Cryogenic Carbon Capture™

For a Cleaner World

What is Cryogenic Carbon Capture™?

Cryogenic Carbon Capture™ (CCC) is a highly innovative technology with the potential to reduce carbon emissions from fossil-fuel power plants and industrial facilities by 90–99%, at half the cost and energy of alternative carbon capture technologies. Acquired by Chart in 2020, CCC is poised for full-scale commercialization success by utilizing Chart's leading engineering capabilities and Integrated Pre-Cooled Single Mixed Refrigerant (IPSMR®) liquefaction process technology. Chart is building the first small-scale CCC plant at Sugar Creek Eagle Materials cement plant in Missouri with an estimated CCC plant start-up date of 2023.

How does CCC work?

The CCC process separates CO_2 by cooling down a post-combustion flue gas stream to the point where the CO_2 changes from a gas to a solid and ultimately "drops out" from the flue gas stream. What remains is a gaseous mixture of Nitrogen and Oxygen – called the light gas stream. The solid CO_2 stream and the light gas stream are warmed up to recover the energy that went into cooling them down. Energy recovery is achieved through heat integration with Chart's Brazed Aluminum Heat Exchanger (BAHX) technology. The light gas stream, with the CO_2 emissions now removed, is then returned to the flue stack to vent into the atmosphere – carbon-free. The solid CO_2, now warmed up under pressure, melts from solid to liquid so that a high-purity liquid CO_2 stream is produced at the outlet of the CCC process.

In CCC, how cold do you have to get the CO_2 for it to freeze?

By supercooling flue gases, you can remove more CO_2. Depending on the initial concentration of the CO_2 in the flue gas 90-99% capture can be achieved by cooling to a temperature of between -110°C and -130°C.

You have dry ice – now what?

The dry ice is high purity CO_2, which the system melts into the liquid CO_2 (LCO_2.) The market applications for LCO_2 vary from chemicals manufacturing, synthetic fuel production, concrete recycling, and enhancing plant growth at commercial nurseries. Permanent sequestration is also possible in new concrete.

Does CCC capture any other pollutants besides carbon dioxide?

Absolutely! Typical pollutants are Nitrogen Oxides (NOx), Sulfur Oxides (SOx), Particulate Matter (PM), and mercury. These pollutants are condensed and separated, allowing the captured CO_2 to be 99% pure and food-grade. For greenfield installations, the capability of CCC can offset the cost of traditional pollutant capture systems, allowing upfront operations savings.

Top Ten FAQ's

What are the transportation challenges for CCC-Reuse?

LCO_2 has a long history of safe transportation by trailer. To get the liquid into the trailers, a loading skid is engineered to meet the specific site requirements.

What do I do with it once I have it?

There is a shortage of high-purity CO_2 that can be put to beneficial use in the world. The 99+% pure, food-grade LCO_2 is typically moved via CO_2 truck transport or rail cars. Liquid CO_2 transportation is much more affordable than transporting CO_2 as a gas. Our well-established relationships with local gas distributors allow us to connect you to nearby distributors who can provide the on-site loading and storage systems to take advantage of merchant sales for the LCO_2. For large applications, we produce CO_2 as a high-pressure liquid or supercritical fluid that is ready to be put in a pipeline for geologic sequestration or enhanced oil recovery.

I have heard of CCC and Energy Storage (CCC-ES). How does this work?

CCC offers a demand response or load-shifting form of energy storage by liquifying excess refrigerant at non-peak times when surplus energy comes onto the grid from renewables or other sources. During peak energy demand, the stored refrigerant is tapped for the cooling process, nearly eliminating CCC energy demand during the peak energy cycle. This process increases the net outputs of Power Plants by grid-scale load balancing in real-time.

Will CCC increase the cost of electricity?

Although less expensive than alternatives, in some cases CCC will increase the cost of producing electricity. In other cases, the value of the CO_2 captured, regulatory incentives, and other value streams like the energy storage above may more than offset the cost of the energy storage.

Does CCC impact water usage at the plant?

In testing, we have demonstrated that CCC has lower water usage rates when compared to competing technologies. CCC process recovers virtually all the water that is in a gas form in the exhaust gas making it water positive or water neutral in some cases.

*Sustainable Energy Solutions (SES), a Chart Industries Company, has been developing patented Cryogenic Carbon Capture™ (CCC) since 2008. Two of these patented processes are External Cooling Loop and Compressed Flue Gas Cryogenic Carbon Capture (CCC ECL™ and CCC CFG™, respectively). SES has acquired 44 US patents, a further 17 pending patents, and 20 patents have been awarded to SES internationally.

If you do not find the answers to your questions here, please contact us at carboncapture@chartindustries.com