

Technology Frontier

News Bite on PolyU's Innovation

Low-cost eco-friendly biodiesel catalyst

One-step conversion from crude plant oil and recycled cooking oil

Biodiesel made from plant oil is a renewable source of energy. But it has been expensive to produce because crude oil and recycled oil must be purified first before it can be converted into biodiesel in the presence of the traditional catalyst. A research team from the Department of Applied Biology & Chemical Technology successfully developed a new reusable catalyst that converts impure crude oil into biodiesel in one step, while producing no waste water whatsoever. This new technology significantly reduces the cost of biodiesel by half.



The newly developed catalyst for green biodiesel production

The human race has been relying on fossil fuel as the main source of energy for centuries. Only in the past decades that people started to worry about its depletion and experts have been looking for renewable energy sources ever since. Besides, burning fossil fuel creates carbon dioxide, the key greenhouse gas that leads to global warming and tips the balance of the ecosystem. Biodiesel made from plant oil is one of the carbon-neutral alternatives, but it hasn't caught on because of its complicated production, water pollution problems and high cost. For this reason, Dr Ka-fu Yung, Assistant Professor, Department of Applied Biology & Chemical

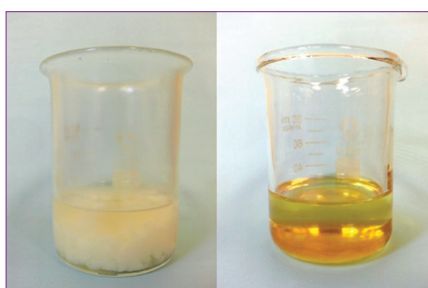
Technology, and his research team have come up with a new catalyst for biodiesel production that greatly simplifies the production workflow without producing any waste water while successfully bringing the cost down by half. Behold the future of low-cost biodiesel.

Traditional biodiesel: pre-treatment and multiple washes

Why is traditionally produced biodiesel expensive? It's because the traditional catalyst can only convert plant oil in its purest form into biodiesel. That means raw plant oil and recycled cooking oil must be purified before it can be used. "Generally speaking, the feedstock must contain less than



Dr Ka-fu Yung (middle) and his research team



Comparison of biodiesels produced with traditional catalyst (left) and with the newly developed catalyst (right)



The catalyst has won a gold medal and a special award at the 43rd International Exhibition of Inventions in Geneva.

0.5% of water and less than 0.5% of contaminants like free fatty acid. This pre-treatment involves addition of strong acid or alkali and intense heating, inevitably consuming energy and costing money. To remove the strong acid or alkali, the oil has to be washed with a large amount of water creating waste water that needs to be treated before being discharged. Again, the treatment costs money. Traditional catalysts like strong acid and strong alkali are also highly corrosive, meaning the equipment is expensive to build. Finally, the biodiesel has to be washed once more to remove the by-product glycerol and the residual catalyst in it. Such series of washing steps are tedious and consume much water," explained Dr Yung.

Low-cost biodiesel catalyst: one-step conversion with no waste water

The revolutionary catalyst developed by Dr Yung and his team is a bimetallic oxide in solid form. Its key advantage is its capability to convert low-purity plant oil into biodiesel at a lower temperature and lower pressure. "We have tested this new catalyst with unprocessed recycled cooking oil containing up to 3% of water and 90% of free fatty acid contaminant. The catalyst successfully converts it into biodiesel with a conversion rate close to 100%. That means the

whole pre-treatment step can be skipped, streamlining the production in major ways. As the conversion takes place at lower pressure and temperature, the equipment tends to cost less too," said Dr Yung.

In addition, the final wash for residual catalyst and glycerol removal is also spared, cutting down on the overall cost of biodiesel production. "The catalyst is a solid, so it can be easily isolated by centrifugation, sedimentation or filtration, and can be used up to 50 times in our experiment," he said. As for the by-product, the crude glycerol generated is much purer in form compared to that of traditional biodiesel. Requiring no washing due to its purity, it can thus be easily converted into a fuel additive that can improve biodiesel performance. Dr Yung explained, "With high viscosity and a high cloud point, biodiesel tends to coagulate into a gel at low temperatures, which hinders the performance of combustion engines. By using a glycerol additive, the biodiesel's viscosity can be reduced and its cloud point can be brought down to as low as -10°C ."

In April 2015, this innovation won a gold medal and a special award in the 43rd International Exhibition of Inventions of Geneva, Switzerland.