

# Chlorine & Its Consequences

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IAP2006, 12.091: MEDICAL  
GEOLOGY/GEOCHEMISTRY

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January 25, 2006

# What do these things have in common?

- Sea
- Chlorox Bleach
- Salt
- Soccer Ball
- Gatorade
- Human Body

How does element 17  
exist?

CHLORIDE ( $\text{Cl}^-$ )  $\rightarrow$  salt

*VERSUS*

CHLORINE ( $\text{Cl}_2$ )  $\rightarrow$  gas

# Chloride Chemistry

- Chloride is a by-product of the reaction between chlorine and an electrolyte such as K, Mg, Na.
- “In its original form, chloride is formed from various rocks into soil and water by years of weathering processes.” (Ref. 3) From there, it is transported to oceans or closed basins, Great Salt Lake.
- Chloride salts are vital for human metabolic processes and have no effects of chlorine gas.



# Chloride-Essential Mineral

- Chloride represents 70% of body's total negative ion content.
- Suggested amount of chloride intake 750-900mg/day.
- Main electrolyte
- Assists in conduction of electrical impulses
- Chlorine is an electrolyte and a minor element making up 0.14% concentration of elements in the human body. (Ref: 12.091 Lecture Notes 1)

# Role of Cl<sup>-</sup> in the Body

- Combines with hydrogen to form HCl, which breaks down proteins, absorption of other metallic minerals.
- Maintains electrical neutrality across the stomach membrane.
- With Na & K, chloride works in the nervous system to facilitate transport of electrical impulses.

# Related Diseases

- **EXCESS INTAKE:**

Chloride toxicity has not been observed in humans except for impaired NaCl metabolism. (congestive heart failure)

-This can be avoided by a healthy diet and an active lifestyle.

- **DEFICIENCY:**

Rare, but:

1. Alkalosis-life threatening condition.

-Blood becomes overly alkaline

-Results from excess loss of sodium (heavy sweating)

**Symptoms:** muscle weakness, loss of appetite, irritability, dehydration, lethargy

2. Hypochloremia-water overload, wasting conditions, extensive bodily burns.

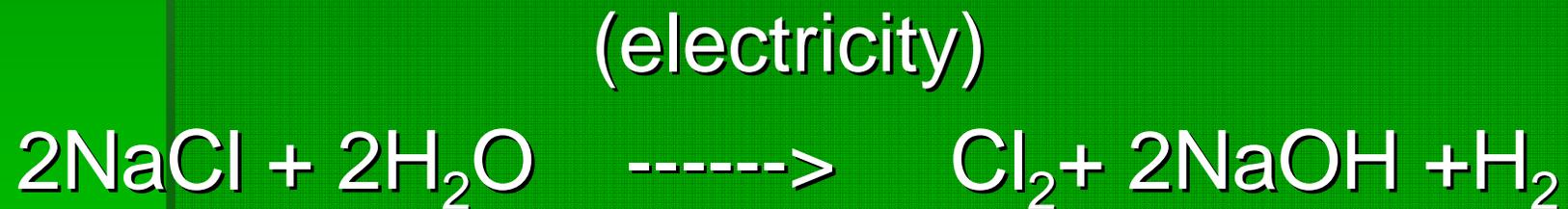
# History of Chlorine

Chlorine- from the Greek word *khloros* meaning greenish yellow

- **1774**-Swedish chemist Karl Wilhelm Scheele discovers chlorine.
- **1826**-First photography: Silver chloride is used in light sensitive images to put the image on film.
- **1847**-Chloroform is used as an anesthetic for 100 years.
- **1908**-Jersey City Waterworks in NJ uses chlorine to disinfect the water supply. (1914-Dep't Treasury required drinking water to be disinfected)
- **1912**-PVC was invented without a purpose. B.F. Goodrich marketed as vinyl and sold it as shower curtains.
- **1915**-First used as a weapon in WWI.
- **1922**-Liquid bleach is sold for individual household use.
- **1933**-Dow Chemical produces Saran (polyvinylidene chloride), and in 1949 it was marketed as saran wrap.
- **1990s**-Chlorine based drugs are used for medical problems ranging from ear infections to cancer.

# Chlorine Chemistry

## ELECTROLYSIS



# Facts about chlorine

- Highly reactive (Group 7 on the periodic table)
- Every year, 12 million tons are produced in North America
- Economically important in the US
  - Chlorine industry supports 2 million jobs in US (Ref: 5)
  - Not replaceable, no alternative processes

# What is chlorine used for?

1. Disinfectant-Pools, drinking water supply, bleach

3. Plastics (~25% of yearly output)

Example: PVC

4. Medical Products

5. Packaging

6. Electronics/appliances

# Chlorine Isotopes

- There are 9 isotopes of chlorine, but 3 are stable.

( $^{35}\text{Cl}$ ,  $^{36}\text{Cl}$ ,  $^{37}\text{Cl}$ )

# Routes of Exposure

- Inhalation
  - generally occupational exposure
- Ingestion
  - in drinking water (penetrated soil and got into water supply)
- Dermal Contact

# Exposure to Chlorine

- Irritates respiratory system
- Liquid-burns skin

## Inhalation:

- 3.5ppm-detect odor
- 1000ppm-fatal
- Workplace: < 0.5ppm

## ■ Diseases

Pulmonary Edema  
(fluid in the lungs)

Lungs become more susceptible to other diseases.

# CAUTION!

- **Dioxin-chlorinated organic compounds**

[Polychlorinated Dibenzo Furans (PCDF) and Polychlorinated Dibenzo Dioxins (PCDD) ]

-Byproduct of vinyl chloride manufacture

Produced From:

Trash barrels, coal fired utilities, wood burning, metal smelting, diesel trucks.

- Bioaccumulates in tissues → Exposure can cause:

-chloracne

-diabetes

-cancer (lab animals)

**\*\*Known Human Carcinogen\*\***

# CAUTION CONTINUED!

- PVC Polymer Production

Toxicology study at Goodrich plant, Ky. 1960s

Vinyl chloride-carcinogenic

PVC workers had occupational cancer (liver angiosarcoma) due to exposure to polymerization process.

- Chloroform

-Vapors depress the central nervous system.

-900ppm-dizziness, fatigue

-Can cause liver and kidney damage

-NTP classified it as a human carcinogen (hepatocellular carcinoma)

# Results

## CHLORIDE

1. Essential for human metabolism and maintaining electrical neutrality in the body.
2. Most common in salt form (NaCl)

## CHLORINE

- Chlorine is helpful and harmful to society.
- Dangerous gas that does not exist in just element form because of its reactivity.
- Need to find a way to use it without any health risks. Follow exposure limits.
- Many chlorine compounds are carcinogenic → Take extra precautions when working with these chemicals

# Conclusions

## -Life without plastics-

- All forms of chlorine are important for humans to live and to facilitate their lifestyles.
- There are many ongoing research projects to determine the health effects of chlorine because it has become such a prevalent chemical in society.

# References

1. [http://c3.org/chlorine\\_what\\_is\\_it/chlorine\\_story2.html](http://c3.org/chlorine_what_is_it/chlorine_story2.html)
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