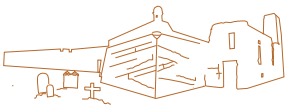


INGREDIENTS OF A FLORIDA FORT: PART II - QUICKLIME

Students learn how quicklime has been found throughout history.

ACADEMIC OUTCOMES/LESSON OBJECTIVES:

- Students read selections introducing them to ways that quicklime (the mortar used to glue coquina blocks together) has influenced history in Florida and abroad.

SUNSHINE STATE STANDARDS ASSESSED:

SOCIAL STUDIES 4TH-5TH
- (SS.A.6.2.2) Understands the influence of geography on the history of Florida.

SCIENCE 4TH
- (SC.4.P.9.1) Identify some familiar changes in materials that result in other materials with different characteristics, such as decaying animal or plant matter, burning, rusting, and cooking.

SCIENCE 5TH
- (SC.5.P.8.2) Investigate and identify materials that will dissolve in water and those that will not and identify the conditions that will speed up or slow down the dissolving process.
- (SC.5.P.9.1) Investigate and describe that many physical and chemical changes are affected by temperature.

RESOURCES:

Florida Public Archaeology Network. 28 February 2008 <http://www.flpublicarchaeology.org>.
"Quarry Historical Site." Florida State Parks. 28 February 2008
<http://www.floridastateparks.org/anastasia/Quarry.cfm>.
"Castillo de San Marcos." National Park Service. 28 February 2008
<http://www.nps.gov/casa/>.

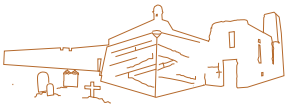
MATERIALS LIST:

None

ANSWER KEY FOR ACTIVITY:

1. Carbon Dioxide is written as CO_2. So it has 1 Carbon and 2 Oxygens.
2. Water is written as H_2O. So it has 2 Hydrogens and 1 Oxygen.
3. Alcohol is written as C_2H_6O. So it has 2 Carbons, 6 Hydrogens, and 1 Oxygen.
4. Sugar is written as $C_6H_{12}O_6$. So it has 6 Carbons, 12 Hydrogens, and 6 Oxygens.

AUTHOR: Kelley Weitzel, http://www.KelleyWeitzel.com



INGREDIENTS OF A FLORIDA FORT: PART II - QUICKLIME

Students learn how quicklime has been found throughout history.

STUDENT ARTICLES & ACTIVITIES:

1. What is quicklime?
2. What are other uses for quicklime?
3. Why doesn't the fort explode when it rains?
4. ACTIVITY: Chemistry in Action

VOCABULARY: Acidic, Calcium, Carbon, Cement, Coquina, Degree, Dissolve, Erode, Exothermic, Fahrenheit, Hydrogen, Limestone, Mason, Mortar, Oxygen, Putty, Quicklime, Reaction, Romans, Whitewash

ASSESMENT OPTIONS:

WRITING PROMPT #1: Quicklime has been used both as a fertilizer and as a weapon. Think about an everyday material that can be used in both positive and negative ways. Write to explain at least one positive way and one negative way your material can be used.

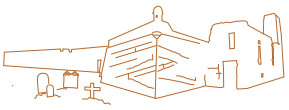
WRITING PROMPT #2: Ancient Romans allowed "slaked lime" to age for three years before using it to build a wall. Think about how life might change if people today had to wait three years before building a new home. Write to explain how life would be different if people had to wait three years to build any new structure.

ASSESSMENT #1: Most people don't realize that chemistry played a big part in Florida's history. Explain how quicklime (or some other chemical) has changed the lives of Floridians in the past or present.

ASSESSMENT #2: Based on your reading of the article titled, "Chemistry in Action," explain how letters and numbers are used in a chemical equation.

FLORIDA PUBLIC ARCHAEOLOGY NETWORK

This project has been financed in part with historic preservation grant assistance provided by the Bureau of Historic Preservation, Division of Historical Resources, Florida Department of State, assisted by the Florida Historical Commission.



INGREDIENTS OF A FLORIDA FORT: PART II - QUICKLIME

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WHY ARE WE STUDYING ABOUT QUICKLIME?

Quicklime is the mortar (glue) that holds coquina blocks together in the walls of old forts, like the Castillo de San Marcos. We're studying quicklime because it demonstrates the important role that chemistry played in Florida's history. In early Florida, chemistry wasn't something that happened in science classes or laboratories. It happened out in the real world. The Spanish used chemistry to make quicklime mortar. Without this important glue, the Castillo de San Marcos could never have been built. Think about it. Without that fort, the English might have conquered Florida sooner. Or, if things had gone differently, the native people may have pushed the Spanish explorers right out of Florida. Without quicklime mortar, many of Florida's forts, hotels, stores, sugar mills, homes, and canals would never have existed. The chemistry of quicklime changed our history, just as the chemistry of plastics and fossil fuels is changing our world today.

WHAT IS QUICKLIME?

To build a coquina fort, the Spanish explorers needed a mortar (or glue) that could fasten the large coquina blocks tightly together. The mortar they used is called "quicklime." They made it by burning oyster shells for about 12 hours in a fire. This fire was hotter than 2200 degrees Fahrenheit. It made the burned shells so brittle that you could actually break them with your fingers. Intense heat changes the chemicals found in oyster shells. In the beginning, oysters are made from calcium carbonate ($CaCO_3$). The heat causes some of the carbon (C) and oxygen (O) to escape as CO_2, carbon dioxide. What's left behind? Calcium (Ca) and oxygen (O) which makes CaO. Another name for CaO is "quicklime." It's called quicklime because it reacts very "quickly" with water. What kind of chemical reaction occurs? A VIOLENT one!

