ENVIRONMENTAL ENGINEERING

DIVISION NEWSLETTER

MAR - 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 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. METALLIC NANOFOAM PULLS HYDROGEN OUT OF WATER

Water electrolysis hasn't quite made it to industrial scale yet, mostly due to the costs of those catalysts and the high-energy input required to trigger the reaction. Washington State University (WSU) researchers used nickel and iron, two cheap and abundant metals, as a catalyst. They created a nano-foam, a material that resembles a sponge on the atomic level. With a large amount of surface area making contact with the water, the nano-foam is able to efficiently trigger reactions, and the team found that the material worked better and required less energy than more expensive catalysts. (Ref 1)

1. ENVIRONMENTAL TECHNOLOGIES

2. AMERICA TO AUSTRALIA BIO-FLIGHT

Qantas flight QF96 departed from Los Angeles and arrived in Melbourne 15 hours later. What made the trans-Pacific flight special is the fact that it was the first time an airliner flying from the US to Australia was powered – at least partially – by biofuel. The Boeing Dreamliner 787-9 was running a blend of 90 percent traditional jet fuel and 10 percent biofuel, the latter of which was derived from a non-food type of mustard seed known as Brassica Carinata. According to Qantas, the biofuel is reportedly capable of reducing carbon emissions by over 80 percent as compared to regular jet fuel. This means that the *blended* fuel used in this week's flight should have resulted in a 7 percent reduction, which works out to 18,000 kg (39,683 lbs) in reduced carbon emissions. Developed by Canada's Agrisoma Biosciences, the Carinata mustard plant can be grown on fallow land unsuitable for other crops, or between regular crop cycles – not only does it reportedly improve soil quality and reduce erosion, but it also provides farmers with an additional source of income. (Ref 2)

3. SMOG-FREE TOWER IN POLAND

First installed in Rotterdam and Amsterdam, and then moving onto Beijing in 2016, the pollution-sucking Smog-Free Tower is now headed for a park in Krakow, Poland. The tower stands 7 m tall and 3.5 m thick and creates a localized bubble of cleansed air by releasing positively charged ions into the air. These cling to fine particles, which are sucked back inside the tower and attracted by a negatively charged surface. Scientists at the Eindhoven University of Technology studied the effectiveness of the Smog Free Tower and found it can capture up to 70 percent of PM10 particles and up to 50 percent of PM2.5 particles. The tower is claimed to use no more electricity than a water boiler. The particles that the tower captures are collected and compressed into cubes for jewelry, which can be made available for order. (Ref 3)

1. ENVIRONMENTAL TECHNOLOGIES

4. WORLD'S MOST INNOVATIVE GAS FIELD

A new Marcellus gas well today yields almost twice as much gas as the same well with similar latitude/ longitude in Haynesville field, East Texas - the second largest producing gas region in the United States. The main driving factor behind such a steep increase in output is a constantly evolving technology that is being applied in the region. Some of the drilling techniques of Appalachian producers have never been seen anywhere in the world. Arrival of super laterals (as long as 20,000 feet long), multiple well drilling (typical pad currently expected to contain dozen wells), prop pant with the latest crush resistance and high conductivity allowed Appalachian rig operators yield an average sixty percent more gas per well compared to 2014 levels. Move towards "walking" rigs that could literally get up and walk from one part of the pad to another substantially reduced the drilling time. It currently takes just few days as opposed to months to complete a well all the while achieving a 50% increase in efficiency of a drilling operation. (Ref 4)

5. POWERFUL NEW BATTERY

A multi-institution team of scientists led by Texas A&M University has discovered an exceptional metal-oxide magnesium battery cathode material. Magnesium is much more abundant than lithium, has a higher melting point, forms smooth surfaces when recharging, and has the potential to deliver more than a five-fold increase in energy density. The team's futuristic solution hinges on a redesigned form of an old Li-ion cathode material, vanadium pentoxide, which they proved is capable of reversibly inserting magnesium ions. This rare phenomenon is achieved by limiting the location of the magnesium ions to relatively uncomfortable atomic positions by design, based on the way the vanadium pentoxide is made -- a property known as meta-stability. This meta-stability helps prevent the magnesium ions from getting trapped within the material and promotes complete harvesting of their charge-storing capacity with negligible degradation of the material after many charge-recharge cycles. (Ref 5)

