CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Kaitlyn A. Arst

Project Number
S1001

Project Title
Using Superabsorbent Biodegradable Hydrogel to Decrease Water Use and Improve Drought Stress on Agronomic Plants

Abstract

Objectives/Goals
The object of this study was to determine whether environmentally friendly hydrogel mixed with soil would retain water, decrease water usage and reduce drought stress on Lima Beans, Peas, and Lettuce plants under simulated drought conditions. 4 experiments were performed 1) To determine whether hydrogel would reduce the amount of water used 2) To determine whether .2%, .4% or .8% hydrogel would be most efficient 3) To determine whether hydrogel application at the roots or at the soil surfaces was most efficient in retaining water 4) To determine whether Lima Beans, Peas or Lettuce would be most tolerant to hydrogel amended soil?

Methods/Materials
Soil was divided into 24 containers. These were then separated into 8 groups of 3 containers per group. The control A group of containers had no hydrogel added to the soil, plants were watered regularly. The control B group of containers, plants was watered once on the first day, no water added afterwards. The third through eight groups of containers, plants had .2%, .4% and .8% hydrogel applied at the root or surface areas of the soil. 15 Lima Bean seeds, 40 pea seeds and 50 lettuce seeds were planted into their appropriate containers The plants were watered when the moisture level were low. The amount of seed germinated were observed and recorded. . The soil content of nitrogen (N), phosphorous (P), potash (K), and pH balance levels were tested.

Results
Soil treated with hydrogel reduced the amount of water usage by approximately 45% when compared with the control A soil which had no hydrogel in the soil. At the beginning of the experiment, control B was able to retain enough moisture for the seeds to germinate, however by the third week the moisture level dropped and the plants started to wilt and die. Although, the moisture level with the .2%, .4% and .8% hydrogel added to the soil were able to retain moisture level higher than the control A, the soil amended with the .2% at the surface of the soil was most effective in retaining water and producing the healthiest plants. The pH balance tests of the soil ranged from 5.5 (Medium Acid) to 7.5 (Alkaline). The N, P and K tests ranged from depleted to surplus.

Conclusions/Discussion
The results show that .2% hydrogel applied at the surface of the soil would be an eco-friendly alternative for use in the agricultural sector to efficiently manage water usage in areas where drought is a considerable problem.

Summary Statement
I applied Eco-friendly hydrogel amendment to the soil of three Agronomic plants to reduce water usage and decrease drought stress.

Help Received
I did the experiment myself after conducting online research. My parents helped with reviewing my work.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Ainesh Arumugam

Project Number

S1002

Project Title

Smart Irrigation Controller Using Computation and Analysis of DGCI of Plants by Image Processing for Water Conservation

Abstract

Objectives/Goals

With the water crisis in California and other places in the world, I started this project with a goal to develop a low cost smart irrigation controller able to significantly reduce water usage, maintain and improve plant health, intelligently adapt, and be efficient. This device should be able to replace standard irrigation controllers and can be applied to both residential and farming applications.

Methods/Materials

The project uses a processing and controlling unit, a camera, and relays to control the irrigation system. To build the prototype, I used a Raspberry Pi B2 and a Raspicam as the main systems. The camera was used to take an image of the vegetation. The processing and control unit was used to segment it, process each pixel in the segment to calculate the DGCI (Dark Green Color Index), a value to measure vegetation health. This generated DGCI value is compared with the THRESHOLD DGCI value, a value corresponding to a level where the vegetation is considered healthy, to generate a watering schedule that will maintain and improve vegetation health. This schedule will be used to control the irrigation system’s start time, duration, and end time through the relay system.

Results

According to my tests and analysis of data, the Smart Irrigation Controller had reduced the water applied for healthy turfgrass and increased the water for dehydrated turfgrass. As the dehydrated turfgrass returned to a normal healthy state in 15 days, the controller reduced the watering schedules according to the DGCI values measured. This resulted in overall healthy vegetation while using 34.17% less water when compared to a timer based standard irrigation controller.

Conclusions/Discussion

The objectives of this project were to develop the necessary hardware and implement the image processing and control software to maintain plant health and have a greater efficiency when watering turfgrass and other vegetation. It was able to detect healthy and dehydrated grass by segmenting and processing the image, and accordingly adjusted the watering schedules. Both objectives were met. Most importantly, the Smart Irrigation Controller was able to save water compared to a standard irrigation controller. In conclusion, my project was able to meet my design criteria.

Summary Statement

By using image processing to measure the health of a plant, the device generates a schedule that will maintain or improve plant health and conserve water significantly.

Help Received

I would like to thank Mr. Tinh Tran of University High School for helping me 3-D print a camera case for my model.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Ricardo A. Beltran

Project Number

S1003

Project Title

Investigation on the Effectiveness of Potential Sorbent Materials When Collecting Oil

Abstract

Objectives/Goals

The goal is to examine and compare the oil collecting effectiveness of three household materials primarily for future potential oil spill occasions.

Methods/Materials

This required a scale, two containers, oil, water, and sorbent materials(sponge, hair, lint)and other materials. The experiment was done by moving sorbent from container to container, weighting the containers, and then by using math finding the results.

Results

Lint was most effective at collecting oil with a ratio of 1 to .05 for the amount collected to amount lost, and while dog hair absorbed more, it also dripped the most oil making it less effective with a 1 to .41 ratio.

Conclusions/Discussion

Finding that lint was most effective at collecting oil helps us understand that previously "useless" byproducts and household materials can be of great use, such as when there's an oil spill or perhaps when oil is spilled in the kitchen. With uses big and small, findings from this experiment have the ability to change the way we see lint, dog hair, sponges and in the future, other available household materials

Summary Statement

As shown by my data, I found that household materials have potential to be sorbents, and that lint was the most effective of the three.

Help Received

My biology teacher, Mrs. Fujimani assisted in working out experimental flaws as well as lending me her scale. My parents also bought the materials, but aside from these things I performed the experiment myself.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Annie C. Benedict

Project Number

S1004

Project Title

Development of a Household Direct-Steam-Generation Solar-Powered Water Recovery System

Abstract

Objectives/Goals

Access to clean water is becoming an increasingly dire issue worldwide, due to rising populations, industrialization, higher living standards, and localized drought. Solar powered water recovery technologies, utilizing free energy to minimize costs and impact on climate change, are viable solutions for obtaining clean drinking water from desalination of ocean or brackish water or reclamation of greywater or field runoff. This study aimed to design, build, and test a small-scale prototype of a self-regulated, sun-tracking solar powered water recovery system for household use.

Methods/Materials

The design is based on the parabolic trough collector (PTC) technology and has various stages to maximize freshwater output. Temperature was measured using DATAQ digital data acquisition system. An additional study was conducted to refine speed of air flow within the prototype. It was hypothesized a peak in water output would occur at intermediate fan speeds, as lower air speeds would stagnate vapor flow and higher air speeds would provide insufficient time within the condensation stage. A secondary study was conducted by altering fan speeds within the air flow stage via different input voltages. A control with no air flow was used as a point of comparison; mass of freshwater output was measured.

Results

Through multiple design revisions, a final system was created and the engineering goal fulfilled. The apparatus has distinct stages for air and/or water flow: evaporation, air flow, recirculation, and condensation. The hypothesis of the secondary study was supported, as one of the intermediate fan speeds (controlled by 9 volt input) provided maximum freshwater output and results were proved statistically significant. When normalized to the mean vapor pressure of the control, data displayed the same trends and further supported the hypothesis.

