Today, that doesn’t work.”

The Carlsberg Group was using 3.4 litres of water per litre of beer produced globally in 2015, according to Tenna Skov Thorsted, Carlsberg Denmark’s Sustainability Manager. “Our ambition was to bring it down to below 1.7,” she says, or reducing water consumption by 50% across Carlsberg Group by 2030. This ambition came from the company’s Together Towards Zero sustainability program, which calls for zero water waste by 2030, among other sustainability targets.



“This has been a dream for many years to actually do this”

Anders Kokholm, Brewing Director
Carlsberg Denmark

A dream for many years

A new onsite wastewater treatment and purification plant is a result of broad collaboration in the Danish Partnership for Resource and Water-Efficient Industrial Food Production (DRIP). In DRIP, businesses, technology providers, research institutes and health and food authorities have worked to rethink how we use and reuse water and expand the limits of water purification and circularity. The Carlsberg Group and Grundfos were part of DRIP, among many others.

Through different water-saving projects, Carlsberg's Fredericia plant had already brought its own water consumption down to 2.8 litres of water per 1 litre of beer. But to get below 1.7 litres, it needed a bigger initiative. So in 2019 after some months of dialogues with stakeholders within the brewery, says Søren Nøhr Bak, Carlsberg decided to go big, building a demonstration facility of what it calls the Total Water Management (TWM) plant.

“Carlsberg has more than 80 breweries around the world – some of them in water-scarce areas,”

Søren Nøhr Bak says. “So they wanted to make sure that they could make this work in a controlled environment so they could then take the concept and implement it in some of these other breweries.” Carlsberg Denmark's Brewing Director Anders Kokholm says, “This has been a dream for many years to actually do this. We had people working on this with some other companies – Grundfos included – and even brewed with the water, so we knew it could be done. It was just not on a big scale. So it was: Let's do this and get it up and running.”



Process water is used for cleaning equipment, floors, surfaces, pipes and tanks, bottle and can washers and more inside the factory.



Heated process water is used to pasteurise beer after it has been sealed in cans and bottles.

“Think of what we can now do. We can actually recycle and close the circuit, making process water available again. It’s fantastic.”

Søren Nøhr Bak, Expertise Director
Water in Food and Beverage at NIRAS

Onsite water reuse becomes real

“The basic idea of the project is to take all the process water and send it to a wastewater treatment plant, and then clean that water afterwards in a safe, drinking water application to make sure that we can reuse the water again within the brewery,” Kokholm says. “It will not be used as brewing water, so it will not go into the product. It will only be used for cleaning processes.”

NIRAS’s Søren Nøhr Bak says that because this had never been tried at this scale before in a Danish food and beverage company, there was a major task of winning the approval from both within Carlsberg and the Danish authorities for quality and risk assessment.

“We were out talking to all the people interested in quality,” he says. “And that’s not just the local quality organisation in the brewery in Fredericia. That’s also the Group quality organisation, as well as the quality organisations for Coca Cola and Schweppes, as this plant was also producing product for those franchises. Other really

important parties were of course the environmental authorities and, of course, the food and beverage authorities in Denmark.”

All parties signed off, and Pantarein Water – a turnkey wastewater treatment plant provider based in Belgium – was tasked with providing the full treatment system. Grundfos would supply pumps and systems to move water and ensure precision dosing in the plant.

“Grundfos has a lot of know-how in pumps, of course,” says Bryan de Bel, Project Manager at Pantarein. “They helped us a lot during the offer phase to choose the right products for all the solutions we needed to offer. We did a lot of talking to get the most durable and efficient solutions – in consideration to both the energy consumption and sustainability. So that made a big difference for us.”

Søren Nøhr Bak adds that Grundfos was chosen because “when it came to pumping and dosing, we wanted to make sure we got very reliable solutions. Because if one of these components is failing, the whole operation will fail. Secondly,

we wanted to get solutions that allowed us to monitor and control the system, so we can constantly see how we are doing within the expected benchmarks. A lot of people learned that it’s not just a pump – there’s actually an intelligence in the pump.



Søren Nøhr Bak, Expertise Director
Water in Food and Beverage, NIRAS

The TWM plant for pure water

The TWM plant can treat 2,000m³ of incoming process water a day, of which 90% – or 1,800m³ – is recovered and recycled.

The plant also produces biogas, which Carlsberg uses to heat its facilities, adding an extra layer of sustainability.

