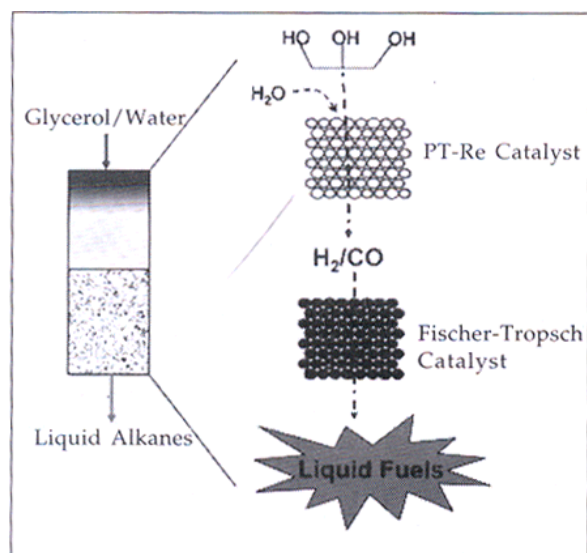


New Developments in Chemical Processes & Equipment

Integrated FT process for conversion of Glycerine to Liquid Alkanes

As oil & gas prices soar, alternatives like biofuels are being increasingly produced and used. This has also led to a glut of the byproduct, glycerine, which scientists are trying to convert into useful products. Now researchers from the University of Wisconsin, Madison, USA, have found a way of using the glycerine to produce liquid alkane fuel. Liquid alkanes have an edge over other biofuels, such as ethanol, for use as transportation fuels because they can be used in existing engines and can be distributed using the existing infrastructure.



James Dumesic and co-workers at the University of Wisconsin have developed an integrated process involving catalytic conversion of glycerol to produce synthesis gas, a mixture of carbon monoxide and hydrogen, followed by Fischer-Tropsch (FT) synthesis, where the synthesis gas is converted to hydrocarbons. Synthesis gas can be produced at high rates and selectivities suitable for FT synthesis. The primary oxygenated hydro-carbon intermediates formed during the conversion of glycerol to synthesis gas are ethanol, acetone and acetol. FT synthesis experiments at 548k and 5 bar pressure, over a Ru-based catalyst show that water, ethanol and acetone in the synthesis gas feed have only small effects, but acetol can participate in FT chain growth, to form pentanones, hexanones and heptanones in the effluent stream. Thus, increasing the selectivity to C₅+ alkanes, with more than 40% of the carbon in the products contained in the organic liquid phase at 17 bar pressure. The aqueous liquid effluent from the integrated process contained 5 – 15% of methanol, ethanol and acetone, which can be separated by distillation and used in the chemical industry or recycled for conversion to gaseous products.

This integrated process would help to improve the economics of 'green' FT synthesis by reducing capital costs and increasing thermal efficiency.

Clean Diesel from Coal

Chemists from the Rutgers University, New Jersey, USA and University of North Carolina, Chapel Hill, have invented a new catalytic process that could improve the yield of diesel fuel from Fischer-Tropsch (FT) synthesis./

The Fischer Tropsch (FT) synthesis is a nearly century-old process for reacting carbon monoxide and hydrogen to make hydrocarbons. The mixture of gases is produced by heating coal. The process was developed and used by the Germans during the World War II to convert coal to fuel for its military vehicles. But a problem with the FT process is that it produces a mixture of hydrocarbons – many of which are not useful as fuel.

The researchers, Alan Goldman, professor of chemistry and chemical biology at Rutgers University and Maurice Brookhart, professor of chemistry at the University of North Carolina at Chapel Hill, have developed a pair of catalysts to convert these undesirable hydrocarbons into diesel.

The catalysts work by rearranging the carbon atoms, transforming six-carbon atom hydrocarbons, for example into two- and then-carbon atom hydrocarbons. The ten-carbon version can power diesel engines. The first catalyst removes hydrogen atoms, which allows the second catalyst to rearrange the carbon atoms. Then the first catalyst restores the hydrogen, to form fuel.

Diesel fuel, thus, produced has several potential advantages. Ordinary diesel contains aromatic molecules, that when combusted, produce particulates. But the diesel formed by new catalysts does not include aromatics, so it burns much cleaner, overcoming one of the vehicles using diesel engines, which are about 30% more efficient than gasoline engines.

Thus, a more efficient and so less expensive method of converting coal to diesel could significantly cut dependence on foreign oil.

