

Basic Water Chemistry

SOUL™

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H2O™

Water Chemistry

- Source of Water
- A) Surface Waters
 - Rain Water
 - River Water
 - Lake Water
 - Sea Water
- B) Underground Waters
 - Spring Water
 - Well Water

MAJOR IMPURITIES OF WATER

Ionic and dissolved		Nonionic and undissolved	Gaseous
Cationic	Anionic		
Calcium	Alkalinity { Bicarbonate Carbonate Hydroxide Sulfate Chloride Nitrate Phosphate Silica Organic Matter* Color*	Turbidity, silt, mud, dirt and other suspended matter	Carbon dioxide
Magnesium		Color*	Hydrogen sulfide
Sodium		Organic matter*	Ammonia
Potassium		Colloidal silica	Methane
Ammonium		Microorganisms, plankton	Oxygen
Iron		Bacteria	Chlorine
Manganese		Oil	
	Corrosion products (condensate)		

Important Properties in water chemistry

- Natural Water may contain
 - 1) Conductivity
 - 2) Turbidity
 - 3) Colour
 - 4) pH
 - 5) Alkalinity
 - 6) Solids
 - 7) Hardness

Conductivity

- A measure of water ability to conduct electricity. It indicates the amount of dissolved minerals and gases in water.
- Conductivity measured in micro mhos/cm or Micro Siemens/cm³

Solids

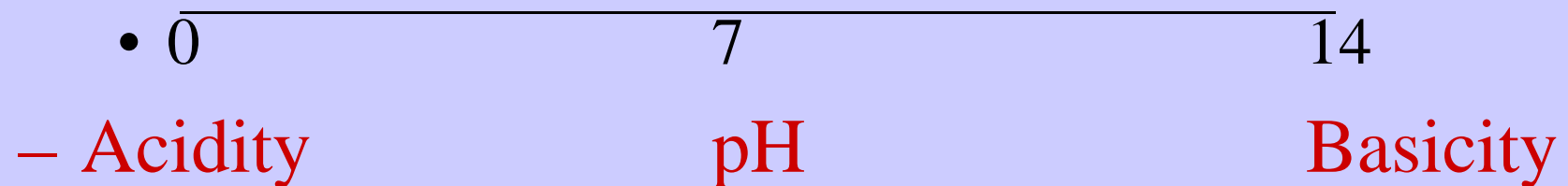
- The term solids refers to the matter that remains as residue upon evaporation.
- Total solids include both DISSOLVED SOLIDS and SUSPENDED SOLIDS.

Colour

- Colour in water may be due to the presence of live particles in suspension or due to certain mineral matter in solution.
- The true colour can be estimated by visual comparison with platinum cobalt standard colour solution.
- Colour is measured with an instrument know as Tintometer

pH

- pH a measure of hydrogen ion activity is used to express the intensity of acidic or alkaline condition of a solution.
- The ph scale runs from 0 to 14 with 0 representing maximum acidity and 14 maximum basicity



Alkalinity

- Alkalinity of water is due to the presence of carbonate bicarbonate and hydroxide ions and it is the most important characteristic of a water when determining the scale forming tendency.
 - Alkalinity---Phenolphthalein Alkalinity
 - Total Alkalinity(Methyl Orange)

Acidity

- Acidity is a measure of the effects of combination of compounds and conditions in water. It is the power of water to neutralize hydroxyl ions and is express in terms of calcium carbonate.
 - Acidity——Free Mineral Acidity
 - —— CO2 Acidity

Hardness of Water

- Hardness in Water is that characteristic which prevents the 'lathering of soap' thus water which does not produce lather with soap solution readily, but forms a white curd is called hard water.
- Type of Hardness
 - Temporary or Carbonate Hardness
 - Permanent Hardness or non carbonate Hardness.

Temporary Hardness

- Temporary Hardness is caused by the presence of dissolved bicarbonate of calcium, magnesium and other heavy metals and the carbonate of ion. It is mostly destroyed by more boiling of water, when bicarbonates are decomposed yielding insoluble carbonates.



