MARINE AND OCEAN CHEMISTRY

Dr. Kübra İNAL

Read the details of the information provided below from the sources recommended as a reference.

This content has been prepared for educational purposes only and the responsibility for copying and sharing belongs to third parties.

PLAN – CONTENT – REFERENCES

1. Introduction
2. The water in seawater
3. Salinity, chlorinity, conductivity, and density
4. Major constituents of seawater
5. Simple gases
6. Salts in solution
7. Carbon dioxide
8. Nutrients
9. Trace metals and other minor elements
10. Chemical extraction of useful substances from the sea

References:

1. An Introduction to the Chemistry of the Sea, Michael E. Q. Pilson
2. Marine Chemistry & Geochemistry, John H. Steele et al.
3. Chemistry in the Marine Environment, R. E. Hester and R. M. Harrison
4. Marine Chemistry, P. J. Wangersky

THE WATER IN THE SEAWATER

1. Physical properties of water

2. Isotopes of hydrogen and oxygen

3. Clathrate compounds

The weather and climate on Earth are in several ways controlled by **the physical properties of water**.

- Factors of special importance are;
  - Its high heat capacity
  - Its high heat of evaporation and condensation
  - Its high heat of freezing and thawing
  - The molecular structuring associated with its expansion when freezing
  - The relationship of its vapor pressure to temperature.

Unusual properties of water

Property	Comments
High boiling point	
High melting point	All these properties relating to heat cause water to be important in moderating temperature extremes, and in transporting heat from place to place around Earth.
High specific heat	
High heat conductivity	
High heat of evaporation	
High heat of melting	
Maximum density at 4 °C	Contrast between oceans and lakes
High surface tension	Droplet formation in clouds, breaking waves
High viscosity	Biologically important
High dielectric constant	Makes a good solvent for ionized substances

6
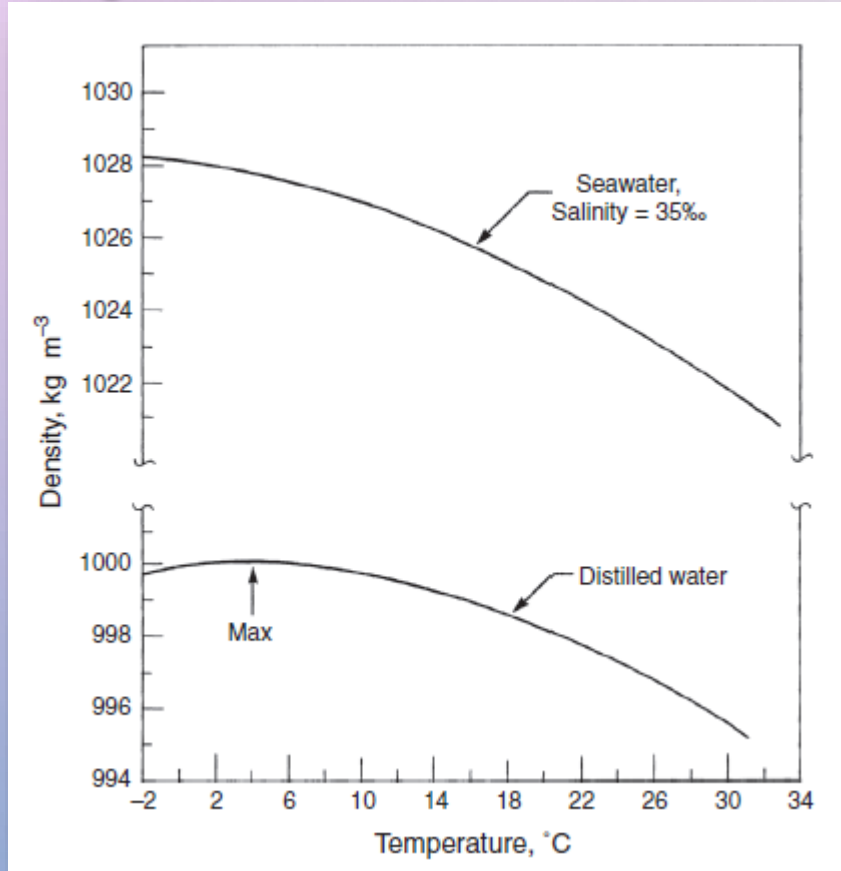
As the pure water is cooled the density reaches a maximum at 3.98 °C, then decreases slightly towards the freezing point.

Speculation that even in liquid water some of the molecules are arranged in an ice-like structure, thought of as miniature "icebergs".

Water is cooled the fraction of the molecules arranged in this way increases.

Causing a decrease in density.

ISOTOPES OF HYDROGEN AND OXYGEN

In ordinary natural water the hydrogen and oxygen each consist of three different isotopic forms with different masses.

- The isotopes present in water are: ^1H, ^2H or D, ^3H or T, ^{16}O, ^{17}O, ^{18}O.

- The nuclei of oxygen have 8 protons, and 8, 9, or 10 neutrons.

- These isotopes are present in all possible combinations, all natural water contains nine kinds of water molecules.

Some characteristics of the different isotopic forms of "pure" water

Form	FP, °C	BP, °C	Temp. of Max. Density, °C	Max. Density, kg m^{-3}	VP, 20 °C Pa
Ordinary water	0.00	100.00	3.98	999.975	2338
D_2O	3.81	101.40	11.2	1106.0	2140
$D_2\,^{18}O$	-	-	11.45	1216.88	-
T_2O	-	-	13.40	1215.01	-
$HD\,^{16}O$	-	-	-	-	2170
$H_2\,^{18}O$	-	-	4.21	1112.49	2316

In the cases of "ordinary water", D_2O, and T_2O, the complete isotopic composition was not specified in the sources.

CLATHRATE COMPOUNDS

When water freezes under the right conditions it can form a lattice-like cage around certain other small molecules.

- The discovery that numerous other small gas molecules (including methane) will form hydrates (now commonly called **clathrate structures** or **clathrates**), though usually this requires a higher gas pressure than was the case with chlorine, which forms hydrates at atmospheric pressure.

There are two sources of methane:

1. Significant amounts of methane can be formed in sediments, enough to reach the necessary gas pressure. This requires a source of organic matter within the sediment.

   - Most methane clathrate occurs in this situation.

2. Leakage from much deeper natural-gas reservoirs. In this situation the gas can come up in a more concentrated flow; when it encounters the stability zone it can form massive deposits and can even be exposed at the sediment surface.