The new catalytic method is not yet ready for commercial use. The process needs to be improved, for example, the second catalyst tends to break down. But Schrock says this problem should be solvable.

Intelligent, Switchable Adhesive

A team of researchers from the Universities of Sheffield (UK) and Bayreuth (Lebanon), led by scientists Mark Geoghegan, have developed an "intelligent adhesive that can stick two surfaces together, separate and then stick together again on command.

One of the surfaces consists of a polyacid gel, a three-dimensionally cross-linked polymer containing many acid groups. This polymer network is so heavily soaked in liquid that it forms a solid, gelatinous mass. The second surface is a silicon chip onto which a poly base has been deposited. This polybase consists of polymer chains that stretch brush-like from the support and contain many basic groups. In water or slightly acidic solution, the acidic groups carry a positive charge while the basic groups are negatively charged, this causes them to attract each other. In addition to this electrostatic attraction, hydrogen bonds are also formed, which cause the two surfaces to be tightly stuck together.

If the surrounding solution is made more strongly acidic (a pH value of about 1), the bonds break up, the basic groups lose their charge, and the electrostatic attraction lets up. The two surfaces can then be slowly and carefully separated from each other without any damage. This detachment is reversible. If the pH value is raised again, making the solution less acidic, the gel and 'brush' stick to each other once again. This cycle can be repeated many times by simply changing the pH value.

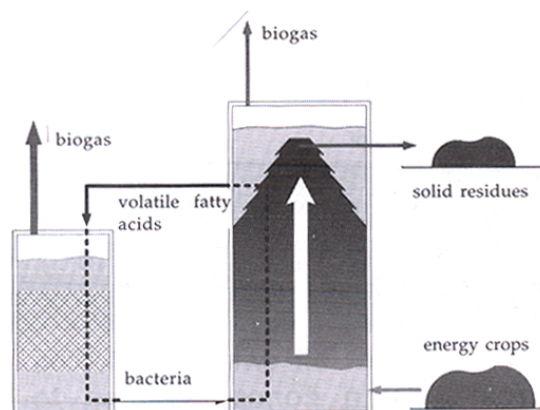
Possible applications for such 'smart' surface pairs include micro electromagnetic components (actuators), components for micro fluidic systems, or carriers for pharmacological agents that could release their cargo under specific physiological conditions.

An Energy Efficient System for Biogas Production

Leibniz Institute for Agricultural Engineering, Germany, has developed a new up-flow leach-bed process that increases the efficiency of biogas production from energy crops.

Conventionally, farm-based biogas digesters are designed for the fermentation of liquid manure. The fiber-rich materials in the manure tend to build up a persistent float layer. To prevent floatation, agitation has to be intensified which uses about 10% of the electric energy produced.

The new up-flow, leach-bed process follows a completely different strategy by stimulating floatation in order to increase not only energy efficiency but biogas production rates as well.



The novel two stage process consists of an anaerobic leach-bed reactor. Plant raw material is continuously fed to the reactor bottom and, after fermentation, removed from the top as solid residue. Gas bubbles generated by bacteria adhere to plant particles and thus, induce floatation like in common digesters. Due to absence of agitation inside the leach-bed reactor a liquid phase is formed and used as leachate. This leachate circulates upwards through the leach-bed reactor and downwards through a high rate anaerobic digester with immobilized bacteria. Volatile fatty acids are leached from the solids and efficiently converted to biogas in the high rate reactor. Excess bacterial are transferred to the leach-bed reactor enhancing solid degradation as well.

Experiments carried out at laboratory-scale reveal that as compared to common farm-based digesters, the reactor loading can be increased by at least two to three times, while yielding the same amount of gas. At significantly reduced energy demands the up-flow leach-bed process promises considerably increased productivity and stability as well as an uncomplicated and precise process control. The risk of overloading is practically eliminated. Testing of this patent pending system at pilot scale (10 M³) is planned.

Low temperature Coal Gasifier developed

KBR, a leading engineering, engineering, construction and services company, headquartered in Houston, Texas, together with Southern Company, one of the largest producers of electricity in the US, has developed an innovative coal gasification process called transport integration at pilot scale (TRIG).

