ASIA-PACIFIC

AUSTRALIA

Scientists retrofit diesel engines to use hydrogen as fuel

Engineers at the University of New South Wales (UNSW) have successfully retrofitted a diesel engine to use hydrogen as a fuel in order to reduce carbon emissions. The team spent 18 months developing the dual-fuel injection system, which uses 90 percent hydrogen as fuel but is confident that future retrofits could be completed in a matter of months.

Electrified transport has been getting a greater push in recent months, with states and countries banning the sale of internal combustion engine-powered vehicles over the next decade. While this is a positive beginning, there is still a need to rapidly advance technologies that can replace the larger and long-haul vehicles that do the heavy lifting across industries.

Retrofitting existing vehicles

Retrofitting existing diesel engines would be a fast way to transition to a cleaner fuel-burning system to get the job done.

Hydrogen can be far more environmentally friendly when created using renewable energy rather than by burning fossil fuels like diesel. The research effort led by Shawn Kook, a professor at the School of Mechanical and Manufacturing Engineering, has demonstrated to have reduced carbon dioxide emissions to 90 g/ kWh, which is about 86 percent lower than that produced by a diesel-powered engine.

How does the dual fuel system work?

The team has retained the engine's original diesel injection and directly added a hydrogen fuel injection to the cylinder. Interestingly, the team's efforts also found a way to avoid the high nitrogen oxide (NOx) emissions associated with hydrogen engines.

Instead of putting hydrogen into the engine and letting it mix well, the researchers found that its stratified addition significantly reduces NOx emissions. This means that the hydrogen presence is more in certain parts of the engine while being less in other parts. Overall, the nitrogen oxide emissions, causative of acid rain and air pollution, were reduced in the dual-fuel engine.

More importantly, unlike hydrogen fuel cell systems, the dual fuel system developed by the UNSW researchers does not require high-purity hydrogen as fuel. Since producing high-purity hydrogen is expensive, the new system could be deployed at lower costs for the end users.

An added benefit is the increase in energy efficiency over existing diesel engines, which the researchers reported to have improved by as much as 26 percent. This was achieved by independently controlling the injection timings of both fuels.

The research team is confident of commercializing the technology within the next two years and plans to first deploy it in industrial locations, such as mining sites, where piped hydrogen lines already exist. Following this, the team will look to make its technology more mobile, which will necessitate the installation of a hydrogen storage system.

https://interestingengineering.com/

INDIA

New approach to using solar energy for EV charging

Researchers from the Indian Institute of Technology Guwahati have developed optimized control schemes for active power distribution networks, allowing for the coordinated operation of photovoltaic (PV) power generation and electric vehicle (EV) charging stations.

Dr. Sanjib Ganguly, Associate Professor, Department of Electronics and Electrical Engineering (EEE), IIT Guwahati, along with his research scholar Arunima Dutta and colleague Dr. Chandan Kumar, have recently published their research in the Journal of Sustainable Energy, Grids and Networks.

Electric vehicles are being increasingly explored as a solution to the transportation sector's carbon emissions. The sustainability of EVs can be enhanced if the power used to charge these vehicles is also based on renewable energy sources such as solar energy. However, solar energy is intermittent, which leads to voltage fluctuation problems in the power distribution networks. Furthermore, EV charging is uncoordinated at present, which may lead to under-voltage of the distribution networks, and associated efficiency loss, according to an IIT Guwahati press statement.

Voltage control approach

A coordinated control approach for power distribution systems is required to derive maximum benefits from renewable power generation and electric vehicle power sourcing. PV and EV inverters need to work in coordination with other Voltage Regulating Devices (VRD) to regulate the system voltages.

Highlighting his research, Ganguly said, "We have developed an optimization-based coordinated voltage control approach of power distribution networks, to mitigate the overvoltage and under-voltage problems due to high PV generation and high EV charging, respectively."

The research team has developed a three-stage model predictive control (MPC) approach to scheduling the charging of EVs and other devices. The three stages comprise coordination of the volt-var devices in two different time scales; reception of the reactive power set points by the local controller, and EV charge scheduling in accordance with the balance between the operating cost and customer satisfaction, as per the release.

https://www.thehindubusinessline.com/

Cheaper EV batteries

Given the abundance of zinc in India, researchers at IIT-Madras are developing mechanically-rechargeable zinc-air batteries as an alternative to Lithium-ion batteries which are used in electric vehicles.

In a significant development for electric mobility and the larger stationary battery

storage ecosystem in India, researchers at the Indian Institute of Technology, Madras, are developing mechanically-rechargeable zinc-air batteries as an alternative to lithium-ion (Li-ion) batteries.

After filing for patents, the researchers from IIT-Madras' Department of Chemical Engineering, led by Dr. Aravind Kumar Chandiran, are collaborating with major industries, to develop zinc-air batteries. Compared to existing Li-ion batteries, the researchers at IIT-Madras claim that their zinc air counterparts have a longer shelf life, are cheaper, safer, and can be used in two or three-wheeler electric vehicles (EVs).

"In our laboratory at IIT-Madras, we invented low-cost, safe metal-air battery systems based on zinc. These metal-air batteries are nearly three times cheaper. Moreover, the technology has been developed in-house. The country has abundant amounts of zinc, making it unique. This creates possibilities for India to own the technology and have the safest technology for its next-generation energy storage systems. These batteries can potentially be used in EVs for low-powered applications like two-wheelers and three-wheelers and stationary energy storage systems," says Dr Chandiran.