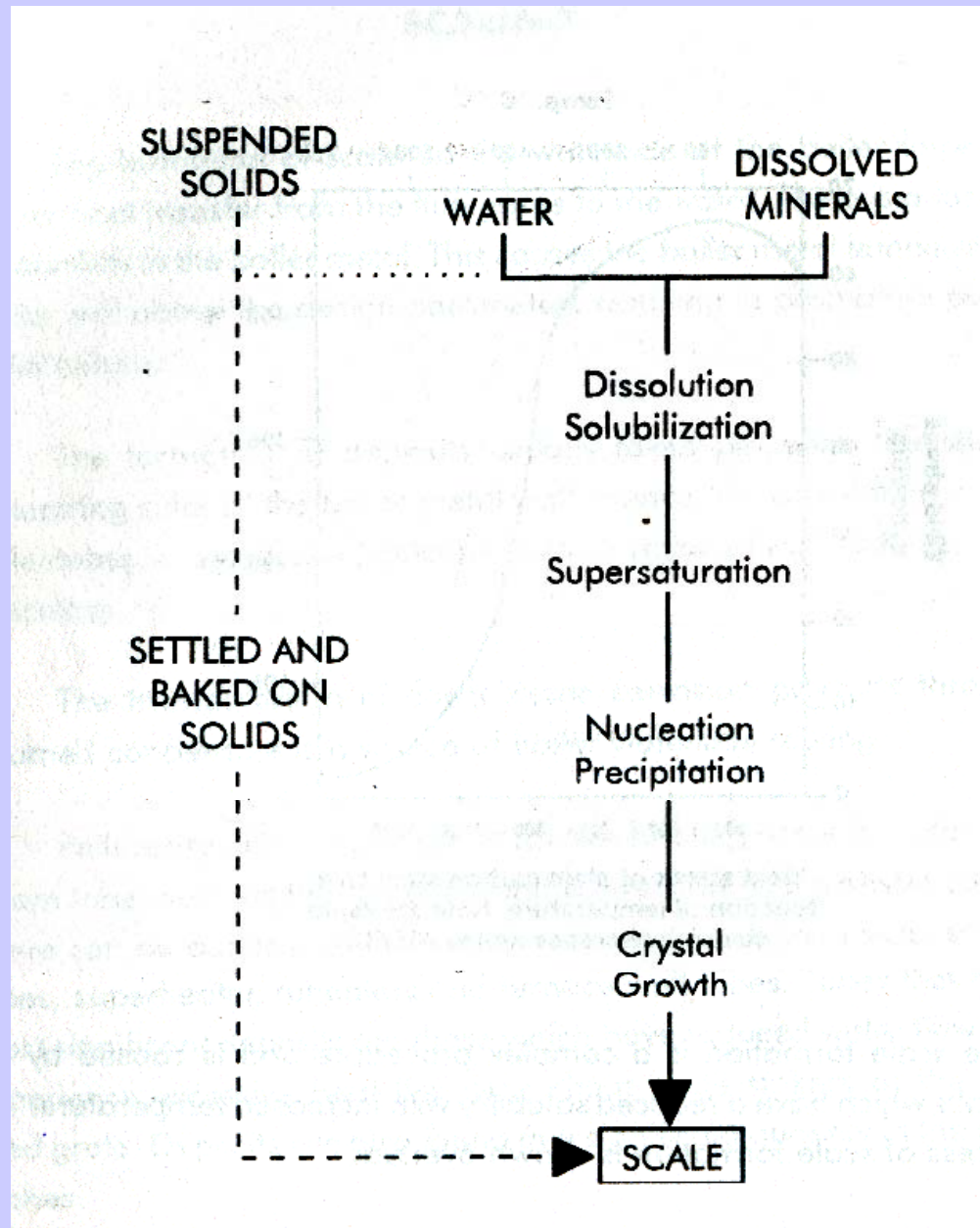
- The Calcium/Magnesium Carbonates thus formed, being almost insoluble, are deposited as a scale at the bottom of vessel, while carbon dioxide escapes out.

