Carbon dioxide:
a more sustainable and practical solution for brewery wastewater treatment.

This case study demonstrates that the use of CO_2 in breweries can easily achieve the desired pH levels in brewery effluent.

GENERATING A CLEANER FUTURE
for the brewing industry.

“He was a wise man who invented **beer**.

– Plato

Beer is one of the oldest alcoholic beverages in the world. In fact, the earliest archaeological evidence of fermentation dates back 13,000 years when beer was consumed as part of ritual feast by the Natufian culture in Western Asia. More popular than wine – and even coffee – and only just behind tea and water. The global beer market size is projected to grow from $851.15 billion in 2024 to $1,167.47 billion by 2032.[1]

Maintaining the correct pH level in the brewing process is extremely important and carbon dioxide (CO_2) is an important factor in regulating it. CO_2 reacts in beer to make it more acidic, altering the flavour of the final beverage.

CO_2 can also play a key role in ensuring that the wastewater produced by breweries is treated in a safe and sustainable way.

[1]Beer Market Size, Share, Growth & Trends Analysis Fortune Business Insights

The challenge

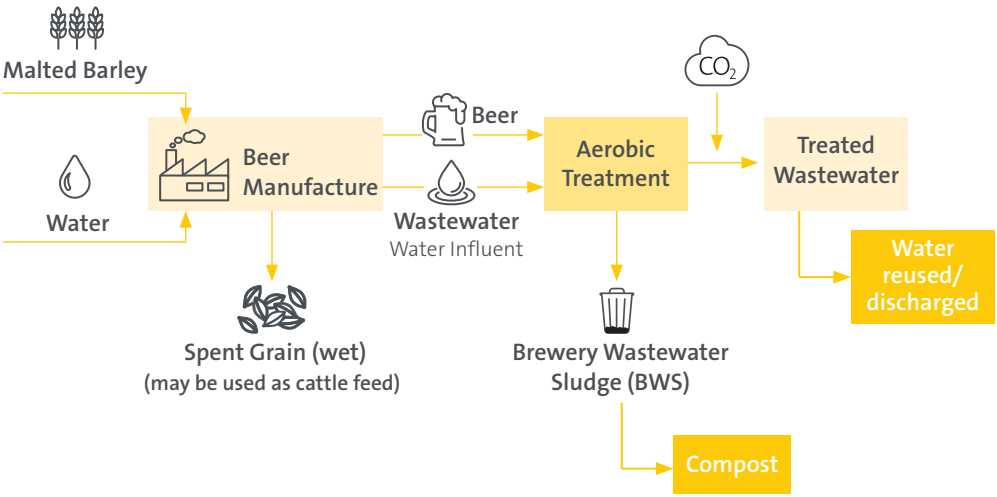
It is estimated that for every litre of beer produced, almost ten litres of water are needed[2], not only for the brewing process itself, but also in rinsing and cooling. Water is used for purging the system at the beginning and end of the brewing process to ensure a quality product. This purged wastewater usually has a low pH value of around 5.

Water is also used for cleaning of equipment and installations, known as Clean-in-Place (CIP). In brewing, CIP of pipes and tubes uses hot or cold alkaline solutions. This is often the most polluting stream, since the water has come into contact with cleaning solutions that contain detergents and disinfectants as well as chemicals such as caustic soda. It has also touched the surface of the equipment, pipes and tanks that have transported or contained wort, beer, or raw materials, significantly increasing the organic load and suspended solids. The pH of the resulting wastewater is therefore very high – around 11 to 12.

Process and CIP water must be disposed of or safely treated for reuse. It should have a pH between 7.0 and 7.8 to comply with discharge limits set by government entities to protect human life and the environment. This is, however, a costly and problematic process for breweries. Traditionally acidic chemicals – such as mineral acids including sulphuric and hydrochloric acids – have been used, but brewers are increasingly seeking more cost-effective, safer, and most importantly sustainable, processes.

[2] The treatment of brewery wastewater for reuse: State of the art - ScienceDirect

The brewery production and wastewater process



The trials

A long-established Belgium brewery approached the Air Products team to explore how CO_2 might solve its wastewater treatment challenges.