"Speaking of stationary energy storage, solar energy is available during the daytime, and that energy peaks around midday and weans off towards the end of the day. We use batteries to store that excess energy available at midday. So far, we have options based on lead-acid or lithium-ion battery technologies. But India does not own any of these technologies, so we will have to move to our in-house technologies with resources available domestically. Zinc is found abundantly in India and we are also one of its largest producers," he added.

Powering Zinc-Air batteries

Akin to petrol stations for IC-engine vehicles, the researchers are mooting separate 'Zinc Recharge Stations.' Using 'Battery-Swapping' technology, EV users can swap used 'zinc cassettes' of the battery for fully-charged 'zinc cassettes' at these 'Zinc recharge stations.'

Elaborating on this aspect, Dr. Chandiran says, "This is a major advantage of the zinc-air batteries as currently the only option available with the lithium-ion batteries is that the entire used battery pack must be removed and swapped with a complete lithium-ion battery pack. This results in double the capital investment in the case of lithium-ion batteries."

In other words, unlike Li-ion batteries, zinc-air batteries require only anode swapping rather than the entire battery.

Advantages of Zinc-Air batteries

Zinc is cheaper than Li-ion batteries. Researchers note that while Li-ion batteries cost USD 200 to 250 a KWh, zinc-air batteries cost around USD 150 KWh. With wider usage, the price is expected to fall below USD 100 KWh. They add that these batteries are water-based, and have a longer shelf life and high turnaround efficiency.

"Zinc-air batteries can offer better range. We are still testing their cycle life, but expect them to serve for a couple of thousand cycles. They do not require a dry atmosphere to fabricate batteries like Li-ion batteries. Zinc-air batteries can also be fabricated in ambient conditions, so there is less investment in CAPEX. They are yet to be tested on the road," explains Dr Chandiran.

Besides zinc-air batteries, there are other alternatives that are being considered for the Indian EV market. For example, there is sodium-ion, which experts believe is "cheaper than lithium-ion cells by about 30-40%". Besides cheaper costs, there are other advantages associated with sodium-ion like its availability in India, battery capacity, and environmental impact.

In developing zinc-air batteries, researchers at IIT-Madras have offered India another option for self-sufficiency in fulfilling its electric mobility and stationary battery storage requirements.

https://www.manufacturingtodayindia.com/

MALAYSIA

Powered by RISE develops in-house technology and expertise to produce EV chargers

With the government's focus on vehicle electrification as one approach to achieve carbon neutrality by 2050, the private sector has many opportunities to engage and contribute to the development of various areas ranging from the sale of zero emissions vehicles to being energy providers. Supporting areas, such as the network of charging points, need to be developed quickly to accelerate adoption of electric vehicles (EVs).

Local tech start-up Powered by RISE is one of the many new companies that is engaged with their new product called ONE RISE. It is said to be one of Malaysia's first EV charging stations that is fully equipped with its own payment system.

Powered by RISE not only installs charging stations but also develops its own chargers and applications utilizing IT expertise. This enabled the company to build in-house knowledge of the technologies and tailor its products to meet the requirements of its customers more closely. Not relying on other companies to supply products and technology also means that Powered by RISE can have more control over the quality and performance of its chargers.

ONE RISE has a comprehensive range of advanced features including an integrated payment system that supports e-wallet payment methods, a user-friendly interface, and safety features like automatic shut-off mechanisms that prevent overcharging and overheating. It also features an AI camera as a security measure to detect numberplates and motion tracking. This added layer of security ensures the car's and the user's safety.

It also incorporates built-in safeguards that protect against electrical faults and other safety issues, which is critical given the presence of high voltages.

Additionally, ONE RISE is the world's first charging station to implement flooding and fire detection and prevention systems.

"Our charging station is powered by sustainable energy sources, reflecting our commitment to environmental sustainability, and facilitating the transition to a clean energy ecosystem. Through our efforts, we aim not only to promote the use of renewable energy but also to encourage the adoption of eco-friendly practices and pave the way for a more sustainable future in Malaysia," said Kray Chong, Founder and Director of Powered by RISE.

"To accelerate the global transition towards sustainable transportation, it is crucial to provide electric vehicle users with convenient and hassle-free charging experiences. With our 'Powered by RISE' solutions, EV users can easily initiate charging sessions by downloading our All-in-One app from Google Play Store or Apple Apps Store. The app is simple and offers real-time monitoring of energy transfer, remaining charging time, and session cost, all accessible from their smartphone, which further enhances user convenience. This innovative solution represents a significant milestone in promoting the widespread adoption of EVs and a greener future," he said.

To date, Powered by RISE has installed more than 14 EV charging ports, with an additional 130 units nationwide in the pipeline. This will contribute to the government's expectation of 10,000 charging points being available nationwide by 2025.

https://www.thesundaily.my/gear-up/

REPUBLIC OF KOREA

New electrode production technique for high-capacity EV batteries

A joint team of researchers developed a new type of electrode using carbon fiber paper to increase the durability of high-capacity lithium metal secondary batteries commonly used in electric vehicles. The new paper-type batteries have the potential to prevent battery combustions, that could trigger catastrophic accidents.