Permanent Hardness

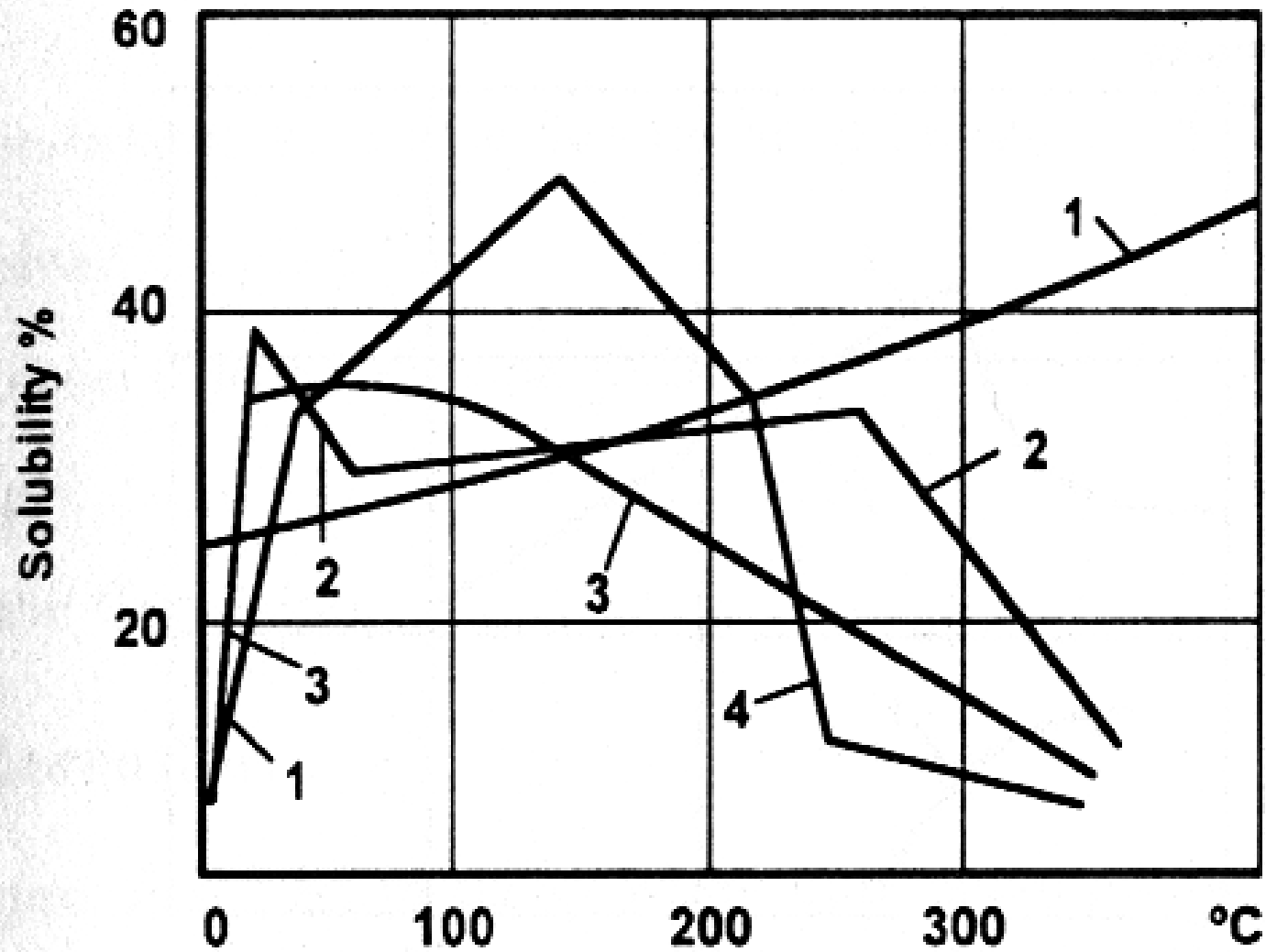
- Non Carbonate Hardness is due to the presence of chlorides, sulfates of calcium, Magnesium, iron and other heavy metals

