

Chemical Parameters of Drinking Water Fact Sheet: Arsenic

Sources

Arsenic can naturally occur in groundwater and some surface water. It is one of the greatest chemical problems in developing countries. The World Health Organization (WHO) considers arsenic to be one of the chemicals of greatest health concern in some natural waters and a high priority for testing in drinking water sources (WHO, 2011; WHO, 2012).

High levels of arsenic can be found naturally in water from deep wells in over 70 countries, including India, Nepal, Bangladesh, Indonesia, Cambodia, Vietnam, Lao PDR, Mexico, Nicaragua, El Salvador, and Brazil. In South Asia alone, it is estimated that 60 to 100 million people are affected by unsafe levels of arsenic in their drinking water. Bangladesh is the most severely affected, where 35 to 60 million of its 130 million people are exposed to arsenic contaminated water. It is possible that arsenic may be found in other locations as more water quality testing is done.

Potential Health Effects

Arsenic is poisonous, so if people drink water or eat food contaminated with arsenic for several years, they develop chronic health problems called arsenicosis.

Melanosis is the first symptom of drinking arsenic contaminated water over a few years. Melanosis is light or dark spots on people's skin, often on the chest, back, or palms. The next step is that hardening skin bulges develop on people's palms and feet – called keratosis. Drinking high amounts of arsenic for a longer time may cause cancer in the lungs, bladder, kidney, skin, liver, and prostate. Arsenic may also cause vascular diseases, neurological effects, and infant developmental defects.

Arsenicosis can be partially reversed and treated in the early stages by making sure people stop drinking arsenic contaminated water and by improving their nutrition. There is currently no effective cure for arsenic poisoning. The only prevention is to drink water that has safe levels of arsenic.

According to the United Nations Development Program (2006), the projected human costs over the next 50 years include 300,000 deaths from cancer and 2.5 million cases of arsenic poisoning.

World Health Organization Guidelines

It is difficult to measure arsenic levels below 1-10 µg/L, and removing arsenic in drinking water to concentrations below 10 µg/L is difficult in many circumstances. In view of the practical difficulties in testing and removing arsenic, the WHO (2011) suggests that drinking water should have less than 10 µg/L of arsenic (10 µg/L is the same as 0.01 mg/L, 0.01 ppm or 10 ppb.)

WHO Guideline for Arsenic in Drinking Water <10 µg/L

Chemical Parameters of Drinking Water

Fact Sheet: Arsenic

Many countries have their own standards which are less strict than the WHO Guidelines, ranging from 25 mg/L to 50 µg/L (25-50 ppb). Many Southeast Asian countries that have an arsenic problem have adopted a temporary standard of 50 µg/L because it is difficult to test accurately to 10 µg/L and to treat water to meet that level.

Water Quality Testing Methods

Testing for arsenic in drinking water, especially at the µg/L level, is difficult. There are no simple paper test strip or colour disc comparator field kits available. Arsenic testing used to be only possible in a laboratory. However, as a result of the discovery of significant arsenic contamination of groundwater in Asia and elsewhere, a variety of portable test kits are now available. All of these rely on the Gutzeit method, which consists of several steps (UNICEF, 2008).

Most commercially available portable test kits typically provide colour reference charts, with reported detection limits around 10 µg/L. However, evaluations have shown that the results are semi-quantitative at best, especially at lower levels (<100 µg/L). The kits are most effectively used in a positive/negative format with a reference value of 50 µg/L, which is the drinking water standard in many countries. At this level, most samples containing 50-99 µg/L are identified as positive, and nearly all samples containing 100 µg/L or more result in positive test results, though the quantitative result may be incorrect (UNICEF, 2008).

However, in recent years manufacturers of portable test kits have modified designs in an effort to lower the detection limit for arsenic. The newer kits are probably still not capable of reliably quantifying arsenic at such low levels, but should have lower false negative rates when used in a positive/negative format (UNICEF, 2008).

Information about commercially available portable test kits are provided in CAWST's Drinking Water Quality Testing Product Sheets.

Household Water Treatment Options

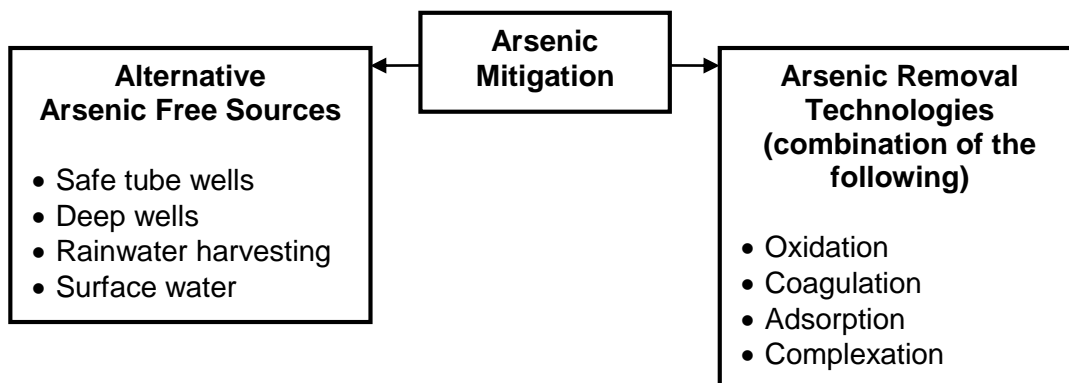
One way to deal with arsenic in groundwater is to use a different source of drinking water, such as rainwater or surface water. Some people collect and store their rainwater and use it for drinking and cooking instead of arsenic contaminated groundwater. If people change to drinking surface water, they will probably need to treat the water to remove turbidity and pathogens.

