ENVIRONMENTAL ENGINEERING

DIVISION NEWSLETTER

JANUARY - 2018

EED NEWSLETTER

ENVIRONMENTAL ENGINEERING features the Application of ENVIRONMENTAL Technologies to ENGINEERING Systems to attain OPTIMAL Performance according to ESTABLISHED Standards.

The Newsletter of the Environmental Engineering Division (EED) will attempt to highlight a Variety of Environmental Technology Applications aimed at Enhancing Engineering Systems Performances in accordance with the Latest Standards by presenting Excerpts of and Links to Selected Articles from a Variety of Websites. EED Members are encouraged to forward materials on Environmental Engineering topics for review by the Newsletter Editorial Staff. EED Newsletter Readers are urged to forward comments on materials that appear in its content.

The EED Newsletter will feature presentations in **NINE** Sections:

1. ENVIRONMENTAL TECHNOLOGIES
2. ENVIRONMENTAL REGULATIONS
3. EDITORIAL BOARD SELECTIONS
4. CHAIRMAN/DIVISION NEWS
5. NEWSLETTER READER COMMENTS
6. NEWSLETTER EDITORIAL BOARD
7. NEWSLETTER REFERENCES - TECH
8. NEWSLETTER REFERENCES – REGS
9. EDITORIAL BOARD SELECTION REFERENCES

It is envisioned that the EED Newsletter will be Monthly enterprise involving ALL members of the EED in its production. Your participation in providing and reviewing EED Newsletter materials is encouraged and will be greatly appreciated by the EED Newsletter Editors.

1. ENVIRONMENTAL TECHNOLOGIES

1. FRACTURE-RESISTANT CEMENT - 1

A team of German researchers has developed a new type of stronger cement inspired by nanostructures found in sea urchin spines. Sea urchin spines are primarily made up of a brittle material called calcite. They are so tough because softer areas of a material called calcium carbonate surround the crystalline blocks of calcite. This means that when the calcite cracks, the energy moves to the softer layer preventing any further cracking. The

challenge when translating this principle to cement is that cement is a much more disordered structure.

1. ENVIRONMENTAL TECHNOLOGIES

1. FRACTURE-RESISTANT CEMENT - 2

The key was discovering a material that only adhered to the cement particles allowing for this brick-and-mortar effect to be replicated within the cement on a nanoscale. Ten negatively charged peptide combinations were identified as perfect molecules to create a nano-structured cement by a team of scientists at the University of Konstanz in Germany.

Using an electron microscope to analyze and test the resulting optimized cement, the team calculated it to have a fracture resistance value of 200 megapascals, which is approaching the value of steel. The study concludes that this new cement could create concrete that is between 40 and 100 times stronger than current mixes. (Ref 1)

2. GREEN TIRES

Researchers from the University of Minnesota's Departments of Chemical and Materials Engineering and the University of Massachusetts at Amherst's Chemical Engineering Department have come up with a way to make automobile tires from organic matter, including trees, grass, and corn. The process just might shift the tire production industry toward the use of renewable resources. The biomass produced car tires would be identical to existing car tires, with the same chemical makeup, color, shape and performance expectations.

The key to the whole tire production process is isoprene. For decades, tire companies have been looking for ways to produce isoprene from organic matter. The university research team discovered a three-step process that combines biological fermentation with conventional catalytic refining to increase isoprene

production efficiency by 90%. As such, bio-sourced isoprene could expand domestic production of car tires by using renewable, readily available resources instead of fossil fuels. (Ref 2)

1. ENVIRONMENTAL TECHNOLOGIES

3. "PRINTED" WIND TURBINE TOWERS

The average height of wind turbines in the United States is about 80 meters. The taller a wind turbine is the more valuable and productive it is, as taller turbines can capture faster winds aloft. There's a reason that towers tend to max out at about 80 meters, however – the taller they are, the larger the diameters of their towers become - making the segments extremely difficult to transport from the manufacturer to the installation site.

