Review paper
UDC 663.64

WATER MANAGEMENT IN THE BEVERAGE INDUSTRY

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Abstract

Secure supply of drinking water is one of the biggest challenges of the future. Saving resources and reducing emissions must therefore be the goal of each person in the food and beverage industry.

The costs of fresh and waste water are continuously increasing and more and more onerous to companies. Tensid-Chemie GmbH introduces a new tool called TC-AQUASAVE useful for detection, evaluation and saving water consumption especially in the cleaning and disinfecting practice. An application example in a great German brewery will be presented.

Key words: *Water consumption, water savings, cleaning and disinfection, brewery*.

1. Introduction

Drinking-water supply will pose one of our greatest challenges in the future. Therefore, each of us must work toward protecting our resources and reducing emissions.

Water costs, especially for fresh water and wastewater, are steadily increasing, which places a growing burden on beverage companies.

Given this background, Tensid-Chemie GmbH has made it a goal to help its customers deal with this complex challenge.

Various system components have been developed and are described jointly by the cross-sector term **TC-AQUASAVE**®. Figure 1 shows the system components (Hien [1]).

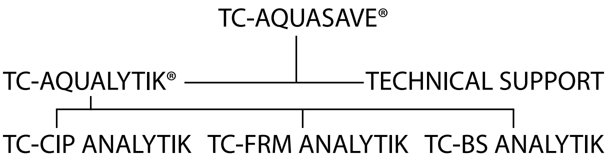

Figure 1. TC-AQUASAVE system components

2. Project basis

In order to protect resources in the future and to slow the constantly increasing costs, thereby efficiently and sustainably saving water, a detailed stocktaking of all current water flows (input/output) will be necessary. A joint workshop with all of the participants and a strategic implementation of the developed goals are essential.

In practice, such projects often remain stuck in the initial stages, with general goals such as "*We need to save water*." Furthermore, there are often personnel shortages that make it impossible for companies to carry out these complex, time-consuming projects themselves.

For this reason, a Bavarian Brewery commissioned Tensid-Chemie GmbH, Germany, to discover the existing savings potentials and to support the resulting optimization measures.

For Tensid-Chemie GmbH, which has been a respected supplier of hygiene concepts for many years, this project was not really anything new; it "simply" needed to summarize the findings from its previous department-based water-savings projects. Looking at the complexity of the water flows in a brewery as a whole was considered a challenge. Figure 2 clearly shows the area where the freshest water is needed.

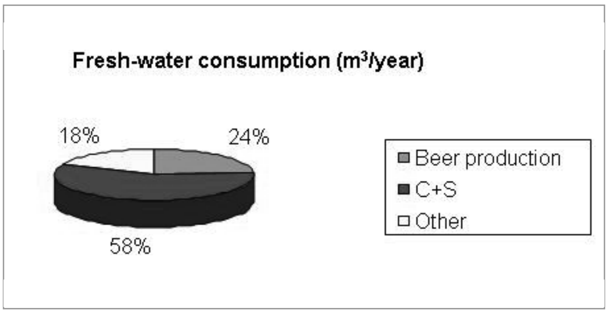

Figure 2. Distribution of fresh-water consumption in a brewery

This very time-consuming work was based on a service agreement between the brewery and Tensid-Chemie, with compensation provided if the project was successful.

The practical sequence of the project is outlined below, describing the most important points.

2.1 General observations

Various factors affect the water costs for a company, particularly the volume of fresh and wastewater as well as any special fees. The possible variations in cost/ m^3 for fresh and wastewater are shown in Table 1. The figures from the German Federal Statistical Office are 1.81 Euros/m^3 for fresh water and 2.69 Euros/m^3 for wastewater (Figure 5), even higher than the average values shown here. This may be because the companies in the table are much larger, and some of them have their own wastewater treatment plants.