This violent reaction is called "slaking," and it requires plenty of safety gear, including goggles, gloves, and a mask. Masons (professional stone workers) use the slaking process to replace the broken mortar on old forts. To do it safely, they add a few burned oyster shells to a tiny bit of water. After a minute or so, the water starts to boil and spit. This slaking reaction creates a lot of heat! Imagine a birthday cake with 420 flaming candles. That's enough heat to make you jump back. It might even singe your eyebrows off! And that's the "safe" way to slake lime.

What's the unsafe way? If someone just poured lots of water over the burned oyster shells, they'd get a downright EXPLOSION. This chemical reaction produces heat SO QUICKLY that the chemicals actually explode. (Remember, it's called "quicklime" for a reason!)

Any reaction that produces heat is called an "exothermic" reaction. The prefix "exo-" means "outside," and the root word "thermal" means "heat." Exothermic reactions put out heat…LOTS of heat. For this reason, burning oyster shells to create quicklime should never be tried at school or at home. It could have some messy consequences.

What happens during a safe slaking process? The oyster shells dissolve, turning the bubbling water from clear to creamy white. In just minutes, a whitish putty will form. This putty is called "slaked lime." Slaked lime should be stored in an airtight container for AT LEAST three months. Then it can be spread between two coquina building blocks as a glue that holds the stones together. The Romans built many structures using slaked lime. They actually had a law that said lime putty had to age for three years before it was used in a building. Three years! That takes a lot of planning.

INGREDIENTS OF A FLORIDA FORT: PART II - QUICKLIME

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Spanish fort builders also allowed their slaked lime to age before using it, often for a whole year. Then they used this putty as a mortar to hold coquina blocks together. Once the coquina walls were complete, the Spanish also used slaked lime to give the walls a protective coating. They made a whitewash by adding extra water to the lime putty and thinning it into a paint-like mixture. Don't worry; it's safe to add water now. Next, they took the whitish liquid and poured it over the coquina walls to form a smooth, white layer. This whitewash helped protect the coquina stone from the weather and from wildflowers and vines that might grow roots into the stone.

At the Castillo de San Marcos, we don't see a whitish coating on the coquina walls today. Why not? Sometime during the last three hundred and thirty years, the Castillo's protective lime coating probably just washed away in the rain. This kind of coating needs to be repainted at least once every five years. Otherwise, the rain will wash it away completely.

WHAT ARE OTHER USES FOR QUICKLIME?

For years, farmers have used quicklime as a fertilizer. Quicklime is made of the mineral calcium, so it actually adds minerals to the soil. When crops like potatoes, peanuts, and watermelons soak up the calcium, this natural fertilizer helps them grow.

Quicklime can also be used to kill germs. In old-style bathrooms (called privies), quicklime was dropped down into the hole where people went to the bathroom. The quicklime helped destroy any germs (and grossness) that might be down there. Pretty useful, right?

Unfortunately, quicklime had another purpose. Long ago, the Greeks mixed quicklime with water, and this violent reaction created a weapon called "Greek Fire." During battles, they threw this flaming material at attacking ships. Because ships were made of wood, Greek Fire was a deadly effective weapon. Today, quicklime is only used for peaceful purposes, usually as a fertilizer on farms.

Oyster Shells

Coquina Well with Quicklime Mortar

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WHY DOESN'T THE FORT EXPLODE WHEN IT RAINS?

If we look back at the previous passage, we see that only BURNED oyster shells explode when you add water. Plain oyster shells are safe. And the slaked lime you get afterwards is safe. Does this seem strange? It actually makes perfect sense. Each of these three materials (oyster shells, burned shells, and slaked lime) has a different chemical equation. That means they are made of different things.

Castillo de San Marcos

1. Regular oyster shells are made of a chemical called Calcium Carbonate. Its chemical equation is written as CaCO3. This tells us that it has 1 Calcium (Ca), 1 Carbon (C), and 3 Oxygens (O).

2. Burned oyster shells are made of a chemical called Calcite (Quicklime). Its chemical equation is written as CaO. This tells us that it has 1 Calcium (Ca) and 1 Oxygen (O).

3. When a mason adds a small amount of water to burned oyster shells, the chemical reaction creates Calcium Hydroxide (Slaked Lime). Its chemical equation is Ca(OH)2. This tells us that it has 1 Calcium (Ca), 2 Oxygens (O), and 2 Hydrogens (H).

Each material has different chemical ingredients. So, it makes sense for each material to have a different reaction to water. Now you know why the Fort's mortar and whitewash don't explode in the rain!

TRY THIS ACTIVITY - CHEMISTRY IN ACTION:

How many Hydrogens, Carbons, and Oxygens are found in each chemical equation? Hint: The number that describes "how many" can be found AFTER each letter. The first one is completed as an example.

1. Carbon Dioxide is written as CO_2. So it has _1_ Carbon(s) and _2_ Oxygen(s).

2. Water is written as H_2O. So it has _____ Hydrogen(s) and _____ Oxygen(s).

3. Alcohol is written as C_2H_6O. So it has _____ Carbon(s), _____ Hydrogen(s), and _____ Oxygen(s).

4. Sugar is written as $C_6H_{12}O_6$. So it has _____ Carbons, _____ Hydrogens, and _____ Oxygens.