If people are unable to change to a water source that does not have arsenic, there are various household water treatment options that have been developed to remove arsenic from water. Each technology has advantages and limitations. Many of these technologies are being used in Bangladesh where the arsenic problem is widespread. See CAWST's Household Water Treatment for Arsenic Removal Fact Sheets for more information on the different technologies.

The following illustration shows the different mitigation options for arsenic in drinking water.

Chemical Parameters of Drinking Water

Fact Sheet: Arsenic



References

United Nations Development Program (2006). Human Development Report 2006: Beyond Scarcity: Power, Poverty and the Global Water Crisis. New York, USA. Available at: <http://hdr.undp.org/en/media/HDR06-complete.pdf>

UNICEF (2008). UNICEF Handbook on Water Quality. UNICEF, New York, USA. Available at: www.unicef.org/wash/files/WQ_Handbook_final_signed_16_April_2008.pdf

World Health Organization (2011). Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwq/secondaddendum20081119.pdf

World Health Organization (2012). Rapid Assessment of Drinking-Water Quality: A Handbook for Implementation. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/publications/2012/rapid_assessment/en/index.html

CAWST (Centre for Affordable Water and Sanitation Technology)
Calgary, Alberta, Canada
Website: www.cawst.org Email: resources@cawst.org
Wellness through Water.... Empowering People Globally
Last Update: October 2013

This document is open content. You are free to:



- Share – to copy, distribute and transmit this document
- Remix – to adapt this document



Under the following conditions:

- Attribution. You must give credit to CAWST as the original source of the document. Please include our website: www.cawst.org

CAWST and its directors, employees, contractors and volunteers do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.



Chemical Parameters of Drinking Water Fact Sheet: Chlorine

Sources

Chlorine is produced in large amounts and widely used both industrially and domestically as an important disinfectant and bleach. In particular, it is the most commonly used chemical disinfectant in drinking water treatment and is widely used in the disinfection of swimming pools.

Chlorine is widely used to disinfect drinking water as the final step in the water treatment process. Chemical disinfection using chlorine has the benefits of being relatively quick, simple, and inexpensive. It also allows a residual amount of chlorine to remain in the water to provide some protection against subsequent contamination.

Three things can happen when chlorine is added to water:

1. Some chlorine reacts with the organic matter and pathogens and kills them. This portion of the added chlorine is said to be consumed.
2. Some chlorine reacts with other organic matter and forms new chlorine compounds. This portion is called combined chlorine.
3. Excess chlorine that is not consumed or combined and remains in the water is known as free residual chlorine (FRC).

The objective of chlorination is to add enough chlorine to leave 0.2-0.5 mg/L FRC after half an hour contact time. Factors influencing the effectiveness of chlorine as a disinfectant are concentration, contact time, pH, temperature, and the presence of organic matter in the water. All of these factors can vary day to day and in different seasons.

Potential Health Effects

Drinking water with high concentrations of chlorine is not known to cause specific adverse health effects. Chlorine, however, can change the taste and smell of water and it may cause people to not use it and to choose another, possibly contaminated, water source instead. People often complain of a strong taste and smell when the FRC concentration is between 0.6-1.0 mg/L (UNICEF, 2008).

World Health Organization Guidelines

There are no specific adverse health effects of exposure to free chlorine, but the World Health Organization (WHO) has conservatively set a guideline value of 5 mg/L, which is well above the taste and odour threshold (WHO, 2011). Most people are able to taste or smell chlorine in drinking water at concentrations well below 5 mg/L, and some at levels as low as 0.3 mg/L.

For effective disinfection, there should be a residual concentration of free chlorine of ≥ 0.5 mg/L after at least 30 minutes contact time at pH < 8.0 . A chlorine residual should be maintained throughout the distribution system. At the point of delivery, the minimum residual concentration of free chlorine should be 0.2 mg/L (WHO, 2011).

Chemical Parameters of Drinking Water

Fact Sheet: Chlorine

WHO Guideline for Chlorine in Drinking Water <5 mg/L

Water Quality Testing Methods

On-site testing is essential for measuring FRC since the concentration can change rapidly during transport and storage (WHO, 2011). Portable digital photometers are available from various commercial manufacturers. These can provide reliable and quantitative measurements of chlorine (UNICEF, 2008). Chlorine can also be easily measured using pool test kits, test strips, or a colour disc comparator.

