Arbeitskreis
Gewerbliches
Geschirrspülen

Compendium of practice for Commercial Dishwashing

Section 05

Water quality

Arbeitskreis Gewerbliches Geschirrspülen

Contents

1. The significance of the water and the water quality for commercial washing

Water is present in many cleaning processes. It is also the basis of the machine automated washing. It is the solvent for treatment agents such as detergent and rinse aid. It dissolves soak, it mechanically removes soak and holds soak in suspension. It ensures thermal transfer and a spotless rinsing and drying result. Its quality has a significant impact on the entire washing result. Therefore, particular attention should be given to the water and the water quality.

There are often no visual differences. These arise from the ingredients, which can have a negative impact on the washing result.

It is possible to avoid negative impairments through suitable water treatment measures.

2. The water and its ingredients

Water contains both solid and dissolved substances.

Solid substances include, e.g., sand, rust or small soak particles from the pipe system, which can cause damage to the dishwasher and water treatment plants (e.g. magnetic valves). The installation of suitable filter systems according to manufacturer specifications (see 3.1) may help here.

Dissolved substances include gases, salts, minerals and organic components.

Dissolved gases are predominantly components in the air: nitrogen, oxygen and carbon dioxide. They do not influence the washing result.

Dissolved minerals such as calcium / magnesium compounds (water hardness), sodium chloride (table salt), silicates, sulphate compounds and substances from water treatment (e.g. chlorine compounds) have a negative impact on the water quality. Mineral-rich water leads to spots, streaks, deposits, corrosion and increased energy consumption.

The mineral content of the water is referred to as the total salinity. This sum parameter is determined indirectly through the electrical conductivity in practice or through the evaporation residue in the lab.

A large proportion of the total salt content comprises hardeners, also referred to as water hardness. For water hardness, a distinction is made between total hardness (TH) and carbonate hardness (CH).

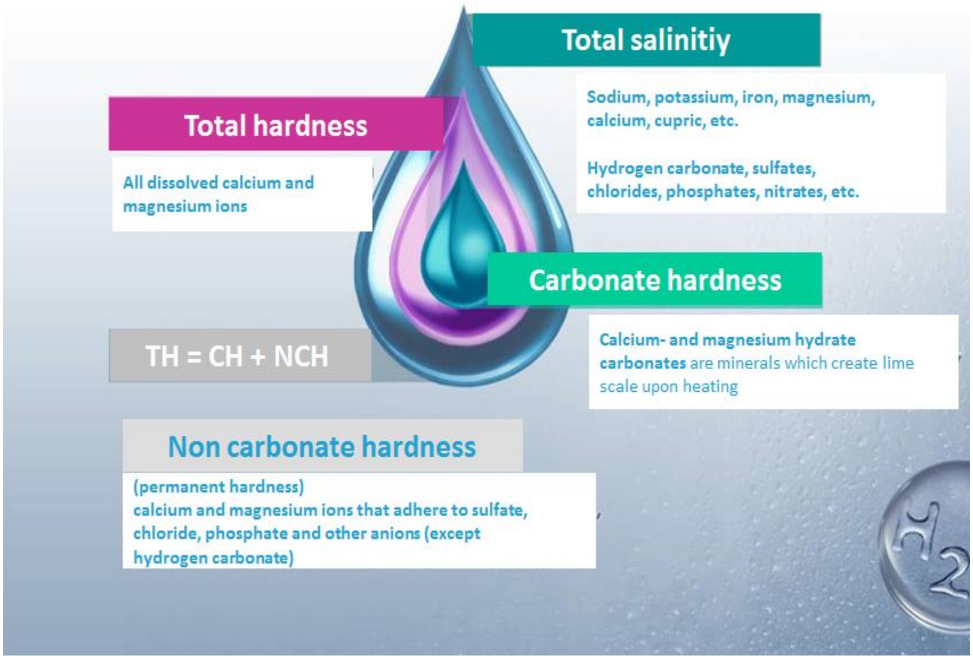

Figure 1: Hardness types in water
Source: Brita Professional GmbH & Co. KG

Definition of total hardness (TH):

Sum of the calcium and magnesium ions dissolved in the water. The total hardness comprises carbonate hardness (temporary hardness) and non-carbonate hardness (permanent hardness)

Definition of carbonate hardness (CH, temporary hardness):

Sum of the calcium and magnesium ions that are allocated to the hydrogen carbonate (these are the minerals that occur as lime and / or form boiler scale when heated).