1. ENVIRONMENTAL TECHNOLOGIES

6. CONVERING METHANE TO OLEFINS

USC scientists have unlocked a new, more efficient pathway for converting methane -- a potent gas contributing to climate change -- directly into basic chemicals for manufacturing plastics, agrochemicals and pharmaceuticals. They used a catalyst called H-SAPO-34, derived from a class of nano-porous crystals called zeolites. This simple method of converting methane directly to ethylene and propylene, or olefins, would replace what are traditionally expensive and inefficient processes that add greenhouse gases to the atmosphere. (Ref 6)

7. MERCURY HIDDEN IN PERMAFROST

A new study found all frozen and unfrozen soil in northern permafrost regions contains a combined 1,656 gigagrams of mercury, making it the largest known reservoir of mercury on the planet. This pool houses nearly twice as much mercury as soils outside of the northern permafrost region, the ocean and the atmosphere combined. The release of mercury could have far-reaching global consequences. Mercury released into the atmosphere can travel large distances and could affect communities and ecosystems thousands of miles away from the release site. (Ref 7)

8. WIRELESS ENERGY SOURCE

In March 2017, a group of physicists at the Clemson Nano-materials Institute (CNI) invented the Tribo-Electric Nano-generator, or TENG -- a device made of plastic and tape that generates electricity from motion. When the two materials are brought together, a voltage is generated in a wired, external circuit. Electrical energy can then be stored in a battery. Nine months later, the researchers have developed a WIRELESS version of the TENG device - the W-TENG - that generates a max voltage of 3000 volts. Because the voltage is so high, the W-TENG generates an electric field around itself that can be sensed wirelessly. Its electrical energy can then be stored wirelessly in capacitors and batteries. (Ref 8)

1. ENVIRONMENTAL TECHNOLOGIES

9. LAND - BASED POLLUTION FROM MICRO-PLASTICS

Tiny plastic particles also present a threat to creatures on land and may have damaging effects similar or even more problematic than in our oceans. Researchers from the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB) and their Berlin colleagues warn: the impact of micro-plastics in soils, sediments and the freshwaters could have a long-term negative effect on terrestrial ecosystems throughout the world. Over 400 million tons of plastic are produced globally each year. It is estimated that one third of all plastic waste ends up in soils or freshwaters. Most of this plastic disintegrates into particles smaller than five millimeters, referred to as micro-plastics, and breaks down further into nanoparticles, which are less than 0.1 micrometers in size. In fact, terrestrial micro-plastic pollution is much higher than marine micro-plastic pollution -- an estimate of four to 23 times more. Sewage is an important factor in the distribution of micro-plastics. In fact, 80 to 90 per cent of the particles contained in sewage, such as from garment fibers, persist in the sludge. Sewage sludge is then often applied to fields as fertilizer, meaning that several thousand tons of micro-plastics end up in our soils each year. (Ref 9)

10. SOLAR FUELS PRODUCTION

For years, solar-fuel research has focused on developing catalysts that can split water into hydrogen and oxygen using only sunlight. The resulting hydrogen fuel could be used to power motor vehicles. Since the only thing produced by burning hydrogen is water, no carbon pollution is added to the atmosphere. In 2014, researchers at CALTECH developed a water-splitting catalyst made of layers of nickel and iron. Researchers hypothesized that the nickel layers were responsible for water splitting. When you take away some of the water, the reaction slows down, and you are able to take a picture of what's happening during the reaction. Those pictures reveal the active site of the catalyst -- the specific location where water is broken down into oxygen -- and showed that iron was performing the water-splitting reaction, not nickel. (Ref 10)