Information about commercially available portable test kits are provided in CAWST's Drinking Water Quality Testing Product Sheets.

Household Water Treatment Options

Generally, people do not try to remove chlorine from their drinking water. Rather, it is often used to treat water to make it safe to drink. However, some people are sensitive to the taste and smell of chlorine in their drinking water. A practical household option to reduce the chlorine level is simply letting the water stand in a container for a period of time ranging from a few hours to a few days so that the chlorine dissipates. Another quick option is to shake a bottle of water to help the chlorine dissipate faster.

References

UNICEF (2008). UNICEF Handbook on Water Quality. UNICEF, New York, USA. Available at: www.unicef.org/wes/files/WQ_Handbook_final_signed_16_April_2008.pdf

World Health Organization (2011). Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwq/secondaddendum20081119.pdf

CAWST (Centre for Affordable Water and Sanitation Technology)
Calgary, Alberta, Canada
Website: www.cawst.org Email: resources@cawst.org
Wellness through Water.... Empowering People Globally
Last Update: October 2013

This document is open content. You are free to:



- Share – to copy, distribute and transmit this document
- Remix – to adapt this document



Under the following conditions:

- Attribution. You must give credit to CAWST as the original source of the document. Please include our website: www.cawst.org

CAWST and its directors, employees, contractors and volunteers do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.



Chemical Parameters of Drinking Water Fact Sheet: Fluoride

Sources

Fluoride can naturally occur in groundwater and some surface water. Drinking water is normally the major source of fluoride exposure (Fawell et al., 2006). However, in some regions, food and burning high fluoride coal can also be major contributors of fluoride in the environment.

High levels of fluoride can be found naturally in many areas of the world. The most well-known and documented area associated with volcanic activity follows the East African Rift from the Jordan valley down through Sudan, Ethiopia, Uganda, Kenya and Tanzania. High groundwater fluoride concentrations have been reported in India, Pakistan, West Africa, Thailand, China, Sri Lanka, and Southern Africa. Another region extends from Iraq and Iran through Syria and Turkey to the Mediterranean region, including from Algeria to Morocco. Other regions include the southern parts of the USA, southern Europe, and the southern parts of the former USSR (Fawell et al., 2006).

Potential Health Effects

A small amount of fluoride in water is generally good for strengthening people's teeth and preventing decay. Fluoride is often added to municipal water systems and certain consumer products (such as toothpaste and mouthwash) to protect teeth.

However, consuming fluoride at higher amounts over time can cause dental fluorosis and damage to people's teeth by staining and pitting. Over many years, fluoride can build up in people's bones, leading to skeletal fluorosis characterized by stiffness and joint pain. In severe cases, fluoride can cause changes to the bone structure and crippling effects. Infants and young children are most at risk from high amounts of fluoride since their bodies are still growing and developing.

There is currently no effective cure for fluorosis – the only prevention is to drink water that has safe levels of fluoride.

World Health Organization Guidelines

There is evidence that drinking water with fluoride levels of 0.5-1.0 mg/L can protect teeth (WHO, 2011). Many cities around the world add fluoride to their drinking water to reach this level.

Higher amounts of fluoride between 1.5-4.0 mg/L can cause dental fluorosis. Very high amounts of fluoride greater than 10.0 mg/L can lead to skeletal fluorosis. This is why the World Health Organization (2011) suggests that drinking water should not have more than 1.5 mg/L of fluoride (1.5 mg/L is the same as 1.5 ppm, 1,500 µg/L or 1,500 ppb).

WHO Guideline for Fluoride in Drinking Water <1.5 mg/L

Chemical Parameters of Drinking Water

Fact Sheet: Fluoride

Water Quality Testing Methods

Fluoride can be tested using a commercial laboratory or portable test kit. Laboratories commonly use an ion-selective electrode or a colorimetric procedure. Portable digital colorimeters are available from various commercial manufacturers. These can provide reliable and quantitative measurements of fluoride (UNICEF, 2008). Fluoride can also be measured using a colour disc comparator; however, this is a less accurate test method than using a digital colorimeter.

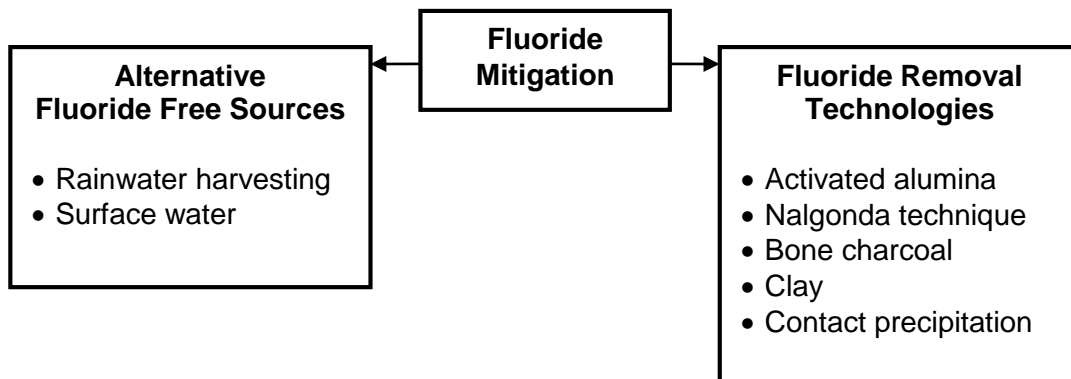
Information about commercially available fluoride test kits are provided in CAWST's Drinking Water Quality Testing Product Sheets.