Definition of non-carbonate hardness (NCH, permanent hardness):

Sum of the calcium and magnesium ions that are not allocated to the hydrogen carbonate, e.g., magnesium chloride (these are the minerals that remain in the solution when heated).

In most cases, however, only the total water hardness value is discussed and / or a classification of the water quality is performed.

The total hardness is indicated in mmol/l. As before, standard country-specific units are still in use:

d (German hardness)

°e (English hardness)

°f (French hardness)

<u>Conversion:</u>

1 °d = 1.25 °e = 1.78 °f = 0.18 mmol/l = 10 mg/l CaO = 17.8 mg/l $CaCO^3$

Since March 2007, in accordance with the European Detergents and Cleaning Products Act, the hardness ranges are divided as follows:

Soft hardness range < 1.5 mmol/l < 8.4 °d

Moderate hardness range 1.5 - 2.5 mmol/l 8.4 °d - 14 °d

Hard hardness range > 2.5 mmol/l > 14 °d

“Soft” water is not necessarily suitable for commercial washing without pre-treatment. Water with a total hardness up to 0.54 mmol/l (3 °d) is only suitable for automated dishwashing if the total salt content is also low.

High total hardness leads to deposits and damage in the machine and to the wash item, impairs the washing result and hygiene, and limits the efficiency through increased consumption of energy, detergent, rinse aid and descaling agents. A limescale layer of just 0.4 mm on the heating elements increases the energy consumption by approx. 25 %.

There are various methods of minimising the impact of the total hardness on the cleaning process (see 3.).

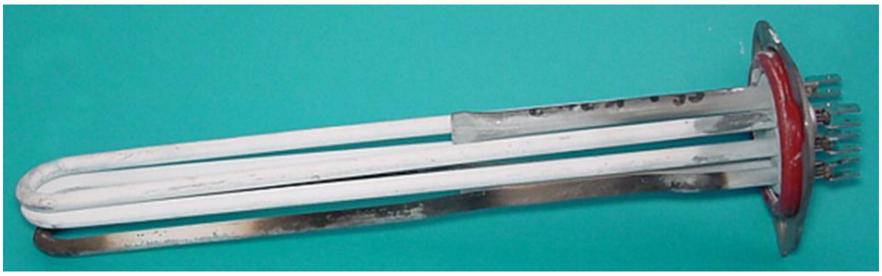

Figure 2: Heating element with limescale deposits
Source: Miele & Cie. KG

Tap water of drinking water quality, in accordance with the valid German Drinking Water Ordinance or European Drinking ‚Water Derective, is not necessarily suitable for automated dishwashing.

The following guide values for a spotless wash result have been developed in practice:

a) Total hardness:

up to 0.54 mmol/l (3 °d)

b) Chloride content:

max. 50 mg/l (e.g. to prevent pitting in low alloy cutlery steels, see *Compendium of practice for Commercial Dishwashing Section 08 "Metal wash items").*

c) Heavy metals:

Threshold values are 0.1 mg/l iron and 0.05 mg/l manganese. 0.05 mg/l copper can lead to discolouration of the wash item and the dishwasher.

d) Silicates (silicic acid)

Increased levels of silicic acid can cause insoluble deposits on the wash item and in the dishwasher. Here, the valid guide values are 20 mg/l SiO^2.

e) Total salt content (measured by electrical conductivity):

max. 400 µS/cm (for porcelain and opal glass)
max. 100 µS/cm (for glass)
max. 80 µS/cm (for stainless steel and cutlery)

Where special demands are made on the washing result, e.g., for glass washing, these guide values may be too high and may have a negative impact on the rinse result.

Treatment agents such as detergent and rinse aid contain components that prevent the precipitation of hardness minerals to a certain extent. From a water hardness above 0.54 mm/l (3 °d), a special softener should be used for economical reasons.

Information on water quality can be requested from your local water supply company. Many countries (like Germany) have an obligation to provide free water analyses. This information is often supplied in the online portals of the respective water supply company.

3. Water treatment processes

Depending on the wash item (e.g. dishes, glasses, cutlery) and demands on the washing result, special water treatment is necessary (hardening, partial desalination, full desalination). If the drinking water does not meet this demand, suitable water treatment must be performed.