Anaerobic and aerobic biological treatment processes combined with MBR membrane filtration remove most of the pollutants and solids in the wastewater. The treated water is then further filtered in a closed-circuit reverse osmosis (CCRO) plant to remove dissolved salts in the water. Then the RO

permeate water is “re-mineralised,” using calcium carbonate to reduce aggressiveness and ensure the water meets drinking water quality. The stabilised water then goes through a UV-light treatment. It also receives an injection of chlorine dioxide to remove bacterial risk as well as prevent potential biofilm build up in the distribution line.

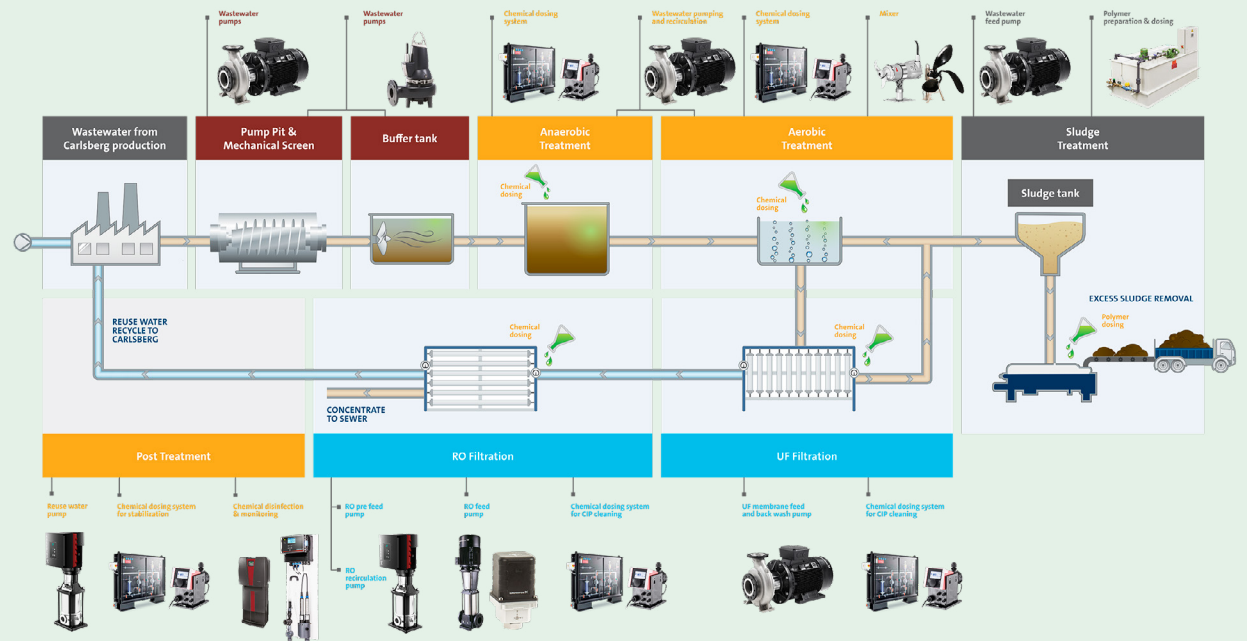
Grundfos pumps help along every step of the process, says Andreas Kirketerp, Manager of the Total Water Management plant, with Grundfos covering 95% of the pumps on site.

Pantarein’s Bryan de Bel says, “As you know, chemicals are always a big risk. So for us it was very timesaving and stresssaving to get a complete dosing solution from Grundfos. We got the full cabinets with the dosing pumps, all the piping, the valves, everything was included, so we were very happy with that. In addition, the Grundfos pumps have a software with flow control. And that guarantees that you’re dosing what you need to be dosing.”



Carlsberg’s Total Water Management plant in Fredericia, Denmark uses anaerobic and aerobic wastewater treatment. The anaerobic tank on the left produces biogas, which Carlsberg uses to produce heat for the brewing processes, adding another layer of sustainability to the project.

Grundfos Solutions at Carlsberg TWM Plant



Bryan de Bel, Project Manager with turnkey WWTP contractor Pantarein



Pantarein's Bryan de Bel says it was "very time-saving and stress-saving to get a complete dosing solution from Grundfos. We got the full cabinets with the dosing pumps, all the piping, the valves, everything was included. And above that, the pumps have a software with flow control. And that guarantees that you're really dosing what you need to be dosing."



Andreas Kirketerp, Manager of the Total Water Management plant, says, "Grundfos pumps are very reliable. And this plant needs to run all the time. It's not cheap to build a facility like this, and it needs to be able to pay itself back. It produces 1,800 cubic meters a day. So if it stands still for a day, that's 1,800 cubic meters you both have to buy and also discharge to the municipality. So it needs to run. Always."