1. ENVIRONMENTAL TECHNOLOGIES

11. UNIVERSITY OF MARYLAND (UMD) SUPERWOOD

Researchers at the University of Maryland (UMD) using a new "densification" process have managed to make "Super Wood" that has the strength of steel. Super Wood gets its super strength through a two-step process. First, the researchers boil samples of wood in a watery mixture of sodium hydroxide and sodium sulfite, which works to partially remove lignin and hemicellulose from the material. The treated wood is then hot-pressed, which causes the cell walls to collapse and forms highly aligned cellulose nano-fibers. The end result is a Densified Wood, which is much stronger than the natural stuff. At the beginning of the process, the wood can be bent and molded into desired shapes. The new wood to step is a cheaper, lighter and more renewable alternative to steel. Super Wood could be used in cars, airplanes and buildings. Soft woods like pine or balsa, which grow fast and are more environmentally friendly, could replace slower growing but denser woods like teak in furniture or buildings. (Ref 11)

12. SHARK SCALES FOR WIND TURBINES & AIRCRAFT

A team of biologists and engineers at Harvard University and the University of South Carolina has shed light on a mystery about sharkskin. The mako shark - the fastest shark in the world – has small scales, or denticles that have three raised ridges, like a trident. Using micro-CT scanning, the team imaged and modeled the denticles in three dimensions. Next, they 3-D printed the shapes on the surface of a wing with a curved aerodynamic cross-section. The researchers tested 20 different configurations of sizes, rows and row positions on airfoils inside a water tank. They found that in addition to reducing drag, the denticle structures - acting as vortex generators - achieved lift-to-drag ratio improvements of up to 323%. The results open new avenues for improved, bio-inspired aerodynamic designs for wind turbines and aircraft. (Ref 12)

1. ENVIRONMENTAL TECHNOLOGIES

13. CELLULOSIC BIOFUEL CROPS

A new report provides agronomic data for five cellulosic feedstocks. The project was backed by the U.S. Department of Energy and the Sun Grant Initiative and evaluated the bioenergy potential of switchgrass, miscanthus, sorghum, energycane, and prairie mixtures in long term trials spanning a wide geographical area. Researchers say the new results are very valuable for producers. Crops were grown for 5 to 7 years in multiple locations and with varying levels of nitrogen fertilizer. A group of statisticians within the research team used field-based yield and environmental data to create maps of yield potential for the five crops across the US. According to the new results, the greatest yield potentials for lowland switchgrass varieties are in the lower Mississippi valley and the Gulf coast states, whereas miscanthus and prairie mixture yields are likely to be greatest in the upper Midwest. The researchers made all the data available online for anyone to access. (Ref 13)

14. DESALINATION MEMBRANE PRODUCES WATER & LITHIUM

A team of scientists from Australia and the US has developed a new water desalination technique that can not only make seawater fresh enough to drink, but recover lithium ions for use in batteries. The key to the process is a metal organic framework (MOF), which has an immense surface area. It is this intricate internal structure that makes MOFs perfect for capturing, storing and releasing molecules. Lithium ions are abundant in seawater, so this has implications for the mining industry who currently use inefficient chemical treatments to extract lithium from rocks and brines. MOF membranes offer the potential for a very effective way to extract lithium ions from seawater. The technique could also be put to work filtering wastewater from industrial processes like fracking. Water from shale gas fields in Texas is rich in lithium. MOF materials could turn this waste stream into a resource recovery opportunity. (Ref 14)

1. ENVIRONMENTAL TECHNOLOGIES

15. DRY LAKE CO2 EMISSIONS

Temporary lakes and ponds emit CO_2 all year –- even when they are dry -- and dry areas actually emit a larger amount of carbon into the atmosphere. This phenomenon could have an impact on the global carbon cycle that controls Earth's climate according to a study at the University of Barcelona, and the Catalan Institute for Water Research. In the study, the experts analyzed fluxes of CO_2 and methane (CH_4) - two gases with a powerful greenhouse effect - in small temporary ponds on the island of Menorca - with a wide range of hydrological properties and hydro-periods (duration of wet phases) that oscillated between several months and some days or weeks. The temporary ponds emit CO_2 during the whole year, according to the study. The amount of CO_2 released from these ponds - around 2 kg of CO_2 per square meter per year - multiplies the effects of fluxes of CO_2 coming from waters in lakes, reservoirs and lagoons. (Ref 15)

