2 Requirements on water supply systems

Drinking water is one of our most important elements and is accordingly subjected to very strict regulations. It is obliged to follow national guidelines on drinking water. The guidelines mentioned in this Specification Manual are based on the regulation in Germany and the European Union.

Directives on the quality of water intended for human consumption:
- Germany: Trinkwasserverordnung TrinkwV2001
- European Union: Drinking Water Directive 98/83/EC

Drinking water
High quality, safe and sufficient drinking water is essential for our daily life, for drinking and food preparation. We also use it for many other purposes, such as washing, cleaning, hygiene or watering our plants. The European Union has a history of over 30 years of drinking water policy. This policy ensures that water intended for human consumption can be consumed safely on a life-long basis, and this represents a high level of health protection. The main pillars of the policy are to:
- ensure that drinking water quality is controlled through standards based on the latest scientific evidence
- secure an efficient and effective monitoring, assessment and enforcement of drinking water quality

The Directive overview
The Drinking Water Directive concerns the quality of water intended for human consumption. Its objective is to protect human health from adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean.

The Directive laid down the essential quality standards at EU level. A total of 48 microbiological, chemical and indicator parameters must be monitored and tested regularly. In general, World Health Organization's guidelines for drinking water and the opinion of the Commission's Scientific Advisory Committee are used as the scientific basis for the quality standards in the drinking water.

National Legislation
When translating the Drinking Water Directive into their own national legislation, Member States of the European Union can include additional requirements e.g. regulate additional substances that are relevant within their territory or set higher standards. Member States are not allowed, nevertheless, to set lower standards as the level of protection of human health should be the same within the whole European Union.

Source: European Union

In Germany the relevant requirements on drinking water and technical requirements on drinking water systems are based on long term practical experience and are laid down in codes of practice. These general accepted codes of practice are a combination of laws, standards and guidelines to ensure:
- Hygienic reliable drinking water
- Long term undisrupted system use
- Avoid discomfort like noise
- Prevention from the loss of waste and energy

Substance	CAS Nr.	EINECS Nr.	Application	Requirement	Allowable addition	Max. concentration after treatment	To be observed reaction product	Remarks
Calciumhypochlorit	778-54-3	321-908-7	Disinfection	DIN EN 900 Tab 1, type 1	1,2 mg/l free Cl_2	max. 0,3 mg/l free Cl_2 min. 0,1 mg/l free Cl_2	Trihalogen-methane, Bromat	Additive to 6 mg/l free Cl_2 and content to 0,6 mg/l free Cl_2 after treatment beside else disinfection is not guaranteed or disinfection is reduced by Ammonium
Chlorine	7782-50-5	231-959-5	Disinfection production of Chlorin-edioxide	DIN EN 937 Tab 2, type 1	1,2 mg/l free Cl_2	max. 0,3 mg/l free Cl_2 min. 0,1 mg/l free Cl_2	Trihalogen-methane	Additive to 6 mg/l free Cl_2 and content to 0,6 mg/l free Cl_2 after treatment beside else disinfection is not guaranteed or disinfection is reduced by Ammonium
Chlorinedioxide	10049-04-4	233-162-8	Disinfection	DIN EN 12671 (EN 937, 901, 939, 899, 938, 12926)	0,4 mg/l ClO_2	max. 0,2 mg/l free Cl_2 min. 0,05 mg/l free Cl_2	Chlorite	Maximum value of Chlorite 0,2 mg/l ClO_2 after treat-ment must be maintained. Note possible formation of Chlorate
Natriumhypochlorite	7681-52-9	231-668-3	Disinfection	DIN EN 901 Table 1, type 1 Limit for impurities with Chlorate ($NaClO_3$): <5,4% (m/m) of active chlorine	1,2 mg/l free Cl_2	max. 0,3 mg/l free Cl_2 min. 0,1 mg/l free Cl_2	Trihalogen-methane, Bromat	Additive to 6 mg/l free Cl2 and content to 0,6 mg/l free Cl_2 after treatment beside else disinfection is not guaranteed or disinfection is reduced by Ammonium
Ozon	10028-15-6	Not applicable	Disinfection, oxidation	DIN EN 1278 Attachment A.3.2	10 mg/l O_3	0,05 mg/l O_3	Trihalogen-methane, Bromat	

