



Sodium & Chlorine: Making Table Salt

Preparer's Version

Introduction

When sodium metal comes into contact with chlorine gas, a chemical reaction occurs where sodium atoms each lose one electron to become positively charged sodium ions. Concurrently, chlorine molecules each gain one electron to form negatively charged chloride ions. This transfer of electrons results in the formation of an ionic bond, creating sodium chloride, commonly known as table salt. This reaction releases a significant amount of energy in the form of heat and light, making it exothermic. The energy release is due to the strong, stabilizing electrostatic attraction between the positively charged sodium ions and the negatively charged chloride ions.

Safety Hazards

- Personal Protective Equipment:
 - Safety glasses/goggles
 - Nitrile gloves
 - Work glove(s)
 - Chemical & flame retardant lab coat
- Physical Hazards
 - In contact with water, sodium releases flammable gasses which may ignite spontaneously.
 - Trichlor may intensify fire; oxidizer.
 - Hexanes is a highly flammable liquid and vapor.
 - Chlorine gas may cause or intensify fire; oxidizer.
- Chemical Hazards
 - Sodium metal causes severe skin burns and eye damage.
 - Trichlor is harmful if swallowed and causes serious eye irritation; may cause respiratory irritation; very toxic to aquatic life with long lasting effects.
 - Hexanes may be fatal if swallowed or if it enters airways; cause skin irritation and may cause drowsiness or dizziness; suspected of damaging fertility or the unborn child and may cause damage to organs (Nervous system) through prolonged or repeated exposure if inhaled. Toxic to aquatic life with long lasting effects.
 - Chlorine gas causes skin irritation and serious eye irritation; fatal if inhaled; may cause respiratory irritation; very toxic to aquatic life with long lasting effects.

Materials

- 1" HTH Chlorine Tablet (approx. 15.4 g, 92.4% trichloroisocyanuric acid/trichlor)
- 7 – 10 mL concentrated hydrochloric acid (12M)
- Sodium metal, ~ 0.8 g
- 10 mL hexanes
- Disposable pipette
- Blowtorch
- 2L Erlenmeyer flask
- Ring stand & three-pronged clamp
- Mortar and pestle
- Specialty glassware piece (quartz sodium basket and suspension piece)

Safety Data Sheet(s)

- [Trichloroisocyanuric acid \(trichlor\)](#)
- [Sodium metal](#)
- [Chlorine gas](#)
- [Cyanuric acid](#)
- [Hexanes](#)
- [Propane](#)

Extra Safety Notes

- Sodium metal is highly corrosive and water reactive. When it touches water, it releases highly flammable gas. Handle with extreme caution and wear full PPE.
- Sodium metal is preserved in mineral oil, which must be cleaned off using hexanes. If the sample of sodium metal looks wet at all, do not use it! This may indicate either oil residue or remaining hexanes. Hexanes are extremely flammable, and can cause the sodium to ignite and burn more aggressively.
- Trichloroisocyanuric acid is an oxidizing solid. Use with extreme caution and wear full PPE.
- Chlorine gas is a highly poisonous gas. Before conducting the experiment, ensure that your fume hood flow is sufficient and that the flask is no closer to the sash/experimenter than the midline of the fume hood's depth. Keep the sash as low as possible at all times.
- The reaction of sodium and chlorine is highly exothermic. There is a risk of fire and/or breaking glass. Wear full PPE and step away from the fume hood while the reaction is progressing.
- If the basket of ignited sodium hits the bottom of the flask (instead of remaining suspended), it may pop/combust more aggressively. Try to keep the basket suspended to encourage a more steady reaction.

Procedure

This demonstration MUST be done inside of a functioning fume hood. The generation of chlorine gas poses a serious hazard due to the toxic nature of chlorine. A member of the Demonstrations Team must be present for this demonstration.

1. Grind one (1) HTH 1" Chlorine tablet into a fine, uniform powder using a clean mortar and pestle. Pour the powder into the bottom of a clean, 2L Erlenmeyer flask. Place the flask in the center of the fume hood.
2. Measure 8 mL of concentrated (12M) hydrochloric acid. Set aside in a small beaker inside the fume hood.
3. On a polypad/chemical mat, cut a small piece of sodium metal weighing no more than 0.8 g. Make sure to cut the sodium so that there are unoxidized surfaces exposed.
4. Measure 10 mL of hexanes to clean the sodium of the mineral oil it is preserved in using hexanes. Be sure to thoroughly wash the sodium and pat it dry. Place in a clean, small beaker or crystallization dish and set aside in the fume hood.
5. Check to make sure the fume hood flow is adequate and that the sash is lowered as far as it can go without obstructing your movement.
6. Pour the hydrochloric acid aliquot into the 2L flask and quickly lower the sash entirely. You will immediately notice a greenish-yellow gas being liberated. This is chlorine gas and is extremely hazardous! Allow a few moments for all of the hydrochloric acid to react with the trichlor powder and for the generation of gas to slow down.
 - a. *Note: Chlorine gas is denser than air, so it should sit inside of the flask. Do not tilt or agitate the flask, as it may result in the release of chlorine gas from the flask.*
7. Prepare to heat the sodium metal. Secure the specialty glassware piece in the three-pronged clamp on a ring stand so that the quartz basket is suspended from the benchtop of the fume hood. Place the sodium metal inside of the quartz basket, and begin slowly heating the sodium using a blowtorch. The sodium should melt and ignite.
 - a. This should be off to the side of the flask, and not immediately next to it.

- b. Go slow! Make sure to keep the flame moving, but provide constant heating to the metal. The goal is to have the sodium ignited enough that, when lowered into an atmosphere of chlorine, it stays hot enough. If it is not hot enough, the flame will go out and the reaction will not progress.
8. Once the sodium has ignited, using a hand protected by a work glove, carefully pick up the glass piece from the top (as far from the sodium basket as possible) and gently lower it into the flask. Step back, lower the fume hood sash, and allow the reaction to proceed.

Tips & Tricks

- Have somebody ready to turn off the lights as soon as the sodium is lowered into the flask!
- Be mindful that chlorine gas is an oxidizer. Do not heat the sodium close to the flask, but keep the two as far from one another as possible.

Clean-Up Procedures

1. Allow the reaction to cool down. It will be extremely hot!
2. Push air through the flask to expel any remaining chlorine or suspended sodium chloride vapor.
3. Quench any unreacted sodium metal in the basket with deionized water.
4. Rinse the flask and any labware used for the chlorine tablet thoroughly with deionized water, bottling the runoff for waste disposal.
5. Rinse the beaker used for hydrochloric acid thoroughly with deionized water, bottling the runoff in an acid/base waste stream. Do NOT mix with the waste from the chlorine tablet.
6. Rinse the basket thoroughly with deionized water, bottling the runoff in an acid/base waste stream (contents should be sodium hydroxide if unreacted sodium was quenched and sodium chloride). Do NOT mix with the waste from the chlorine tablet.
7. Rinse all labware used for the sodium metal cleaning with acetone, bottling any runoff in a separate waste container if necessary.
8. Clean all rinsed labware thoroughly with laboratory detergent and water.