Household Water Treatment Options

The best way to deal with fluoride in groundwater is to find a different source of drinking water, such as rainwater or surface water. Some people collect and store their rainwater during the rainy season and use it for drinking or to dilute their groundwater during the rest of the year. This helps to lower the amount of fluoride in their water and make it safer to drink. If people change to drinking surface water, they will probably need to treat the water to remove turbidity and pathogens.

Many of the areas that have fluoride contamination are arid and alternative sources of water are not available. There are emerging household water treatment technologies that are able to remove fluoride from drinking water. More research is needed to find simple, affordable and locally available technologies that can be easily used by households. See CAWST's Household Water Treatment for Fluoride Removal Fact Sheets for more information on the different technologies.

The following illustration shows the different mitigation options for fluoride in drinking water.



Chemical Parameters of Drinking Water

Fact Sheet: Fluoride

References

Fawell, J., Bailey, K., Chilton, J., Dahi, E., Fewtrell, L. and Y. Magara (2006). Fluoride in Drinking-water. World Health Organization. IWA Publishing, London, UK. Available at: www.who.int/water_sanitation_health/publications/fluoride_drinking_water/en/index.html

UNICEF (2008). UNICEF Handbook on Water Quality. UNICEF, New York, USA. Available at: www.unicef.org/wash/files/WQ_Handbook_final_signed_16_April_2008.pdf

World Health Organization (2011). Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwg/secondaddendum20081119.pdf

CAWST (Centre for Affordable Water and Sanitation Technology)
Calgary, Alberta, Canada
Website: www.cawst.org Email: resources@cawst.org
Wellness through Water.... Empowering People Globally
Last Update: October 2013

This document is open content. You are free to:



- Share – to copy, distribute and transmit this document
- Remix – to adapt this document



Under the following conditions:

- Attribution. You must give credit to CAWST as the original source of the document. Please include our website: www.cawst.org

CAWST and its directors, employees, contractors and volunteers do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.



Chemical Parameters of Drinking Water Fact Sheet: Iron

Sources

Iron can be naturally found in groundwater and some surface water (such as creeks, rivers and some shallow dug wells). There are some areas of the world that have naturally high amounts of iron in their groundwater. Iron can also be found in drinking water that is passed through rusty steel or cast iron pipes.

Iron can come in two forms in water: dissolved and suspended. If groundwater comes from a deep tube well, the iron may be dissolved and not visible. However, once the iron is exposed to air, it usually turns the water a black or orange colour. If surface water has iron in it, it will be a red-orange colour from the iron that is suspended in the water.

Iron is a nuisance – high levels can cause an objectionable colour and taste and can stain cooked food, water pipes, and laundry. Some types of bacteria use dissolved iron as an energy source and leave slimy red deposits that can clog water pipes.

Potential Health Effects

Drinking water with high concentrations of iron will not make people sick. Iron however, can change the colour and smell of water and it may cause people to not use it and choose another, possibly contaminated, water source instead.

World Health Organization Guidelines

The World Health Organization (WHO) does not have a suggested guideline for iron in drinking water since it does not have any adverse health effects (WHO, 2011).

Usually, people do not like the taste and smell of drinking water that has more than 0.3 mg/L of iron. Concentrations between 1.0-3.0 mg/L can be acceptable to people used to drinking anaerobic (low levels of oxygen) well water.

Iron levels above 0.3 mg/L can stain water pipes and clothes during washing.

The presence of iron may also lead to bacterial growth that can clog water pipes.

No WHO Guideline for Iron in Drinking Water

Water Quality Testing Methods

Iron can be tested using a commercial laboratory or portable test kit. Portable digital colorimeters and photometers are available from various commercial manufacturers. These can provide reliable and quantitative measurements of iron (UNICEF, 2008). Iron can also be measured using a colour disc comparator.

Chemical Parameters of Drinking Water

Fact Sheet: Iron

Information about commercially available portable test kits are provided in CAWST's Drinking Water Quality Testing Product Sheets.

Household Water Treatment Options

There are some different technology options that can be combined to help take iron out of drinking water, depending on the level of contamination. Practical household options include aeration to precipitate any dissolved iron, sedimentation, and then filtration to remove any iron particles that remain in suspension.

Removing suspended iron can be as simple as letting the water stand in a container for a period of time ranging from a few hours to a few days then decanting it, or by filtering the water through a cloth. The iron residue will need to be disposed.