Lithium-ion batteries' anode material plays a crucial role in the operation of the power bank by storing ions from the cathode inside the battery and discharging them to generate electric current. Theoretically, lithium metal anode materials can greatly improve the capacity of batteries by up to 1,000 percent.

However, the lithium-based electrodes can form lithium dendrites, an uneven deposition of lithium crystals, which can damage the separator membrane and trigger combustions. It is virtually impossible to extinguish lithium-ion battery fires, and the best way is to wait until all lithium is burnt off.

The Korea Institute of Science and Technology (KIST) said that its researchers collaborated with other researchers from the Gwangju Institute of Science and Technology (GIST) to develop the carbon fiber-based paper electrode. The anode consists of thin carbon fiber paper film containing lithium metal. To prevent lithium dendrites from forming, the film was coated with sodium carbonate and amorphous carbon nanoparticles.

Through tests, a conventional lithium anode wrapped in a thin copper film was short-circuited after about 100 charge-discharge cycle tests but the new carbon fiber paper anode was stable after more than 300 test cycles. The energy density was increased from the conventional lithium-ion battery's 240 watt-hours per kilogram to 428 watt-hours per kilogram.

"The anode material developed by the joint research team is a great achievement that can accelerate the commercialization of durable and lightweight lithium metal batteries, considering that the density of carbon is about five times less than that of copper and its price is also cheaper,".

https://www.ajudaily.com/

Revolutionary Lithium-ion battery technology

POSTECH-Sogang University joint research team develops layering-charged, polymer-based stable high-capacity anode material.

The electric vehicle market has been experiencing explosive growth, with global sales surpassing $1 trillion (approximately 1,283 trillion Korean Won/KRW) in 2022 and domestic sales exceeding 108,000 units. Inevitably, demand is growing for high-capacity batteries that can extend EV driving range. Recently, a joint team of researchers from POSTECH and Sogang University developed a functional polymeric binder for stable, high-capacity anode material that could increase the current EV range by at least tenfold.

A research team led by POSTECH professors Soojin Park (Department of Chemistry) and Youn Soo Kim (Department of Materials Science and Engineering) and Professor Jaegeon Ryu (Department of Chemical and Biomolecular Engineering) of Sogang University developed charged polymeric binder for a high-capacity anode material that is both stable and reliable, offering a capacity that is 10 times or higher than that of conventional graphite anodes. This breakthrough was achieved by replacing graphite with Si anode combined with layering-charged polymers while maintaining stability and reliability.

High-capacity anode materials such as silicon are essential for creating high-energy density lithium-ion batteries; they can offer at least 10 times the capacity of graphite or other anode materials now available. The challenge here is that the volume expansion of high-capacity anode materials during the reaction with lithium poses a threat to battery performance and stability. To address this issue, researchers have been looking towards polymer binders that may successfully restrict the volumetric expansion.

However, research to date has focused solely on chemical crosslinking and

hydrogen bonding. Chemical crosslinking involves covalent bonding between binder molecules, which solidifies them, but it has a fatal flaw: once broken, the bonds cannot be restored. On the other hand, hydrogen bonding is a reversible secondary bonding between molecules based on electronegativity differences, but its strength (10-65 kJ/mol) is relatively weak.

The new polymer developed by the research team not only utilizes hydrogen bonding but also takes advantage of Coulombic forces (attraction between positive and negative charges). These forces have a strength of 250 kJ/mol, much higher than that for hydrogen bonding, but they are reversible, making it easy to control volumetric expansion. To effectively bind with the anode, the layering-charged polymers are arrayed alternately with positive and negative charges, and the surface of high-capacity anode materials is mostly negatively charged. Furthermore, the team introduced polyethylene glycol to regulate the physical properties and facilitate Li-ion diffusion, resulting in a thick high-capacity electrode and the maximum energy density found in Li-ion batteries.

https://scitechdaily.com/

KINGDOM OF SAUDI ARABIA

AI to speed up development of greener fuels

Computers can be taught to generate mixtures from a set of target properties using an inverse mixture-design approach based on machine learning. KAUST-developed technology could be used to identify high-performance transportation fuels with minimal atmospheric carbon dioxide (CO_2) emissions.

Most of the increase in global temperatures can be attributed to greenhouse gas emissions. The combustion of hydrocarbon fuels, such as gasoline, which power most automotive engines, is a major source of CO_2 emissions.

Engineering transportation fuels with higher efficiency and reduced carbon emissions is a viable answer to these environmental problems.

Numerous methods for fuel screening have been developed; however, they are typically only proven on smaller blends or call for additional preprocessing, making these combinations unsuitable for inverse fuel design.

Kuzhagaliyeva, Mani Sarathy, and colleagues built a deep learning model that consists of numerous smaller networks dedicated to certain tasks in order to effectively screen fuels.

"*This problem was a good fit for deep learning that allows capturing nonlinear interactions between species*," stated Kuzhagaliyeva.

The researchers used the inverse-design method to identify possible fuels by first defining combustion-related characteristics, such as fuel ignition quality and sooting propensity.

Few experimental data are available to the general public. To train the model, the researchers created a large database utilizing experimental measures from the literature. The database included all kinds of pure compounds, substitute fuel blends, and complex mixtures, like gasoline.