Recently, RCAM Technologies was awarded a $1.25M grant from the California Energy Commission to develop and test 3D printing technology that would allow wind turbines to be constructed directly on site - eliminating the need for trucks to haul the giant tower sections from one location to another. RCAM estimates that a 140-meter wind turbine would increase electricity production by more than 20% at a site with moderate wind shear, thus lowering electricity costs.

Under the terms of the agreement with the California Energy Commission, RCAM Technologies will design the lower half of two wind turbine towers measuring between 140 and 170 meters tall. While the upper halves of the towers will be constructed using conventional tapered steel assembled in sections, the lower halves will be constructed onsite from reinforced 3D printed concrete. Prototype sections of the towers will be 3D printed using a robotic arm and 3D printer and will be tested at the University of California, Irvine.

According to the National Renewable Energy Lab (NREL), the best wind power sites - which are located in the Great Plains - are posting annual capacity factors of more than 50 percent. The rest of the country, however,

isn't meeting the levels needed to compete with other energy technologies such as natural gas and even solar. Taller wind turbines could make a big difference in the wind power levels of the whole country. (Ref. 3)

1. ENVIRONMENTAL TECHNOLOGIES

4. SOLAR SQUARED BUILDING BLOCKS

Renewable Energy experts from the University of Exeter are developing a pioneering new technique that could accelerate the widespread introduction of net-zero energy buildings through the latest Building Integrated Photo-Voltaics (BIPV). These products - similar to the solar tiles created by Tesla - can become a part of a building's architecture to generate electricity.

The team has created an innovative glass block, which can be incorporated into the fabric of a building and is designed to collect solar energy and convert it to electricity. This new technology would allow electricity to be produced at the site of use while being seamlessly integrated into the building. The blocks - called Solar Squared - are designed to fit seamlessly into either new buildings or as part of renovations to existing properties.

They are similar to existing glass blocks that allow daylight to resonate around a property by replacing traditional bricks and mortar with transparent glass bricks. Crucially, however, the Solar Squared blocks have intelligent optics that focus incoming solar radiation onto small solar cells that enhance the overall energy generated by each solar cell. The electricity generated will then be available to power the building, be stored or used to charge electric vehicles of the occupants.

The Exeter team - which has created a start-up company Build Solar to market and produce the pioneering product - is now looking to encourage investment for commercial testing of the product, and aims to take it to market in 2018. The Build Solar blocks may have better thermal insulation properties than traditional glass blocks. The patent pending technology is at prototype stage and the development team members are now in the process of fine-tuning their

component designs in order to test the new block technology at pilot sites. (Ref 4)

1. ENVIRONMENTAL TECHNOLOGIES

5. SOLAR POWERED TRAIN

Visitors to the northern New South Wales coastline in Australia will have the chance to ride on new sustainably powered transport service. The Byron Bay Railroad Company is setting the wheels in motion for what it describes as the world's first solar-powered train - whose roots are traced back to World War II.

The two railcars used in the innovative rail service were originally constructed in 1949 to transport the massive influx of European immigrants arriving in the wake of WWII around the state of New South Wales. The train bodies were created with the same aluminum fuselage construction used for aircraft bombers.

Those two cars sat unused in a yard from the mid-90s until 2013, when the Byron Bay Rail Company took on the task of restoring the heritage trains. The original plan was to power them with diesel. However, the company realized that the rapid, recent advances in solar technologies made going green a possibility

The train rooftops have been fitted with custom-built curved solar panels to charge onboard batteries - which also draw on a regenerative braking system to recapture around 25 percent of energy the train uses to decelerate. The batteries can also be charged at train stations thanks to large rooftop solar arrays on the platforms. Failing that, it can draw power from the grid - which the company states is sourced from a local green energy provider.