Biosand or ceramic filters, which are designed primarily for pathogen removal, can also be used to remove some of the iron from drinking water. High levels of iron may cause these filters to clog more quickly, requiring more frequent maintenance which can reduce the efficiency of pathogen removal. In this case, it is recommended to sediment the water beforehand.

References

UNICEF (2008). UNICEF Handbook on Water Quality. UNICEF, New York, USA. Available at: www.unicef.org/wash/files/WQ_Handbook_final_signed_16_April_2008.pdf

World Health Organization (2011). Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwq/secondaddendum20081119.pdf

CAWST (Centre for Affordable Water and Sanitation Technology)
Calgary, Alberta, Canada
Website: www.cawst.org Email: resources@cawst.org
Wellness through Water.... Empowering People Globally
Last Update: October 2013

This document is open content. You are free to:



- Share – to copy, distribute and transmit this document
- Remix – to adapt this document



Under the following conditions:

- Attribution. You must give credit to CAWST as the original source of the document. Please include our website: www.cawst.org

CAWST and its directors, employees, contractors and volunteers do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.



Chemical Parameters of Drinking Water Fact Sheet: Manganese

Sources

Manganese can be naturally found in groundwater and surface water, and it usually occurs with iron. However, human activities may also cause manganese contamination in some areas.

Manganese can come in two forms in water: dissolved and suspended. If groundwater comes from a deep tube well, the manganese may be dissolved and not visible. In surface water, manganese can be dissolved or suspended. Water with high levels of suspended manganese usually has a black colour or black flakes in it.

High concentrations of manganese can turn water a black colour. It also causes an objectionable taste, stains water pipes and laundry, and forms coatings on water pipes. As well, some types of bacteria feed on manganese and leave black-brown deposits that can also clog pipes.

Potential Health Effects

People need small amounts of manganese to keep healthy, and food is the major source of manganese for people. However, too much manganese may also cause adverse neurological effects.

High levels of manganese can turn water a black colour and it may cause people to not use it and choose another, possibly contaminated, water source instead.

World Health Organization Guidelines

Manganese is not of health concern at levels causing acceptability problems in drinking water and there is no World Health Organization (WHO) guideline value (WHO, 2011).

Usually, people do not like the taste of drinking water that has more than 0.1 mg/L of manganese. Also, amounts above 0.1 mg/L can stain water pipes, clothes during washing, and food during cooking. Even levels of manganese at 0.2 mg/L may form black coatings on distribution pipes that come off into water as small black flakes.

The presence of manganese may also lead to bacterial growth that can clog water pipes.

No WHO Guideline since manganese is not of health concern at levels causing acceptability problems in drinking water

Water Quality Testing Methods

Manganese can be tested using a commercial laboratory or portable test kit. Portable digital colorimeters and photometers are available from various commercial manufacturers. These can provide reliable and quantitative measurements of manganese (UNICEF, 2008). Manganese can also be measured using a colour disc comparator.

Chemical Parameters of Drinking Water Fact Sheet: Manganese

Information about commercially available test kits are provided in CAWST's Drinking Water Quality Testing Product Sheets.

Household Water Treatment Options

Manganese treatment options are similar to iron; however, the removal rates are not as high. There are some different technology options that can be combined to help take manganese out of drinking water, depending on the level of contamination. Practical household options include aeration to precipitate any dissolved manganese, sedimentation, and then filtration to remove any manganese particles that remain in suspension.

Removing suspended manganese can be as simple as letting the water stand in a container for a period of time ranging from a few hours to a few days then decanting it, or by filtering the water through cloth. The manganese residue will need to be disposed in a safe location.

Biosand or ceramic filters, which are designed primarily for pathogen removal, can also be used to take out some of the manganese from drinking water. High levels of manganese may cause these filters to clog more quickly, requiring more frequent maintenance which can reduce the efficiency of pathogen removal. In this case, it is recommended to sediment the water beforehand.

References

UNICEF (2008). UNICEF Handbook on Water Quality. UNICEF, New York, USA. Available at: www.unicef.org/wash/files/WQ_Handbook_final_signed_16_April_2008.pdf

World Health Organization (2011). Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwg/secondaddendum20081119.pdf

CAWST (Centre for Affordable Water and Sanitation Technology)
Calgary, Alberta, Canada
Website: www.cawst.org Email: resources@cawst.org
Wellness through Water.... Empowering People Globally
Last Update: October 2013

This document is open content. You are free to:



- Share – to copy, distribute and transmit this document
- Remix – to adapt this document



Under the following conditions:

- Attribution. You must give credit to CAWST as the original source of the document. Please include our website: www.cawst.org

CAWST and its directors, employees, contractors and volunteers do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.



Chemical Parameters of Drinking Water Fact Sheet: Nitrate and Nitrite

Sources

Nitrate and nitrite are naturally occurring chemicals in the environment. Nitrate (NO_3^-) is an important plant nutrient and found at different concentrations in all plants. Nitrite (NO_2^-) is not usually found in significant concentrations in the environment, since nitrate is the more stable chemical.