Units of Hardness

- Most Common unit of Hardness
 - Parts per million(ppm)
 - 1ppm=1 part of CaCo3 eqt Hardness in 106 part of water
 - Milligrams per liter (mg1litre)
 - 1mg=1mg of CaCo3 eqt Hardness in liter
 - 1mg liter=1ppm
 - Clare's Degree(Cl)
 - 1 Clarke= 1graira of CaCo3 eqt Hardness per gallon of water
 - Degrees French(Fr)
 - 1 Fr.=1part of CaCo3 eqt per 105 parts of water

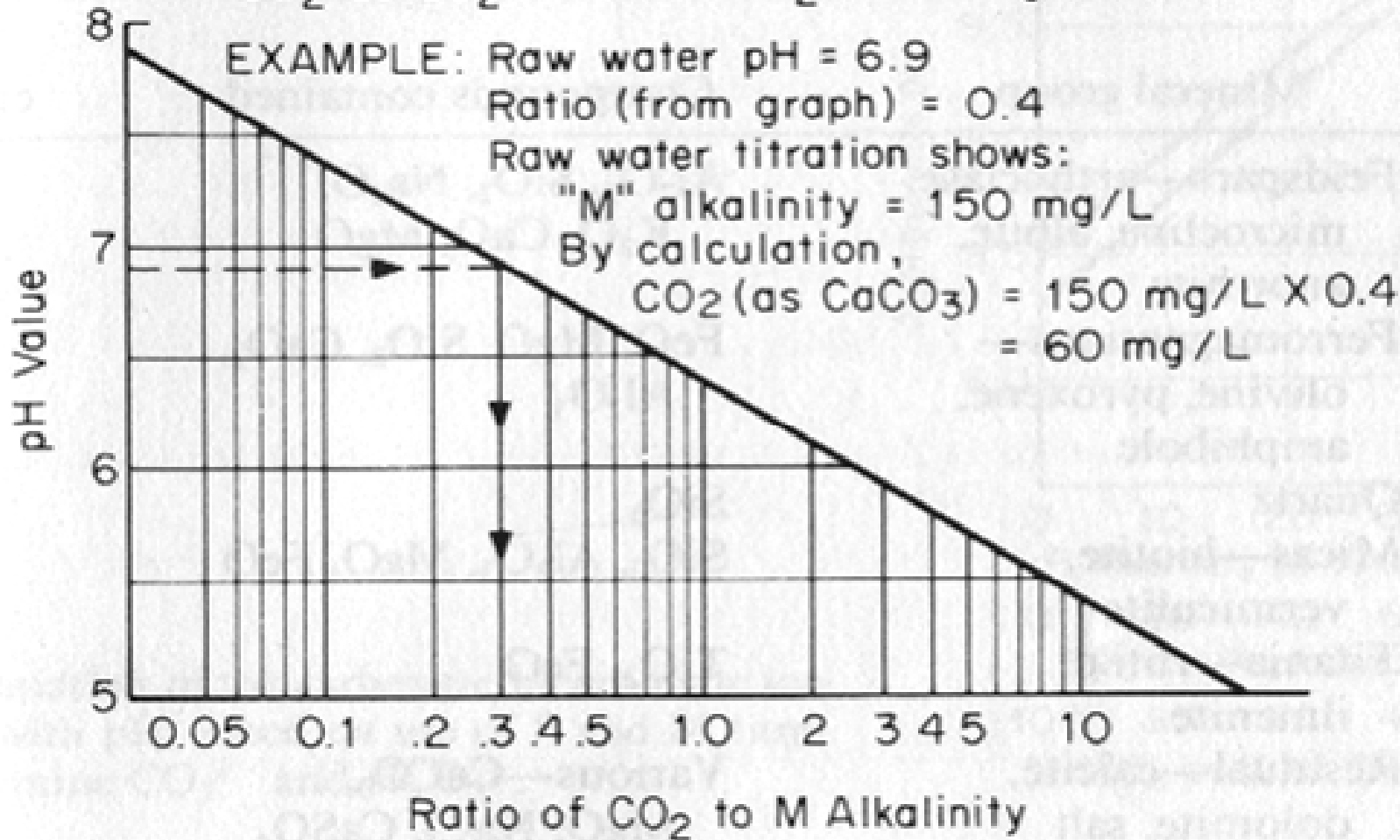


Scale Formation Process



Solubility of some sodium salts
 (1) NaCl (2) Na₂SO₄ (3) Na₂CO₃ (4) Na₃PO₄

Both CO₂ and alkalinity, as CaCO₃
CO₂ as CO₂ X 1.14 = CO₂ as CaCO₃



Approximate relationship of carbon dioxide, alkalinity and pH

Chemical Water Analysis

- Laboratory tests on water, determine concentration of particular ions in solution test results are normally expressed as weight of actual exist in milligrams per liter of water, or calcium carbonate equivalent concept.
- Water must be electrically neutral, the sum of the cations should equal the sum of the anions.
 - Ions concentration as $\text{CaCO}_3 = 100 \times \frac{\text{Actual element (Mg/L)}}{\text{Equivalent Weight}}$
»

Example

• Constituent	Mg/lt.	As CaCo3(Mg/L)
• Calcium	112.8	282
• Magnesium	20.64	86
• Sodium	29.9	65
• Total Catons		433
• Bicarbonate	429.44	352
• Carbonate	0	0
• Hydroxyl	0	0
• Sulfate	51.84	54
• Chloride	17.75	25
• Nitrate	1.24	1
• Fluoride	0.38	1
• Total Anious		433
• M Alkalinity		352
• P Alkalinity		0
• CO2		35
• pH		73
• Silica(as Sio2)		31
• Iron(as Fc)		6.9
• Manganese (asMn)		1.4
• Turbidity		--
• TDS		488
• Colour		2

Carbonate Calcium Equivalent of Common Substances

	Formula	Molecular Weight	Equivalent Weight – Negative ions	Substance to CaCO ₃	CaCO ₃ to Substance
