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TRENDS IN FOOD SCIENCE & TECHNOLOGY

EHEDG Update

Safe storage and distribution of water in food factories

This article is an extended summary of the report prepared by the Process Water Subgroup of the European Hygienic Engineering and Design Group (EHEDG). This guideline is part of a series of three on Process Water. Originally published in April 2004, it is the 27th in the series of EHEDG summaries published in TIFS. The full report was prepared by A.M. van Buren (Chairman), J.A. Milligan, H.M.J. van Eijk, J.O' Brien, A.Winkler, D. Lawrence, R. Hopman and W.G.J.M. van Tongeren and is available from CCFRA at pubs@campden.co.uk. Information about EHEDG can be found at www.ehedg.org. The production of EHEDG Guidelines is supported by the European Commission under the Quality of Life Programme, Project HYFOMA (QLK1-CT-2000-01359).

It is strongly recommended that for application in the field, operators in the food industry should read the guideline in its entirety, to ensure a holistic approach.

Introduction

Water is a vital medium used for many different purposes in the food industry. The quality of water used in food factories can be critical with respect to product quality/safety in the marketplace, the reliability of production processes and the safety of personnel in the workplace. Water used in manufacturing operations must be safe in microbiological and toxicological terms and available at, or treated to, a specified quality.

Water storage and distribution systems can influence this quality and should therefore be designed and operated following strict safety guidelines. This guideline summarizes the best practice for three water categories used in the food industry: domestic water, product water and utility water.

Definitions

Domestic water	Water of potable quality for all personal (employee) uses such as washing, food and drink preparation.
Product water	Water of potable quality used as – a product ingredient – a transport vehicle in direct contact with the product – for rinsing the surfaces in contact with food, and water for cleaning and disinfection solutions
Utility water	Water used in a secondary process where no direct contact with the product should be possible at any stage, e.g. hot and cooling water systems, fire fighting water storage
Potable water	Water which meets the standards of the World Health Organisation and European or national legislation for drinking water (EU Council Directive 98/83/EC, 1998; WHO Guidelines)
Disinfection	The reduction, by means of chemical agents and/or physical methods, of the number of micro-organisms in the environment, to a level that does not compromise food safety or suitability.
Preservation	A process by which chemical or physical agents prevent micro-organisms from multiplying within water or food.

Product water

When town water is used, it is preferred that this water is obtained directly from a main supply rather than from storage tanks. A proper break facility to separate the town and factory system should always be present. Other sources of product water can be wells and surface water. They should also be equipped with a break facility to prevent back flow.

The product water should always be fit for the intended purpose. The risks in all steps during storage and distribution should be clearly assessed using HACCP methodology. No connection should be possible between product water circuits and circuits holding other water qualities.

At the point of use, the water should meet drinking water requirements. In case of risk of pollution in the distribution system the water should be filtered to at least <10 μm and analysed to ensure compliance with drinking water requirements.

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Distribution systems for product water within the factory

An up-to-date layout of the distribution system must be available. The construction materials must be identified, recorded and meet relevant international and national standards and/or local codes as appropriate.

Incoming and outgoing water streams should be separated in such a way that cross-contamination is avoided.

Product water distribution should not allow deterioration of the water quality:

- Equipment used must be of hygienic design.
- In particular cases, aseptic (sterilizable and bacteria-tight) equipment may be needed.
- Little used branch pipes and cross connections are undesirable.
- Dead ends must be eliminated and water lines no longer used should be removed.
- New and repaired installations must be adequately cleaned and disinfected before re-use. Freedom from chemical residues shall be ensured before going back to operation.
- If a line is out of use for more than 48 h, it should preferably be flushed through prior to use.
- If a branch line is not used for long periods of time it should be separated from the main line by isolation valves.

For systems where there is a chance of formation of aerosols or stagnant water, control measures for *Legionella* must be in place (EHEDG Doc. 24, 2002; UK Health and Safety Commission)

Product water storage

When water cannot be used directly from the water mains and must be stored prior to use, the following criteria must be followed

- Storage tanks must be enclosed, e.g. fitted with lids to prevent ingress of foreign material and pests.
- Ventilation openings should be screened by corrosion resistant mesh with a maximum aperture size of 0.65 mm.
- They should be sized in accordance with water consumption so as to minimize stagnation (residence time should ideally be less than 24 h).
- The temperature should be below 20 °C (or above 60 °C in the case of hot water), and insulation should be provided where relevantly.
- The tank should be fitted with a filtered air vent (preferably class F7) and a backflow protection device.
- The tank should drain completely to a drain or drains at the lowest point(s) to allow easy removal of all sediments.
- Access to the tank should be secured against unauthorized entry (e.g. fenced enclosures, padlocked fittings).