Based on the integrated gasification combined cycle (IGCC) for power generation, this technology offers an advanced method for producing electrical power from coal with reduced emissions. The TRIG process can handle high moisture, high-ash coals. The gasifier uses dry feed and ash does not melt back into the feedstock. Thus, it is well suited for fuels such as sub-bituminous and lignite coals. The new process incorporates KBR's fluid catalytic cracking technology.

The conventional gasifiers operate at high temperatures at which the ash melts. The TRIG process operates at lower temperatures (600o F – 700o F), which are much lower than the melting points of ash, thus preventing the ash from melting back into the feedstock. Un-like the conventional systems, this system use a air-blown system and hence does not require an air separation unit, thus making it more cost effective.

Based on this technology, KBR and Southern are building an advanced an advanced 285 MW coal gasification facility near Orlando, Florida. The project is supported by the US Department of Energy, under the Clean Coal Power initiative.

Indian Scientists Develop new Process to Manufacture Cellulose Nanofibre from Banana Waste

Bananas and plantains, described as common man's food, are grown abundantly in almost all tropical countries. India produces about 15% of the world's total production of banana and plantain fruits.

The banana/plantain plants produce a lot of waste. Scientists have been working at how to put tonnes of banana waste to good use. Prof. Varkey Mathew, Head of the Department of Chemistry, Baselius College, Kottayam and his team of researchers, have developed a new technology for manufacture of cellulose nanofibre from the waste of banana and plantain plants.

The process is named 'Varkey – Unnikrishnan – Sivasankaran (V-U-S) Process', after the researchers. The mass obtained from the process contains a gelatinous mass of cellulose nanofibre and short micro – fiber of plantain/banana. The gelatinous mass can be separated from this mixture and converted into sheets for special applications. The product can be used in a range to composites and moulded products. The materials can also be used as a substitute for paper and plastics in many applications.

The process would also help the cultivators to earn an extra income from the waste of this fruit bearing plant.

New Aerogels could clean contaminated water, Purify hydrogen for fuel cells

Scientists at the U.S. Department of Energy's Argonne National Laboratory have identified a new technique for cleansing contaminated water and potentially purifying hydrogen for use in fuel cells, thanks, to the discovery of an innovative type of porous material.

Argonne materials scientists Peter Chupas and Mercuri Kanatzidis, at Northwestern and Michigan State universities, created and characterized porous semiconducting aerogels at Argonne's Advanced Photon Source (APS). The researchers then submerged a fraction of a gram of the aerogel in a solution of mercury-contaminated water and found that the gel removed more than 99.99 percent of the heavy metal. The researchers believe that these gels can be used not only move impurities from hydrogen gas that could damage the catalysts in potential hydrogen fuel cells.

The Aerogels, which are fashioned from chalcogenides are expected to be able to separate out the impurities from hydrogen gas much as they did the mercury from hydrogen gas much as they did the mercury from the water: by acting as a kind of sieve or selectively permeable membrane. The unique chemical and physical structure of the gels will allow researchers to "tune" their pore sizes or composition in order to separate particular poisons from the hydrogen stream.

"You can put in elements that bind the poisons that are in the stream or ones that bind the hydrogen so you let everything else fall through," Chupas said. For example, gels made with open platinum sites would extract carbon monoxide, a common catalyst poison, he explained. Kanatzidis and his co-workers recognized that aerogels offered one remarkable advantage over powders: because the material maintained its cohesion, it possessed an enormous surface area. One cubic centimeter⁴ of the aerogel could have a surface area as large as a football field, according to Kanatzidis. The bigger the surface area of the material, the more efficiently it can bind other molecules, he said.

Previous experiments into molecular filtration had used oxides rather than chalcogenides as their chemical constituents. White oxides tend to be insulators, most chalcogenides are semiconductors, enabling the study of their electrical and optical characteristics. Kanatzidis hopes to examine the photocatalytic properties of these new gels in an effort to determine whether they can assist in the production, and not merely the filtration, of hydrogen.

Unlike periodic materials, which possess a consistent long-range structure, the gels formed by the North-western and Argonne researchers are highly disordered. As a result, conventional crystallographic techniques would not have effectively revealed the structure and behavior of the gels. The high-energy X-rays produced by the APS, however, allowed the scientists to take accurate readings of the atomic distances within these disorganized materials. "This is where the APS really excels. It's the only place that has a dedicated facility for doing these kinds of measurements, and it allows you to wash away a lot of old assumptions about what kinds of materials you can and cannot look at," Chupas said

Reference Book:

[Chemical Industry Digest](#)

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