• Bicarbonate	HCO ₃ ⁻	61.0	61.0	0.82	1.22
• Carbonate	CO ₃ ⁻	60.0	30.0	1.67	0.60
• Chloride	Cl ⁻	35.5	35.5	1.41	0.71
• Chromate	CrO ₄ ⁻	116.0	58.0	0.86	1.16
• Fluoride	F ⁻	19.0	19.0	2.63	0.38
• Iodide	I ⁻	126.9	126.9	0.39	2.54
• Hydroxyl	OH ⁻	17.0	17.0	2.94	0.34
• Nitrate	NO ₃	62.0	62.0	0.81	1.24
• Phosphate(tribasic)PO ₄ ⁻		95.0	31.7	1.58	0.63
• Phosphate(dibasic)HPO ₄		96.0	48.0	1.04	0.96
• Phosphate(monobasic)H ₂ PO ₄ ⁻		97.0	97.0	0.52	1.94

Impurities and Methods of Correction

• Nature	Corrections
<ul style="list-style-type: none"> • Turbidity • Organic matter • Micro – Organisms bacteria • PH • Hardness • Alkalinity • Carbonic Acid • Oxygen • Sulfate, Chlorides • Silica • Iron • Manganese • Oil 	<p>Coagulation – Decantation -Filtration</p> <p>Coagulation – Decantation – Filtration –Chlorination.</p> <p>Chlorination – Ozonization – Filtration on sterlized candies.</p> <p>Treatment by acid or alkali.</p> <p>Softening by ion exchangers. Internal treatment in boiler.</p> <p>Softening with lime. Treatment with acid</p> <p>Derbonisation by ion exchangers.</p> <p>Aeration – Degassing – Naturalization by alkalies – Protection or neutralization by amines.</p> <p>Thermal degassing, sodium sulfate or Hydrazine</p> <p>Total demineralization.</p> <p>Precipitation of magnesium salts by heating, filtration through anthracite Filters. Absorption by ion exchangers.</p> <p>Aeration and filtration and filtration. Coagulation and filtration. Softening with lime.</p> <p>Aeration and filtration. Coagulation and filtration.</p> <p>Coagulation and filtration. Filtration on disatomic earths or active coal.</p>