Conclusions/Discussion

The engineering goal was fulfilled and a working multi-stage, sun-tracking water recovery system prototype was developed. Furthermore, the maximum freshwater output produced by an intermediate fan/air flow speed, when coupled with the DATAQ-recorded temperatures, indicates a necessary balance between temperature and air flow within the evaporation stage. While the current small-scale prototype will produce over 1 liter of freshwater per day, further refinements and scaling up this design will provide enough drinking water for household use.

Summary Statement

This study aimed to design, build, and test a small-scale prototype of a self-regulated, sun-tracking, solar-powered water recovery system for household use.

Help Received

Father aided in device construction; parents paid for research materials. Gibson's Roofing donated Solatube sheeting; Innovative Insulation provided sample of radiant barrier sheeting. Mr. Peter Starodub provided support throughout the process

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Jacquelyn M. Davila

Project Number
S1005

Project Title
A Pair of Biosticks

Abstract

Objectives/Goals
The objective of this experiment is to produce a pair of eco-friendly and effective disposable chopsticks from a food waste-based bioplastic.

Methods/Materials
(9) individual conventional, disposable wooden chopsticks; (9) individual leftover bread-bioplastic chopsticks; (5) individual butternut squash skin-bioplastic chopsticks; (5) individual parsnip peel-bioplastic chopsticks; (1) spring scale; weights (200 g to 1 kg, increments of 100 g); (1) stopwatch; (2) 20 L buckets; (20) Chopstick Consumer Test questionnaires; (20) volunteers; (40) rubber bands;(20) mini-sized, wrapped chocolates; (40) wrapped, Starbursts; (4) small bowl plates

I gathered 4 food materials that were high in starch content, and made starches from 3 of their respective food waste materials. Using silicone putty, I constructed a chopstick mold. I tested different ratios of ingredients commonly used in starch-based bioplastic recipes. After 11 different trials, I found my master recipe for my bioplastic chopsticks. I was looking for a recipe that produced a bioplastic that was malleable, uniform, and hard but not brittle. Using this master recipe, I then tested the 3 different food waste starches by making 3 different varieties of food-waste based bioplastic chopsticks.

Results
The strength test consisted of testing my food waste-based bioplastic chopsticks (biosticks) against wooden chopsticks in five different 30-second trials, ranging from 2N to 10N of force. I then chose the biostick with the highest breaking point in the strength test to compete against the conventional, wooden disposable chopstick in a timed usage efficiency test, where 20 chopstick users transferred rubber bands (noodles) and mini-sized candy (meat pieces) from one plate to another. After, these chopstick users completed a quick consumer questionnaire.

Conclusions/Discussion
I produced my own pair of biosticks that met the performance of conventional, wooden disposable chopsticks, in strength (breaking point), usage efficiency, and consumer input tests. The results of my experiment show that with some improvements, specifically a factory made chopstick molds and a production plan, we can successfully replace wooden disposable chopsticks with biosticks made from safe, biodegradable ingredients.

Summary Statement
I produced and tested a pair of food-waste based bioplastic, disposable chopsticks as a culturally-sensitive solution to help reduce deforestation, petroleum-based plastic pollution, and food waste.

Help Received
I sought the advice of my chemistry teacher and my regional science fair's mentorship program for planning my procedure. I completed my research, and produced and tested my biosticks by myself.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Michele L. Eggleston

Project Number

S1006

Project Title

Is It Clear? Is It Clean? Methods for Testing and Treating Water with Cheap Materials for Use in Developing Countries

Abstract

Objectives/Goals

In some countries, clean water is a luxury and polluted water causes numerous diseases. We became interested in this problem and studied correlation between turbidity and bacterial contamination. We tried to find an easy way to estimate the quality of water and purify it to make it safer to drink.

Methods/Materials

We built a nephelometer with scraps of wood and cheap components. We tested it on milk dilutions and on growing bacterial cultures. We collected sea water from 3 beaches and 3 water ways around San Diego and measured their turbidity using our instrument.

We centrifuged, sedimented and filtrated our samples, measured their turbidity and cultured them on agar plates to estimate their level of bacterial contamination before and after these treatments. Tap water was used as control.

We built filters with plastic bottles, fabrics, coffee filters, pillow stuffing, and packing foam to find out the best material to decrease turbidity and bacterial contamination. Fabric was also washed with dirty water and exposed to the sun for several hours to see if sunlight could kill enough bacteria to reuse these fabrics.

Results

Our nephelometer could measure the turbidity of all samples which was proportional to the amount of particles in suspension in milk dilutions and in bacterial cultures.

Sedimentation, centrifugation and filtration all greatly reduced the turbidity and bacterial contamination of the samples, filtration was the fastest. We also found that there is correlation between turbidity and bacterial contamination

All tested filters decreased turbidity and bacterial contamination, the more layers, the more efficient. At least 4 hours of sun exposure on fabrics washed with dirty water killed enough bacteria to reuse them.

Conclusions/Discussion

Taking into account limited resources in some countries, we managed to estimate the quality of water and treat it by filtration with cheap materials such as pillow stuffing and multi layers of cotton fabric widely available from recycled clothing to improve its quality. We are also working on a bigger filter to handle more than a cup or 2 of water.

Studying life style and customs of less developed areas can help us find even more inexpensive ways of purifying water using local resources. Learning about what microorganisms contribute to water-borne diseases will also help us understand what level of purification is acceptable to obtain relatively safe water.

Summary Statement

I could estimate water quality with a home made instrument and made efficient and inexpensive filters to improve its quality

Help Received

I found a basic design for my nephelometer from the ScienceBuddies site but improved it myself to make it portable and more robust. I designed and performed the experiments myself, some of them in a lab setting for centrifugation and used of incubator)

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Matthew M. Houlihan

Project Number
S1007

Project Title
Water-Wise Farming

Abstract

Objectives/Goals
Less water will be required to grow plants in a healthy environment using an aquaponics farming method compared to a traditional soil farming method. If I grow tomato and lettuce plants using both types of systems, then less water will be necessary using the aquaponics farming method.

Methods/Materials
Two 10-gallon aquariums, two 2.5-quart plastic buckets for grow beds, four tomato plants, four lettuce plants, soil potting mix, lava rock, twenty gold fish, submersible pump, water filter, fish food, light, and water. Measured amount of water used for each grow bed for the growth of healthy tomato and lettuce plants over seven weeks.

Results
The two farming methods used different amounts of water during the seven weeks of testing. The aquaponics farming method started with 32 liters of water and required additional water throughout the testing period. By the end of the testing period, an additional amount of 11.3 liters was added to the aquaponics system. The traditional soil farming system began with 0 liters of water and over the course of the seven weeks, 38.85 liters of water was used. For the seven week period, the traditional soil farming used less water than the aquaponics system. However, based on the steady increase in water use in the traditional farming system, a period of longer than seven weeks would show that the traditional farming method would use more water than the aquaponics farming method.

Conclusions/Discussion
Water conservation has become a way of life in California. Various techniques are sought to reduce the amount of water used, especially within urban areas. Because traditional farming uses the majority of the water in California, alternative techniques to grow fruits and vegetables need to be explored. Based on my experiment, I found that the use of aquaponics systems would substantially reduce the amount of water used to grow fruits and vegetables compared to traditional soil farming. We could yield more plants and use less water if aquaponics systems are used over a long period of time.

Summary Statement
The Water-Wise Farming experiment explores an alternative farming method (Aquaponics) to reduce water use to grow vegetables compared to the traditional soil farming method.

Help Received
The help that I received was from a family friend, Scott Thompson, who assisted me in setting up and constructing the aquaponics and traditional soil farming grow beds.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Atticus J. Humphrey

Project Number

S1008

Project Title

Bromelain Feed Supplement: A Pollution Mitigation Strategy

Abstract

Objectives/Goals

This project sought to determine the bioremediation ability of Bromelain enzyme to reduce nitrogen, potassium, and phosphates from chicken manure.