With enough capacity for 100 passengers, the train will shuttle riders between two newly constructed stations connecting the coastal town Byron Bay with a nearby arts precinct and luxury resort. Each charge of the batteries is said to

provide enough power for 12 to 15 runs. The train will be making hourly trips, with the service set to begin in January 2018. (Ref 5)

1. ENVIRONMENTAL TECHNOLOGIES

6. "PRINTED" MARINE STEEL

"Marine Grade" stainless steel is valued for its ability to stave off corrosion. Its high ductility makes it a preferred choice for oil pipelines, ships, kitchen utensils, chemical equipment, medical implants, engine parts, and nuclear waste storage products. However, conventional techniques for strengthening marine steel typically come at the expense of ductility. Lawrence Livermore (Ames) National Laboratory researchers have found a way to make Marine Steel via 3D printing. Their new method - proven to work for one of the most common forms of marine grade stainless steel—low-carbon 316L—could lead to new products of high ductility and strength made from the ubiquitous alloy.

To come up with this improved version of 316L steel, researchers first had to overcome a major problem for 3D printing metals. Porosity - created during laser melting (or fusion) of metal powders - can lead to parts easily degrading or fracturing. Researchers addressed this shortcoming by varying the material's density using computer modeling. Using two different laser powder bed fusion machines, researchers printed thin plates of 316L steel for mechanical testing. The laser melting technique inherently resulted in hierarchical cell-like structures that could be tuned to alter the mechanical properties of the material.

The eventual goal of the research is to use high-performance computing to validate and predict future performance of stainless steels - employing models to control the underlying microstructure and discovering how to make high performance steels more corrosion resistant. The work took several years and required the contributions from the Ames Lab - which did X-ray diffraction to understand material performance, from Georgia Tech – which did modeling to

understand how the material could have high strength and ductility and Oregon State - which performed characterization and composition analysis. (Ref 6)

1. ENVIRONMENTAL TECHNOLOGIES

7. PROJECTS OF THE YEAR AT POWERGEN

During the Keynote Session of POWER-GEN International, Renewable Energy World and Power Engineering Magazine named the Energy Storage and Renewable Energy PROJECTS OF THE YEAR. In the energy storage category, Southern California Edison's Hybrid EGT project was the winner. It added battery energy storage at two Southern California Edison natural gas peaking plants consisting of 10 MW/4.3 MWh lithium-ion batteries plus Hybrid Control Systems.

Once online and synchronized, the turbines need only two to three minutes to ramp up to full load. Because they have instantaneous response capabilities, each Hybrid EGT can participate in California's spinning reserves markets fulltime - with no fuel consumption or emissions while the turbine is offline.

In the best renewable project category, China Resources Power won for its Ningxia Haiyuan Xihua Mountain Wind Farm. Built in what the United Nations Food Development Agency dubbed as one of the most uninhabitable places for humans, the 300-MW Mountain Wind Farm combines the development of renewable energy with poverty alleviation and environmental improvement.

The $313.4 million clean energy project can provide 755M KwHrs of power annually while avoiding the use of 326,000 tons of coal! The wind farm spans six towns and 41 villages and brought jobs and economic development to the remote region located some 8,000 feet above sea level. Project developer China Resources Power contributed $3M to plant trees in Haiyuan and also created a five-year plan for the region to develop its grass and cattle livestock industry for which China Resources Group donated an additional $57.5M.

Despite construction taking place during the winter, with temperatures ranging from -4C to -22C, the project was completed in record time. (Ref 7)

1. ENVIRONMENTAL TECHNOLOGIES

8. BEER BOTTLE SAND

DB Breweries of New Zealand has launched "Beer Bottle Sand" - an environmentally friendly campaign designed to encourage the recycling of glass beer bottles. The Beer Bottle Sand project aims to keep recyclable glass out of landfill. The brewery has built a fleet of machines that let beer drinkers instantly turn their empty bottles into a sand substitute. DB Export Beer Bottle Sand will then be supplied to construction companies and commercial partners, reducing the country's dependence on beach-derived sand.

