

Water Chemistry & Treatment – Cheat Sheet (Theory Only)

1. Water Sources & Impurities

Sources of Water:

- **Surface Water** → Rivers, lakes, ponds.
- **Groundwater** → Wells, borewells.
- **Rainwater** → Collected through harvesting.
- **Sea Water** → Contains high dissolved salts.

Common Impurities in Water:

- **Suspended Impurities** → Sand, clay, organic matter.
 - **Dissolved Impurities** → Salts, gases, minerals.
 - **Microbial Contaminants** → Bacteria, viruses, algae.
 - **Chemical Contaminants** → Heavy metals, pesticides.
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2. Water Quality Parameters & Their Significance

Parameter	Definition	Significance
Color	Visual appearance of water	Indicates presence of organic matter or metal ions
Odour	Smell of water	May indicate contamination by sewage or industrial waste
Turbidity	Cloudiness due to suspended particles	Affects water filtration and microbial growth
pH	Measure of acidity/alkalinity	Ideal range: 6.5 - 8.5 for drinking water
Hardness	Presence of calcium & magnesium salts	Causes scale formation in pipes and boilers
Alkalinity	Water's ability to neutralize acids	Affects corrosion and water treatment processes
Total Dissolved Solids (TDS)	Sum of dissolved ions in water	High TDS affects taste and usability
Chemical Oxygen Demand (COD)	Oxygen required to break down organic/inorganic matter	Indicates pollution level in industrial water
Biological Oxygen Demand (BOD)	Oxygen needed by microorganisms to decompose organic matter	High BOD indicates organic pollution

3. Desalination of Brackish Water: Reverse Osmosis (RO)

Reverse Osmosis (RO) is a process that removes dissolved salts from brackish or seawater using a **semi-permeable membrane**.

Process:

- **High pressure is applied** to push water through the membrane.
- **Impurities and salts are rejected**, producing clean water.

Disadvantages of RO:

- **High energy consumption.**
- **Expensive membrane replacement.**
- **Wastewater generation during treatment.**

4. Disadvantages of Using Hard Water in Boilers

Scale Formation → Reduces heat transfer efficiency.

Corrosion → Forms rust due to dissolved oxygen & salts.

Sludge Formation → Accumulates insoluble salts at the bottom.

Steam Carryover → Causes foaming and deposits in steam pipes.

5. Treatment of Boiler Feed Water

(A) Internal Treatment (Inside Boiler System)

Used to prevent scaling, corrosion, and sludge formation within the boiler.

Methods:

- **Phosphate Conditioning** → Converts calcium salts into soft sludge.
 - **Colloidal Conditioning** → Uses starch & tannins to prevent scale adhesion.
 - **Sodium Aluminate Conditioning** → Helps remove silica & suspended matter.
 - **Calgon Conditioning** → Uses sodium hexametaphosphate to prevent calcium scale.
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(B) External Treatment (Before Entering Boiler)

Removes hardness, dissolved gases, and impurities before feeding water into the boiler.

1. Ion Exchange Demineralization

Uses cation & anion exchange resins to remove all dissolved salts.

Process:

- **Cation Exchange** → Removes positively charged ions (Ca^{2+} , Mg^{2+} , Na^+).
 - **Anion Exchange** → Removes negatively charged ions (Cl^- , SO_4^{2-} , NO_3^-).
- Produces highly pure deionized water.

2. Zeolite Process

Uses sodium-based zeolite to remove calcium & magnesium ions.

Hardness-causing ions (Ca^{2+} , Mg^{2+}) are replaced with sodium (Na^+).

Advantages:

- Simple & cost-effective.
- Does not require chemicals.

Disadvantages:

- Does not remove silica or fine particles.
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Applications of Water Treatment

Industrial Boilers → Prevents scaling & corrosion.

Power Plants → Used for steam generation.

Pharmaceuticals → Purified water for drug manufacturing.

Drinking Water Treatment → Removes harmful contaminants.

This **Water Chemistry Cheat Sheet** covers **water sources, impurities, quality parameters, desalination, boiler water treatment, and ion exchange methods**. Let me know if you need further details!