Methods/Materials

The test chickens were divided into 4 test groups of 25 subjects each. All test subjects were weighed on day 1 and at day 15 to monitor animal health. Feed modification consisted of mixing various concentrations of Bromelain enzyme (0.5g, 1.0g, and 1.5g) added to 2500g of chickenfeed. Each group received feed once daily. Manure was collected once daily. Samples were dried at 90°F for 48 hours and homogenized. Inductively Coupled Plasma (ICP) optical emission spectrometer was used for phosphate and potassium analysis. Homogenized manure was analyzed LECO Machine for nitrogen quantity.

Results

The chickens fed with the 0.5g of bromelain had the greatest reduction in phosphates at 16.4 pounds per ton and in potassium at 17.4 pounds per ton while the control had the highest amount of nitrogen at 31 pounds per ton. The 0.5g of bromelain also showed the greatest weight gain at 4,607g when compared to the control at 3,521g.

Conclusions/Discussion

Bromelain enzyme does not reduce pollutants when compared to enzymes like protease. Bromelain enzyme supplement had a secondary, unexpected effect of increasing chicken growth and meat production. Further study is needed to determine if Bromelain enzyme supplementation increases productivity of laying hens or increased size in broilers.

Summary Statement

I focused on indentifying feed amendments that reduce pollution from chicken manure.

Help Received

I recieved guidence from Mr. Aalto on how to run the statistics of my results.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Christopher D. Isozaki

Project Number

S1009

Project Title

Separating Carbon Dioxide from the Atmosphere to Help Minimize Global Warming: Year1

Abstract

Objectives/Goals

Global warming is one of the world#s greatest challenges and it is clear that reducing emissions will not stop the global warming process. Removing CO2 from the atmosphere is a necessity. The project#s long term goal is to develop a system to be run at a home that can extract CO2 from the atmosphere. The first year goal was to take the first steps towards creating a gas separation system that produces higher concentrations of CO2.

Methods/Materials

A zeolite pressure swing adsorption system design was modified to create a simpler and cheaper single cylinder system to separate the atmospheric gas mixture into two gas streams. One stream was an oxygen rich mixture with Argon and CO2 and the other stream was a nitrogen rich mixture with CO2. Tested using a variation of pressures and hold times. The next step took hydrogen from an electrolysis system and using a fuel cell, combined the hydrogen and oxygen to eliminate the oxygen from the oxygen rich mixture.

Results

The redesigned adsorption system separated the air into two mixed gas streams and achieved the expected 25% of the original CO2 in the oxygen rich mixture and 75% in the nitrogen rich mixture. A critical result was determining an optimal pressure/hold time combination of 20 psi and 20 seconds.

Conclusions/Discussion

The new adsorption process was successful in separating the air into the expected gas mixtures and is a good starting point for the next step of further separation of the resulting gas streams.

Summary Statement

Using the system I have designed and created , that uses technologies such as pressure swing adsorption, I can remove CO2 from the air and concentrate it.

Help Received

While constructing my experiment I received supervision from older siblings and parents.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Ishan Jain; Dillon Jayanthan; Neil Sangha

Project Number

S1010

Project Title

The Engineering of Carbon Dioxide Reduction, Part 2

Abstract

Objectives/Goals

Every year, over two trillion pounds of CO2 are emitted from cars and trucks globally. The goal of our innovation is to reduce CO2 by half through air filtration of the exhaust of a petrol-based automobile.

Methods/Materials

Throughout this procedure, a galvanized steel pipe was filled with flywire mesh capsules containing sodium hydroxide, a chemical compound that has CO2 absorption properties. Metal protrusions were added to each side of the pipe in order to disperse heat.

Results

The cars tested were a 1998 Toyota Camry (inline 4), a 2006 BMW 325i (inline 6), and a 2015 Mercedes CLS63 AMG (V8), which reduced the CO2 emitted by 38%, 44%, and 36% respectively. In all trials executed with the three different types of cars, all showed similar success in the reduction of CO2.

Conclusions/Discussion

Our tests of the wide variety of cars showed that the filter reduced the CO2 emissions by almost 50%. One problem is that we tested in an open environment, which meant that we were not able to exactly measure the gaseous compounds that were being inducted into the engine, going through the exhaust system, and passing through the filter. In the future we will implement an airtight gas analyzer which will measure the exact compounds inducted into the engine and emitted by the exhaust.

The cooler the crystals, the more CO2 they absorb. Since steel is a good conductor of heat, the temperature of the crystals became very high, reducing their efficiency. To address this we added metal protrusions to disperse heat.

Summary Statement

Our innovation filters out CO2 from an automobile using sodium hydroxide, a chemical compound that absorbs CO2 and thus contributes to CO2 reduction.

Help Received

None, my team members and I designed, built, and performed the experiments ourselves.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Shomil Jain

Project Number

S1011

Project Title

Developing an Artificial Turf Field with Thermoelectric Generators for Heat Absorption and Electricity Generation

Abstract

Objectives/Goals

Extreme heat in artificial turf has been well documented. The purpose of this project is to cool the surface of the turf while generating electrical energy. An artificial turf field prototype was developed that utilizes thermoelectric generators to transfer heat from the surface layer of the turf to the base layer and convert the heat to electricity.

Methods/Materials

A wooden container (46 cm x 60 cm x 10 cm) was filled with potting soil, a cardboard frame with 16 evenly spaced thermoelectric generators (TEGs), thermal grease, the artificial turf mat, and black crumb rubber infill. The TEGs were connected in four parallel circuits of four generators in each. Holes were drilled into one side of the box at multiple heights to allow for an accurate measurement of thermal quantities at each layer of the turf structure. A heat lamp was placed 40 cm above the turf box to simulate a daytime environment. Trials consisted of activating the heat lamp and recording measurements of electricity and temperature. Trials were conducted at lengths of 40, 60, 90, and 360 minute intervals. Open-circuit voltage was measured using a multimeter. Temperature gradients at 5 different levels was measured using digital thermometers.

Results

The maximum temperature gradient and electricity generation was 11.1°C and 25.8 mV, respectively. Six rounds of a 150 minute testing period resulted in a consistent direct relationship between the temperature gradient and electricity generated. A statistical test of correlation found a strong correlation between the two data sets with an average R-Value of 0.9623. The correlation between heat and electricity proved that the generators were working as expected.

Conclusions/Discussion

Extrapolation of the data from the prototype to a full scale artificial turf field of 90 m x 120 m resulted in an electrical output of 1.5 MW. This amount of electricity would be enough to power the majority of an artificial turf stadium's power needs, including a scoreboard or LED floodlights, for an extended period of time. In a residential application, an artificial turf lawn would be able to produce enough electricity (60 kW) to power the average American home. In addition, an artificial turf field with thermoelectric generators would also be capable of producing electricity in the night, due to a temperature difference between the surface layer of turf (cold side), and the base layer (warm side).

Summary Statement

I developed a prototype of an artificial turf field that utilized thermoelectric generators to absorb heat from the surface layer of the field and convert the heat to electricity.

Help Received

My science teacher, Cathy Messenger, helped me procure the required materials, and Brian Messenger, an electrical engineer, helped me verify my electrical data and calculations.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Oliver W. LaCapria

Project Number
S1012

Project Title
Removing Nitrogenous Waste from an Ecosystem

Abstract

Objectives/Goals
In my experiment, I set out to find the most efficient way of removing nitrogenous waste from an ecosystem.

Methods/Materials
I set up 7 jars: the first was a control, with neither nitrifying bacteria nor plants, the second and third had nitrifying bacteria only, the fourth and fifth had both plants and bacteria, and the sixth and seventh had only plants. Each day, I added .5 mL of ammonium hydroxide. Then, 24 hours later I would measure the pH, ammonia, nitrite, and nitrate levels. This experimentation lasted 12 days.

