Water treatment

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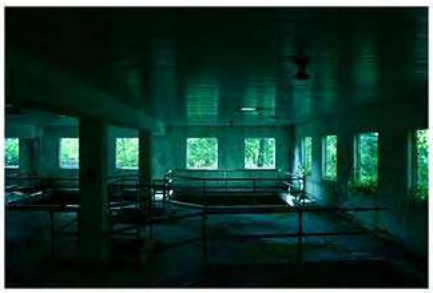
Water treatment is any process that makes water more acceptable for a specific end-use. The end use may be drinking, industrial water supply, irrigation, river flow maintenance, water recreation or many other uses, including being safely returned to the environment. Water treatment removes contaminants and undesirable components, or reduces their concentration so that the water becomes fit for its desired end-use.



Abandoned Water Purification Plant
Springfield, Tennessee, United States

Contents

Treatment for drinking water production

Treatment for drinking water production involves the removal of contaminants from raw water to produce water that is pure enough for human consumption without any short term or long term risk of any adverse health effect. Substances that are removed during the process of drinking water treatment include suspended solids, bacteria, algae, viruses, fungi, and minerals such as iron and manganese.

The processes involved in removing the contaminants include physical processes such as settling and filtration, chemical processes such as disinfection and coagulation and biological processes such as slow sand filtration.

Measures taken to ensure water quality not only relate to the treatment of the water, but to its conveyance and distribution after treatment. It is therefore common practice to keep residual disinfectants in the treated water to kill bacteriological contamination during distribution.

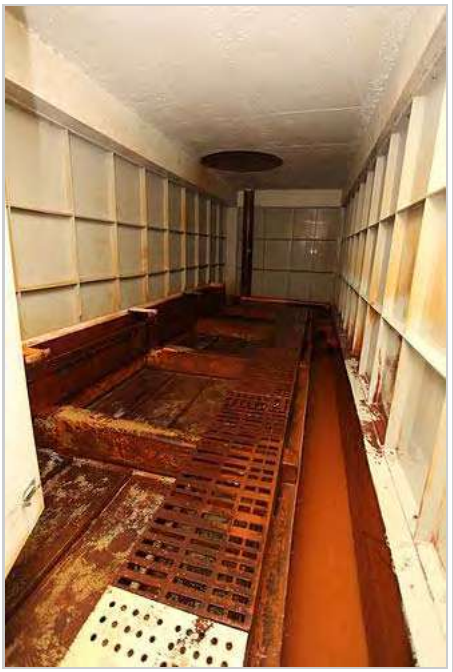
World Health Organization (WHO) guidelines are a general set of standards intended to apply where better local standards are not implemeted. More rigorous standards apply across Europe, the USA and in most other

developed countries. followed throughout the world for drinking water quality requirements.

Processes

A combination selected from the following processes is used for municipal drinking water treatment worldwide:

- Pre-chlorination for algae control and arresting biological growth
- Aeration along with pre-chlorination for removal of dissolved iron when present with small amounts relatively of manganese
- Coagulation for flocculation or slow-sand filtration
- Coagulant aids, also known as polyelectrolytes – to improve coagulation and for more robust floc formation
- Sedimentation for solids separation that is removal of suspended solids trapped in the floc
- Filtration to remove particles from water either either by passage through a sand bed that can be washed and reused or by passage through a purpose designed filter that may be washable.
- Disinfection for killing bacteria viruses and other pathogens.



Empty aeration tank for iron precipitation

Technologies for potable water and other uses are well developed, and generalized designs are available from which treatment processes can be selected for pilot testing on the specific source water. In addition, a number of private companies provide patented technological solutions for treatment of specific contaminants. Automation of water and waste-water treatment is common in the developed world. Source water quality through the seasons, scale and environmental impact can dictate capital costs and operating costs. End use of the treated water dictates the necessary quality monitoring technologies, and locally available skills typically dictate the level of automation adopted.

Tanks with sand filters to remove precipitated iron (not working at the time)

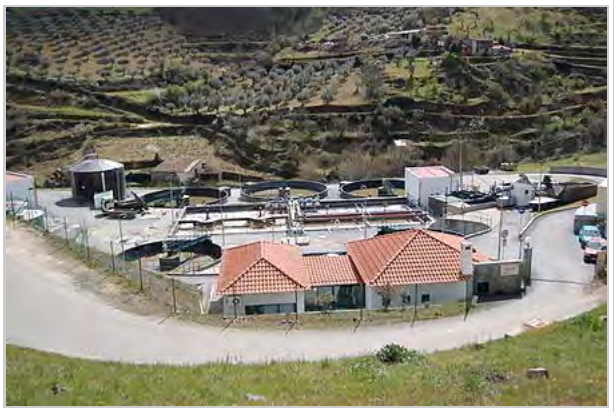
Polluted water treatment

Wastewater treatment is the process that removes the majority of the contaminants from wastewater or sewage and produces both a liquid effluent suitable for disposal to the natural environment and a sludge. Biological processes can be employed in the treatment of wastewater and these processes may include, for example, aerated lagoons, activated sludge or slow sand filters. To be effective, sewage must be conveyed to a treatment plant by appropriate pipes and infrastructure and the process itself must be subject to regulation and controls. Some wastewaters require different and sometimes specialized treatment methods. At the simplest level, treatment of sewage and most wastewaters is carried out through separation of solids from liquids, usually by sedimentation. By progressively converting dissolved material into solids, usually a biological floc, which is then settled out, an effluent stream of increasing purity is produced.[1][2]

Industrial water and wastewater treatment

Two of the main processes of industrial water treatment are *boiler water treatment* and *cooling water*

treatment. A lack of proper water treatment can lead to the reaction of solids and bacteria within pipe work and boiler housing. Steam boilers can suffer from scale or corrosion when left untreated. Scale deposits can lead to weak and dangerous machinery, while additional fuel is required to heat the same level of water because of the rise in thermal resistance. Poor quality dirty water can become a breeding ground for bacteria such as *Legionella* causing a risk to public health.



