CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Amanda T. Roberts

Project Number

36255

Project Title

Is It Possible to Turn CO2 Waste into a Usable Product?

Abstract

Objectives/Goals

My project tested whether CO2 can be converted into a useful product or into an alternative construction material that has superior strength properties. I tested how CO2 (a waste product of burning fossil fuels) reacts with calcium ions dissolved in a solution of water and calcium chloride at different temperatures. This is relevant to the world because CO2 emissions dramatically increase every year and there is a large environmental concern associated with the rise in use of fossil fuels. If large companies can create a useable product from CO2 waste, then we are closer to a green future!

Methods/Materials

I used 0.1 moles NaOH and CaCl2, in 400 mL of water to prepare the solution used for the measurements at each temperature (25°C and 80°C). I also added 0.02 and 0.1 moles of magnesium ions into two separate solutions in 80°C to see how magnesium would affect the structure of our precipitate. I bubbled C02 into the solution with a magnetic heater using a magnetic stirring rod and measured pH with a pH meter. I filtered the solution using a Millipore Durapore filter connected to a vacuum which separated the solid precipitate from the filtrate. The precipitate was then transferred to a small glass vial for storage until further X-Ray Diffractometer and Nuclear Magnetic Resonance experiments were conducted.

Results

When magnesium ions were placed in a beaker with sodium hydroxide, calcium chloride, and water while CO2 was bubbled through the solution, the magnesium ions influenced the crystal structure by preventing the production of calcite and instead, I obtained an aragonite structure.

Conclusions/Discussion

Without magnesium ions, sodium hydroxide and calcium chloride create calcium carbonate as a brittle calcite structure. In the presence of magnesium, a hard aragonite structure is formed that is not only vital to help utilize CO2 waste by turning it into a useful material, but it will also benefit aquatic animals in preventing ocean acidification. By creating an aragonite material, we would be able to use this product to build structures as strong as a car or buildings. My project is very relevant to the world because CO2 emissions dramatically increase every year and there is a big environmental concern associated with the rise of burning fossil fuels. If large companies can use their CO2 waste to create aragonite as a construction material, we would be one step closer to a green future!

Summary Statement

I found that adding magnesium to the reaction of NaOH and CaCl2, a hard aragonite structure (e.g. abalone shell) was formed when calcium carbonate precipitated rather than the normal calcite structure (e.g. brittle limestone).

Help Received

Dr. Brad Chmelka helped me brainstorm on how to turn carbon dioxide into a useful product. Rahul Sangodkar assisted with using the testing equipment and guided my procedures. Dr. Brad Chmelka is a professor for the UCSB Chemical Engineering Unit, and Rahul is one of his graduate students.