Nitrate is commonly used in agricultural fertilizers, and nitrite is used as a food preservative, especially in processed meat.

Nitrate in groundwater and surface water is normally low, but can reach high levels if there is leaching or runoff from agricultural fertilizers or from human and animal feces. Nitrite is formed as a result of microbial activity in soil and the levels in water can vary.

Nitrite can also be formed in water distribution pipes by *Nitrosomonas* bacteria if the water is stagnant and without a lot of oxygen, or if chloramine is used to treat the drinking water and provide a residual disinfectant.

Potential Health Effects

High nitrate and nitrite levels can cause serious illness by acute exposure. The main health concern is methaemoglobinaemia, or blue baby syndrome, which occurs in infants that are bottle fed with formula prepared with drinking water. It causes them to have difficulty breathing and their skin turns blue from a lack of oxygen. It is a serious illness that can sometimes lead to death.

Babies with methaemoglobinaemia often also have gastrointestinal illness (e.g., diarrhea) at the same time. This is because high nitrate levels are often associated with higher levels of microbiological contamination from manure or sewage.

World Health Organization Guidelines

The World Health Organization (WHO) suggests that drinking water should have less than 50 mg/L of nitrate and 3 mg/L of nitrite to protect against methaemoglobinaemia in bottle fed infants (short-term exposure). In addition, the sum of the ratios of the concentrations of each to its guideline value should not exceed 1 (WHO, 2011).

For example, a drinking water sample contains 30 mg/L nitrate and 1.5 mg/L nitrite. Does the sum of the ratios of the concentrations exceed the guideline value?

$$\frac{30 \text{ mg/L nitrate (water sample)}}{50 \text{ mg/L nitrate (WHO guideline)}} = 0.6 \quad \frac{1.5 \text{ mg/L nitrite (water sample)}}{3 \text{ mg/L nitrite (WHO guideline)}} = 0.5$$

Add the ratio of the concentrations together: $0.6 + 0.5 = 1.1$

1.1 is greater than 1, so this drinking water sample exceeds the WHO guideline value.

Chemical Parameters of Drinking Water

Fact Sheet: Nitrate and Nitrite

In most countries, nitrate levels in surface water are not more than 10 mg/L, although nitrate levels in well water often exceed 50 mg/L. The WHO guideline was set specifically for bottle fed infants who are most vulnerable to nitrates and nitrites in drinking water. Therefore the guideline value is more than adequately protective for older children and adults (WHO, 2011).

WHO Guideline for Nitrate in Drinking Water <50 mg/L (short-term exposure)

WHO Guideline for Nitrite in Drinking Water <3 mg/L (short-term exposure)

Water Quality Testing Methods

Nitrate and nitrite can be tested using a commercial laboratory or portable test kit. Portable digital photometers are available from various commercial manufacturers. These can provide reliable and quantitative measurements of iron (UNICEF, 2008). Nitrate and nitrite can also be measured using test strips or a colour disc comparator.

Information about commercially available test kits are provided in CAWST's Drinking Water Quality Testing Product Sheets.

Household Water Treatment Options

The best way to deal with nitrate and nitrite in groundwater or surface water is to use a different source of drinking water, such as rainwater. Some people collect and store their rainwater and use it for drinking, cooking, and preparing baby formula. If people change their water source from groundwater to surface water, they will probably need to treat the surface water to remove turbidity and pathogens.

High nitrate levels are often associated with higher levels of microbiological contamination since the nitrates may have come from manure or sewage. If high levels of nitrate are detected, then people should also treat their water to remove the potential microbiological contamination.

The WHO (2011) suggests that high levels of nitrite may be reduced to acceptable levels by using chlorination.

References

UNICEF (2008). UNICEF Handbook on Water Quality. UNICEF, New York, USA. Available at: www.unicef.org/wash/files/WQ_Handbook_final_signed_16_April_2008.pdf

World Health Organization (2011). Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwq/secondaddendum20081119.pdf



Chemical Parameters of Drinking Water Fact Sheet: Nitrate and Nitrite

CAWST (Centre for Affordable Water and Sanitation Technology)
Calgary, Alberta, Canada
Website: www.cawst.org Email: resources@cawst.org
Wellness through Water.... Empowering People Globally
Last Update: October 2013

This document is open content. You are free to:



- Share – to copy, distribute and transmit this document
- Remix – to adapt this document



Under the following conditions:

- Attribution. You must give credit to CAWST as the original source of the document.
Please include our website: www.cawst.org

CAWST and its directors, employees, contractors and volunteers do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.