Table 1.* Prices of fresh water and wastewater for various companies in the beverage industry

Brewery	Euros / m^3 FW	Euros / m^3 WW	Total
1	2.30	0.70	3.00
2	1.95	1.95	3.90
3	1.75	0.50	2.25
4	1.66	1.66	3.32
5	1.50	1.50	3.00
6	1.50	1.50	3.00
7	1.45	1.45	2.90
8	1.10	1.50	2.60
9	0.99	0.99	1.97
10	0.74	0.85	1.59
11	0.38	2.35	2.73
12	0.25	3.00	3.25
13	0.20	2.70	2.90
14	0.20	1.11	1.31
15	0.19	1.96	2.15
16	0.25	1.69	1.94
Ø	**1.03**	**1.59**	**2.58**
from - to	**0.19 – 2.30**	**0.50 – 3.00**	**1.31 – 3.90**

The variations in water consumption by hL/hL SB (sales beer) are shown in Table 2. Earlier statistics gave figures from 4 to 10 hL or 5 to 8 hL/hL SB here, with an average of 6.5 hL/hL SB. In Table 2, the value is somewhat lower due to the larger companies.

Table 2.* Fresh-water consumption by various companies in the beverage industry

Brewery	hL FW/hL SB	hL SB/year
1	6.3	50,000 – 100,000
2	5.3	100,000 – 200,000
3	5.0	200,000 – 300,000
4	4.2	300,000 – 400,000
5	5.4	> 500,000
6	6.0	> 1 million
7	5.7	> 1 million
8	5.6	> 2 million
9	3.9	> 2 million
10	4.7	> 3 million
11	4.9	> 4 million
Ø	**5.2**	
from - to	**3.9 – 6.3**	

*The values in Tables 1 and 2 are based on self-surveys of breweries with more than 50,000 hL in annual production) (Hien *et al*. [2]).

If one takes the very different prices for fresh water and wastewater into account, the known figure of hL/hL sales beer can only be used to determine the consumption volume, not the actual costs involved. By converting this into Euros/hL sales beer, and taking the water costs into account, we can also obtain a figure for the actual water costs. This figure can be used to estimate whether water-saving projects are worthwhile in terms of their cost.

This cost analysis is important for both contractual partners, even before a service agreement is concluded. Upon closer inspection, an apparently good figure in hL/hL SB can quickly become a bad figure in Euros/ hL SB; it is worth considering this more carefully. For ecological reasons, of course, water savings are always valuable.

In order to better evaluate the water costs as a cost center, they were compared with the chemical costs (Figure 3).

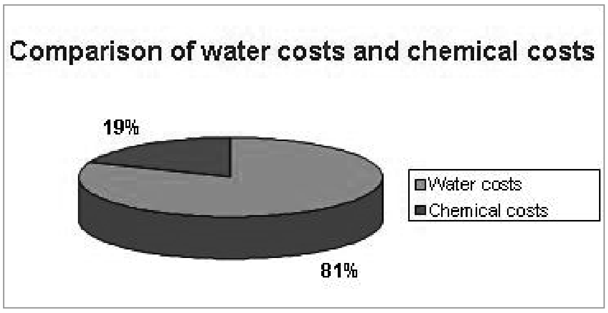

Figure 3. Comparison of water costs and chemical costs

There are two possible approaches for reducing water costs: first, reducing the use of fresh water and thus the volume of wastewater, and second, reusing wastewater.

The project described here primarily focuses on reducing fresh-water use. Water reuse was only taken into consideration where this was possible without wastewater treatment.

In general, when carrying out this type of project it is important for everyone in the company to be on the same page. Only open and collaborative work can lead to the desired goal.

2.2 Procedure

2.2.1 Current-situation audit – preliminary discussion

Despite the already relatively low specific fresh-water consumption of 5.3 hL/hL SB (mean statistical value in 2011: 5.6 hL FW/hL SB), the management at the Bavarian Brewery was not satisfied with these results, and wanted to discover further savings potentials.

The kick-off meeting for the project collected all of the basic data:

- Water prices in €/m3 for the various water types (tap water, well water, softened water, wastewater)
- Distribution of overall water consumption for individual areas (Distribution of fresh water by tap and well water is showed in Table 4).
- Fresh water and wastewater volume in m3/year
- Manufactured volume in hL, in order to derive the specific figure in hL FW/hL SB.
- All available data, such as water meter readings, water network maps, etc.

