Point of Entry/Point of Use Water Treatment Systems

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Point of Entry (POE) Water Treatment Device

- Water treatment device installed on the main supply line and treats all the water used in the home (at the point of entry into the home).
- Most common is a water softener.
Point of Use (POU) Water Treatment Device

- Water treatment device installed on a single tap (or multi taps) and intended to treat water for drinking and cooking only (at the point of use in a home).

- Most common is a carbon filter.
Two Groups of POE/POU Water Treatment Devices

1. Those that
   - Improve the overall taste, smell and appearance of the water.
   - Remove undesirable chemicals and minerals

2. Those that disinfect water
POU System Styles

- Personal water bottle with filter
- Pour through filter with pitcher
- Faucet Mounted Filter with diverter.
- Counter top manual fill system.
- Counter top system connected to sink faucet.
- Plumbed into sink faucet.
- Plumbed into separate tap.
**Regulation of POE/POU Devices**

- Generally fall under the scope of the *Hazardous Products Act*.

- No specific regulation applicable to these devices under the Act.

- False or misleading claims prohibited under the *Consumer Packaging and Labelling Act* and the *Competition Act*, both administered by Industry Canada.

- Medical claims regulated by *Medical Devices Regulations* of the *Food and Drugs Act*.

**What POE/POU Devices are Recommended?**

- Health Canada does not recommend specific treatment devices

- Health Canada has worked closely with the NSF International to develop performance standards for water treatment devices.

- Units are certified as meeting the applicable ANSI/NSF health based performance standards.

- There are six standards
What POE/POU Devices are Recommended? (Con’t)

NSF/ANSI 42 - Drinking Water Treatment Units-Aesthetics
NSF/ANSI 44 - Cation Exchange Water Softeners
NSF/ANSI 53 - Drinking Water Treatment Units-Health Effects
NSF/ANSI 55 - Ultraviolet Microbiological Water Treatment Systems
NSF/ANSI 58 - Reverse Osmosis Drinking Water Treatment Systems
NSF/ANSI 62 - Drinking Water Distillation Systems

Canadian Certification

CSA has authorized three certification groups:

- NSF International and UL
  All six standards listed previously
- CSA International
  Only two standards

NSF/ANSI 42 - Drinking Water Treatment Units-Aesthetics
NSF/ANSI 53 - Drinking Water Treatment Units-Health Effects
POE/POU Treatment Technologies

- Adsorption Filters
- Reverse Osmosis Systems
- Water Softeners
- Distillation Systems
- Ultraviolet Disinfection Products

Adsorption

- Physical process occurring when liquids, gases, or dissolved or suspended matter adheres to the surface of, or in the pores of, an adsorbent medium
- Most commonly used technology
- Used to improve taste, smells, appearance (NSF 42)
- Generally more effective in removing organic chemicals than inorganic chemicals (NSF 53)
- Combined with other treatment processes
Limitations of Adsorption
Carbon Filters

- Can become saturated with chemical contaminants which can be released in the water at high concentrations
- Bacterial growth a concern
- Use only on municipally treated water or other supply known to be microbiologically safe

POE/POU Treatment Technologies

Reverse Osmosis (RO) Systems (Membrane Process)
- Involves passing mineralized water under pressure through a semi-permeable membrane.
- The membrane allows fresh water to pass through while leaving many of the minerals behind.
- Microfiltration (MF)
- Ultrafiltration (UF)
- Nanofiltration (NF)
- Can remove inorganic chemicals
- Combined with Carbon Filters to remove chlorine and organic chemicals
Limitations of Reverse Osmosis

- Reject water volume a concern.
- Membranes have different removal rates for turbidity, DOC, and colour (requires bench or pilot scale testing).
- Calcium hardness a concern.
- Barriers to micro-organisms such as Cryptosporidium, Giardia, bacteria and viruses vary with the membrane types (disinfectant required to maintain residual)

POE/POU Treatment Technologies

Softeners (Ion Exchange)

- A water softener uses a cation exchange resin, regenerated with sodium chloride, to reduce the amount of hardness (calcium, magnesium) in the water
- Will also remove low concentrations of iron and manganese
Limitations of Ion Exchange