Besides reliability, Brewing Director Anders Kokholm says the initiative came with other practical challenges that just needed time to resolve.

"One of the things that was a worry was the water coming off the

plant, compared to the municipal water we were getting from the public supply. The temperature was higher," Kokholm says. Municipal water in Denmark is around 8-9°C, whereas the TWM's output was at 20-28°C.

"What would actually be the impact in our brewery? Of course we did studies and so on before, but nobody really tried this before. Would it have any negative effects on microbiology, for instance? But it's actually been working very well. And a lot of the processes are in place to make sure that the microbiology is okay – also at the places of consumption. And all our tests have shown that the water is clean. And there's no impact from that."

The outcome

After its first half year in operation, the TWM facility has been slowly working up to capacity. Anders Kokholm calls it a gradual process.

“It’s exciting starting it up. We’re learning a lot. We switched it on in early 2021 and started to fill up the plant gradually, getting the bacteria in the wastewater treatment plant used to our wastewater,” Kokholm says. “It takes some time to build up enough sludge to handle the wastewater. So it’s a journey getting it up to full speed. We’ve seen a very positive effect in the [total water-to-brewed beer] ratio for the brewery. We are not quite at the target level yet, but we will get there in time.”

Søren Nøhr Bak says, “This is such a paradigm shift for so many people. Can you actually recycle water in a food and beverage industry? And yes, it has demonstrated it

is possible to do that. We have a technology that allows us actually to safely, reliably to produce drinking water out of process effluent. It’s fantastic. This is something we can really look into implementing in all the places where we have water scarcity. All the places where we are not treating the wastewater. Think of what we can do. We can actually recycle, and we can close the circuit, making water available again.”

“For the Carlsberg group the impact is testing here and then moving into regions where we have water scarcity,” adds Anders Kokholm. “There are regions where we operate in both India and China and elsewhere where there’s not enough water. And recovering our process water in this way to make it into drinking water or similar is definitely a step forward and will get Carlsberg towards the 2030 goal.”



Carlsberg Denmark's Sustainability Manager Tenna Skov Thorsted

Carlsberg Water Reuse Facts

3.4

Total litres of water used per litre of beer produced globally in 2015 on average.

<1.7

2030 global goal in litres of water used per litre of beer produced, or a reduction of 50%, part of Carlsberg's Together Towards Zero ambition.

2,000m³/day

Amount of process wastewater the Total Water Management (TWM) plant can treat at a time.

65%

Amount of total water that is used as process water.

1,800m³/day

Amount of PURE water sent back to the factory for reuse, or 90% of the total. The remaining 10% is excess sludge and wastewater concentrate, sent to public wastewater treatment.

560,000m³

Amount of water saved by TWM per year (or 560 million l/y).

9.6%

Reduction of energy from TWM plant's biogas production and hot water recirculation.

17

Number of Carlsberg breweries in high water risk areas globally. Carlsberg plans to use learnings from the TWM plant to reduce water waste at these sites.

Uses of process water

Cleaning vessels, tanks, pipes, machinery, bottles, cans and more; also used in the pasteuriser, boiler, cooling tower and more.



Four sets of Grundfos NB pumps circulate the water in and among the anaerobic, aerobic and conditioning tanks plus the biogas washer at Carlsberg's Total Water Management plant.

Sources. Information in this article came from interviews with all sources on-site at Carlsberg in September and October 2021, onsite at NIRAS in October 2021 and via online video chat with Pantarein in October 2021. More information about the DRIP partnership and studies on water reuse can be found at [this website](#).

Note: When sources refer to "drinking water," it is a term for specifying the highest purity level of water. This means that in principle, the treated water is safe to drink, but in this case it is not an ingredient in the final product.

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Grundfos Supplied

For Carlsberg Denmark's Total Water Management plant in Fredericia, Grundfos worked with Pantarein and Carlsberg to identify the most optimal pumps and dosing systems for the entire treatment and purification process.

This includes:

- Submersible SL wastewater pumps and mixers;
- NB end suction pumps for circulation among the biological tanks and biogas washer;
- Complete dosing cabinets with digital dosing pumps, piping and accessories needed for all treatment steps;
- UF-RO membrane CIP;
- Powerful CR vertical multistage pumps for the RO system;
- Complete systems like
 - Oxiperm Pro for disinfection
 - POLYDOS for polymer production
- DID for monitoring and control of water disinfection

[Learn more.](#)

The Partners

- Carlsberg A/S
- NIRAS, consulting partner
- Pantarein, turnkey wastewater treatment plant provider
- Grundfos, water solutions provider
- And others.

[Watch video](#)

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