Results
All jars, except for the control, were able to remove all forms of nitrogenous waste. This was unexpected in the jar with plants only and in the jar with bacteria only, but I attribute this to contamination of nitrifying bacteria and algae/cyanobacteria, respectively.

Conclusions/Discussion
I found the most effective way to remove nitrogenous waste from an ecosystem. By using a combination of plants and nitrifying bacteria, ammonia, a toxic compound produced by aquatic organisms, can be completely removed from water. This is applicable directly to the aquaculture industry, accounting for 50% or more of seafood consumed annually. By establishing a biological filtration system based on the model ecosystems I designed, one can keep the levels of nitrogenous waste in the water nontoxic to the organisms living there.

Summary Statement
I found the most effective combination of organisms in the nitrogen cycle to remove nitrogenous waste from an ecosystem, which was through an ecosystem with both a nitrate-absorbing autotroph and nitrifying bacteria present.

Help Received
I designed the ecosystems, routine of experimentation, and performed calculations myself. However, Mrs. Corbett, the AP Chemistry teacher at Villa Park High School, and Mr. Hunt, the AP Biology teacher at Villa Park High School, were both very helpful by explaining concepts critical to my experiment.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Juan C. Lara De Nova

Project Number

S1013

Project Title

Bioremediation: The Effect of Oil-Eating Bacteria on the Oxygen Production of Elodea canadensis

Abstract

Objectives/Goals

Objective: To determine the effects of oil-eating bacteria on the bioremediation process of oil spills on Elodea canadensis#s ability to produce oxygen.

Methods/Materials

I used plastic chambers with oxygen sensor probes plugged into Lab Quests and then transferred my data on the Logger Lite Software from Vernier Software and Technology.

Results

It was shown that the experimental plant had produced 17.38% less oxygen than the control plant in the first trial and 12.20% less oxygen in the second trial. The key finding is that the experimental plant began to produce more oxygen when the oil-eating bacteria solution was introduced to its environment. The oxygen production had increased 14.5% in the first trial and 10.3% in the second trial as a result from oil-biodegradation. This variation in oxygen levels produced from an impaired E. canadensis has revealed the negative impact from the oil, but positive effect from bioremediation on its photosynthetic capability.

Conclusions/Discussion

The experimental group had major changes in oxygen production levels. An influential factor was the addition of 10mL of oil that soon created an oil slick on the surface. This prevented natural sunlight from reaching the Elodea Canadensis plants within the water. Some oil was coated on the leaves of the E. canadensis plant, the fundamental location for photosynthesis. Oil also caused water pollution, reducing the water quality. These factors damaged E. Canadensis by reducing photosynthesis. When the oil-eating bacteria solution was introduced to the oil affected plant, it soon began to produce more oxygen than it did when it was harmed by the oil. The bacteria degraded oil molecules and cleared a lot of the oil concentration. This increased the water quality and allowed more sunlight to reach the leaves of the plants. However, this plant had not produced as much oxygen as the control plant in the experimental time frame. Although the biodegradability from the bacteria solution was great, it did not totally eliminate the hydrocarbon and toxic molecules from the environment. Since it only broke a percentage of them down, these molecules are still present in the water and prevent the plant from completely recovering and producing as much oxygen as the control plant.

Summary Statement

I tested the effects of Bioremediation via oil-eating bacteria on the oxygen production of an aquatic plant affected by an oil spill.

Help Received

Summer Science Institute, Allan Hancock College, Riccardo Magni

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Juwon Lee

Project Number

S1014

Project Title

Designing an Environmentally Friendly Fire Retardant and Extinguisher Using Kelp

Abstract

Objectives/Goals

Design an environmentally-friendly fire retardant and extinguisher using Macrocystis pyrifera, a species of kelp, that can substitute toxic chemical fire retardants and extinguishers. Compare the designed fire retardant and extinguisher to other types used today through flame tests and forest fire simulation apparatus.

Methods/Materials

I designed a fire retardant and extinguisher from samples of Macrocystis pyrifera, which were collected at Newport Beach. Macrocystis pyrifera based fire retardant was compared to other fire retardants in a flame test on a Bunsen burner using polyurethane foams and cotton shirt strips. The types of fire retardants were borax, alum, ammonium chloride and sodium bicarbonate, aluminum hydroxide, magnesium hydroxide, magnesium oxide, and Macrocystis pyrifera. The number of swipes over the fire the foam or the cotton strip took to catch on fire was recorded.

Macrocystis pyrifera based fire extinguisher was compared to other fire extinguishers in the market with a forest fire simulation apparatus I created. The types of fire extinguishers were baking soda, soil, Macrocystis pyrifera powder, and dried Macrocystis pyrifera. The number of seconds to fully extinguish the forest fire using each of the fire extinguishers was recorded.

Results

Macrocystis pyrifera#based fire retardant was the third most effective fire retardant for polyurethane foam and the most effective for cotton strips. Dried Macrocystis pyrifera was the most effective for fire extinguishers.

Conclusions/Discussion

The results showed that Macrocystis pyrifera based fire retardant and extinguishers could be an alternative to toxic chemical fire retardants and extinguishers that are being used today. Furthermore, large mounds of kelp overwhelm the California beaches and are left to rot. Using them as a source of natural fire retardant and extinguisher will help the environment by eliminating waste and protecting wildlife from fire.

Summary Statement

Macrocystis pyrifera, a species of kelp, was used to design an environmentally-friendly fire retardant and extinguisher then compared to different fire retardants and extinguishers used today.

Help Received

I used lab equipment at Concordia University under the supervision of Dr. John Kenney. I also got advice from Mr. Ethan Barbour about the scientific process.

Name(s)
Lauren Lum; Victoria Vo

Project Number
S1015

Project Title
The Effect of the Addition of Acetic and Nitric Acids to Natural Dyes on the Electrical Output of a DSSC

Abstract

Objectives/Goals
The purpose of this experiment was to determine the effect of the addition of acetic and nitric acid to two natural dyes, raspberry and azalea, on the electrical output of a dye sensitized solar cell (DSSC). It was hypothesized that DSSCs using dyes treated with acetic acid, rather than nitric acid, would produce a higher electrical output.

Methods/Materials
Major equipment used in the project include raspberry dye, azalea dye, 0.01 M nitric acid, 0.87 M acetic acid, pH meter, hot plate, halogen lamp, and a voltmeter, TiO2 paste and iodine electrolyte. A total of 18 DSSCs were constructed, 6 tested for each of the 3 trials. Each DSSC tested a different type of dye (raspberry control, raspberry-acetic, raspberry-nitric, azalea control, azalea-acetic, azalea-nitric). DSSCs were built using two glass slides acting as the electrodes, one coated with titanium dioxide paste and soaked in the natural dye and the other coated with carbon. The DSSC was placed under the halogen lamp and its maximum voltage (in mV) and maximum current (in mA) were measured and recorded after 5 seconds using a voltmeter.

Results
The experimental mean for the azalea control was 212.1 +/- 53.4 mV, the azalea acetic was 265.1 +/- 38.1 mV, and the azalea nitric was 107.1 +/- 48.8 mV. The experimental mean for the raspberry control was 370.9 +/- 11.2 mV, the raspberry acetic was 402.7 +/- 20.3 mV, and the raspberry nitric was 312.3 +/- 39.3 mV.