3.1. Water filtration

A suitable water filter (sieve filter, cartridge filter, depth filter) should be installed upstream to remove undissolved components (particles) from the water. Regular maintenance (at least once a year) is required to ensure correct function.

3.2. Water softening

Softening involves ion exchange process, whereby all calcium and magnesium ions are exchanged for sodium ions. Left in the water are only minerals that cannot form limescale. An ion exchange granulate is used, which possesses a limited absorption capacity for the hardeners and must therefore be regenerated on a cyclical basis. Special regeneration salt (sodium chloride) is used for the regeneration.

The softener slightly increases the total salinity of the water.

After softening, visible mineral residues may remain on the wash item; however, most are water soluble and are removed during the next cleaning process.

Both internal softening systems in the machine and external softening systems are used for softening.

With central softening plants, the softened water is mixed (blended) with untreated water. Thus, the hardness of the water increases again depending on the blend and does not necessarily meet the requirements for commercial washing.

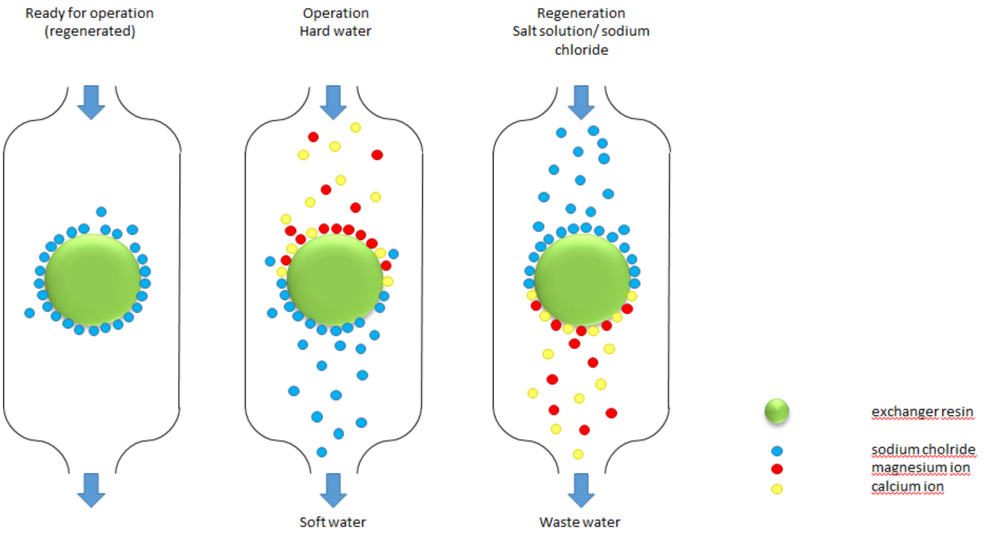

Figure 3: Water softening
Source: Miele & Cie. KG

3.3. Partial water desalination

Partial water desalination, also referred to as decarbonisation, is a cation exchange method in which the carbonate hardness of water is completely removed. The calcium ions and magnesium ions in the water, which are assigned to the carbonate hardness, are exchanged for hydrogen ions. These react with the hydrogen carbonate dissolved in the water to create carbon dioxide, which is dissolved in the water as gas and / or is released into the air when the water is heated. Unlike conventional softening (see 3.2), this process considerably reduces total salt content, specifically by the proportion of the carbonate hardness. The ion exchanger is normally regenerated using strong acids in special regeneration stations and not on-site.

