

# CHEM 9.4.5 WATERWAYS

Human activity also impacts on waterways. Chemical monitoring and management assists in providing safe water for human use and to protect the habitats of other organisms

5.1 Identify that **water quality can be determined** by considering:

## CONCENTRATIONS OF COMMON IONS

- Important cations measured, e.g.  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$  and anions, e.g.  $\text{Cl}^-$ ,  $\text{PO}_4^{3-}$ ,  $\text{NO}_3^-$ 
  - E.g.  $\text{PO}_4^{3-}$  and  $\text{NO}_3^-$  required in small amounts for **aquatic life**
- Measurements: metal cations measured using **AAS**, anions through **gravimetric analysis**

## TOTAL DISSOLVED SOLIDS

- **TDS: total mass of solids dissolved** in a volume water – measured in mg/L or ppm
  - Drinking water: TDS < 500 ppm, mainly measuring **salts (ionic)**
- Measurements:
  - **Filtering and evaporating, then weighing** solids (gravimetric) – inaccurate and inefficient
  - **Electrical conductivity** – TDS mostly ions, accurate

## HARDNESS

- **Hard water**: water with high levels of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions
  - Forms **grey scum** when **soap** is added to water – removes soap's cleaning power
    - Can stain fabrics, creates deposits on sinks and bathtubs
- Measurements:
  - **Volumetric titration** against **EDTA** (ethylenediamine tetra-acetic acid)
  - **Expressed as mg/L** of  $\text{CaCO}_3$

## TURBIDITY

- **Turbidity**: presence of **suspended solids** – small enough to remain suspended
  - Causes **cloudiness** of the water – unpleasant taste and appearance
- Measurements: with **turbidity tube** – plastic cylinder with a mark at the bottom, water poured till invisible
  - Height of water measures turbidity, measured in **NTU** (nephelometric turbidity units)

## ACIDITY

- **pH** indicates **pollution or discharge of chemicals** – normal range **6.5 to 8.5**
- Measurements: using **indicators, pH meters, pH strips**

## DISSOLVED OXYGEN AND BIOCHEMICAL OXYGEN DEMAND

- **DO: level of  $\text{O}_2$  dissolved** in water – measured as it is **important for aquatic life for respiration (> 5ppm)**
  - Measurements: using **chemical titration – Wrinkler method**: DO oxidises  $\text{Mn}^{2+}$  to **Mn(IV)**, Mn(IV) oxidises **I<sup>-</sup> to I<sub>2</sub>** and titrated against sodium thiosulfate ( $\text{Na}_2\text{S}_2\text{O}_3$ ), starch indicator
- **BOD**: concentration of  $\text{O}_2$  for **breakdown of organic matter** by anaerobic bacteria – how fast  $\text{O}_2$  used
  - High BOD indicates **large amounts of organic matter**, e.g. sewerage – drains  $\text{O}_2$
  - Measurements: two samples taken: 1 measured immediately, 1 sealed at 20°C for 5 days
    - **Difference in DO** is the BOD

5.2 Identify **factors that affect the concentrations** of a range of **ions** in solution in **natural bodies of water** such as rivers and oceans

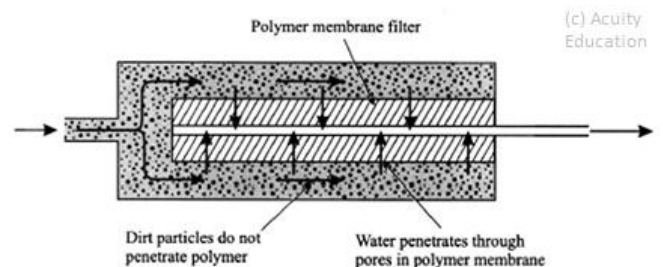
- **Path from rain to body of water** affects ions levels – especially rivers/oceans due to **small volume**
- Rain may run off **bushland** to streams –  $\text{NO}_3^-$  and  $\text{PO}_4^{3-}$ , some  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  (TDS < 50 ppm)
- Rain water **soaking into ground (aquifers)** –  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ ,  $\text{SO}_4^{2-}$ ,  $\text{Cl}^-$  (TDS 100 to 300 ppm)
- Clearing land **reduces stability of soil** –  $\text{Na}^+$  and  $\text{K}^+$  ions from minerals in soil
- Agriculture and **increased phosphate and nitrate ions**, and organic matter
- **Sewage** (TDS > 200), **stormwater** (urban areas), **industrial/factory effluents** (heavy metal ions)

5.3 Describe and assess the **effectiveness of methods** used to **purify and sanitise mass water supplies**

- SCF SFC
1. **Screening** – metal screens remove debris, e.g. **sticks, leaves, trash**
    - Effectiveness: **cheap**, clears **large objects** that may interfere, more **treatment** required
  2. **Clarification and Flocculation** – **suspended particles (colloidal particles)** removed
    - Particles **coagulated** to form large particles
    - pH increased using lime –  **$\text{AlCl}_3$  electrolyte** to force particles to precipitate
    - Effectiveness: **removes most particles**, including bacteria, fast, cheap
  3. **Sedimentation** – dirt and particles **settle in the tank**, forms a sludge
    - Effectiveness: low cost, slow speed
  4. **Filtration** – water passed through **fine sand and gravel, anthracite** added to reduce odour
    - Effective in **removing flocculated particles**, cannot remove some bacteria/viruses
  5. **Chlorination** – Chlorine gas bubbled –  **$\text{OCl}^-$  ion** kills pathogens (some viruses)
    - Chlorine may have unpleasant odour

5.4 Describe the **design and composition of microscopic membrane filters** and explain **how they purify contaminated water**

- **Membrane filter**: **thin membranes** with pores of uniform size – classified on **size of pores**
  - Membranes are **capillaries (hollow fibre)** around hollow core – **large surface area**
  - Water is forced under **pressure** into pores
  - Clean water exits via **hollow core**
  - Cleaned out by **backflushing**



5.? • Gather, process and present information on the **features of the local town water supply** in terms of:-

---

#### CATCHMENT AREA

- Catchment area: area where rain water drains to a water body
- **Warragamba Dam** – main water storage dam – 9000 km<sup>2</sup>

---

#### POSSIBLE SOURCES OF CONTAMINATION IN THIS CATCHMENT

- Agriculture – growing crops can lead to **high phosphate and nitrate** levels
  - Some **pesticides** or **animal faeces** from cattle
- Natural soil contains **iron and manganese**, causing **metallic taste** to water
- Sewerage, mining and animals can cause contamination

---

#### CHEMICAL TESTS AVAILABLE TO DETERMINE LEVELS AND TYPES OF CONTAMINANTS

- See above

---

#### PHYSICAL AND CHEMICAL PROCESSES USED TO PURIFY WATER

- See above

---

#### CHEMICAL ADDITIVES IN THE WATER AND THE REASONS FOR THE PRESENCE OF THESE ADDITIVES

- **Chlorine and Fluoride** are added
  - Cl<sub>2</sub> added by **bubbling through water** to **kill bacteria and viruses**
  - F<sup>-</sup> added as it **strengthens teeth enamel**, added in concentration of 1 ppm NaF