Scientists pave way for possible carbon-neutral aviation

For more than a century now, modern civilization, human growth, resources, and well-being have been reliant on the burning of hydrocarbon fuels; either fossil fuels or biofuels. However, this has greatly affected our biosphere owing to the increased emissions of greenhouse gases; in particular carbon dioxide (CO_2), oxides of nitrogen (NO_x) and methane (CH_4). Out of these, CO_2 is the most abundant and prevalent greenhouse gas with its strong greenhouse effect and long atmospheric lifetime. It is emitted in almost all forms of combustion involving hydrocarbons; mostly by large and small industries, transport sectors (automobiles, ships and aircraft), power generation, domestic sectors which includes wood burning, dung cake burning and the sorts, forest fires and slash-and-burn agriculture. Getting CO_2 out of the atmosphere (carbon sequestration) is known to help, or at least to check, the increasing abundance of this gas and hence global warming and some efforts are being made in this direction. The UN Intergovernmental Panel on Climate Change estimates that global warming below 1.5°C has already caused the normal temperatures to double and triple across the Arctic.

In view of these recognized environmental issues, the development of clean, energy-efficient technologies for the production of sustainable or renewable fuels are now imperative. Scientists continue to look for ways to cut the amount of CO_2 released into the atmosphere, and now they are more focused on the aviation industry. By 2050, the aviation sector alone is predicted to absorb more than 25% of the CO_2 emissions that mankind will produce. The global biofuel production reached record peaks in 2019, and growth was expected to be 3% in 2020 before the novel coronavirus dramatically limited international travel. The jet fuel presently used is created by burning fossil fuels, a process that basically takes carbon buried under the Earth's surface and releases it into the atmosphere. Also, the difficulty of installing batteries that are big enough to run on electricity from the wind or solar power has been challenging too. However, a research team in the UK has now come up with a process for converting CO_2 in the air into an alternative jet fuel that could power existing aircraft. This is a low-cost approach that could potentially pave the basis for a circular economy for aviation fuel.

The researchers used a chemical process known as organic combustion method (OCM), which was developed to prepare highly active metal catalysts for a variety of processes. It was achieved by passing CO_2 over a mixture of citric acid, hydrogen, and a catalyst consisting of iron, manganese, and potassium heated to 350°C. The process pushed the carbon atoms, aside from the oxygen atoms in the CO_2 molecules. These were then bound to the hydrogen atoms, to create the kind of hydrocarbon molecules that form liquid jet fuel. Hydrocarbons are considered to be the primary components of fossil fuels. When burnt, heat is emitted and CO_2 is released. The more carbon the fuel emits, the more heat it produces. For example, gasoline has between 7 and 10 carbon atoms in its molecular chain, whereas jet fuel has between 10 and 16. The test indicated that for more than 20 hours, the process converted 38% of the CO_2 into jet fuel in a pressurized stainless-steel reactor. The outcome was a little bit of fuel and some by-products that included petrochemicals. The fuel accounted for 48% of the total output, with the remaining 52% of by-products consisting of water, propylene, ethylene and butanes. These are important raw materials for the petrochemical industry and are currently made only from fossil crude oil. Researchers further point out that, because of this CO_2 separated from air and re-emitted from jet fuels while burning in flight, the ultimate effect is a carbon-neutral fuel.

In the past, efforts to turn CO_2 into fuel have relied on catalysts produced from relatively costly materials, such as cobalt, which have required several chemical processing phases. The current catalytic process is cheaper than even methods such as those that convert hydrogen and water to fuel (hydrogenization) mainly because it uses less electricity. The CO_2 used for the experiment came from a canister. But to adapt the concept for the real world would be to capture significant amounts of CO_2 from either a factory or directly from the air to remove it from the environment. The conversion systems could be installed at places such as an oil refinery, a coal-fired power plant or a steel or cement factory. Recycling CO_2 as a carbon source for both fuels and high-value chemicals offers significant potential for both the aviation and petrochemical industries. In the meantime, researches have already been underway to find alternatives to conventional jet fuel. Some of them are produced from municipal solid waste, straw, timber biomass and even waste cooking oil.

When fossil fuels such as oil or natural gas burn, they are converted into CO_2, and water and energy are released. But, this new finding reverses the process of converting CO_2 into aviation fuel. This may prove to be a challenge as the team has been able to produce only a few grams of fuel at a time so far. But if it can be done on a larger scale, it would be an excellent way of offsetting CO_2 emissions from the airline industry while fuelling it simultaneously. Rather than creating a new fleet of electric planes, which would require enormous advances in battery storage technology, this new approach allows the world to reduce its carbon footprint. This also represents a major social progress that emphasizes CO_2 recycling and the reuse of energy as an important, pivotal part of greenhouse gas management and sustainable growth. This catalytic method is likely to be the road to reaching net-zero carbon emissions from the aviation sector in the near future – before we as a society are sufficiently ready to operate on environmentally friendly electrical aircraft. Also, it will not only preserve renewable fossil fuels and protect the environment, but will also create new jobs, financial sectors and marketplace.

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