Iron Analysis (High School) Revised July 4th, 2007

Purpose: To determine the Iron concentration in drinking water from 4 different sources, plus a Canadian Guideline Limit Sample for Iron sample (Aesthetic Limit), this will be done for quality control purposes:

- Urban treated water
- Rural (aboriginal and/or non- aboriginal community) treated water
- Untreated raw source water
- Local community treated water
- Canadian Guideline Limit Sample for Iron (CGLS)

Determination will be done by adding a chemical reagent to the water. You will compare the different results, you will also see if the water meets the Canadian Drinking Water Guidelines.

Naturally occurring Iron is present in meat and meat products, as well as potatoes and vegetables. Iron is absorbed by the body, and is an essential part of hemoglobin which gives our blood its red colour and it transports oxygen through our bodies.

The direct health implications of iron are very limited, there are however indirect problems some of which are: colour, which comes from iron in a particulate form which is too small to filter so you get "coloured water" (see the Raw Untreated Water supplied in some kits), iron bacteria, this is when bacteria and iron form a slime which can lead to poor pipe flow, this can occur when the iron concentration exceeds 0.3 mg/L, the Canadian Drinking Water Guideline (CGLS).

A 0.3 mg/L Canadian Guideline for Iron is included for quality control purposes; this is the limit for Iron, according to the Canadian Drinking Water Guidelines.

Materials:

- 1 - 0.3 mg/L Canadian Guideline Limit Sample for Iron (CGLS).
- 5 – Aluminum pouches containing chemical reagents that react with iron.
- 5 - 10 mL disposable beakers.

Method:

1. Label five beakers with their respective names: Urban Treated Water, Rural Treated Water, Untreated Raw Water, Local Community Treated Water, Canadian Guideline Limit Sample for Iron (CGLS).
2. Put 10 mL of a water sample or (CGLS) in their respective labeled beakers.
3. With a scissor cut the top of each aluminum pouch, then squeeze pouch (opens it) and add the contents of one pouch into each beaker.
4. Wait for 3 minutes, and then compare the colour (look at the beaker from the top) with the CGLS (giving CGLS a rating of 10), estimate what the other beakers contain, the lower the colour, the lower your rating. Write down the ratings that you got for each sample.

Results:

The Canadian Guideline Limit Sample for iron of 0.3 mg/L was rated 10; a lower rating (lighter colour) means that the water meets the guideline; a higher than 10 rating means that the water **Does Not** meet Canadian Drinking Water Guidelines.

Safe Handling of Materials

Caution must be taken at all times when handling any chemicals. Although this test is safe to use in any area, please be cautious with the materials supplied.

Visit the Safe Drinking Water Foundation Website www.safewater.org to learn more about issues affecting safe drinking water.

Iron Fact Sheet

What is Iron and why do we test for it?

Iron is the fourth most abundant element in the earth's crust. Iron is a very common problem in drinking water, and has a strong relationship with water hardness (see Harness tests) typically with both hardness and iron increasing at the same time. Iron can cause staining (laundry and plumbing), unpleasant taste, colour and promotion of growth by iron bacteria. Iron can also precipitate in distribution systems and household plumbing thereby causing additional problems.

When there is no oxygen in the water then the iron is present in a reduced, dissolved form (Fe^{2+}), which is frequently present in well water. This form of iron is dissolved and has no colour. When this iron is exposed to oxygen it will oxidize and this iron (Fe^{3+}) is not very soluble and instead forms small particles or colloids. These rust particles are red in colour and are quite small making it a challenge to

remove them. Both sedimentation and filtration are commonly used methods to remove oxidized iron.

Bacteria can use reduced iron as an energy source by converting it to oxidized iron. The biologically oxidized iron is then incorporated into compounds around or in the bacterial cells. This can cause problems in restricting water pipes as can be seen in the picture below.

Picture1: A thick layer of iron bacteria growing inside a water pipe

However, this bacterial growth can also be used in the water treatment plant to remove iron from the water. This is called biological filtration where bacteria are sitting on a surface (can be sand or different forms of material that have been

designed with high surface areas). Bacteria attached to a material used for drinking water treatment are shown in the picture below.

Picture2: Electron microscope photograph of bacteria cells attached to expanded clay (Filtralite).

What are the Canadian Drinking Water Guidelines for Iron?

Based on aesthetic reasons the *Guidelines for Canadian Drinking Water Quality* recommends that the iron levels should be kept below 0.3 mg/L. However, levels as low as 0.100 mg/L can cause problems with microbial growth within Reverse Osmosis and other types of membrane systems as well as in the distribution systems. The U.S. Environmental Protection Agency's Maximum Contaminant Level (MCL) is also 0.3 mg/L. The major source of iron is food (around 10 mg/day), while drinking water typically contributes less than 0.5 mg/day.

What are some of the health risks associated with Iron?

Iron is an essential element for humans with food providing the majority of the iron requirements. There should be no direct health effects with iron in drinking water, but iron can be linked to excessive bacterial activity. The end result of this action is water that is not pleasant to drink (smell and taste), cooking with this water can also lead to a very unpleasant experience, as will using it to do laundry or wash with.

What do I do if my water exceeds the Canadian Drinking Water Guidelines?

Iron can be removed by biological filtration as shown above (chemical-free iron removal) or various forms of oxidants including air, potassium permanganate and chlorine can be use to form oxidized iron, which can then be filtered from the water. If the iron is generated in the distribution system then the corrosiveness of the water (see Alkalinity and Hardness tests) may have to be decreased (that is alkalinity and hardness increased). Iron removal water treatment processes are frequently used for groundwater treatment while particulate oxidized iron sometimes present in surface water will be removed by coagulation processes (bunching up small particles that can be removed when particle size increases).