

Project Description

Project Title: Green Solution to an Orange Problem: Energy Producing Purification of Acid Mine Drainage

General Description: Acid mine drainage is one of mining industry's biggest messes because, like nuclear waste, we really don't know how to deal with it effectively. The problem forms when minerals deep in the earth's crust are exposed to water and air as a result of mining. This makes the water acidic, creating an environment that is void of life. Nothing is able to live in or around this polluted volume of water. There are ways to temporarily deal with this pollutant but they are not used because they are not cost-effective, and perhaps there are no long-term solutions at all.

I intend to investigate the feasibility of energy production through electrolysis and examine the energy output produced from different hydrogen-producing solutions. This study is very important especially now that we, as a nation, are coming to the realization that there is no choice other than sustainable energy production. This process would use fuel cells to convert hydrogen into electricity. Fuel cells have been around for years but because they require almost as much energy to run as the energy they produce it has never really gone anywhere. But with the union of solar power or wind power this technology may become a real choice in our struggle for energy independence. Also I believe that hydrogen may be a better way than batteries to store energy that is produced.

With electrolysis and the hydrogen fuel cell, I intend to measure if there is a change in acid mine drainage quality. Acidity is the result of too much hydrogen in the water. Through electrolysis, it may be possible to reduce the hydrogen content and enhance the quality of the water. If the quality is enhanced then there may be potential for changing this pollutant into a reliable source of energy. The result could be an economically feasible solution to pollution problems through affordable sustainable energy production.

Background / Brief Review of Literature

- “Hydrogen.” www-formal.stanford.edu/jmc/progress/hydrogen.html

This article gives a good description of the hydrogen cycle. As well as some of its uses. It also looks at the economic environment of hydrogen including its potential as motor fuel.

- “New Horizons for Hydrogen-producing Hydrogen from Renewable Resources.”

This source gives a good look at different ways to extract hydrogen and different place to find it. It also touches on safety and storage techniques as well as giving a good idea of where we stand reliable renewable hydrogen for fuel.

- “The Science of Acid Mine Drainage and Passive Treatment.” Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation, January 25, 2006.

This article gives a good description of acid mine drainage where it originates, its chemistry, and contemporary techniques for treatment.

- “Electrochemical Treatment of Acidic Aqueous Ferrous Sulfate and Copper Sulfate as Models for Acid Mine Drainage.” Nigel J. Bunce, Michelle Chartrand, and Peter Keech. Water Research, Vol.35, Issue 18, December 2001.

This is an excellent source describing previous attempts at using electrolysis to either increase or decrease the pH of synthetic acid mine drainage. It describes techniques that include using different metals as well as chemicals to attempt altering the solution while preserving cathodes (used in electrolysis).

- “Removal of Arsenic from Synthetic Acid Mine Drainage by Electrochemical pH Adjustment and Coprecipitation with Iron Hydroxide.” Jenny Weijun Wang et al, Environmental Science and Technology, vol. 37, NO. 19, 2003 (American Chemical Society)

This source out lines the approach of a professor at the University of Ontario to the

removal of arsenic and consequentially lowered the pH as well. This is a very good source that uses two techniques to produce positive results.

- “Hydrogen Production” National Renewable Energy Laboratory, US Department of Labor. January 15, 2006. Also available at http://www.nrel.gov/learning/eds_hydro_production.html

This straight forward article gives a good over view of the different ways to produce hydrogen. Including thermo chemical, electronic, electrochemical photolytic, and biological photolytic production methods of hydrogen.

- “Co-Production of Hydrogen and Sulfuric Acid by Electrolysis.” - Maheshkumar Chettiar, PhD Thesis, College of Engineering, University of South Florida, 2004.

This is a great resource that explores, in depth, several way that hydrogen is produced. It also in detail explains the process that was used for the development of electrolysis using sulfuric acid as an electrolyzer to aid the splitting of water. This source goes into detail problems encountered and recommendations for further study.

Specific Goals of the Project

- 1) To determine if there is a change in water quality after electrolysis.
- 2) To measure the energy produced from acid mine drainage compared to the energy produced from other water solutions (ie. hydrochloric acid, alcohol, distilled water etc.)
- 3) To test the feasibility of using a solar array to support an electrolysis unit to clean up acid mine drainage in real world situations.

Methods and Timeline

Spring 2009 1. Set up fuel cell for laboratory testing.

2. To determine if the water quality is enhanced, I would do a water conductivity test as well as testing the PH.

3. Test different hydrogen-producing water solutions for change in water quality and energy produced.

Summer 2009 1. Collection of 10 gallons acid mine drainage.

2. Set up solar array and larger hydrolysis unit

3. To determine the energy produced, I would use the mounted fuel cell under 1 hour of noon day sun to record the amount of time it takes the fan to stop working. This process would be repeated for each of the water solutions and should show a different amount of energy produced (this step will be continued in Fall 2009).