Conclusions/Discussion
Overall, the hypothesis was determined to be inconclusive due to insufficient data, high deviations, and small sample size. Though the data showed that the DSSCs using dyes treated with acetic acid produced the most energy, the difference between electrical output of acetic DSSCs and the electrical output of the control (unmodified) DSSCs was not very significant. The nitric acid DSSCs produced significantly less energy. Flaws in experimental design, such as the dilution of the acetic and nitric dyes through the addition of acidic solution or the cracks in the TiO2 paste could have contributed to the inconclusive results.

Summary Statement
Though the data was determined to be inconclusive, the results showed the addition of acetic acid to the natural dyes of the DSSCs produced the most energy.

Help Received
Our chemistry teacher assisted us in our studies of DSSCs. Throughout experimentation, we constructed the the DSSCs and carried out the experiment on our own; however, Mr. Lum helped us when heating the DSSC anodes on hotplates.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Cassandra K. Man

Project Number

S1016

Project Title

The Effect of Visible Light Irradiation on Photocatalyst Mediated Decolorization of Crystal Violet in Wastewater

Abstract

Objectives/Goals

Crystal violet is an organic dye that is a serious, yet untreated pollutant in wastewater. Photocatalysis, the acceleration of a reaction involving light through a catalyst, has been investigated as a means to treat crystal violet. The purpose of the experiment was to determine the effect of visible light irradiation on photocatalyst-mediated decolorization of crystal violet for application in water purification. It was hypothesized that exposure to light and zinc oxide photocatalyst will decompose and decrease the concentration of crystal violet in solution.

Methods/Materials

The experiment required the use of zinc oxide, crystal violet solution, 40W light bulbs, magnetic stirrers, various laboratory glassware, the Spectronic 20D+ Vis-spectrophotometer, and the Ultra-8V Centrifuge. Exposure to light was tested in the study. Three trials of 40 mL 2.5 x 10^-5 M crystal violet, with 0.200 grams zinc oxide photocatalyst, were exposed to light. Every 50 min., for a total of 200 min., 10 mL of the suspension was centrifuged and analyzed in a Vis-spectrophotometer for absorption. Two controls of crystal violet solution exposed only to light and crystal violet solution exposed only to zinc oxide were tested for absorption similarly.

Results

The absorption values of each trial and control were determined through Vis-spectrophotometer analysis, then converted into concentration using Beer#s Law. In order to obtain more representative data, average concentrations of the trials were taken from each 50 min. time interval. The average concentration values were plotted against time, and the samples that underwent photocatalysis decomposed to a greater extent after 200 min. than the controls. Based upon the exponential equation obtained from the data, crystal violet is expected to completely decompose at 2500 min.

Conclusions/Discussion

The concentration of crystal violet solution decreased, signifying decomposition. However, the percentage of decomposition within 200 min. fell short of that obtained using nano-zinc oxide in a 2013 study, showing that zinc oxide, though cheaper, may not be an effective substitute for nano-zinc oxide in purifying wastewater. The concentration of the controls also decreased; hydroxide production through self-ionization of water molecules may have been the cause. These findings warrant a reconsideration of how to most cost-effectively purify wastewater given the various resources needed.

Summary Statement

This project aims to investigate the feasibility, chemically and economically, of photocatalysis to decompose crystal violet dye that is contaminating wastewater supplies.

Help Received

This project utilized equipment (Vis-spectrophotometer and centrifuge) from my high school classroom lab.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Nicole Matthias; Rhiannon Russell

Project Number

S1017

Project Title

The Effects of Additives on Soil Stability

Abstract

Objectives/Goals

The objective of this project was to determine what additives could potentially make saturated soil stronger.

Methods/Materials

We cut 3-inch diameter PVC pipes into 2-foot long sections and drilled five 7/16-inch holes along the length of each pipe. We filled each PVC pipe with either plain soil or a mixture of soil and an additive. The four additives used in this project were sand, polyester fiberfill, construction paper, and compost. After letting the pipes sit in 5-gallon buckets of water until the contents of the pipes were saturated with water, we inserted 4-inch long wooden dowels through the holes of the pipes, simulated an earthquake by dropping them, and then removed the dowels using a force gauge. A higher force measurement reflected a stronger contact force. A lower force measurement reflected a weaker contact force.

Results

The mixture of soil and polyester fiberfill was consistently stronger than soil alone. The other mixtures yielded inconsistent results.

Conclusions/Discussion

The polyester fiberfill appears to have provided cohesion for the saturated soil but it may have also acted as a shock absorber during the agitation. Sand and compost may have caused their mixtures to clump resulting in inconsistent numbers. The paper mixture was more consistent than the sand and compost mixtures but not to the extent of the plain soil and the soil/polyester fiberfill mixture.

Summary Statement

This project is about the stability of soil and soil mixtures when saturated with water and subjected to agitation.

Help Received

Mother helped saw PVC pipes and wooden rods as well as drilling holes into PVC pipes.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Mark Morreale; Nicholas Sercel

Project Number

S1018

Project Title

Investigation of CO2 Enhancement for Kratky Hydroponics in Greenhouses for Low Water Consumption Agriculture

Abstract

Objectives/Goals

The purpose of our experiment was to determine if Kratky grown plants in a controlled green house environment can benefit from controlled increases in the level of CO2 and to better understand how to limit water usage when employing the Kratky method by controlling VPD. Improving crop yield and reducing water usage are increasingly important in drought stricken areas such as California. Growing plants hydroponically may reduce water usage while producing abundant food crops.

Background: The Kratky Method, developed by the Prof. B.A. Kratky of the University of Hawaii, is a non-circulating method of hydroponics that is especially good for water conservation. It is well known in conventional agriculture that increased atmospheric CO2 increases plant growth rate. The Vapor Pressure Deficit (VPD) is a measure of humidity and is defined as the difference between the water vapor pressure and the saturation vapor pressure of water in the air. VPD is known to drive the rate of evaporation in standing water. Black Seeded Simpson lettuce is a cultivar of the species Sativa in the genus Lactuca.

Methods/Materials

We measured how changes in the level of atmospheric CO2 and VPD in small indoor greenhouses affected water usage and the growth rate of Black Seeded Simpson lettuce in Kratky hydroponics. We measured plant mass, plant physical dimensions, and water usage after a controlled growth period. Six plants were placed into each of three separate indoor home greenhouses where light, heat, water, and atmospheric composition were controlled. The CO2 level was varied between greenhouses using CO2 generators in which yeast metabolized sugar anaerobically in an aqueous solution inside the greenhouses. In a control greenhouse there was no CO2 generator and CO2 level was found to be in the range of 400 to 600 ppm. The two variable greenhouses were held at 800-1000 ppm and 1200-1500 ppm of CO2 respectively. Humidity and temperature were recorded in all cases to allow calculation of VPD.

Results

CO2 level was found to be a strong driver of plant growth and VPD was found to drive water consumption.

Conclusions/Discussion

Kratky hydroponic greenhouses with carefully controlled CO2 and VPD levels constitute a promising and environmentally friendly approach to agriculture. Crop yields can be maximized and water consumption minimized through the careful control of CO2 and VPD in this approach.

Summary Statement

We found that careful control of CO2 level and VPD can be used to increase agricultural yield and limit water consumption in Kratky hydroponic greenhouses with strong environmental and productive benefits.

Help Received

Mrs. Sercel taught us about gardening, hydroponics, and greenhouse methods. Alex Sercel showed us how to use Prizm. Dr. Sercel coached us on how to analyze and present data. Mrs. Morreale helped us with our board. We did the work, took the data, plotted it and analyzed it.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Gajan R. Nagaraj

Project Number

S1019

Project Title

Drought or Deluge: Creating a Novel Ground Water Basin for the Efficient, Economic, and Eco-friendly Capture of Runoff

Abstract

Objectives/Goals

With an increasing worldwide population, rapid industrial growth, and exponential commercial growth, water is becoming a scarce commodity. Climate change is causing unpredictable patterns of drought and deluge. A system which can effectively capture runoff is needed to preserve water for future use and to prevent excessive water during rains from causing floods. The goal of this work was to design and implement a novel water harvesting pond for the efficient, economic, and eco-friendly capture of runoff to enable water management through drought or deluge.