The Beer Bottle Sand Machines reduce an empty bottle of DB Export into sand substitute in just 5 seconds. As the bottle is inserted, a laser triggers a wheel of small steel hammers spinning at 2800 rpm. As the bottle is pulverized a vacuum

system removes silica dust and plastic labels, leaving behind 200 grams of sand product. The brewery is in the process of finalizing a two-year deal to supply DB Export Beer Bottle Sand to Drymix – New Zealand's biggest producer of bagged concrete. Beer Bottle Sand will also be supplied to national road projects as well as commercial and residential construction ventures. (Ref 8)

1. ENVIRONMENTAL TECHNOLOGIES

9. "PRINTED" ARMY HUTS

The US Army Construction Engineering Research Laboratory (CERL) in Champaign, IL, has successfully three-dimensionally printed a 512 square-foot concrete structure. The structure - called a barracks hut or B-Hut - was printed as a result of a three year Army Program called the "Automated Construction of Expeditionary Structures - ACES." It utilizes a new additive manufacturing process to "print" semi-permanent structures in a theater of operation. The ability to use concrete sourced from readily available materials greatly reduces logistical requirements.

The ACES system provides a capability to print custom designed expeditionary structures on-demand - IN THE FIELD - using locally available materials. ACES systems will allow the Army to print buildings and required infrastructure, such as barriers, culverts and obstacles ON LOCATION. The technology has the potential to reduce building materials shipped by half and to reduce construction manpower requirements by 62% compared to expedient plywood construction.

CERL is currently working with NASA to design, build and test a third generation concrete printer that will be delivered in September 2017. NASA plans to explore additive construction of extraterrestrial infrastructure in the future.

ERDC has also established a Cooperative Research and Development Agreement with Caterpillar Inc. to explore commercialization of ACES technology, with the potential application for disaster relief operations and conventional construction.

Unlike previous efforts, ACES can use up to 3/8" aggregate in the concrete mix. In addition, the ACES project paid particular attention to methods of reinforcing printed concrete - both horizontally and vertically.

CERL is an integral component of the U.S. Army Engineer Research and Development Center, headquartered in Vicksburg, Mississippi. (Ref 9)

1. ENVIRONMENTAL TECHNOLOGIES

10. RENEWABLE ENERGY STORAGE - AUSTRAILIA

A system to capture biogas from a wastewater treatment plant, store it as thermal energy and sell it to the electricity grid is among the next wave of projects to receive money from the South Australian (SA) Government Renewable Technology Fund. South Australian company 1414 Degrees has spent almost a decade developing its Thermal Energy Storage System (TESS) technology to store electricity as thermal energy by heating and melting containers full of silicon at a cost estimated to be up to 10 times cheaper than lithium batteries.

The wastewater treatment plant project will use $1.6 million in government funding to help build a 0.25-MW/10-MWh thermal energy storage device that holds heat generated from the combustion of biogas produced on site. SA Water already generated electricity to power its operations from biogas produced by wastewater treatment processing at the site. The 1414 Degrees technology will instead burn the biogas and store the thermal energy, so the heat and electricity can be harnessed to better coincide with SA Water operational needs in times of high electricity demand.

A metric ton of silicon can store enough energy to power up to 28 houses for a day. Its high latent heat capacity and melting temperature of 1414 C make silicon ideal for storing large amounts of energy. The process also generates clean useable heat that can be utilized for district heating or industrial purposes.

South Australia is a particularly good laboratory because it's one of the first places in the world where a very large proportion of renewable energy is exposing the issues around incorporating these technologies into the electricity grid. South Australia leads the nation in the uptake of wind energy and rooftop solar with renewable sources accounting for more than 40% of the electricity generated in the state. (Ref 10)

2. ENVIRONMENTAL REGULATIONS

1. MODEL SMART CITY DRIVES RESEARCH ON FUEL EFFICIENCY

To meet future demands for enhanced fuel efficiency, a professor at the University of Delaware has created his own miniature Smart City to test algorithms of connected autonomous vehicles (CAVs).

Andreas Malikopoulos, in the university's Department of Mechanical Engineering, is the team leader of a three-year, $4.2 million ARPA-E project to research how CAVs can optimize fuel consumption using data from other vehicles together with their own sensor and onboard camera data. The goal of his experiments is to slash fuel consumption of an Audi A3 E-tron by 20 percent.