Disinfection of water systems

Product and domestic water services should be disinfected before being taken into use or re-use or if routine inspection shows it to be necessary. After cleaning, disinfection may be:

Chemical: chlorinating the storage tank to 20–50 mg/l free chlorine and filling the whole distribution system and holding for 1 h. Note: This water must then be drained off!

Thermal: raising the temperature throughout the whole system to min. 60 °C and re-circulating for 1/2 h after reaching 60 °C.

Domestic water

When town water is used, it is recommended that this water be obtained directly from a mains supply rather than from storage tanks.

Distribution systems for domestic water within the factory

As per product water.

Domestic water storage

When domestic water cannot be used directly from the water main, the precautions for storage tanks are the same as for product water.

Specific requirements for domestic installations

Deluge showers, eye showers

These should be flushed weekly as part of the routine validation of safety systems operability and familiarization with the locations and operation of such equipment.

Vending machines, ice making machines, drinking fountains

Water for these must be from a potable source. They should be connected well upstream of final draw off points and never at the end of the system. Connecting pipe-work should be as short as possible and constructed according to hygienic design criteria.

Ornamental fountains

This kind of fountain is not recommended on food factory premises since it attracts birds, rodents, etc. thereby increasing the risk of contamination in the plant.

Utility water

Hazards and risks associated with utility water can have significant implications for process reliability. For example,

the use of hard water could lead to scale formation in the equipment which in turn, could lead to cleaning problems, under-pasteurization or malfunctioning of valves essential for the microbiological or chemical safety of the process.

For some but not all utility water applications, water of potable source is required. Therefore, the requirements regarding safe storage and distribution may vary.

Below are a selection of guidelines and standards for selected utility water applications in the food industry.

Hot water systems

Hot water systems are widely used in factories for heating and for cleaning. The systems can be open or closed. Open systems must be protected against ingress of foreign material and the residence time in the system limited to preferably less than 24 h. Closed systems re-circulate hot water via a heating source. Heating methods commonly used are live steam injection, heat exchangers or induction heating.

Regular thermal or chemical disinfection of the equipment may be necessary using for example chlorine. The system should be drained and refilled at a frequency dependent on analytical results.

Hot water systems should preferably be operated at a temperature above 60 °C. If water has to be operated at lower temperatures then the water shall be of the same quality as cooling water.

For systems where there is a chance of formation of aerosols or stagnant water, control measure for *Legionella* must be in place (EHEDG Doc. 24, 2002; UK Health and Safety Commission)

It is recommended that softened water be used for hot water systems where the formation of scale is recognized as a significant problem. Dosing with anticorrosion chemicals or selection of resistant construction materials can be used to control corrosion.

Cooling water systems

Water that is used in equipment such as heat exchangers and jacketed vessels, although not usually in direct contact could, as a result of breakdown, e.g. pinhole corrosion, come into contact with product. This water must always be derived from a potable source and should be particulate free when used in food plants or in applications for other sensitive products.

Regular thermal or chemical disinfection of the equipment may be necessary using, e.g. chlorine. The system should be drained and refilled at a frequency dependent on analytical results.

Corrosion and fouling issues also need to be considered as these can lead to malfunctioning or breakdown of vital process equipment.

Once-through cooling systems

Once-through cooling is the simplest cooling system and can be used where large quantities of river or sea water can be extracted and the resulting discharge of warm/hot water is allowed. River or sea water must not be used to directly cool food or other sensitive products.

The accumulation of dirt in heat exchangers and warm conditions favoring growth of micro-organisms and other aquatic organisms in biofilms are the main concerns.

Incoming water will normally have to undergo filtration to remove solids, biological material and/or organisms.

Biological growth can be prevented by:

- Sufficiently high velocity water (>1 m/s).
- Use of antifouling paint.
- Periodic thermal shock or dosing of chemicals like chlorine or bromine.
- Avoidance of dead legs.

Heat exchangers will require occasional mechanical cleaning (dismantling, scraping, brushing, etc.).