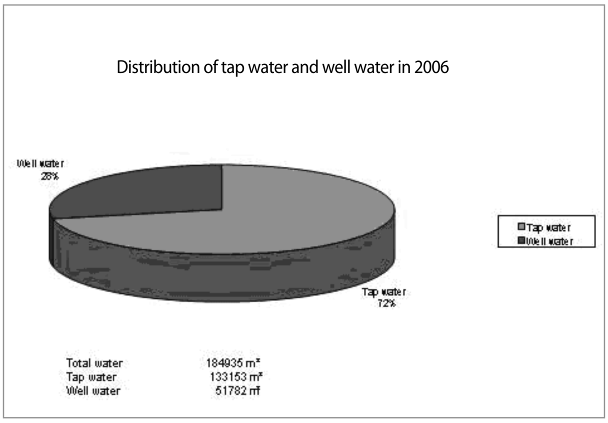

Figure 4. Distribution of fresh water by tap and well water

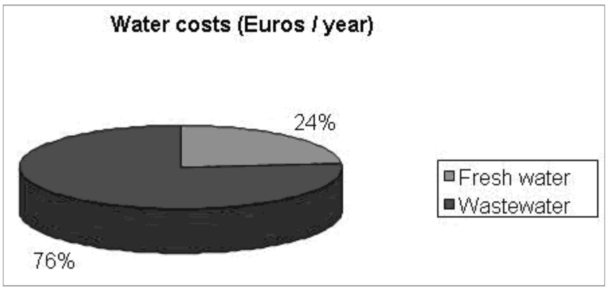

Figure 5. Distribution of water costs by fresh and wastewater

The company data obtained during an inspection during the kick-off meeting, as well as the data already available, was entered into the corresponding screens of the **TC-AQUALYTIK**® software. The software creates tables to represent the water flows; these can be allocated to the individual originating departments or combined into groups. Sorting features using various criteria (cost, volume, areas, water type, etc.) allow an analysis from many different perspectives.

The project is divided into four sections:

- Collecting data
- Evaluating the collected data
- Identifying savings potentials
- Realizing the savings potentials

2.2.2 Data collection by Tensid-Chemie

The current structures of all water flows have been recorded and graphically represented (Figure 6).