Chemical Parameters of Drinking Water

Fact Sheet: pH

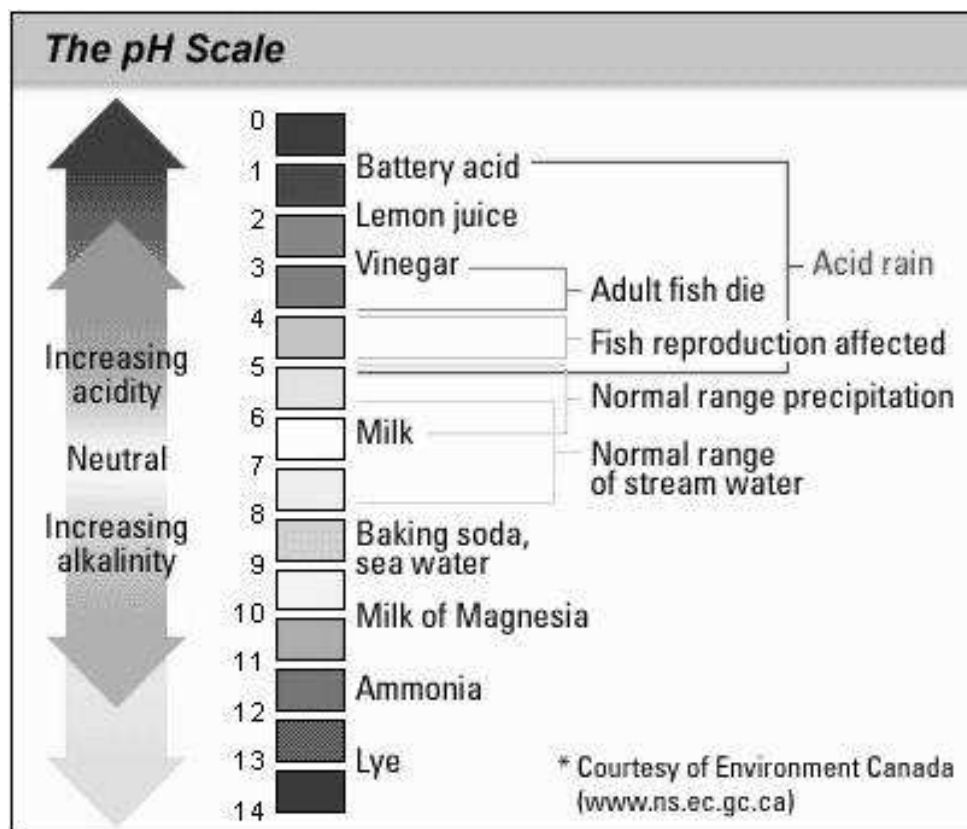
Source

pH is a measure of the acidity or alkalinity of the water. The pH for drinking water generally lies between 6.5 and 8.0. Water at 25°C (80°F) with a pH less than 7.0 is considered acidic, while a pH greater than 7.0 is considered basic (alkaline). When the pH level is 7.0, the water is considered to have a neutral pH.

The pH of the water in a stream, river, lake or underground flow will vary depending on a number of conditions, such as the:

- Source of the water
- Type of soil, bedrock, and vegetation through which water travels
- Types of contaminants the water encounters in its path
- Amount of mixing and aeration of the water due to turbulence in its flow

Extreme values of pH can also result from accidental chemical spills, water treatment breakdowns, and insufficiently cured cement mortar pipe linings or cement mortar linings applied when the pH of the water is low (WHO, 2011).



Chemical Parameters of Drinking Water

Fact Sheet: pH

Potential Health Effects

There are no direct health concerns for pH at levels normally found in drinking water.

World Health Organization Guidelines

There is no World Health Organization guideline value for pH since it is not a health concern at levels found in drinking water. However, the WHO notes that pH is an important operational water quality parameter (WHO, 2011).

No WHO Guideline for pH of Drinking Water

Water Quality Testing Methods

pH can be tested using a commercial laboratory or portable test kit. pH can be easily tested on-site using a digital pH meter or test strips. Some test strips only indicate whether the water is alkaline or acidic, while other test strips indicate the pH within the full range from 1 to 14. The most suitable range for pH test strips is between 4 to 9 because that is the pH of most natural waters).

Information about commercially available test kits are provided in CAWST's Drinking Water Quality Testing Product Sheets.

Household Water Treatment Options

The best way to deal with too high or low pH is to use a different source of drinking water.

pH is one of the most important parameters for the effectiveness of many water treatment technologies. For example, for effective disinfection with chlorine, the pH should be less than 8.

References

Environment Canada (2004). Canadian Water Quality Guidelines. Available at: www.ec.gc.ca/eau-water/default.asp?lang=En&n=FDF30C16-1

World Health Organization (2011). Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwq/secondaddendum20081119.pdf



Chemical Parameters of Drinking Water Fact Sheet: pH

CAWST (Centre for Affordable Water and Sanitation Technology)
Calgary, Alberta, Canada
Website: www.cawst.org Email: resources@cawst.org
Wellness through Water.... Empowering People Globally
Last Update: October 2013

This document is open content. You are free to:



- Share – to copy, distribute and transmit this document
- Remix – to adapt this document



Under the following conditions:

- Attribution. You must give credit to CAWST as the original source of the document.
Please include our website: www.cawst.org

CAWST and its directors, employees, contractors and volunteers do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.