Methods/Materials

A novel design for a groundwater harvesting system which could outperform contemporary percolation ponds was created. Rocks in an inverted conical structure were positioned from top to bottom in the system to increase the surface area for water to diffuse and disperse. A carbon fiber filter was added to the surface of the pond, allowing for easier and more frequent desilting and to add to the efficiency. In order to collect data I created a novel soil/sand sampler which is positioned in the system at any point and can accurately collect a sample of any point. I created a parameter to normalize all data values, called effective dispersion factor, which is defined as the moisture content of a sample per unit distance away from the point water is poured and per unit volume of water poured.

Results

Overall the samples from the experimental percolation ponds had an average effective dispersion factor of 4.47, while the control ponds only had an average effective dispersion factor of 1.79. Desilting and redeploying the carbon filter for every trial also speeds the downward flow. Additionally, the experimental system had a greater effective dispersion factor everywhere, meaning it is able to spread water more effectively throughout the surrounding soil both horizontally and vertically.

Conclusions/Discussion

In conclusion, the experimental redeployable layered harvesting pond was more effective by allowing easier desilting, then allowing water to diffuse and disperse efficiently, and being a cost effective scalable solution to contemporary percolation ponds. The experimental harvesting pond has proven to be around 250% more effective in dispersing water. This redeployable harvesting pond is the most efficient method known now which can help communities survive during harsh droughts, deluges, or as a regular water supply.

Summary Statement

This project is about creating a novel ground water basin for the efficient, economic, and eco-friendly capture of runoff to enable water management through drought or deluge.

Help Received

No help asked for. I designed, built, and performed the experiments myself.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Alyssa L. Plese

Project Number

S1020

Project Title

Analyzing Biodegradation of Polystyrene by Mealworms

Abstract

Objectives/Goals

Determine whether mealworms be able to consume greater quantities of a condensed polystyrene variety compared to a non-condensed variety.

Methods/Materials

2.5 grams polystyrene (normal state), 2.5 grams condensed polystyrene , 10 Clear containers ,Yellow mealworms, .5 grams wheat bran. Recorded the mass of the enclosures containing mealworms and polystyrene on daily intervals for one week, averaging the total amounts consumed upon conclusion of the trials.

Results

The mealworms consumed approximately 40 milligrams more of the condensed Styrofoam than the non-condensed over a one week period, for an average of 5 mg more per day.

Conclusions/Discussion

Mealworms are able to consume greater amounts of condensed polystyrene than non-condensed; on a larger scale, this difference in quantities suggests a more efficient method for the biodegradation of polystyrene by mealworms in a sustainable and humane manner.

Summary Statement

Determine whether mealworms can consume greater quantities of condensed polystyrene compared to non-condensed polystyrene.

Help Received

NA

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Cole R. Rabano

Project Number

S1021

Project Title

Mustard Algae: Swimming Pool Pest or Vegetable Garden Growth Enhancer?

Abstract

Objectives/Goals

To prove that if polyphosphates enhance a plant's growth, then mustard algae, a prevalent swimming pool pest containing polyphosphates could be used to enhance the growth of backyard vegetable plants.

Methods/Materials

Place two deck boxes in the backyard in direct sunlight for at least six hours a day. Fill with potting soil and plant kale 1.5" from each other, inserted into a hole 2" deep. Label boxes and plants. Extract mustard algae from infected pool using Max Liquidator. Transfer mustard algae water into two 3-gallon buckets placed in area of part sun/part shade (See logbook on mustard algae cultivation). Water plants daily with 200ml of garden hose water in one watering can for control group and 200ml of mustard algae water in the other watering can for experimental group. Record height of each kale plant every 5-6 days.

Results

After eight weeks, the control group reached an average height of 43.79cm, while the experimental group grew to an average height of 34.2cm and the coloring of the control group was a deeper, healthier green.

Conclusions/Discussion

Experiment did not support the hypothesis because the average growth per week for the experimental group fed mustard algae water was significantly smaller than the control group's growth over the eight weeks. Limiting factors were a) the caterpillar infestation; b) the use of moisture control soil which retained the polyphosphate algae water and caused the roots to grow too rapidly, overdosing on phosphorus and suspending growth; and c) failure to check the PH of the soil--optimal conditions to make polyphosphates available to the plant is 6.5. Limiting factors could be overcome in the future by using different soil to make way for accelerated, steady growth, while monitoring PH levels to keep the soil stable. By taking the findings from this experiment, addressing limiting factors and running another trial, it might still be possible to transform the mustard algae swimming pool pest into a product that enriches and enhances backyard vegetables organically.

Summary Statement

Experiment intended to transform mustard algae, a common swimming pool pest, into an organic, backyard garden growth enhancer.

Help Received

I designed and conducted the experiment on my own. My teacher Mrs. Susan Ackermann reviewed my results. I sought the advice of gardening experts Gary Bollman of Armstrong Garden Centers and Chris Brown of Holywood Hydroponics and Organics to trouble shoot gardening problems and Pool Store

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Amanda T. Roberts

Project Number
S1022

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.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Kaitlyn A. Russo

Project Number
S1023

Project Title
The Effect of Vertical Gardening on Soil Quality

Abstract

Objectives/Goals
The purpose of my science fair project is to determine at which level of vertical gardening the water run-off becomes the most contaminated and is recycle the water an affective way to reduce contaminating run-off.

Methods/Materials
Materials: Two 5-layer Vertical Gardens, 3 bags of Unfertilized Soil, 3 bags of fertilized soil, 160 Radish seeds, The Lamotte water test kit, N-P-K Kit, 1000ml beaker, 2 Black Bins, Window screening, Syringe, Small piping, 2 containers to collect water, 2 wooden planks, Duct tape, Aquarium pump, and 1.5 in tubing
Procedures: Set up the vertical gardens using the 2 bins and place two layers of soil in each: one fertilized, and one unfertilized. Next plant readish seeds. Water as needed but when watering collect the water run-off from bins and test for nitrates and phosphates. Continue first trial for two weeks, then after two weeks start second trial adding a third level. Then after another two weeks conduct another trial but adding another level. Then lastly conduct a fourth trail but this time both vertical gardens will have fertilized soil and you will connect an aquarium pump tyo one of them to recylce the water run-off back up to water again. Plant radish seeds again and then let them grow to maturity, then compare plants from the vertical garden with the pump and the one without one. Record all results

Results
My results were surprising at first becuase instead of the nitrates increasing with each level they decreased, but after further research I found that was because of the denitrafication process. The nitrates from the soil becuase of a heat increase left the soil in to the air. But overall I proved my hypothesis correct.

Conclusions/Discussion
When farmer farm they fertilize, well most of that fertilizer is lost when the water strips the nutrients. Vertical gardens and recycleing cannot only help prevent water pollution of nitrates and phosphates but also save farmers money but recycling the water with all the nutrients back through the soil.

Summary Statement
I used vertical gardens to analyze soil quaity and determine a method to prevent nutrient lose.

Help Received
I used Vertical Gardens that Sherra Vongher provided through a grant program.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Ritika P. Sahai

Project Number

S1024

Project Title

The Reduction of Hexavalent Chromium through the Use of Steel Wool and Ferrous Sulfate

Abstract

Objectives/Goals

To explore methods to reduce/remove the presence of hexavalent chromium in drinking water through use of steel wool filtration and chemical precipitation using ferrous sulfate . Further determine the optimum pH, effective dosage, temperature, reaction times, and other optimal conditions to achieve this.