The researchers had to incorporate vector representations into the model as no model could be modified for inverse fuel design, according to Kuzhagaliyeva. They created a mixing operator that directly connects hidden representations of pure compounds and mixes through linear combinations.

This mixing operator was inspired by text processing methods that use hidden vectors to connect words to phrases. They also included search algorithms to find fuel mixes within a chemical space that match the predefined parameters.

The model correctly predicted the fuel ignition quality and the sooting propensity of different molecules and mixes. Additionally, it found several gasoline blends that met the predetermined standards.

The team is now improving model accuracy by adding new properties to the property database, like volatility, viscosity, and pollutant generation. The technique is being improved to create synthetic aviation fuels and e-fuels for gasoline.

https://www.azorobotics.com/

SINGAPORE

5G projects in EV manufacturing, river cleaning

Singapore will see three new applications of 5G technology this year, including two firsts in electric vehicle manufacturing and river cleaning.

Singapore's first two 5G standalone networks have reached 95 per cent nationwide outdoor coverage, ahead of a 2025 target for nationwide coverage.

In one project, more than a hundred 5G-enabled robots are being deployed to transport materials to vehicle manufacturing cells on the factory floor of the Hyundai Motor Group Innovation Centre in Singapore.

The 5G technology will allow for real-time data transmission between the automated control system and the robots. It will reduce labor-intensive activity, enhance workers' safety and allow them to take on higher-value roles.

River Cleaning Vessels

In another new project, IMDA and Weston Robot will collaborate to use 5G-enabled electric unmanned surface vessels for river cleaning and inspection.

Currently, river cleaning is done manually from petrol-fueled boats. Each boat emits up to 20 tons of carbon per year and costs S$6,000 to S$12,000 a year to maintain.

The electric vessels can run autonomously and use video analytics to detect and clear trash outside of the pre-programmed paths. They will also reduce carbon emissions by 80 percent compared to the gasoline boats.

https://www.channelnewsasia.com/

EUROPE

FRANCE

Low-cost method of generating green hydrogen

Green hydrogen is needed as a fuel for the decarbonization of transportation as well as for the energy sector and the chemical industry, particularly fertilizer production. However, the hydrogen production cost currently limits its use on a large scale.

Researchers from Swansea University and Grenoble Alpes University (Université Grenoble Alpes) have joined forces to develop a practical way to produce green hydrogen using sustainable catalysts. This could be a major step towards making green hydrogen production simpler, more affordable, and scalable, according to researchers.

In their work, the team used natural enzymes – hydrogenases – to generate green hydrogen, using sunlight. Hydrogenases are biological catalysts that can reversibly convert protons and electrons into hydrogen at low overpotentials without the use of precious metals.

Unlike synthetic catalysts based on precious metals like platinum, hydrogenases contain only earth-abundant elements such as iron and nickel. However, researchers say these enzymes are very sensitive and quickly deactivate when exposed to air, making their practical use nearly impossible.

Now, the team has developed engineered solvents that enable hydrogenases to function in the air. Simply placing hydrogenases in these solvents, instead of water, makes them more active and stable so that they can be practically used to generate hydrogen.

"We integrated synthetic nanoparticles with natural enzymes into so-called hybrid materials, which combine the best of both worlds to achieve new, superior functionality. TiO2 nanoparticles are excellent at using sunlight to generate charges, and hydrogenases are extremely efficient in using these charges to generate green hydrogen," said Dr. Christine Cavazza, senior scientist at CEA Grenoble. "*Combining the two, therefore, allows for the efficient generation of green hydrogen from sunlight, something none of the separate components are capable of.*"

The research brought together Swansea University's expertise in photocatalysis, solvent design, and its focus on delivering practical solutions to complex problems and combined this with knowledge of extracting natural enzymes and utilizing them for renewable energy conversion at the Alternative Energies and Atomic Energy Commission (CEA) and Université Grenoble Alpes (UGA).

Using sustainable catalysts such as hydrogenases instead of expensive platinum can lower the cost of electrolyzers and fuel cells, making green hydrogen more affordable to produce and use. It also lowers dependence on imports, which can be disrupted by external factors.

https://www.inceptivemind.com/

GERMANY

Ammonia-based systems for mobile energy

Researchers at the Fraunhofer Institute for Microengineering and Microsystems IMM are developing ammonia-based systems for a mobile, decentralized energy supply in the infrastructure, transportation and industry sectors.

An alternative to fossil fuels is power-to-X fuels, which are synthesized from electrolysis-based hydrogen.

To date, ammonia has primarily been known as a source material for agricultural fertilizers. However, it is also a high-quality energy carrier, notably as a storage medium for hydrogen.

The conversion of hydrogen into ammonia is a viable option for using it as an energy source both on-site for industrial processes on a large scale as well as on a decentralized basis in the logistics sector.

As part of the Spaltgas project, researchers at Fraunhofer IMM and their project partners are developing a combustion technology for this gas mixture that will be used in the brick firing process. Ammonia produced from hydrogen via electrolysis can thus be used to make the entire brick manufacturing process chain carbon dioxide-free. The Spaltgas project is funded by the German Federal Ministry of Education and Research (BMBF) as part of the "Klim-Pro-Industrie" program.