Chemical Parameters of Drinking Water Fact Sheet: Total Dissolved Solids

Sources

Total dissolved solids (TDS) is the term used to describe the inorganic salts (mainly sodium chloride, calcium, magnesium, and potassium) and small amounts of organic matter that are dissolved in water. Technically, anything that dissolves in water contributes to the TDS level.

There are areas of the world that have naturally high amounts of TDS in their drinking water. TDS in drinking water comes from natural sources, and to a lesser extent from sewage, urban runoff, and industrial wastewater. Brackish or saline aquifers can exist naturally or develop over time in coastal regions with sea water infiltration due to lowering aquifer depths.

- Fresh: <1,000 mg/L TDS
- Brackish: 1,000–5,000 mg/L TDS
- Highly Brackish: 5,000–15,000 mg/L TDS
- Saline: 15,000–30,000 mg/L TDS
- Sea Water: 30,000–40,000 mg/L TDS

(Water Quality Association, nd)

Fresh water with high or low levels of TDS is often called “hard” or “soft” water, respectively. Hard water received this name because it requires more soap to get a good lather and makes the water “hard” to work with. Soap is less effective with hard water due to its reaction with the magnesium and calcium, leading to high use of soap for laundry and bathing. As well, hard water (>500 mg/L) can leave a residue and cause scale to build up on household appliances (e.g., electric kettle, dishwasher), cooking pots, and water pipes.

Soft water is usually preferred for laundry, bathing and cooking.

Potential Health Effects

Although there are no direct health concerns of drinking water with high concentrations of TDS, the presence of dissolved solids in water may affect its taste. People generally prefer the taste of hard water due to the dissolved minerals, however high concentrations of TDS can cause a bitter or salty taste. According to the World Health Organization (2003), the acceptability of drinking water has been rated by a panel of tasters in relation to its TDS concentrations as follows:

- Excellent: <300 mg/L
- Good: 300-600 mg/L
- Fair: 600-900 mg/L
- Poor: 900-1,200 mg/L (e.g., brackish water)
- Unacceptable: >1,200 mg/L (e.g., saline water)

Chemical Parameters of Drinking Water

Fact Sheet: Total Dissolved Solids

Some people can taste salt in drinking water at levels around 500 mg/L, and it may cause them to not use it and choose another, possibly contaminated, water source instead.

Water with extremely low TDS concentrations (e.g., rainwater) may also be unacceptable because of its flat taste.

World Health Organization Guidelines

The World Health Organization (WHO) does not have a suggested guideline for total dissolved solids since it occurs in drinking water at concentrations well below those at which health effects may occur. Most people will reject drinking water due to odour, taste, and colour at a level much lower than is required for harm. People usually do not like the taste of water that has more than 600 mg/L of TDS (WHO, 2011).

No WHO Guideline for Total Dissolved Solids in Drinking Water

Water Quality Testing Methods

Dissolved ions increase the electrical conductivity (EC) of water, which is easily measured with a digital meter, so testing for EC is often done instead of testing directly for TDS. EC in microsiemens per centimetre ($\mu\text{S}/\text{cm}$) usually ranges from 1 to 2 times the TDS in mg/L (UNICEF, 2008).

Testing for EC does not give specific information about the chemicals present in water, but it gives an estimation of the TDS. More specific testing must be done to discover which chemicals are present.

Household Water Treatment Options

There are some limited household options to remove total dissolved solids from drinking water. Filtration does not work since the chemicals and organic matter are dissolved in the water. Distillation technologies can help reduce TDS levels in drinking water; however they may not be practical or easy to use at the household level. Reverse osmosis systems are becoming popular in industrialized countries for removing TDS, however they are relatively expensive and require a power supply.

Chemical Parameters of Drinking Water Fact Sheet: Total Dissolved Solids

References

UNICEF (2008). UNICEF Handbook on Water Quality. UNICEF, New York, USA. Available at: www.unicef.org/wes/files/WQ_Handbook_final_signed_16_April_2008.pdf

Water Quality Association (n.d.). Water Classifications. Available at: www.pacificro.com/watercla.htm

World Health Organization (2003). Total Dissolved Solids in Drinking-Water: Background Document for Development of WHO Guidelines for Drinking-Water Quality. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwq/chemicals/tds.pdf

World Health Organization (2011). Guidelines for Drinking-Water Quality, Fourth Edition. WHO, Geneva, Switzerland. Available at: www.who.int/water_sanitation_health/dwq/secondaddendum20081119.pdf

CAWST (Centre for Affordable Water and Sanitation Technology)
Calgary, Alberta, Canada
Website: www.cawst.org Email: resources@cawst.org
Wellness through Water.... Empowering People Globally
Last Update: October 2013

This document is open content. You are free to:



- Share – to copy, distribute and transmit this document
- Remix – to adapt this document



Under the following conditions:

- Attribution. You must give credit to CAWST as the original source of the document. Please include our website: www.cawst.org

CAWST and its directors, employees, contractors and volunteers do not assume any responsibility for and make no warranty with respect to the results that may be obtained from the use of the information provided.