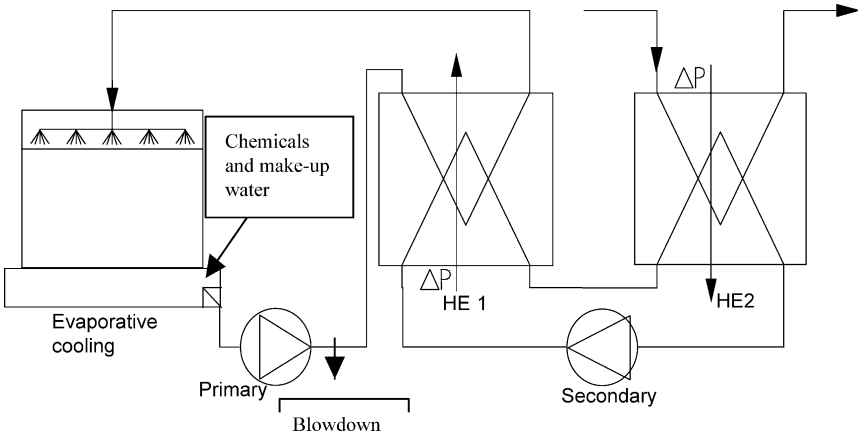

Fig. 1. Illustration of cooling method with cooling tower loop.

Cooling systems using cooling towers

If cooling tower loops are used, there should preferably be a separate secondary controlled loop when cooling foods or other sensitive products. (See Fig. 1). Scaling and microbial growth can present serious problems to cooling tower operations.

In order to control scaling three main methods are used:

water pre-treatment (base exchange water softening)
acid dosing (lowering of pH)
scale inhibitors (e.g. polymers, phosphate).

In order to control microbial growth two main groups of biocides are used:

non-oxidising biocides (e.g. isothiazolone)
oxidising biocides (e.g. chlorine, bromine)

When cooling tower water is applied directly on heat exchangers for food cooling, risk analyses (HACCP) should exist to prove that risks are properly managed for the particular application.

When cooling towers are applied *Legionella* is a major concern. Proper precautions as per EHEDG Doc. 24 and UK Health and Safety Commission documents are essential.

Non-potable cooling water loops

Closed systems re-circulate cooling water in a single loop via a cooling source. Demineralized water or good quality steam condensate are recommended for filling closed circuit systems and should be used for stainless steel equipment operated at elevated temperatures. This minimizes the risk of chloride induced stress corrosion, cracking and pitting corrosion.

If carbon steel is used it is recommended to raise the pH to 8–10 to reduce corrosion, although it is necessary to ensure that there would be no adverse effect on any other metals present in the system.

Depending on the quality of the water used to fill a closed circuit and on operating temperatures, there could be a risk of both corrosion (especially in brine circuits) and microbiological growth. Corrosion inhibitors and bactericides may be required, usually as initial filling dosages. As losses tend to be negligible, relatively expensive high performance chemical treatments can be used.

Any eutectic mixture used in heat exchangers must not be toxic in the event of inadvertent contamination of the food product.

The applied chemicals must be approved for use in the foods industry by the authority in charge of public health.

If a glycol system is used for the cooling of products (only separated by one wall), only propyleneglycol shall be used. Concentration of propylene glycol must exceed 38% to prevent microbiological growth.

Note: Safe glycol can be registered by manufacturers according to NSF HT-1 (incidental food contact).

Water in air conditioning systems

In air conditioning systems, the humidifier, where potentially contaminated air is present in a warm humid environment, represents a major risk for infection with micro-organisms, particularly *Legionella* (EHEDG Doc. 24, 2002; UK Health and Safety Commission).

Water storage for emergency use (fire fighting and sprinkler systems)

In general storage should be designed such that biological contamination of the water is avoided, e.g. in closed tanks.

Reference should be made to any local fire authority regulations before defining operating procedures.

However, this water will only be used in the event of a major emergency and the distribution pipe-work from the storage vessel would normally remain dry.

Back-flow from fire fighting systems to the potable water system must be prevented.

In wet fire sprinkler systems severe corrosion can occur by the action of sulphate reducing bacteria. Where possible, therefore, water with a low sulphate content should be used. Alternatively, biocide could be dosed into the system to prevent or limit growth and consequential corrosion.

References

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