Methods/Materials

Water from Hinkley tested at 3.1 micrograms per liter was ran through a spectrophotometer to find initial presence of hexavalent chromium.The water was then treated in a steel wool and in a carbon filter. The water was further treated with ferrous sulfate and 5% acetic acid. The water was tested for pH, alkalinity, and hardness level. The resulting water was also run through the spectrophotometer to determine effectiveness of hexavalent chromium reduction.

Results

The presence of iron rusted the steel wool extremely quickly. Sediment formed in all three trials, but there was a lot of chromium left in the sample. The water also turned a yellowish tint which would make it unappealing for consumption. The vinegar and steel wool also turned the water yellow . There was less hexavalent chromium than the iron and steel wool, and the steel wool did not rust. There was some sediment. Both trials with the carbon filter ended up with some of the carbon in the water. The trial with the vinegar had a lower amount of hexavalent chromium than the steel wool, The carbon filter and iron does not seem to be a viable option; there was a lot of iron sediment left in the filter. The vinegar and carbon filter combination seemed to work better than the iron and carbon filter. There was the most transmittance, indicating least hexavalent chromium. The most sediment formed.

Conclusions/Discussion

The best method of reducing the hexavalent chromium was the vinegar and the steel wool filter. Although the vinegar made the water very acidic, it left the least sediment in the water. It also had the best transmittance rate, which means the lowest levels of hexavalent chromium. Since the purpose of this experiment was to find the most cost effective way of treating hexavalent chromium, the use of household items was helpful. However, this method would not be helpful for large scale or for human consumption because the water is extremely acidic. This could be used potentially for growing plant life. It does seem likely that in the future a treatment method can be developed using a better carbon filter.

Summary Statement

Finding the optimum conditions for reducing the known carcinogen hexavalent chromium in drinking water through the use of steel wool and ferrous sulfate.

Help Received

The spectrophotometer used belonged to Apple Valley High School.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Sanjana V. Shah

Project Number

S1025

Project Title

Smart Flood Sensor: Detect, Analyze, and Predict Water Accumulation in City's Drainage System

Abstract

Objectives/Goals

Build a Smart Flood Sensor device that can be used in a network of flow sensors in a city's drainage system to collect, analyze, and predict rain and storm water flow data. Specifically, the device should be able to calculate water flow with 90% accuracy, upload the data periodically to the IoT cloud, and send text alerts to nearby utilities crew if flood levels reach a certain threshold. The analysis software should be able to predict flood at a drain, given the historic and real time flood level buildup at adjacent drains. It should also recommend optimal drain pipe sizes needed to fix the choking points. The software component should be serviceable wirelessly within 25 feet radius.

Methods/Materials

My device uses a Hall Effect based water flow meter, Arduino microcontroller, GSM/GPRS shield, a Bluetooth link for UART connection, and a rechargeable battery (10K mAh), all enclosed in a UL rated waterproof enclosure. It has low power requirements (~20mA idle, 40-60mA operating), small form factor (4.5"x4.5"x2"), and is non-obstructive to water flow. My software running in this device calculates flow rate, connects to thingspeak.com servers, and uploads data in 15 sec intervals. Analysis phase uses my MatLab software and my graph theory algorithm to predict flood levels in the drain network.

Results

I tested my project by installing devices at five different drain openings in my neighborhood streets. During the recent rainy days, these devices successfully recorded water flow data and uploaded them to the IoT servers in 15 sec intervals. In parallel, the analysis software analyzed data every 15 minutes. One of the devices sent a text alert that it has detected an excessive water flow (>350ml/sec) at a drain. HOA was notified to increase pipe capacity at that opening. It also identified a drain where flow was gradually decreasing while other drains showed higher flow rate. HOA was alerted in real time and it was found that debris was the cause. This device saved a flood occurrence in that street. In another case, HOA was alerted of a leaking sprinkler.

Conclusions/Discussion

Regular flooding in city streets proves that the city planners are not connected to what is happening under the ground. My Smart Flood sensor, a low cost (~$220) device, can not only help identify drain openings in city streets that are getting clogged in real time, but can also determine areas where more drain pipes are needed.

Summary Statement

In order to reduce flooding in city streets, I made a Smart Flood Sensor device to collect, analyze, and predict water flow data in city's drainage system.

Help Received

My Home Owners Association for allowing me to test my devices in 5 streets. My Java teacher, Mrs.Debbie Frazier for providing guidance and reviewing the results throughout the project.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Alana R. Tessman

Project Number

S1026

Project Title

Testing (EA) Bioremediation for Treatment of Sumps, Percolation Ponds, and Produced Water Intended for Agriculture

Abstract

Objectives/Goals

The objective of these tests were to determine if a particular type of bioremediation agent (enzyme additive) at the right concentration could effectively reduce toxins in sumps, percolation ponds and produced water intended for agriculture.

Methods/Materials

Collected 57L Produced Water(PW)treated for Ag.use. Filled 7 glass aquariums with 4L each PW, aerated 6 bubbles per minute. Added 1/50(EA)bioremediation agent to 3 tanks, 1/25 (EA) to 3 tanks, 1 control tank. Used 100ml glass collection containers. Took acute readings at 24, 48 and 96hrs. Tested samples using TD-500D (Turner Lab) calibrated to local crude. Added 10ml Hexane solvent to control, agitated 2min, got non-detect reading. Switched to TD-3000, added Hexane to(EA)samples,agitated 2min,unexpected clouding,could not calibrate. Tried waiting 24-48 hrs,still clouded. Took fresh samples to GeoTech Environ.for VOC/PAH testing using miniRae3000. All non-detect even with smell present. Re-evaluated testing method. Obtained new PW samples from source intended for sumps and percolation ponds instead of already treated PW. Had to learn 'Chain of Command' procedure to obtain water. Currently re-testing at Turner Labs and Geotech. Changed testing procedure using surfactant heated to 'cloud point'(140F) to create homogenized oily water sample instead of using solvent and then manually filtering solids. Testing at Geotech same procedure with new samples.

Results

First experiments with treated PW all resulted in non-detect at ppm except control at 0.125ppm. Learned that Hexane solvent can not be used with (EA)bioremediation agent. Researched other testing methods. Currently using untreated new samples of PW, longer testing times, and surfactant 'cloud point' method. Results pending

Conclusions/Discussion

More than 900 percolation ponds exist in the southern Central Valley, most of them in Kern County where I live. Regional water quality regulators plan to issue enforcement actions this year to operators of about 200 local oil field wastewater percolation ponds. If (EA)bioremediation at the right concentration could lower toxicity to acceptable levels,this could improve air quality, lower environmental impact and help oil companies deal with their waste. By testing positive to lowering these levels with untreated PW, I could also predict that this particular enzyme additive agent could lower toxicity of PW intended for agriculture.

Summary Statement

By using an Enzyme Additive bioremediation agent, I hope to engineer an environmentally safe and efficent way to reduce toxins in produced water.

Help Received

I designed the experimental methods and procedures. I worked with a scientist at Turner Labs in Fresno who helped me understand how to use meters and collect viable samples. I also worked with experts from GeoTech Environmental in Long Beach. I took readings with the supervision of these people.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Tyler White

Project Number
S1027

Project Title
Biosand Filter: Which Model Works Best?

Abstract

Objectives/Goals
In my experiment, I am testing the effectiveness of adding charcoal (activated carbon) layers into the traditional biosand filter build and discovering whether the addition of this compound is beneficial to the system. I hypothesized that the charcoal will indeed be a very beneficial component in this apparatus.