Fall 2009 1. Continue testing and refinement of hydrogen production techniques.

2. If the quality improves I would use the solar array and a customized electrolysis unit to purify larger quantities of acid mine drainage.

3. Continue step 3 from Summer 09.

Spring 2010 1. Present findings and methodology at student research day.

Role of the Student and Faculty Sponsor

This project team consists of one student and one faculty advisor. [REDACTED] will meet with me regularly to fill out my knowledge base, answer questions, process the purchase orders, and provide scientific planning and advising. Student is responsible to carry out the steps outlined in the timeline and methodology section. As well as keeping meticulous records of purchases.

BUDGET PAGE

STUDENT APPLICANT NAME(S): [REDACTED]

FACULTY SPONSOR NAME(S): [REDACTED]

PROJECT TITLE: Green Solution to an Orange Problem: Energy Producing Purification of Acid Mine Drainage

List all items requested for funding and provide a brief narrative to justify requested expense.

\$500.00 Student Fellowship

Name(s): [REDACTED]

Amount: \$500

TOTAL: \$500

\$798.95 Supplies/Materials/Minor Equipment

\$499.00 Pasco Hydrogen fuel cell-product #8573 mounted with solar cell, electrolyzer, fuel cell, and fan

\$299.95 REI (Recreational Equipment Inc.) Solar array - 8 solar cells mounted on mat capable of producing 12-volts of electricity

\$100.00 Travel

Collection and transport of acid mine drainage.

\$30.00 food

\$20.00 camping

\$50.00 gas

\$ 100.00 Other Expenses

Parts for larger electrolysis units including metal plates, nylon bolts, one way valves, and miscellaneous electrical supplies.

TOTAL REQUEST: \$1498.95

FACULTY SPONSOR FORM

This form must be completed by the faculty sponsor(s), printed and signed, and included in the grant package for submission by the application deadline (noon, 10 November 2008). Additional pages are allowed for narrative comments, which will be strongly considered in the review process.

STUDENT APPLICANT NAME(S): [REDACTED]

FACULTY SPONSOR NAME(S): [REDACTED]

PROJECT TITLE: Energy Production in Conjunction With Purification of Acid Mine Drainage

Rate the quality of the project and the ability of the student(s) to carry out and complete the project.

1 Excellent 2 Very good 3 Good 4 Fair 5 Poor

- | | | |
|-------------|--|--|
| Project: | <input type="checkbox"/> 1 Originality of project | <input type="checkbox"/> 1 Significance of the project |
| Student(s): | <input type="checkbox"/> 3 Familiarity with work in the applicable field | <input type="checkbox"/> 3 Ability to organize work |
| | <input type="checkbox"/> 3 Perseverance in pursuing goals | <input type="checkbox"/> 3 Self-reliance and independence |
| | <input type="checkbox"/> 2 Potential to complete project | <input type="checkbox"/> 2 Laboratory skills and techniques, if relevant |
| | <input type="checkbox"/> 2 Ability to work cooperatively with others | <input type="checkbox"/> 2 Ability to communicate effectively |

Rate the student(s)' contribution to this proposal, including originality of ideas, background research, and writing.

< 25% 25-50% 50-75% 75-100%

In the space below (and additional pages, if needed), please comment on the following:

Your role in developing the proposal and how you will facilitate completion of the project.

[REDACTED] approached me in the Spring of 2008 with a strong desire to research energy production using hydrogen fuel cells. My research interests address acid mine drainage (AMD), and for some time I had been pondered whether the production of hydrogen gas from AMD would lead to water quality improvements. This project is the integration of both of our ideas, and [REDACTED] and I are very excited about the possibilities. As faculty advisor on this project, I will provide [REDACTED] with his own lab space, oversee his progress, provide motivation to complete the research, and help him to work through the inevitable challenges that occur in research projects. Ultimately, I will help [REDACTED] to generate a poster presentation for Student Research Day in 2010, and encourage him to give a similar presentation at the Northeast Section Meeting of the Geological Society of America that spring.

The applicant(s) potential to carry out the proposed research or creative activity and the relevance of the project to the applicant(s)' chosen field of study; compare the applicant(s) with other students you have supervised or with other successful students you have known.

I have served as [REDACTED] academic advisor for two semesters. He strikes me as a bright student yearning for a research project that he can put his heart and soul into, as well as a project that has the potential for an environmentally positive outcome. I believe that he is motivated to complete this project. In comparison to some of the students I have supervised, I feel that [REDACTED] is more likely to think and work independently to resolve problems. He is a very good writer and has produced the entire application himself with few comment from me. He has also taken considerable time to acquaint himself with the background literature, which has not always been my experience. I think he will do an exceptional job.

Additional remarks:

Signature of Faculty Sponsor(s): [REDACTED]