Malikopoulos runs one facility where his team has installed six driving simulators that help represent real-world driving conditions in cities. The combination of human drivers in the simulators and virtual drivers provides Malikopoulos a test bed to study interactions between CAVs and human-operated vehicles.

In a second laboratory, the university has constructed a 1:24 scale "Smart City" that spans 20 square feet where 35 autonomous mini-cars execute different traffic scenarios. The simulators and scaled Smart City work in tandem by allowing researchers to create algorithms through the simulators and then test them in miniature city. The next step could be real-world testing in a city like New York.

For help with research, Malikopoulos receives support from the Delaware University Center for Fuel Cells and Batteries and has also partnered with the University of Michigan, Boston University, Bosch Corporation and the Oak Ridge National Laboratory. (Ref 1)

3. EDITORIAL BOARD SELECTIONS

1. CLEANING EXHAUST FROM MODERN ENGINES

As cars become more fuel-efficient, less heat is wasted in the exhaust, which makes it harder to clean up the pollutants being emitted. Researchers at The University of New Mexico (UNM), Washington State University (WSU) and the Pacific Northwest National Laboratory (PNNL) have created a catalyst capable of reducing pollutants at the lower temperatures expected in advanced engines.

Catalysts have been an integral part of diesel and gasoline-powered engines since the mid-1970s as federal regulations called for reductions of carbon monoxide, hydrocarbons and nitrogen oxides. Catalytic converters convert the pollutants to benign gases such nitrogen, carbon dioxide and water. The research team addressed the daunting challenge of designing a catalyst that could endure engine exhaust temperatures of up to nearly 750 degrees Celsius (about 1,500 degrees Fahrenheit) encountered under high engine loads. Yet, the catalyst would still have to work when an engine is started cold.

The work builds on research that found a novel way to trap and stabilize individual platinum atoms on the surface of cerium oxide, a commonly used component in emissions control catalysts. The so-called single-atom catalyst uses costly platinum more efficiently while remaining stable at high temperatures. For their latest test, the researchers steam-treated the catalyst at 750 degrees Celsius which is nearly 1,400 degrees Fahrenheit. This made the already stable catalyst become very active at the low cold-start temperatures and able to meet the

challenges of both the high-temperature stability and the low-temperature activity. (Ref 1)

(CONTRIBUTED BY DR. JAMES ZUCCHETTO, EED NEWSLETTER ASSOCIATE EDITOR)

4. CHAIRMAN/DIVISION NEWS

EED will be sponsoring a Joint Meeting with the St. Louis, MO Section of ASME and is currently looking for a Speaker for the event. The meeting will be scheduled in either February or March of 2018 at the Engineers Club in St. Louis, MO. We are looking for a speaker to present for 1-2 hours on an environmental topic such as Remediation/Superfund sites. If you are interested please email Ryan at ryanneil84@hotmail.com with a potential topic and availability.

5. EED NEWSLETTER READER COMMENTS

YOU ARE ENCOURAGED TO FORWARD YOUR COMMENTS ON THE TOPICS AND DISCUSSIONS PRESENTED IN THE EED NEWSLETTER. PLEASE FORWARD YOUR COMMENTS BY EMAIL TO ANY MEMBER OF THE EED NEWSLETTER EDITORIAL BOARD. THEIR EMAIL ADDRESSES APPEAR IN THE SECTION BELOW

6. EED NEWSLETTER EDITORIAL BOARD

DR. JAMES ZUCCHETTO – USA (jimzuc@comcast.net)

7. NEWSLETTER REFERENCES - TECHNOLOGIES

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9. EDITORIAL BOARD SELECTION REFERENCES

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NOTE: IN ORDER TO VIEW THE REFERENCES LISTED ABOVE, IT IS NECESSARY TO SWIPE OVER THE REFERENCE TEXT ON YOUR SCREEN – THEN COPY THE REFERENCE TEXT – AND THEN ENTER THE TEXT COPY INTO A WEB ADDRESS AREA ON A SECOND WINDOW SCREEN TO VIEW THE REFERENCE MATERIAL.