A sewage treatment plant in northern Portugal.

With the proper treatment, a significant proportion of industrial on-site wastewater might be reusable. This can save money in three ways: lower charges for lower water consumption, lower charges for the smaller volume of effluent water discharged and lower energy costs due to the recovery of heat in recycled wastewater.

Corrosion in low pressure boilers can be caused by dissolved oxygen, acidity and excessive alkalinity. Water treatment therefore should remove the dissolved oxygen and maintain the boiler water with the appropriate pH and alkalinity levels. Without effective water treatment, a cooling water system can suffer from scale formation, corrosion and fouling and may become a breeding ground for harmful bacteria. This reduces efficiency, shortens plant life and makes operations unreliable and unsafe.[3]

Domestic water treatment

Water supplied to domestic properties may be further treated before use, often using an in-line treatment process. Such treatments can include water softening or ion exchange. Many propriety systems also claim to remove residual disinfectants and heavy metal ions.

Desalination

Saline water can be treated to yield fresh water. Two main processes are used, reverse osmosis or distillation. Both methods require high energy inputs and are usually only used where fresh water is difficult to source.

Field processes

Living away from drinking water supplies often requires some form of portable water treatment process. These can vary in complexity from the simple addition of a disinfectant tablet in a hiker's water bottle through to complex multi-stage processes carried by boat or plane to disaster areas.

Ultra pure water production

Some industries such as the production of silicon wafers, space technology and many high quality metallurgical process require ultrapure water. The production of such water typically involves many stages, and can include reverse osmosis, ion exchange and several distillation stages using solid tin apparatus.

History

Early water treatment methods still used included sand filtration and chlorination. The first documented use of sand filters to purify the water supply dates to 1804, when the owner of a bleachery in Paisley, Scotland, John Gibb, installed an experimental filter, selling his unwanted surplus to the public.[4][5] This method was refined in the following two decades, and it culminated in the first treated public water supply in the world, installed by the Chelsea Waterworks Company in London in 1829.[6][7]

Society and culture

Developing countries

As of 2006, waterborne diseases are estimated to have caused 1.8 million deaths each year. These deaths are attributable to inadequate public sanitation systems and in these cases, proper sewerage (or other options such as small-scale wastewater treatment) that must be installed.[8]

Appropriate technology options in water treatment include both community-scale and household-scale point-of-use (POU) designs.[9] Such designs may employ solar water disinfection methods, using solar irradiation to inactivate harmful waterborne microorganisms directly, mainly by the UV-A component of the solar spectrum, or indirectly through the presence of an oxide photocatalyst, typically supported TiO_2 in its anatase or rutile phases.[10] Despite progress in SODIS technology, military surplus water treatment units like the ERDLator are still frequently used in developing countries. Newer military style Reverse Osmosis Water Purification Units (ROWPU) are portable, self-contained water treatment plants are becoming more available for public use.[11]

For waterborne disease reduction to last, water treatment programs that research and development groups start in developing countries must be sustainable by the citizens of those countries. This can ensure the efficiency of such programs after the departure of the research team, as monitoring is difficult because of the remoteness of many locations.

See also

- Agricultural wastewater treatment
- Peak water (water supply & demand)
- Pulsed-power water treatment
- Reclaimed water
- Water purification
- Water quality
- Water softening
- Water supply

References

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5. Buchan, James (2003). *Crowded with genius: the Scottish enlightenment: Edinburgh's moment of the mind*. New York: HarperCollins. ISBN 9780060558888.
6. Frerichs, Ralph R. "History of the Chelsea Waterworks". *John Snow*. Fielding School of Public Health, University of California, Los Angeles. Retrieved 2016-07-09.
7. Christman, Keith (September 1998). "The history of chlorine". *WaterWorld*. Tulsa, OK: PennWell. **14** (8): 66–67.
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9. "Household Water Treatment Guide". Centre for Affordable Water and Sanitation Technology, Canada. March 2008.
10. "Sand as a low-cost support for titanium dioxide photocatalysts". *Materials Views*. Wiley VCH.
11. Lindsten, Don C. (September 1984). "Technology transfer: Water purification, U.S. Army to the civilian community". *The Journal of Technology Transfer*. **9** (1): 57–59. doi:10.1007/BF02189057.

Further reading

- Eaton, Andrew D.; Franson, Mary Ann H. (2005). *Standard methods for the examination of water and wastewater* (21 ed.). American Public Health Association. ISBN 978-0-87553-047-5.

External links

- International Water Association (http://www.iwahq.org) Professional / research organization
- Center for Biological and Environmental Nanotechnology (CBEN), Rice University (http://cben.rice.edu)
- NSF International (http://www.nsf.org) – Independent non-profit standards organization
- Transnational Ecological Project (http://www.hydropark.ru/index.en.htm) – Industrial wastewater treatment (Russia)
- Water Environment Federation (http://www.wef.org) – Professional association focusing on wastewater treatment
- WHO.int (http://www.who.int/water_sanitation_health/dwq/gdwq3rev/en/index.html), WHO Guidelines
- Safe and Sustainable Water for Haiti web site hosted by Grand Valley State University (http://www.gvsu.edu/haitiwater/)