Methods/Materials
I used water quality test kits to determine the presence of bacteria, lead, pesticides, nitrates, nitrites, pH, hardness, and chlorine in three different water samples. These samples came from a reservoir at Jim May Park in Santa Maria, a pond inside Waller Park in Santa Maria, and from the Pacific Ocean at Avila Beach, CA. I tested each sample before and after running it through both of the filters. I recorded all the data in tables for each specific sample and analyzed the numbers for any changes or continuities. Then I did my second test where I added lead and a pesticide into tap water and tested the collected water for the presence of those two substances only.

Results
I found that the original filter worked extremely well at filtering out impurities but the modified filter did better, especially at pH and hardness. I found that the pesticide passed through both filters while the lead only passed through the control filter. I had succeeded in filtering out lead from water by using activated carbon.

Conclusions/Discussion
The performance of the modified biosand filter for removing impurities was more effective than that of the traditional biosand filter. This means the modified filter can provide a significant improvement in water filtration systems all over the world, especially in third world countries.

Summary Statement
I modified a biosand filter for the better since it functioned significantly better than the original.

Help Received
None. I designed, built, and performed everything myself.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Erica S. Whiting

Project Number

S1028

Project Title

Digestion of Styrofoam by Mealworms (larvae of Tenebrio molitor): The Effect of a Nutritional Boost

Abstract

Objectives/Goals

A 2015 study showed mealworm degradation of Styrofoam. To extend this, an experiment could discover if mealworm larvae (larvae of Tenebrio molitor), on a Styrofoam diet, would eat more styrofoam when extra nutrient sources were present. This research could provide better methods for dealing with Styrofoam waste.

Methods/Materials

Seven containers were placed in a larger box in the shade of my home at room temperature. Container 1 held only Styrofoam, Container 2 held bran and larvae as controls. Container 3 held Styrofoam and larvae. Container 4 held larvae, Styrofoam and 0.1 grams of brewer#s yeast, a nutritional source. Container 5 held larvae, Styrofoam, and 0.3 grams of yeast. Container 6 held larvae, Styrofoam, and 1.0 gram of yeast. Container 7 held larvae, Styrofoam, 0.3 grams of yeast, and 0.3 grams of powered eggshells, another nutritional source. The styrofoam and larvae masses will be measured every 5-6 days from 12/11/2015-1/11/2016.

Results

The largest decrease in Styrofoam mass was 0.59 grams, in container 6. More development of pupae occurred in containers with brewer#s yeast, specifically 5 and 6. Container 3#s styrofoam decreased 0.50 grams. Container 7 produced no pupae and its styrofoam decreased 0.4 grams.

Conclusions/Discussion

The larvae ate and developed more when the nutrients of Brewer#s yeast were added. This project confirms the knowledge that Styrofoam, previously thought to resist biodegradation, can be biodegraded via mealworm digestion. Degradation is increased in the presence of added nutrients. Further research could show chemically how larvae digest Styrofoam.

Summary Statement

I found that by sprinkling nutrients over styrofoam, there was increased mealworm degradation of that styrofoam.

Help Received

I designed the tanks and setup myself, and my science teacher, Ms. Mary Hines, and her colleague, Ms. Karen Jain, provided the necessary materials.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Jeffrey L. Yin

Project Number
S1029

Project Title
Utilizing Floating Solar Panels to Save Dry Reservoirs: Folsom Lake

Abstract

Objectives/Goals
In 2015, California experienced the worst drought in history and reservoirs have been highly affected by it. Water levels in reservoirs slowly decreased, but there is a solution. Through the use of solar panels and hydroelectric generators, water can be conserved by reducing surface area of water exposed to sunlight and by moving water upstream. The system proposed utilizes a simple two way hydroelectric generator along with a floating array of solar panels. Large arrays of solar panels will be deployed into the lake and will be connected to the hydroelectric pumps to reduce evaporation and produce energy.

Methods/Materials
The materials consisted of a 60W solar panel, water pump and a generator. I designed a prototype model of the generator and the proposed floating solar panels. The solar panel was connected to the generator by wires to produce solar energy for the generator to act as a motor. The motor is what generates motion for the water to transfer from one side to another. The transfer of water was directed through tubes on the water pump.

Results
By comparing Folsom Lake to similar situations where solutions have been applied, the total cost of the proposed Folsom Lake drought solution is preliminarily estimated to be about $400 million. As calculated the Floating Solar Panels would only take up 1/10 of the lake#s surface area to produce the same kWh/year as the Folsom Lake Power Plant. For the water that is covered by the solar panels, evaporation would be reduced up to 70% in that area and Folsom Lake would save a total of 10% or more of water storage. In addition, the solar power would also be utilized to pump water from the American River to Folsom Lake if ever needed.

Conclusions/Discussion
Floating Solar Panels on reservoirs save land, are up to 30% more efficient in generating solar power, improves water quality, reduces evaporation, slows algae growth, and withstands earthquakes. The prototype model was built to illustrate the effectiveness of solar panels in the transfer of water and to study the effect of floating solar panels on top of Folsom Lake. To calculate different numbers and percentages, similar projects were researched for comparison purposes. By focusing our attention on one reservoir can aid other reservoirs with the same issue which is the main goal of this project.

Summary Statement
My project focuses on Folsom Lake, but proposes a solution to save all reservoirs that suffer from drought, evaporation, and lack of water.

Help Received
Professor Zhao at UC Davis helped answer questions that I had about solar energy and its importance on the world. I designed the prototype model and came up with the idea myself.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Annette Chang

Project Number

S1099

Project Title

Turning Harmful Greenhouse Gas Into Valuable Fuel: A Novel Method for Biogas Reforming

Abstract

Objectives/Goals

Biogas represents a promising alternative fuel to combat our increasing dependency on fossil fuels and rising greenhouse gas (GHG) emissions. For my project, I sought to design an efficient biogas reforming reaction in a heat exchanger platform reactor by using metal foam catalysts to reduce GHG emissions and generate a renewable source of electricity.

Methods/Materials

A heat exchanger platform (HEP) reactor is a coupled reforming and combusting reactor integrated with a solid oxide fuel cell. A unique metal foam supported catalyst was developed for implementation in biogas reforming. Six different configurations of the Pd-Rh catalyst were tested in order to optimize the catalyst formula. Parameters of operating temperature, conversion, efficiency, and coke formation were used to determine optimal operating conditions. The HEP reactor was used for testing the applicability of Pd#Rh/metal foam catalyst in a SOFC fuel processor where reforming reaction was coupled with catalytic combustion of SOFC stack flue gas.

Results

Overall, the integrated reaction reduced about 93.5% GHG emission from biogas. Out of all six different sets of reforming catalyst the Pd-Rh/CeZrO2-Al2O3 catalyst was found to be most promising. However, net 80% CO2 conversion was not achieved due to production of CO2 by the reforming reaction. More than 90% methane conversion at temperature above 1023 K was possible over the catalysts with a H2/CO ratio of syngas above 2. Thus, biogas reforming was shown to be an important means of CO2 reduction if used with a suitable catalyst.

Conclusions/Discussion

This project developed two key innovations that enabled the feasibility of the reforming reaction for energy generation: a metal-foam catalyst with reduced coke deposition and deactivation at higher temperatures than commercial catalysts, and a compact HEP reactor that coupled reforming and combustion reactions in a highly efficient and self-sustaining method. Overall, the developed reaction offers two main environmental benefits: renewable electricity generation and significant GHG emission reduction.

Summary Statement

The purpose of my project is to develop an efficient method for biogas reforming in a self-sustaining heat exchanger platform reactor using metal foam Pd-Rh catalyst to generate electricity through solid oxide fuel cells.

Help Received

Used lab equipment at UCR under supervision of Dr. Chan Park