DISCLAIMER

Disclaimer: This Newsletter may contain articles that offer differing points or views regarding energy and environmental engineering issues. Any opinions expressed in this publication are the responsibility of the Editor, Editorial Board

and the Environmental Engineering Division and do not represent the positions of the American Society of Mechanical Engineers (ASME).

DIVISION NEWS – SPECIAL ANNOUNCEMENT

ASME Enhances Environmental Impact Through EED Education Support Program

PROPOSAL DUE DATE: FEBRUARY 15, 2018

Environmental engineers use the principles of engineering, soil science, biology, and chemistry to make the air, water and land better and safer for humans. To engage students and educators in this discipline, and foster the impact of environmental engineering education in communities around the world, the ASME Environmental Engineering Division (EED) Announces the 2018 Environmental Engineering Education Support Program. This program will fund a maximum of $25,000 per year. No more than five proposals will be funded with a limit of $5,000 per award to students, educators and EED members who propose interesting ways to impact environmental education in their communities. Based upon judgment of final reports, at least one proposer will be invited to discuss their project at the annual EED meeting. All travel expenses will be provided.

Examples of Environmental Engineering Education Support Program Proposals

- **Funding an EED Member Paired with a Local Educator to Develop a Curriculum Unit Over a Summer that can be Put Into Practice the Following School Year. EED Members will Share Units that are Successful with Other Educators.**
- **Funding support for a non-ASME member educator (Primary and/or Secondary School Teacher) to Attend an ASME Sponsored Environmental Event (e.g., Conference, Training/Certification Program, Workshop, etc.) in Support of Curriculum Development.**

- **Funding of a Project Based on Environmental Engineering and Mechanical Engineering Principles that Appears Promising for Enhancing Environmental Education.**
- **Funding Support for a College, or a Graduate Student to Attend an ASME Sponsored Environmental Event (e.g., Conference, Training/Certification Program, Workshop, etc.).**

DIVISION NEWS – SPECIAL ANNOUNCEMENT

ASME Enhances Environmental Impact Through EED Education Support Program

This will be the THIRD YEAR that EED has funded an Education Support Program. Projects supported in the first two years of the program were:

- **"*Wind Energy Student Organization;*" Iowa State University (ISU)**
- **"*Lab Component for Sustainability Course,*" Philadelphia University**
- **"*Using Interactive iPython Simulations to Model Life Cycle Analysis of Ethanol Production,*" Marshalltown High School (Iowa), ISU**
- **"*High School Student Laboratory Education Module: Use of Abundant Waste Materials in Concrete Mix Design,*" University of Akron**
- ***"Education of Rural Community Members and Leaders About the Health Effects, Current State, and Minimizing of Particulate Matter Exposure in Rural Households that Use Biomass for Cooking,*" FEU Institute of Technology, Manila, Philippines**
- ***"Experimental Design: Development of a High School Environmental Research Program, "* Hope College, Holland, MI.**
- ***"Water for Life: A Project-Based Approach to the 7th Grade Classroom,"* Mission Achievement & Success Charter School, Albuquerque, NM**
- ***"Citizen Science: Effects of Stream Restoration on Water Quality,"* George Mason High School, Falls Church, VA**
- ***"Designing a Sustainability Makerspace,"* Rose-Hulman Institute of Technology, Terre Haute, IN.**

PROPOSALS - INCLUDING A BUDGET - MAX 5 PAGES - MUST BE SUBMITTED ELECTRONICALLY BY 15 FEB 2018 TO:

edelsonm2@asme.org

PROJECTS THAT PAIR AN EED MEMBER WITH AN EDUCATOR WILL RECEIVE THE HIGHEST PRIORITY. EXPECTATION IS THAT THE MAJOR SHARE OF FUNDING WOULD SUPPORT EFFORTS OF THE EDUCATOR.