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Let's Solve Water

Drinking Water

Drinking water: Definition and quality requirements
Drinking water is defined as water which is intended for human consumption.
According to the European directive 98/83/EC from 1998, drinking water is

"all water either in its original state or after treatment, intended for drinking, cooking, food preparation […]"

(Article 2, 1., (a)).

This results in high quality requirements which Xylem can help with.

In terms of this quality, the directive lists microbiological, chemical and indicator parameters as contributing factors. A main objective is,

"to protect human health by ensuring that it [the drinking water] is wholesome and clean."

(Article 1, 2.).

Whats the usage of drinking water?
Besides the above mentioned usage, the following topics are also relevant as drinking water applications:

1. Body care and cleansing
2. Cleaning of goods intended to be in contact with food
3. Cleaning of goods intended to be in contact with the human body
4. All water in any food-production processing facility, undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption

According to the directive 98/83/EC
(Article 3, 1.), drinking water excludes:

1. "natural mineral water […] in accordance to […] 80/777/EEC […]"
2. "waters which are medicinal products within […] 65/65/EEC […]"

Where are the threshold values for drinking water?
Threshold values were defined for a range of parameters. They are divided into microbiological, chemical, and indicator parameters. One of the most common ones are **nitrate** and **chloride**. According to the European directive 98/83/EC, the associated **thresholds** are **50 mg/l** and **250 mg/l**, respectively.
The full lists can be visited under this link (ANNEX I, parts A to C).
Country specific guidelines are for example:

- Germany: TrinkwV
- UK: WRAS/REG 31, 33
- Switzerland: SR 817.022.102

If thresholds are not met, drinking water is not allowed to be provided. The associated authorities/relevant bodies must then take remedial actions or put in place restrictions to its use.

Sources
The most common sources of drinking water are **groundwater (wells)** or **surface waters (lakes/rivers)**. Many utilities receive their raw water from several sources in order to be able to guarantee supply in case of failure or reduced quality of one source.
Depending on the quality of the raw water, a corresponding expense has to be invested into the treatment. The numerous processes can be roughly divided into pretreatment, filtration, disinfection/oxidation and others.

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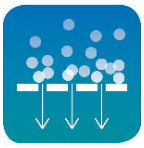
Treatment

Pretreatment

In addition to sedimentation to separate coarse material, pretreatment also includes precipitation (addition of Fe or Al salts) and flocculation (addition of polymers).
The latter two processes serve to form micro or macro flocs to accelerate the subsequent sedimentation.
Typical measuring parameters are (measuring technique see below):

- Salt or polymer concentration and filling level
- Turbidity
- SAC
- Sludge level

Filtration



The filtration process can be divided into *filtration through a matrix* (e.g. sand filter with or without activated carbon) and *filtration on a surface* (e.g. membrane filtration).
Sand filtration is used for the separation of solids as the raw water flows through the filter and the solids adhere and remain in the matrix. As the filter has to be rinsed regularly, often several filters are operated to clean the raw water on the other filters in the meantime. In addition, a biologically active layer builds up on the filter surface, which must be regularly removed. If an activated carbon layer is embedded, dissolved organic substances or impurities that are difficult to degrade are also removed.
Monitoring parameters are (measurement technique see below):

- Turbidity
- Oxygen
- SAC

Depending on the pore size, membrane filtration is able to remove not only solids but also dissolved particles and also has a disinfecting effect. However, membrane filtration is not approved for disinfection at least in Germany. Depending on the pore size, a distinction is made between micro (0.1–10 µm), ultra (0.001–0.01 µm), nano filtration (0.0005–0.007 µm) and reverse osmosis (<0.001 µm).
Monitoring parameters are:

- Particle/solid
- Hygienic parameters
- Turbidity

Desinfection

For disinfection, the addition of chlorine, chlorine dioxide, ozone (chemical disinfection) or UV treatment (physical disinfection) can be considered.
In Germany, ozonation is not permitted as the sole disinfection method.

In the chemical processes, microorganisms are inactivated. The inactivation depends on the c*t values, i.e. on the concentration (c) to which the microorganisms are exposed over a certain time (t). The disinfection performance is limited by the presence of ammonium (formation of chloramines) and at higher turbidity levels (>1 NTU). Chemical oxidation of inorganic or organic components also takes place in all processes. For ozonation this is the primary objective.
Monitoring parameters are (see below for measurement technology):

- Chlorine
- chlorine dioxide
- O_3
- pH
- UV transmission
- Turbidity

Physical disinfection damages the DNA of microorganisms and thus deprives them of their ability to divide. The performance here depends on the UV dose and requires a low turbidity (<1 NTU). Chemical oxidation only takes place in the presence of H_2O_2.

Others (e.g. activated carbon, Deferrization/Manganese removal)

Among the numerous other processes, activated carbon and deferrizing/demanganization are the most common.

The activated carbon removes dissolved organic and hardly degradable (micro) impurities. In addition, it also promotes biological degradation and provides protection in the event of short-term exposure shocks. The process can be carried out using its own filter bed, stored in other filters or integrated into the treatment process using powdered activated carbon. Depending on the raw water and rinsing processes, it can take one month or one year until the carbon is fully loaded. Afterwards the coal has to be regenerated or burned.
Typical monitoring parameter is (measurement technology see below):

- SAK before and after the treatment stage

Iron and manganese removal is a combination of oxidation and subsequent filtration. In oxidation, Fe^{3+} or Mn^{4+} are oxidized to Fe^{2+} or Mn^{2+}. The iron precipitates from the beginning in the subsequent filter. The manganese is removed with some delay by manganese eating bacteria. The delay results from the fact that these bacteria must grow in sufficient quantity first.
To be measured:

- Oxygen in the oxidation
- Iron/manganese after filtration

How to monitor drinking water

Frequency and the extent of drinking water monitoring depends on the size of the supplied area and the monitored parameter.
In general, larger drinking water plants have to be monitored more often.

For example, in a supplied area of 500 m³/day, conductivity has to be monitored once a year. A detailed presentation for Germany can be found here. Independent of this mandatory minimum surveillance, waterworks are usually monitoring their water quality continuously. Besides the monitoring, these continuous measurements also enable a control of the single processes.
The most common analytical monitoring parameters are as follows (in alphabetical order):

- Chlorine
- Chlorine dioxide
- Conductivity
- Particles/solids
- pH
- ORP
- Oxygen
- Ozone
- Temperature
- Turbidity
- UV transmisson

Do you have further questions?
Please contact our
Customer Care Center:

Xylem Analytics Germany Sales GmbH & Co. KG, WTW
Am Achalaich 11
82362 Weilheim, Germany
Phone +49 881 1830
Fax +49 881 183-420
Info.WTW@xylem.com

xylemanalytics.com

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