Air Products undertook a technical study in its European Water Lab. Conducting a set of experiments at laboratory scale, the team set out to assess the feasibility of pH neutralisation using CO_2, to establish:

- The pH evolution of the brewery wastewater samples
- The amount of dissolved CO_2 needed to reduce the pH from 12 to below 7.8

The team used a 3.5 litre bench scale **Halia® pH neutralisation system**. It was equipped with a pure CO_2 injection line and a pH sensor. They monitored a range of parameters including dissolved CO_2, alkalinity, hardness, temperature, electrical conductivity, and pH.

Further in-situ trials were then carried out at the brewery over a period of two weeks using a **Halia® QM pH neutralisation system** demo skid.

The outcome & recommendation

The results of the studies demonstrated that CO_2 could easily achieve the desired pH levels in wastewater from the brewery and that it was a viable alternative to mineral acids.

The Water Lab results showed that it was feasible to lower the pH to the desired level with 110 ppm of dissolved CO_2.

After two weeks of on-site demonstration tests, it showed that by injecting between 5 and 10 kg CO_2/h, we can reduce the pH from an average of 11.95 to 7.7.

In addition, the anaerobic sludge phase after pH treatment, by eliminating the addition of sulphuric acid, resulted in less odour, less tarnishing by sulphur fumes from surrounding plants and simply less toxicity to the bacteria in the sludge.

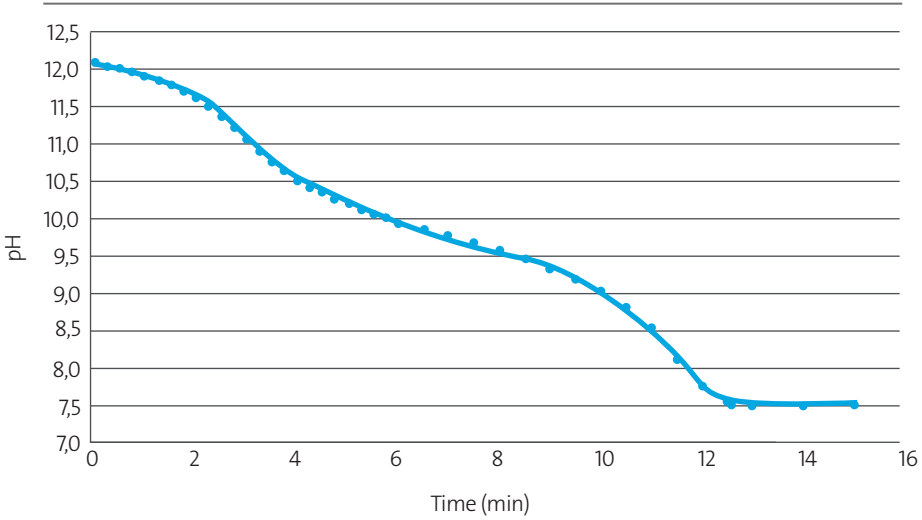
Economic evaluations of CO_2 versus traditional chemicals showed that the treatment costs were comparable.

CO_2 also offers additional benefits, including safer handling and healthier conditions for users. As it forms a stable buffer solution, it can neutralise any basic constituents, maintaining the pH level for longer.

Above all, as CO_2 bonds with the water creating a bicarbonate ion, it is a more sustainable option. It forms a weak acid and is not corrosive or toxic, leaving no contaminating residue in the treated water. As injection of CO_2 is a straightforward process, overdosing of chemicals is no longer an issue.

Other water parameters, such as electrical conductivity and Langelier Index were also enhanced, improving water quality after the treatment.

Figure 1: pH evolution of the water samples coming from the brewery by the injection of a constant flow of pure CO_2.



About the Halia® QM pH neutralisation system

Compact, automated and applicable to a wide range of water treatments, the **Halia® QM pH neutralisation system** comprises a mobile skid-mounted hardware and digital software, enabling easy configuration into an existing treatment line. Designed to meet specific wastewater characteristics and particular pH neutralisation requirements, the system can be incorporated into existing installations, whether basin or pipe-based and a continuous process or batch. Specially designed for high CO_2 dissolution efficiencies >85%) the **Halia® QM pH neutralisation system** ensures effective economic and environmental viability.

Benefits of pH control

After the on-site trials, the brewery concluded that replacing chemicals such as sulphuric acid by CO_2 using a Halia® QM pH neutralisation system offered them a range of benefits:

- Improved health and safety
- Safe and easy to use
- Minimal environmental footprint
- Continuous operation, reduce maintenance and downtime
- Low and economical maintenance
- No risk of over-acidification
- Cost efficient

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