2. ENVIRONMENTAL REGULATIONS

1. NEW MARITIME FUEL STANDARDS

In 2020, a regulation by the International Maritime Organization (IMO) will require ship fuels to contain 80-86% less sulfur. A new study in *Nature Communications* quantifies the resulting health benefits and finds cleaner shipping fuels will result in a 3.6% reduction of childhood asthma globally. The study was led by University of Delaware and included a team of researchers from the Finnish Meteorological Institute (FMI), Rochester Institute of Technology (RIT) in New York and Energy and Environmental Research Associates. Roughly 14 million annual cases of childhood asthma are estimated to be related to global ship pollution using current fuels. The change to cleaner ship fuels will reduce the ship-related childhood asthma cases by 50%. (Ref 1)

2. ENVIRONMENTAL REGULATIONS

2. NEW OZONE DATABASE

Although ozone pollution is dropping across many parts of the United States, Europe and Japan, many people living in those countries still experience more than a dozen days every year in which levels of the lung irritant exceed health based standards. That's one conclusion from a new health assessment based on the Tropospheric Ozone Assessment Report (TOAR) - an effort by the International Global Atmospheric Chemistry Project to create the world's most comprehensive database of surface ozone observations from all available ozone monitoring stations around the globe. The international scientists who compiled and analyzed the global ozone pollution database hope it will give scientists and public health managers better insight on trends and patterns of human health exposure around the world. TOAR is the largest database of surface ozone from hourly observations at more than 4,800 monitoring sites worldwide and the data is freely available to anyone who wants to investigate the impact of ozone on human health, vegetation, and climate. (Ref 2)

3. OPTIMAL BRIDGE REPAIR - 1

Using probabilistic modeling and analysis, as well as advanced computer simulation, researchers at Lehigh University developed the tools and techniques necessary to assess the effects of multi-hazards, such as natural disasters, on infrastructure. They found optimum solutions that can save money, time and even lives. Deck, pier and foundation failure are the three most common bridge failure modes. However, the risk assessments of bridges exposed to hazards to date have typically included only one or two of these modes. Considering only one or two failure modes provides an incomplete picture because the risk level of each mode differs and, when assessed together, they compete with each other.

2. ENVIRONMENTAL REGULATIONS

3. OPTIMAL BRIDGE REPAIR - 2

For example, the addition of retrofit measures to prevent deck dislodgement decreased the probability of failure of the deck, and, in turn, the bridge. However, it increased the probability of failure of the foundation. Since the consequence of a foundation failure is larger, the overall risk is increased. Given aging U.S. infrastructure, limited public resources and the challenges created by a changing climate, the need to understand the most cost-efficient approach to the design, construction and maintenance of structures is more important than ever. (Ref 3)

4. MEGACITIES DATABASE

The European Union Joint Research Center (JRC) has launched a new tool with data on all 10,000 urban centers across the globe. It is the most comprehensive database on cities ever published. Globally, more than 400 cities have a population between 1 and 5 million. More than 40 cities have 5 to 10 million people, and there are 32 'megacities' with above 10 million inhabitants. There are some promising signs for the environment: Cities became 25% greener between 2000 and 2015. And although air pollution in urban centers was increasing from 1990, between 2000 and 2015 the trend was reversed. The data is free to access and open to everyone. It applies big data analytics and a global, people-based definition of cities, providing support to monitor global urbanization and the 2030 Sustainable Development Agenda. The information gained from the JRC is used to map out population density and settlement maps. Satellite, census and local geographic data are used to create the maps. The city centers database was showcased for the first time at the 9th annual World Urban Forum in Kuala Lumpur. The World Urban Forum was created by the United Nations Human Settlements Program in 2002 to examine rapid urbanization and the impact this has on communities, economy and area climate. (Ref 4)

2. ENVIRONMENTAL REGULATIONS

5. DUTCH BREAKTHRU ON CONCRETE WALLS

Akke Suiker, professor in Applied Mechanics at Eindhoven University, has developed a model with which engineers can now determine the dimensions and printing speeds for which printed wall structures remain stable. His formulae are so elementary that they could become commonplace in the fast-growing field of 3D printing.