- Increases the sodium concentration of water (individuals on sodium restricted diets should consult with their physician before consuming “softened” water.)
- Increases the aggressive nature of the water

POE/POU Treatment Technologies

Distillation Systems
- Distillation systems heat water to the boiling point and then collects the water vapour as it condenses.
- Contaminants left as waste.
- Bacteria is destroyed by the heat
Limitations of Distillation Systems

- Volatile organic chemicals may be carried over with the water vapour
- Limited water volume production
- Power consumption and noise

POE/POU Treatment Technologies

Ultraviolet Treatment (UV)
- UV disinfection refers to disinfecting water with UV Radiation of 254 nm wavelength, a band of radiation located just beyond the visible light spectrum
- UV radiation is absorbed by the cells of microorganisms
- UV radiation damages the genetic material in such a way that they organisms are no longer able to grow or reproduce, thus ultimately killing them
Advantages of Using POE/POU UV Disinfection

- No chemicals are added to the water, therefore the water retains its natural flavour and odour
- There are no known health by-products
- The process is not affected by ammonia and pH
- The disinfection process is rapid, and therefore a “detention time” is not required

Disadvantages of POE/POU UV Disinfection

- The process does not provide a residual to protect the water quality in the distribution system
- Secondary disinfection with chlorine required?
- More frequent sampling for bacteriological quality is typically required
- The equipment is generally considered as moderately complex and of fair to good reliability.
Comparison with Chlorine

Advantages of using chlorine

- Provides a residual disinfectant in the distribution system which protects the bacteriological water quality in the distribution system. (This is very important)

- Daily monitoring of the chlorine residual, when there are no known concern, can be used to indicate that the bacteriological quality is satisfactory.

- The equipment is generally considered as being simple to use and of good reliability.

Disadvantages of using chlorine

- Taste and odour complaints may be received from consumers.

- Health by-product concern (THM)

- A storage tank is required for contact time to provide disinfection.

- Residual may be affected by organic and inorganic concentrations in the water.

- Process is affected by ammonia and pH concentrations.

- Effectiveness of chlorine solution decreases with time.
Common Water Quality Problems

- Aggressive Water
- Arsenic
- Chloride
- Hard Water
- Hydrogen Sulphide
- Iron and/or Manganese
- Iron Bacteria
- Lead
- Sodium
- Sulfate
- Turbidity
- Uranium
- VOC
- Zinc

Aggressive Water

- **Potential Source**
  - natural conditions in surface water
- **Problems**
  - metallic taste (first flush)
  - deterioration of pipes
  - greenish stains (copper pipes)
  - lead poisoning (lead services, solder, brass)
  - copper poisoning (copper pipes)
- **Corrective Measure**
  - make water less aggressive
- **Restriction**
  - higher pH may result in precipitation of iron and manganese
  - increased colour and turbidity if not filtered
  - preferred treatment at source

Example of corroded piping
Arsonic

- **Potential Source**
  - naturally occurring
  - man made (dug well)

- **Problem**
  - medical (symptoms depend on arsenic concentration and length of exposure)

- **Corrective Measure**
  - construct a new well (drilled vs dug)
  - ferric hydroxide unit
  - reverse osmosis (NSF 58)
  - activated alumina
  - distillation (NSF 62)

Chloride

- **Potential Source**
  - road salting
  - seawater intrusion
  - sewage contamination

- **Problems**
  - salty taste
  - aggressive water

- **Corrective Measure**
  - new source
  - reverse osmosis
  - distillation

- **Restrictions**
  - NSF does not currently certify products for chloride reduction
**Hard Water**

- **Potential Source**
  - mainly calcium and magnesium dissolved in water
  - factors:
    - Ca x 2.5
    - Mg x 4.116
    - Fe x 1.8
    - Mn x 1.8

- **Problem**
  - mineral scale build-up in kettles, water heaters and plumbing
  - bath tub ring, soap scum
  - excess soap consumption

- **Corrective Measures**
  - water softener (NSF 44)