CAS: Chemical Abstracts Service Registry Number
EINECS: European Inventory of Existing Commercial Chemical Substances

Table 2.1 Water treatment substances for disinfection in drinking water, according to Trinkwasserverordung Trinkw V2001

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Substances list
For preparation of water for human consumption only substances may be applied which are recognized by the German ministry of health. With the goal to:
a. Remove undesired substances from the water
b. Make the water suitable for human consumption
c. Kill or inactivate disease exciters at:
- preparation of the water in the water treatment plant (primary disinfection)
- distribution of the water in pipe systems (secondary disinfection)
- storage of water in tanks (secondary disinfection)

Water treatment substances consumed in certain levels may harm public health. To prevent an excessive consumption of these substances the maximum allowed concentration of applied water treatment substances in the drinking water is specified in table 2.1.

The reference to standards or regulations is on a general level. Follow all applicable national and international laws, standards, guidelines, regulations and instructions for environmental protection, from professional associations and the local utility companies.

2.1 Hygienic reliability

Protection against contamination of hygienic quality by:

- *Increase of microbiological growth*
  Water contains a certain low amount of pathogenic germs which can lead to illnesses when the bacteria start to grow and increase in the water, like legionella and dysentery. These organisms generally develop at temperature between 20°C and 55°C. So the water in the system needs to avoid this temperature range or water needs to be exposed to this temperature for a limited time.

- *Contamination applied materials*
  The drinking water makes contact to the materials applied in the water distribution system. Elements applied in the materials for pipe work can migrate into the drinking water. Some elements have a negative effect on human beings when a certain value is exceeded. So it needs to be avoided that materials applied contain elements which can wash out and accumulate in the drinking water to an unaccepted level. A knowable example is the application of lead pipes in drinking water distribution. But also weak makers and colour dies applied in plastics are potential contaminators.

- *Back flow of 'used water' into the system*
  When water flushes from the tap point, like in a bath, it makes contact with soap or oils and is no longer fit for human consumption. Flush systems have the likely chance of not being operated every day and the flush water is exposed to elevated temperature with the result that it might contain an increased amount of bacteria. So no fixed connections between bath tub, flush cistern, heating system or cooling system is allowed.

2.2 Long term undisrupted use

For long term undisrupted use the system should be protected:
- against fire
- against freezing
- against excessive heating
- against condensation
- against corrosion
- against mechanical damage

Standard	Title
DIN 1988	Technical rules for drinking water installations - Technical rules from DVGW
DIN 4708	Central heat water installations
EN 806	Specifications for installations inside buildings conveying water for human consumption

Table 2.2 Specification for drinking water installations

Standard	Title
W551	Technical measures to reduce legionella increase
W552	Reduction of legionella - remediation and operation
W553	Dimensioning hot water circulation systems
W554	Operated valves in circulation systems
VDI 6023	Guideline on how to plan, design, engineer, operate and maintain

Table 2.3 Codes of practice: specification for large scale drinking water installations

- *Protection against fire*
  In buildings protection against fire is in principle based on zones with barriers to slow down the spread of fire, to limit the exposure and providing time to extinguish the fire. Pipe systems usually exceed these areas. Pipe and cable work may not operate as a fuse for the development of a fire. So apply fire protection sleeves when the water system crosses a fire barrier zone.

- *Protection against freezing*
  When pipe systems freeze, the flow and function of the system gets blocked. The frozen pipe system might get damaged and starts leaking as soon as the water will melt again. So apply insulation when there is a potential risk of freezing.

- *Protection against excessive heating*
  When cold and hot water systems are near each other or at crossings, the cold water might be heated up by the hot water system, with the result that the cold water is no longer fresh. Excessive heating after a heater might damage the pipe system, resulting in early failure of the material.