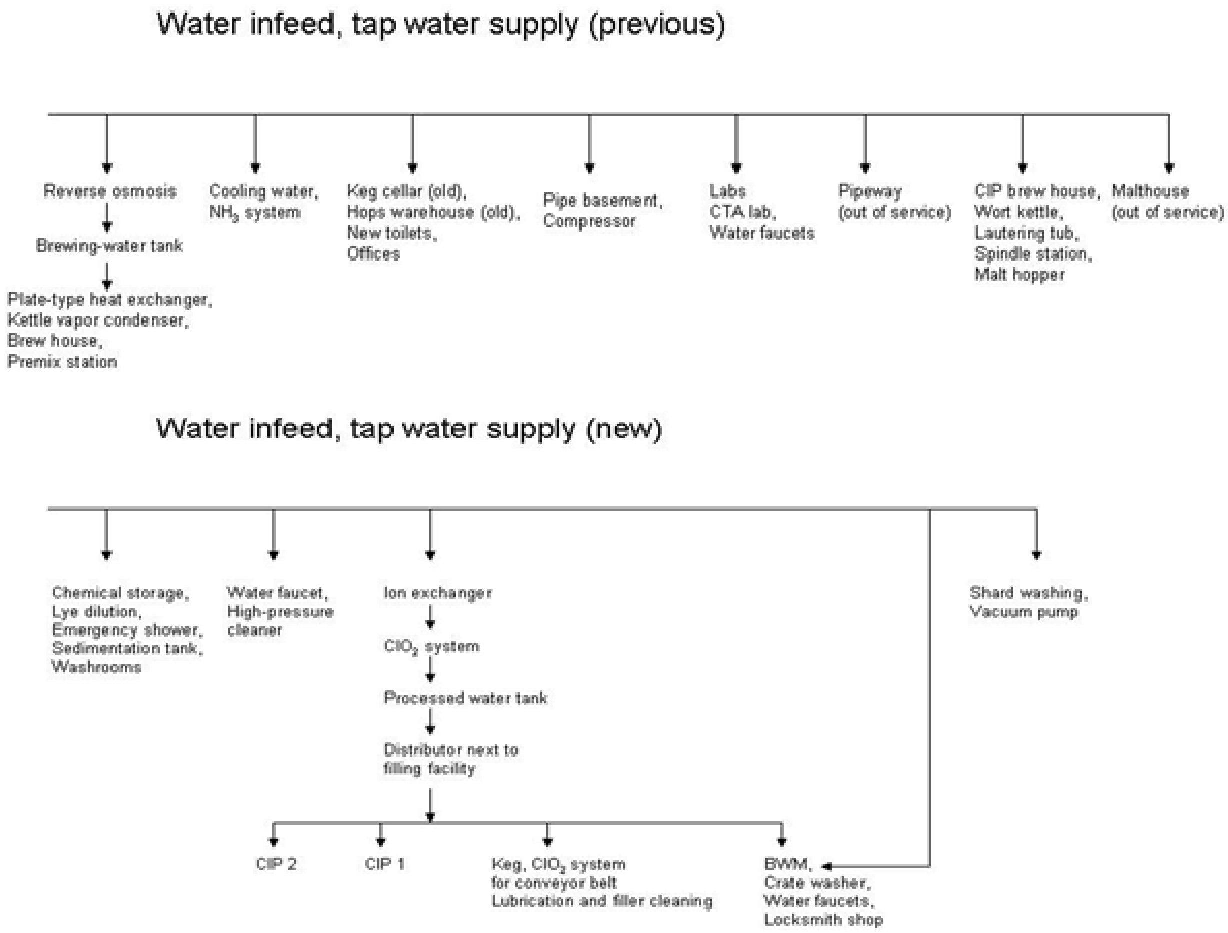

Figure 6. Graphic representation of the fresh-water network

The next step was to allocate the outlined water flows to the respective consumption volumes in order to further subdivide the known main volumes. This data is collected into various blocks.

2.2.2.1 TC-CIP ANALYTIK

This part includes the data collected from all of the CIP plants. It collects and optimizes rinse times and C+S process steps. With this practice-tested method, water consumption can be represented as an overview not only for each CIP plant, but also for each consumption site (Figures 7 and 8).

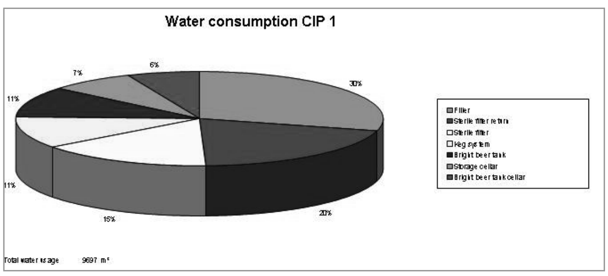

Figure 7. Water consumption for CIP plant 1

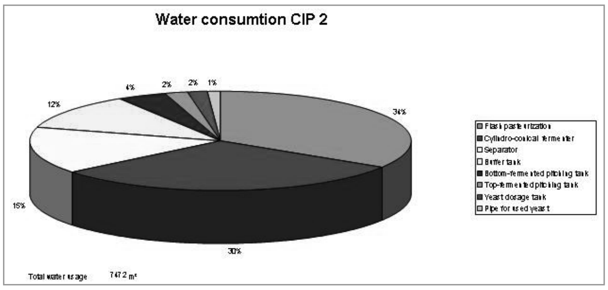

Figure 8. Water consumption for CIP plant 2

2.2.2.2 TC-BS ANALYTIK

This step takes a close look at the conveyor lubrication: evaluating the spray/interval settings and the associated water consumption as well as the existing dosing technology, etc. The existing savings potentials can be determined immediately and represented clearly through simulation calculations.