- **Restrictions**
  - sodium in water may be a health concern to some individuals
  - softeners may not operate efficiently at pH > 7.5
  - backwash water required (volume and discharge a concern)
  - softened water are more aggressive (disputed by CWQA)

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**Hydrogen Sulphide**

- **Potential Source**
  - occurs naturally in groundwater
  - caused by plugging the air vent in drilled wells
  - electric hot water heaters

- **Problems**
  - rotten egg smell and taste
  - tarnish silver and copper
  - corrodes plumbing

- **Corrective Measures**
  - check air vent
  - chlorination-filtration unit
  - greensand filter (NSF 42)
  - aeration
  - disinfection of hot water heater
  - replace/remove hot water sacrificial rod (hot water problem only)

- **Restriction**
  - removal of sacrificial rod voids heater warranty
Iron and/or Manganese

- **Potential Source**
  - dissolved ions of iron and manganese

- **Problem**
  - rusty (iron) and/or black (manganese) stains on fixtures and laundry
  - rusty to black water
  - metallic taste

- **Corrective Measure**
  - water softener
  - greensand filter
  - chlorination-filtration unit
  - adsorption systems (NSF 42)

- **Restrictions**
  - limited on how much iron and manganese can be removed by softener (3 mg/L) and greensand (10 mg/L)
  - pH>7.5 required for greensand
  - pH<7.5 required for softener
  - greensand more costly than softener but more effective
  - backwash water required (volume and discharge)
  - growth of iron bacteria

Iron Bacteria

- **Potential Source**
  - nuisance organisms which derives its energy from the oxidation of the iron to its insoluble form. This insoluble iron then deposits on pipes, fixtures, laundry etc.

- **Problem**
  - red to brown slime in toilet tanks and plumbing, reddish filament-like particles in water
  - reduced well yield
  - sudden appearance of iron staining
  - unpleasant taste or odours

- **Corrective Measure**
  - shock chlorination of well
  - chlorination-filtration unit
Lead

• **Potential Source**
  – piping (aggressive water)
  – galvanized well liners (contain impurities)
  – soldering
• **Problem**
  – lead poisoning
• **Corrective Measure**
  – raise pH (Langlier Index)
  – remove source of lead
• **Comment**
  – Lead not listed by NSF under common contaminant

Sodium

• **Potential Source**
  – softened water
  – road salting
• **Problem**
  – medical
• **Corrective Measure**
  – reverse osmosis (NSF 58)
  – distillation (NSF 62)
  – separate (unsoftened water) at drinking water tap if water softened
• **Comment**
  – sodium restricted diet - 500mg/d
  – sodium from other sources - 460 mg/d
  – water concentration - \(\frac{(500-460) \text{ mg/d}}{2 \text{ L/d}} = 20 \text{ mg/L}\)
**Sulphate**

- **Potential Source**
  - natural
- **Problem**
  - Gastrointestinal irritation (laxative effects)
- **Corrective Measure**
  - reverse osmosis
  - distillation
- **Restrictions**
  - NSF does not currently certify products for reduction of sulphates

**Turbidity**

- **Potential Source**
  - natural
- **Problem**
  - aesthetics
  - interferes with disinfection
- **Corrective Measure**
  - adsorption (NSF 53)
  - reverse osmosis (NSF 58)
Uranium

- **Potential Source**
  - naturally occurring
- **Problem**
  - medical
- **Corrective Measure**
  - reverse osmosis
  - distillation
  - anion exchange
- **Restrictions**
  - NSF does not currently certify products for uranium reduction

Volatile Organic Chemicals (VOCs)

- **Potential Source**
  - natural
  - by product of chlorination
- **Problem**
  - medical
- **Corrective Measure**
  - adsorption (NSF 53)
Zinc

- **Potential Source**
  - galvanized well liner

- **Problem**
  - milky appearance to the water
  - white residue on pipes and fixtures

- **Corrective Measure**
  - remove source of contamination
  - Adsorption (NSF 42)

**Recommendations**

- Use multiple barrier approach
  - Source Water Protection
  - Treatment as Appropriate
  - Distribution System Maintenance
  - Monitoring
  - Certified Operator

- Use POE/POU units as last resort
  - Limitations very important