- *Protection against condensation*
  When moist warm air gets in contact with cool surfaces, it solves moist condensates on the cool surface in tiny water drops. When this process continues, it can cause a wet area where funguses can develop. This can be the case on cold water systems and cooling systems. So insulate cold water systems and cooling systems and the risk on condensation will be elevated.

- *Protection against corrosion*
  Corrosion is a degradation process of the pipe material. It will lead to early failure of the system. So for metal pipe systems measures like passivation or insulation are applied to reduce the risk for corrosion.

- *Protection against mechanical damage*
  Mechanical damages like scratches or notches by bad handling lead to weakening of the material. Careless clamping and insufficient expansion compensation leads to additional material stresses. Both can lead to early failure of the system.

2.3 Avoid discomfort

Avoid discomfort due to:

- *Noise*
  Hearing water flow becomes a discomfort above a noise level 30 dB(a). Apply insulation to prevent noise to exceed this noise level.

- *Waiting time before availability of warm water*
  Waiting on the right temperature becomes a discomfort after a certain time. Apply an application specific pipe diameter to avoid excessive waiting time.

2.4 Waste prevention

Waste prevention against excessive use of:

- *Water*
  When excessive time is necessary to wait for the required water temperature, the water gets spilled. Spilling of valuable drinking water should be avoided. Apply a specific dimension of the pipe system to avoid excessive waiting time.

- *Energy*
  Reduction of energy consumption in buildings is regarded as a substantial attribution to climate goals. Beside insulation of buildings and modern heating technology also reduction of energy for the availability of hot water is possible. In modern buildings the energy consumption is optimized in such a way that hot water preparation requires substantial lower energy.

2.5 Disinfection

Although properly treated to comply with stringent national health regulations and safe for human consumption, drinking water may contain traces of bacteria and chemicals.

Drinking water supplied according to the public water authority regulation is not perfectly sterilized. It contains (pathogenic) germs in concentrations which are not harmful for public health. In the public distribution network with temperatures below 20°C the growth of bacteria is prevented. In general the public water authorities supply a good drinking water quality.

In the building the owner has to take care that the water quality does not deteriorate before it is tapped. Drinking water installations in private and public buildings harbor a danger source for the drinking water quality. Raised temperature and retention period of the drinking water in the pipe system and cisterns lead to bacterial growth and raised quantity of bacteria in the water. This is caused by inadequate heat insulated pipes, less operated pipe segments and at low temperature (below 60°C) operated hot water storage.

Most significant for drinking water quality in buildings is legionella. It distinguishes itself from other pathogenic bacteria that it does not increase inside the human body but in biofilm, especially in the temperature range from 20°C to approximately 55°C. They are absolutely the most relevant environmental germ for which the human population needs to be protected.

Legionella can grow to questionable concentration in the temperature range from 20 to 55°C with a retention time of several hours to days. This needs to be considered when the operational temperature for hot water systems is reduced for the purpose of energy consumption reduction.

Thermal disinfection
Legionella growth is stopped at a temperature between 55-60°C. Killing legionella settlements requires a minimal temperature of 70°C for minimal 30 minutes in the total pipe system. A frequent heating above 60°C limits the lifetime of installation materials.

Chemical disinfection
Legionella bacteria on the surface of biofilms are killed by chlorine substances such as Calcium Hypochlorit, Chlorine, Chlorine Dioxide, Natrium Hypochlorite. In general the chemical resistance of polypropylene to these chlorine substances is not satisfactory. However in reality these chlorine substances are dosed in aqueous solutions at low concentrations and prepared at 20°C. This reduces the impact on installation materials.

Reduction of energy consumption by reducing boiler temperature setting may not endanger the hygienic quality of the water. It is preferably realized by:
- Insulation of pipe systems and storage tanks
- Hydraulic alignment of circulation systems
- Applying economic circulation pumps and storage tanks
- Applying water saving taps

Codes of practice for drinking water installations make a distinction between large and small scale installations. Large scale installations require a circulation system to prevent that heated water cools down in the pipe system (when it flows back from a tap branch) before it is heated again on the required temperature. Circulation systems lead to heat loss and additional energy consumption.

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