2.2.2.3 TC-FRM ANALYTIK

TC-FRM ANALYTIK refers to the detailed recording of data for the bottle-cleaning machine. This primarily involves looking at fresh-water consumption in terms of caustic carry-over, thermal efficiency and the rinse values for the bottles. Completely new findings are collected here and simulations are carried out; above all, the focus is on technical optimizations for the bottle-cleaning system (Figure 9).

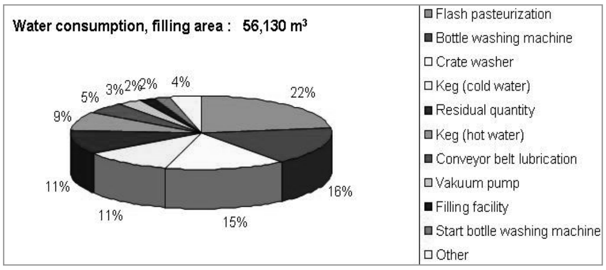

Figure 9. Distribution of water consumption for the bottling hall

2.2.2.4 Other users

When the data collected in this way is entered into the current-condition screen in **TC-AQUALYTIK**®, any remaining gaps in recording the water flows will be immediately visible. These values are then entered manually.

The use of **TC-ULTRASONIC** (external ultrasonic sensors) to measure all water flows allow you to be independent from the existing magnetic flow meters or water meters and thus very flexible.

2.2.3 Interim audit

At a second meeting, all of the participants are given an overview of the current status of the project, and the next steps are established on both sides.

After an initial presentation of the discovered data, the estimated savings potential is used to establish the sequence for looking at the processes more closely.

For example, water flows may have been identified, but a longer observation period is necessary in order to make a reliable evaluation. In some circumstances, measuring points would need to be installed for this purpose.

Of course, any additional identified savings potentials were undertaken immediately so that unnecessary costs were not incurred before the end of the project.

A tabular summary of the most important water flows quickly reveals the greatest potentials.

2.2.3.1 Identifying savings potentials – data evaluation

During multiple necessary meetings, the data is discussed, possible solutions are developed, and practical concepts are created. Figure 10 shows the main users of fresh water as a % of total water users.

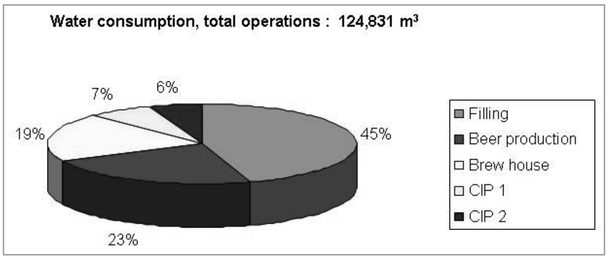

Figure 10. Distribution of fresh-water consumption by departments/areas

After all of the data has been entered into the **TC-AQUALYTIK**® software, the program presents the results of processing the current-condition data in the form of a target-value table. This table shows all of the savings potentials, regardless of size or profitability.

A joint evaluation of the individual processes reduces these to the relevant data, which is then used to show the "real savings potential" in m³/a and Euros/a in another table.

This table then also contains concrete descriptions of the necessary measures for implementing and realizing the savings.

The last step of the program determines the total savings potential as well as the net savings and the ROI.

4. Conclusions

- The Return on Investment (ROI) for this project, after subtracting all of the costs, is only 1.1 years. In addition to the realized water savings, the detailed, cross-departmental evaluation of the water flows gave the company a clearer understanding of various processes. Graphics, tables, and new maps also provided a good visual representation of the processes, which makes future considerations significantly simpler.
- Another important result for the brewery is that the employees are becoming more aware of the importance of saving water.
- As a system provider, Tensid-Chemie GmbH does not just consider the cleaning and disinfecting steps, but also assesses the entire beverage manufacturing process in terms of ecological and economic factors. In this way, Tensid-Chemie GmbH is making an important contribution to the Responsible Care program.

5. References

[1] Hien O. (2009). *So wenig wie möglich, so viel wie nötig!* BRAUINDUSTRIE 94(5), pp. 28-31.

[2] Hien O., Küpferling E., Guggeis H. (2008). *Wassermanagement in der Getränkeindustrie.* BRAUWELT, 148, (23), pp. 640 – 643.