Ammonia can also be used for supplying hydrogen to land vehicles. It can be converted into hydrogen right at the filling station using decentralized plants. This eliminates the need to transport compressed and liquefied hydrogen—a costly and complex process.

To this end, Fraunhofer IMM is developing a cracking reactor based on innovative catalyst technology and microstructure reactor technology. In this reactor, pure hydrogen is produced from ammonia through cracking and subsequent purification, which is then injected into PEM fuel cells. Hydrogen for use in fuel cell vehicles can therefore be produced sustainably from ammonia right at the filling station.

The AMMONPAKTOR reactor from Fraunhofer IMM, which was financed by the State of Rhineland-Palatinate using ERDF (European Regional Development Fund) funds, is also the most efficient reactor on an international scale. Even in its first generation, the cracking reactor achieved the second-highest specific hydrogen production rate ever published, owing to Fraunhofer IMM 's unique technology.

The second-generation cracking reactor, which is currently in the manufacturing process and has a throughput of 25 kg/hour of ammonia, produces 70 kilos of purified hydrogen per day. It was exhibited at the Hannover Messe 2023.

In addition to supplying hydrogen to land vehicles, ammonia is also of interest for maritime propulsion systems because conventional fuels have failed to achieve the CO2 reduction goals in this sector, and there are numerous applications where compressed or liquefied hydrogen cannot be used as an alternative. Partially cracked ammonia can be combusted in (ship) engines, in the same way that Spaltgas reactors can.

Furthermore, as part of the ShipFC project, Fraunhofer IMM is collaborating with 13 European consortium partners to develop the world's first ammonia-based fuel cell system for maritime applications.

https://www.greencarcongress.com/

USA

Hydrogen-powered train engine

As the United States shifts away from fossil-fuel-burning cars and trucks, scientists at the U.S. Department of Energy's Oak Ridge and Argonne national laboratories are exploring options for another form of transportation: trains. The research focuses on zero-carbon hydrogen and other low-carbon fuels as viable alternatives to diesel, for the rail industry.

Researchers from the multidisciplinary team kicked off the project and celebrated the installation of rail technology company Wabtec's single-cylinder dual-fuel locomotive engine in the National Transportation Research Center, a DOE-designated user facility located at ORNL.

Both laboratories have entered into cooperative research and development agreements with Wabtec, described in an ORNL news release, as a leading manufacturer of freight locomotives. The Argonne and Wabtec agreement also includes Convergent Science Inc., a software developer. The project will run for four years.

Hydrogen as a fuel has many advantages, but locomotive engines must be modified to ensure safe, efficient, and clean operation. The team will develop hardware and control strategies for the engine, which will run on hydrogen and diesel fuel to demonstrate the viability of using alternative fuels.

"We are excited to be a part of this collaboration because it addresses the need to decarbonize the rail industry by advancing hydrogen engine technology for both current and future locomotives," said Josh Pihl, an ORNL distinguished researcher and group leader for applied catalysis and emissions research. "It is also a perfect example of how a DOE-funded collaboration between industry and national laboratories can accelerate the development and commercialization of technologies to help reduce carbon emissions from transportation."

Pihl said the project aligns with the goals of DOE's Vehicle Technologies Office to use low-carbon fuels in hard-to-electrify transportation sectors. While electrifying vehicles is an effective strategy in reducing carbon emissions from some parts of the transportation sector, railways are seen as more problematic due to the high cost of constructing a single coordinated electrified rail system across North America. Each year, the North American rail fleet emits approximately 87.6 billion pounds of carbon dioxide, a major driver of climate change.

Researchers are exploring the potential of hydrogen combustion engine technology in the rail industry, said Muhsin Ameen, Argonne senior research scientist. Hydrogen is an energy carrier that can be produced from clean energy sources such as solar and wind power. Scientists have been researching hydrogen-powered vehicles for decades.

"To reduce carbon dioxide emissions to net zero by 2050, we must make dramatic improvements in energy efficiency and emissions in the overall transportation system, including railways," Ameen stated in the release. "Hydrogen has been used in light-duty combustion engines. However, hydrogen is a newer area of research in railway applications."

The research team is developing combustion technology to power the next generation of trains with up to 100% hydrogen and other low-carbon fuels. The team's goal is to design train engines that will deliver the same power, range, and cost-effectiveness as the current diesel technology.

In the project's first phase, the ORNL team will work on hardware changes for retrofitting locomotives. Their goal is to reduce carbon dioxide emissions from the roughly 25,000 locomotives in use in North America. Locomotives have a service life of more than 30 years, so replacing the entire fleet would take decades.

During the second phase of the project, ORNL and Wabtec will continue to alter the engine hardware to increase the amount of hydrogen that can be used. The team aims to completely replace diesel with hydrogen or low-carbon fuels in new locomotives.

At the same time, Argonne will leverage more than a decade of experience in modeling hydrogen injection and combustion to create a modeling framework to study combustion and emission control technologies used in hydrogen combustion engines. The project will be overseen by experts in fuel injection, kinetics and combustion modeling, design optimization, high-performance computing, and machine learning.

Scientists are using Argonne's high-performance computers to develop simulation software. This tool will help predict the behavior of combustion engines as operating conditions change and hardware is modified. Simulations help researchers understand the combustion process, which drives engine efficiency and reduces emissions.

