Carbon dioxide from exhaust fumes used to make new chemicals

February 13 2014, by Jessica Breen

New source of making chemicals. Credit: fahrertuer

To stop global warming, most governments are advocating reducing the amount of carbon dioxide (CO_2), a greenhouse gas, put into the atmosphere. But some argue that such action won't be enough – we will need to remove CO_2 already present.

The reduction of CO_2 is a big challenge, as it requires large amounts of

renewable energy. Until then, short-term solutions to remove CO_2 from fossil fuel power plants is becoming necessary, including carbon capture and storage (CCS). The other option is to use the storage part, as new research from Korea shows, and to use CO_2 directly from exhaust gases to make new chemicals.

Catch me if you can

Carbon capture involves the "capture" of CO_2, either by a chemical or physical process. Often CO_2 from a exhaust gas stream is captured by nitrogen containing compounds called amines. The reaction results in the formation of solid chemicals. These can be heated, allowing the CO_2 to be released, which can then be compressed, transported and stored in geological features, such as depleted oil fields, or used as raw material in chemical factories.

Although trees and some microbes can capture CO_2 and use it as fuel, humans have struggled to replicate the process on a large scale. Most chemical reactions involving CO_2 require expensive catalysts, high temperatures, or high pressures to make it react. The most common use of CO_2 as a chemical feedstock is in the formation of urea, which is found in around 90% of the world's fertilisers.

In the new research, published in the journal *Angewandte Chemie*, Soon Hong and colleagues from the Institute for Basic Science in South Korea have caught CO_2 from exhaust gas and used it for many reactions that make useful chemicals. One type is called alkynyl carboxylic acid, which has many uses such as making food additives. The other, cyclic carbonate, is used to make polymers for cars and electronics. Cyclic carbonates can also be used in place of phosgene, which is a very reactive and highly toxic chemical that is used as a starting material to make a wide variety of useful products.

Hong also used highly pure CO_2, which is sold at a high price and required lots of energy to make, in the same chemical reactions and found there was hardly any difference in the final yield (the amount of product formed minus wastage).

Use me if you do

Like CCS technologies, Hong passes exhaust fumes through a solution of amines, where CO_2 is captured and other gases pass unreacted. Then the resulting salt is heated to yield pure CO_2 for chemical reactions. Hong can recycle the amine solution at least 55 times without loss in yield.

In another research paper just published in Nature Communications, Matthias Beller and colleagues at the University of Rostock in Germany show a new reaction that can use CO_2. The reaction is called alkene carbonylation, and it usually required the use of carbon monoxide (CO), which, as home detectors know well, is a highly toxic and flammable gas.

CO_2 has previously been used in the synthesis of carboxylic acids by using diethylzinc as one of the drivers of the reaction. But diethylzinc is flammable in air. Using the reaction Beller can make chemicals are found in varnishes and paints. The researchers carried out a number of reactions but most importantly confirmed that the source of the newly formed C-O bond was CO_2. This work shows CO_2 can be used as a viable alternative to carbon monoxide in carbonylation reactions and increasing the importance of CO_2 in the chemical industry.

While this is good news, these advances don't offset the energy needed to trap and use CO_2. They will help increase the demand of CO_2 at industrial scale, and may then drive CCS and renewable energy technologies to become cheaper.

This story is published courtesy of The Conversation (under Creative

Commons-Attribution/No derivatives).

Source: The Conversation