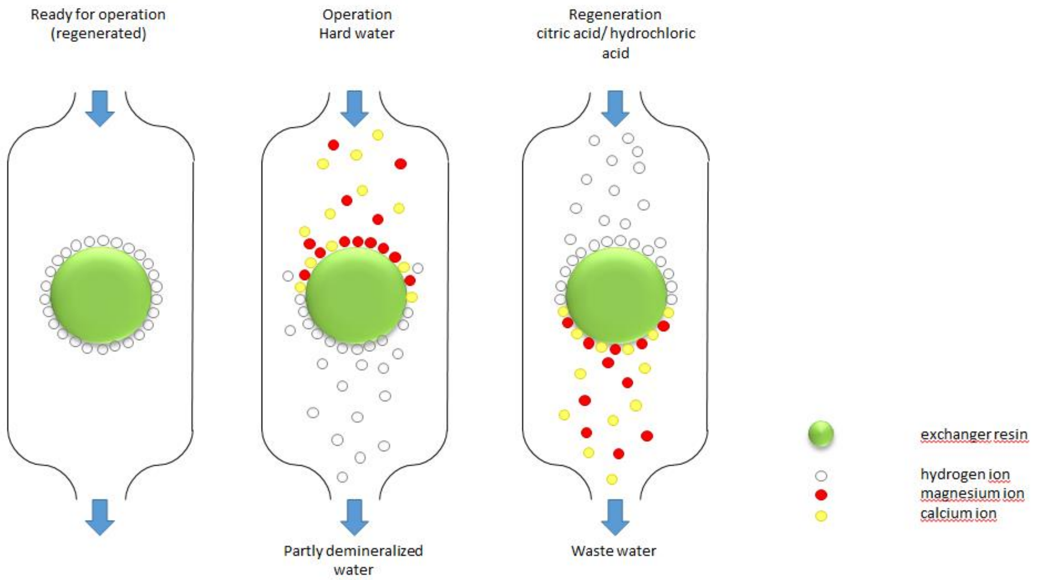

Figure 4: Partial water desalination
Source: Miele & Cie. KG

3.4. Full water desalination

2 processes are used in commercial washing for full desalination and / or demineralisation.

3.4.1. Full desalination through ion exchange

In full desalination through ion exchange, all minerals including all hardeners are removed from the water through the combination of two different ion exchangers (mixed-bed ion exchanger). Specific minerals, e.g., silicic acid (SiO2) are partially not removed. Regeneration is performed using strong acids and alkalis. Mixed-bed ion exchangers are predominantly used for commercial washing. The ion exchanger is normally regenerated using strong acids in special regeneration stations and not on-site.

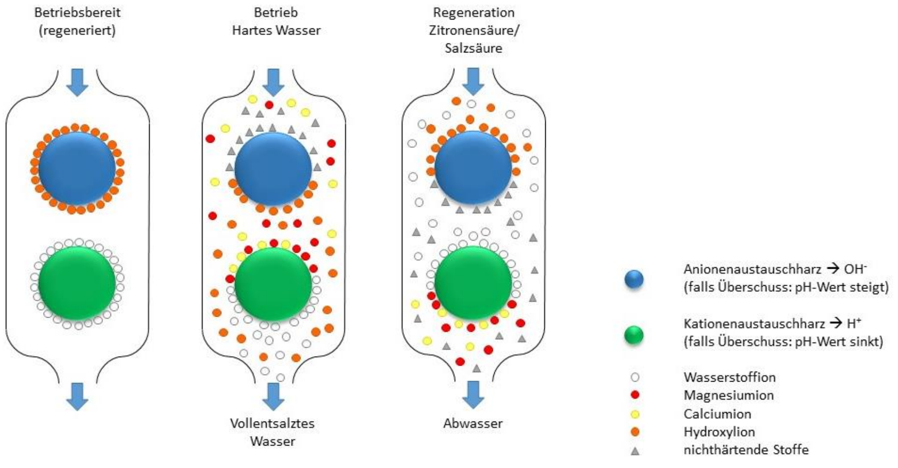

Figure 5: Full desalination through ion exchange
Source: Miele & Cie. KG

3.4.2. Full demineralisation through reverse osmosis

Reverse osmosis refers to the desalination of water using a semi-permeable membrane, through which the minerals are separated from water under pressure. The separating membrane has small openings, through which only water and not minerals can easily pass. Depending on the quality of the untreated water, water pre-treatment may be required.

This procedure requires increased water consumption as only a portion of the water can be used.