Each diesel-powered locomotive that is converted to a zero or low-carbon energy source is anticipated to save up to 5.6 million pounds of carbon dioxide per year.

https://www.oakridger.com/

Method for making net-zero aviation fuel

New Sustainable Aviation Fuel Would Significantly Reduce Long-haul Flight Emissions

An interdisciplinary team of researchers at Worcester Polytechnic Institute (WPI) has developed a potential breakthrough in green aviation: a recipe for a net-zero fuel for planes that will pull carbon dioxide (CO_2) out of the air.

Aviation accounts for approximately 2.5% of all global greenhouse emissions, according to the International Council

on Clean Transportation (ICCT), and that number is only expected to increase.

Through modeling and computation analysis, the team developed a formula for a fuel that consists of magnesium, a mineral that is found all over the globe, most abundantly in the world's oceans. A slurry of magnesium hydride, a chemical compound made up of magnesium and hydrogen, mixed with hydrocarbon fuel would burn to produce CO_2, water vapor and magnesium oxide (MgO) nanoparticles. The magnesium hydride fuel would also give planes the range for long-haul flights, such as those from Boston to Tokyo, which has proven difficult for other sustainable aviation fuels to provide. That longer range is achieved, in part, due to the chemical properties of the slurry, a lower volume of it is needed for combustion than a typical aviation fuel.

The Department of Energy describes sustainable aviation fuel as a "biofuel used to power aircraft that has similar properties to conventional jet fuel but with a smaller carbon footprint." These biofuels have been made from resources including corn grain, algae, forestry, and agricultural residues, among others. Using biofuel as the hydrocarbon in this slurry with magnesium hydride could potentially lead to net negative emissions.

https://www.wpi.edu/

Hydrogen from plastic waste

A team of university and U.S. Army researchers has developed a way to extract hydrogen from plastic waste, that can be used as fuel for transportation and to produce electricity in fuel cells.

Hydrogen is a clean-burning fuel, generating energy while leaving only water as a byproduct. It is currently produced mainly by reforming natural gas or by splitting water into hydrogen and oxygen through electrolysis.

According to the U.S. Energy Information Administration, global energy demand is projected to increase by 56% by 2040, driven by population growth and industrialization, particularly in developing countries. At the same time, more than 400 million tons of plastics are produced globally each year, which, combined with low recycling rates, has led to a dramatic increase in plastic waste, polluting the environment and interfering with ecosystems.

The team is using plasma technology to address both challenges simultaneously, by breaking down plastic waste – in this case, low-density polyethylene (LDPE) – into its chemical components. Hydrogen is then produced efficiently in the process, while minimizing carbon dioxide emissions, according to Trelles.

In 2019, the United States produced an estimated 3.5 million metric tons of LDPE, which is commonly used in single-use plastic bags and packaging, as well as in containers, bottles, trays, tubing, and molded parts for many consumer products. Unlike other plastics, LDPE breaks down when exposed continuously to sunlight, releasing significant amounts of greenhouse gases like methane and ethylene.

The researchers say their strategy could help address the challenge of disposing plastic waste, which is often incinerated or dumped in landfills, thereby cutting down greenhouse gas emissions while simultaneously providing a source of hydrogen.

The team's reactor differs from thermal plasma reactors, which have temperatures that typically exceed 12,000 degrees Celsius (more than 21,000 degrees Fahrenheit) and are employed in waste treatment plants around the world.

With their current system, the researchers estimate that from 1 metric ton of LDPE, they can produce up to 6 kilograms of hydrogen.

In addition to LDPE, the team's plasma technology can potentially be applied to convert other plastic wastes, as well as biomass waste from agriculture, food industry and cellulose from sawmill dust, into high-value chemicals and additives.

https://www.uml.edu/

New type of fuel cell

Researchers found an ultrafast alternative to the slow oxide ion transfers of conventional fuel cells, increasing efficiency and performance by using hydrocarbon fuel directly. The commercial applications are promising.

Like batteries, fuel cells produce energy through an electrochemical process. Unlike batteries, they do not run down or require recharging. However, the potential advantages of fuel cells are offset by challenges that include cost, performance, and durability.

Michigan Technological University researcher Yun Hang Hu and two graduate students, Hanrui Su and Wei Zhang, took on those challenges, changing the conventional path of a fuel cell by creating an interface between the electrolyte and melted carbonate as an ultrafast conduit for oxygen ion transfer.

"This allowed us to invent an entirely new type of fuel cell, a carbonate-superstructure solid fuel cell (CSSFC)," said Hu.

Like other fuel cells, CSSFCs have a wide array of potential uses, from providing energy to operate fuel cell vehicles and household power generation to powering whole power plants. Because CSSFCs are fuel flexible, they offer higher durability and energy conversion efficiency at lower operating temperatures than other types of fuel cells.

Most fuel cells are powered by hydrogen, typically produced from hydrogen-containing compounds, most often methane, through an expensive process called reforming. But the CSSFC developed in Hu's lab can directly use methane or other hydrocarbon fuels.

Hu said fuel flexibility is of particular interest for commercial applications. Furthermore, the new fuel cell's electrochemical performance at lower operating temperatures offers several other advantages. "The operating temperature of a conventional solid oxide fuel cell is usually 800 degrees Celsius or higher, because ion transfer in a solid electrolyte is very slow at a lower temperature," Hu said. "In contrast, the CSSFC's

superstructure electrolyte can provide a fast ion transfer at 550 degrees Celsius or lower, even as low as 470 degrees Celsius."