Using his equations, Suiker is able to calculate how quickly he can lay down printing layers, given the material curing characteristics and wall dimensions. He can also calculate how to make the structure with as little material as possible, and what the influence of structural irregularities is. The equations can also be used to explore what happens when one makes a wall slightly thicker or increases the material curing rate, or uses a completely different material.

All told, there are about 15 to 20 factors that one has to take into account, but because Suiker has scaled his equations, he was ultimately left with just five dimensionless parameters.

“The insights provided by the model create essential basic knowledge for everyone who prints 3D structures,” said Suiker. “For structural designers, engineering firms but also, for example, for companies that print thin-walled plastic prostheses of small dimensions, because that is where my equations also apply." Suiker validated his model with results of tests done with the 3D concrete printer at Eindhoven University of Technology, carried out by his PhD student Rob Wolfs.

Wolfs also developed a computer model at the same time as Suiker compiled his formulae, with which one can calculate the wall structural behavior during the printing process based on the finite-element method. Fortunately, the results from their independently developed models readily confirm one another. (Ref 5)

3. EDITORIAL BOARD SELECTIONS

PHOTOENZYME HELPS ALGAE PUMP OUT FUEL

Finding enzymes in nature that convert plant oils into fossil fuel–like hydrocarbons could lead the way toward harnessing new energy sources. After observing that the freshwater alga *Chlorella variabilis* can convert fatty acids into alkanes or alkenes, a team of researchers from France decided to investigate how it accomplished this feat.

The researchers detected a particularly abundant hydrocarbon-forming enzyme that appeared to be located in the *C. variabilis'*schloroplast membrane, says study leader Frederick Beisson, who researches algae metabolism at the Institute of Biosciences and Biotechnologies at Aix-Marseille University. So they expressed the protein in *E. coli* to test its function, and used mass spectrometry to get a close look at its mechanism of action. The enzyme turned out to be capable of converting a range of fatty acid substrates into hydrocarbon chains, but only under blue light.

The researchers were surprised to find that the new enzyme - dubbed fatty acid photodecarboxylase - captures energy directly from light, in contrast to enzymes whose expression is regulated by light. "It wasn't something we were expecting," remarks Beisson. Additionally, unlike enzymes that need just a flash of light to become active, the new enzyme only works under continuous light, making it an addition to a mere handful of known "photoenzymes."

The production of hydrocarbons is a well-studied process in algae, Gunther Knör, a chemist at Johannes Kepler University in Austria, thinks that photoenzymes could be used to more efficiently produce hydrocarbons in light-driven artificial systems in the near future: "This would be a breakthrough for solar fuel generation inspired by nature."

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

4. CHAIRMAN/DIVISION NEWS

EED is pleased to announce a joint event with the St. Louis Section of ASME. Please consider attending if you are in the area.
When: Wednesday March 7, 2018
5:30pm-6:00 Sign-in and Networking
6:00-7:00 Dinner and Presentation from EED Board Member Martin Edelson
7:00-8:30 Presentation from Dr. Mark Fitch on Lead Mining and Remediation
Where: Engineers Club of St. Louis, 4359 Lindell Blvd, St. Louis MO 63108
Cost: Free RSVP: www.asmestlouis.org or Ryan Neil at ryanneil84@hotmail.com

Dr. Mark Fitch is a Professor at Missouri S&T in the Environmental Engineering program. His areas of research are Remediation of Lead and Treatment of Air Pollution by Membrane Bioreactors. Dr. Fitch has been a Senior Environmental Engineer at Burns & McDonnell and an Environmental Scientist/Remedial Project Manager with the USEPA in Region 7. He advises the S&T chapter of Engineers Without Borders, which works with communities in Latin America.

5. EED NEWSLETTER READER COMMENTS

FORWARD YOUR COMMENTS ON PRESENTATIONS IN THE EED NEWSLETTER BY EMAIL TO ANY MEMBER OF THE NEWSLETTER EDITORIAL BOARD. THEIR EMAILS APPEAR IN THE SECTION BELOW.

6. EED NEWSLETTER EDITORIAL BOARD

7. NEWSLETTER REFERENCES - TECHNOLOGIES

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