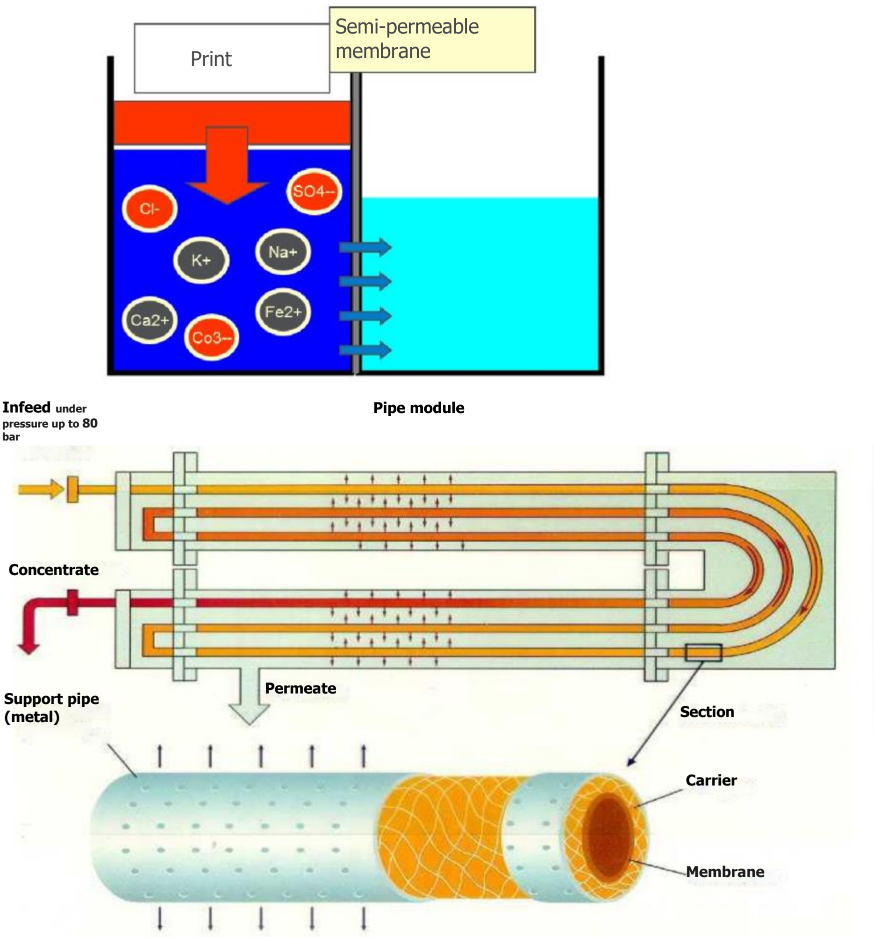

Figure 6: Structure of a reverse osmosis module
Source: Ecolab

Such demineralised water with very low electrical conductivity has considerable corrosion potential. The water should reabsorb minerals if possible and therefore dissolve light substances from pipe materials and other raw materials. Therefore, stainless steel components are resistant, unlike components made of materials susceptible to corrosion such as copper or copper alloys. If demineralised water is used, only stainless steel or plastic pipes should be installed if possible.

To reduce the corrosion potential, the demineralised water (conductivity 0 - 5 µS/cm) can be blended with untreated water at 70 - 80 µS/cm. Furthermore, only neutral rinse aids should be used with low water conductivity. Acidic products can increase the corrosive nature even further under certain circumstances and are no longer required for good water quality.

3.5. Inductive and / or magnetic water treatment

In principle, this is not a water softening procedure. Calcium and magnesium ions form the total water hardness; these are not extracted from the water through magnetic or inductive fields. Only the crystal structure of the limescale that forms from approx. 60 °C (calcium / magnesium carbonate) should be influenced by these fields so that this limescale no longer settles in the pipes.

This operating principle is scientifically contested. Having said that, the efficacy for the commercial cleaning process is irrelevant, as this “soft” lime settles in the dishwasher and builds up on the dishes. Considerable disruptions to the dishwashing procedure should be expected.

3.6. Water treatment with conditioning agents

Conditioning agents include phosphates, silicates (inhibitors), etc. They protect the pipes of the water pipe systems. Adding this substance increases the total salinity of the water. This can lead to spots and streaks on the wash item.

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This compendium of practice, which has been drawn up by experts, should remind the reader that commercial machine washing cannot be successfully conducted on a superficial level or without the corresponding input of all persons involved in the cleaning process.

Only the understanding of technical processes, the resulting interrelations and the cooperation of all participants, particularly the dishwasher operator and staff, as well as having regular maintenance of the dishwasher, the dosing equipment and the water treatment system by the manufacturer, can produce the cleaning results expected by the user.

Consistent cooperation between the dishwasher, detergent and dosing equipment manufacturers, as well as the manufacturers of wash items, guarantees constant and optimal adaptation to practical requirements for the benefit of customers and the environment.

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