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Hu said fuel flexibility is of particular interest for commercial applications. And, the new fuel cell's electrochemical performance at lower operating temperatures offers several other advantages. "The operating temperature of a conventional solid oxide fuel cell is usually 800 degrees Celsius or higher, because ion transfer in a solid electrolyte is very slow at a lower temperature," Hu said. "In contrast, the CSSFC's superstructure electrolyte can provide a fast ion transfer at 550 degrees Celsius or lower even as low as 470 degrees Celsius."

The relatively low operating temperature offers high theoretical efficiency and lower cell fabrication costs. Hu said it is also potentially safer to operate than other solid fuel cells.

Tests on the CSSFC also showed an unprecedentedly high open circuit voltage (OCV), indicating negligible current leakage and high energy conversion efficiency.

Hu estimates that CSSFC fuel efficiency could reach 60%. By comparison, the average fuel efficiency of a combustion engine ranges between 35% and 30%. The CSSFC's higher fuel efficiency could lead to lower carbon dioxide emissions in vehicles.

https://www.mtu.edu/

New battery with 4 times energy density of lithium-ion

Scientists and engineers at US-based technology research center Argonne claim to have developed a new battery which, according to them, has four times the energy density of lithium-ion batteries.

The researchers from the Illinois Institute of Technology (IIT) and U.S. Department of Energy's (DOE) Argonne National Laboratory say that the new battery could power an EV for more than a thousand miles (1600 km) and could also someday be used to power domestic planes and long-haul trucks.

"The main new component in this lithium-air battery is a solid electrolyte instead of the usual liquid variety,"

"The battery chemistry with the solid electrolyte can potentially boost the energy density by as much as four times above lithium-ion batteries, which translates into longer driving range."

More electrons stored means higher energy density. Lithium-air battery has the highest projected energy density of any battery technology being considered for the next generation of batteries beyond lithium-ion.

"The chemical reaction for lithium superoxide or peroxide only involves one or two electrons stored per oxygen molecule, whereas that for lithium oxide involves four electrons," said Argonne chemist Rachid Amine.

Argonne says the new lithium-air design is the first lithium-air battery that has achieved a four-electron reaction at room temperature. It also operates with oxygen supplied by air from the surrounding environment.

The capability to run with air eliminates the requirement for oxygen tanks, which Argonne says was a problem with earlier designs.

"With further development, we expect our new design for the lithium-air battery to also reach a record energy density of 1200 watt-hours per kilogram," said Curtiss. "That is nearly four times better than lithium-ion batteries."

For comparison Tesla's new 4680 cells have an energy density of 272-296 Wh/kg and which is considered very high by current standards. At four times the density, the new cells would open up all sorts of possibilities, including aircraft capable of flying well over 1000 km on a single charge.

https://thedriven.io/

New battery technology

The tech, which was developed by researchers at Penn State and EC Power, could reduce battery size significantly.

Researchers at Penn State may have found a way to make EVs even more appealing.

The university has just unveiled a new battery technology that has the potential to cut charging times in half for EVs. The technology could also reduce the size of the batteries, which could certainly improve their performance in other ways, including range.

The new technology, which was developed in collaboration with university-backed startup EC Power, is an internal thermal modulation system for EV batteries. An ultra-thin nickel foil is added to the structure of the battery that helps regulate temperature, keeping it "hot, but not too hot," without the need for bulky heating and cooling systems, according to the school. Not only would this allow for 10-minute charge times, but it could also reduce battery size by up to two-thirds. A smaller battery would store energy more efficiently and cost less.

"Our fast-charging technology works for most energy-dense batteries and will open a new possibility to downsize electric vehicle batteries from 150 to 50 kWh without causing drivers to feel range anxiety," Chao-Yang Wang, the university's William E. Diefenderfer Professor of Mechanical Engineering and lead author of the study, said in a statement. "The smaller, faster-charging batteries will dramatically cut down battery cost and usage of critical raw materials such as cobalt, graphite and lithium, enabling mass adoption of affordable electric cars."

Long charging times are currently viewed as one of the main drawbacks of EVs.

EC Power is currently trying to manufacture and commercialize the new battery, according to Penn State. The timing could not be better, as EVs seemed to have hit a tipping point over the last couple of years. While they currently only represent five percent of the new vehicles sold, and one

percent of those on the road, adoption is quickly increasing. On top of this, the last few months have seen both the EU and the state of California announce plans to ban the sale of new gas-powered vehicles by the middle of the next decade.

https://robbreport.com/

Zero-emissions, ammonia-fueled tractor demonstrated

Amogy, Inc., a Brooklyn, New York-based startup, demonstrated a zero-emissions, ammonia-fueled tractor. For the demonstration, Amogy blended its ammonia-to-power technology into a standard mid-size John Deere tractor, giving it a 100-kW capacity. The technology uses ammonia cracking modules with a hybrid fuel cell system combined with a liquid storage tank. During the demonstration, the ammonia-fueled tractor was operated for several periods and refueled. The demonstration took place at Stony Brook University in New York. (In 2021, the startup demonstrated an ammonia-powered, zero-emissions 1 kW drone.) Amogy was founded in 2020 and has received funding from AP Ventures and Amazon's Climate Change Fund.

Ammonia is attracting increasing attention as an enabler of emissions reductions in hard-to-abate transportation sectors like long haul trucking, locomotives, aviation, and shipping. Produced by combining hydrogen with atmospheric nitrogen, ammonia has been used by various industries for more than a century, primarily as a chemical precursor to nitrogen fertilizers. However, ammonia also possesses a relatively high volumetric energy density compared with hydrogen and existing battery chemistries, which makes it an attractive energy carrier.

Technological advances in recent years have presented new opportunities for using ammonia within the transportation sector. These include more efficient methods of cracking ammonia to generate hydrogen for use in fuel cells or combustion engines; propulsion systems optimized for the direct use of ammonia; or combined approaches that can include blending ammonia or hydrogen with conventional fuels.

At Amogy, we have developed a compact, high efficiency reactor that cracks ammonia and uses hydrogen to generate power through a fuel cell. The design leverages superior physical characteristics of liquid ammonia to carry the performance advantages of hydrogen far from the supply source and does so at lower operating temperatures and higher efficiency levels than alternative designs.

Ammonia is not a flammable or explosive chemical, but it is a toxic substance.

Because of its toxicity, ammonia is not viable for consumer vehicles, which is why Amogy is targeting commercial vehicles only.

What is the ammonia source and cost? Is it cost-competitive with gasoline and diesel fuel?

Per dollar-per-energy basis, ammonia presents about 2x larger cost compared to conventional fuels (e.g., gasoline or diesel). However, this cost is substantially cheaper than other potential alternative fuels, e.g., hydrogen. Ammonia is produced today from natural gas, and there is a large pipeline of "blue" & "green" ammonia projects that have been announced to develop ammonia in a more sustainable way, as technology advances and demand increases from adoption of zero-emissions technologies such as Amogy's.

We expect that the cost of "green" ammonia will be in parity with diesel by 2035, or potentially sooner, if carbon taxes are enacted by then.

https://cleantechnica.com/

Technology to convert methanol to SAF

ExxonMobil has unveiled its new process technology to produce sustainable aviation fuel (SAF) from renewable methanol.

ExxonMobil converts methanol derived from the gasification of biomass and waste, captured carbon dioxide or lower-carbon hydrogen into SAF, using its methanol to jet proprietary process technology and catalysts.

ExxonMobil lower-emission fuels venture executive Russ Green said: "SAF produced from renewable methanol can play an important role in helping the aviation industry achieve the transition to a net-zero future.

"Reaching that goal by 2050 will require a multi-faceted approach, including advancements in aircraft-related technology, changes to infrastructure and operations, and a dramatic increase in SAF supply. Our process technology can be an important step in this direction."

With its new technology and infrastructure, ExxonMobil aims to grow its lower-emission fuel business.

The new solution also enhances ExxonMobil technologies that are engineered to manufacture SAF from bio feeds, such as used cooking oils, animal fats and vegetable oil.

The company is also in the process of identifying opportunities to deploy these technology solutions to help with decarbonization in the aviation industry.

ExxonMobil catalysts and licensing president James Ritchie said: "Methanol to jet technology is scalable and suitable for the conversion of methanol produced from today's world-scale plants. The work necessary to qualify the resulting renewable jet fuel pathway has already started."

ExxonMobil agreed to supply the green fuel to Changi Airport using an existing fuel hydrant system.

https://www.airport-technology.com/

EV batteries charge in just 10 mins

Researchers have developed a novel EV battery tech that can charge an EV battery in just ten minutes, paving the way for the mass adoption of much more affordable electric vehicles.

The technology has been developed by researchers from Penn State and it is

based on internal thermal modulation, an active method of temperature control to pull the best performance possible from the battery.

Researchers explain that batteries operate most efficiently when they are hot, but not too hot. Keeping the temperature consistent at the perfect sweet spot has been a challenging endeavor for battery engineers.

Researchers in the past have relied on external, large heating and cooling systems for battery temperature management, which does not really work as promptly and ends up wasting energy along the way.

Researchers from Penn State, however, decided to try a different approach, and regulate the temperature from inside the battery. For this, they created a new battery structure with an ultrathin nickel foil as the fourth component alongside anode, cathode, and electrolyte.

Nickel, acting like a stimulus, self-regulated the battery's temperature and reactivity that allowed for 10-minute fast charging on any EV battery type.

Chao-Yang Wang, the William E. Diefenderfer Professor of Mechanical Engineering at Penn State and lead author on the study, explained, "The need for smaller, faster-charging batteries is greater than ever. There are simply not enough batteries and critical raw materials, especially those produced domestically, to meet anticipated demand."

Wang added, "Our fast-charging technology works for most energy-dense batteries and will open a new possibility to downsize electric vehicle batteries from 150 to 50 kWh without causing drivers to feel range anxiety. The smaller, faster-charging batteries will dramatically cut down battery cost and usage of critical raw materials such as cobalt, graphite and lithium, enabling mass adoption of affordable electric cars."

Researchers in the study conclude stating that true fast-charging batteries could have an immediate impact, as there are not enough raw materials for every internal combustion engine car to be replaced by a 150kWh-equipped EV, fast charging is imperative for EVs to become mainstream.

https://www.indiatimes.com/