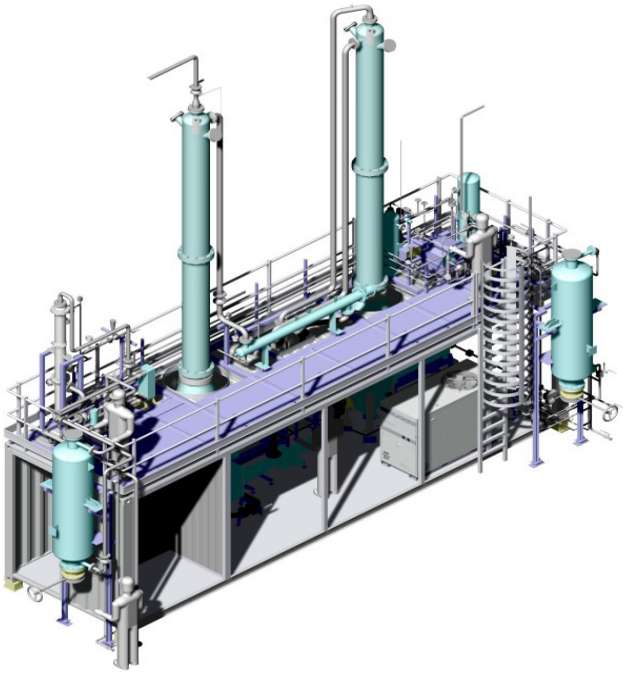
CO_2 recovery with ionic liquids

a step towards a CO_2 circular economy



The RECODE project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grand Agreement No. 768583

Background

Not the cement industry alone, many industries worldwide have the obligation to lower their CO_2 emissions. If their processes cannot be adjusted to suppress emissions, CO_2 needs to be captured. To do so, ionic liquids can be the key technology. Due to their extraordinary capabilities, the state-of-the-art-process for CO_2 separation – chemical scrubbing with amines – can be simplified and thus operated in an energy efficient and economically viable way.

Technology

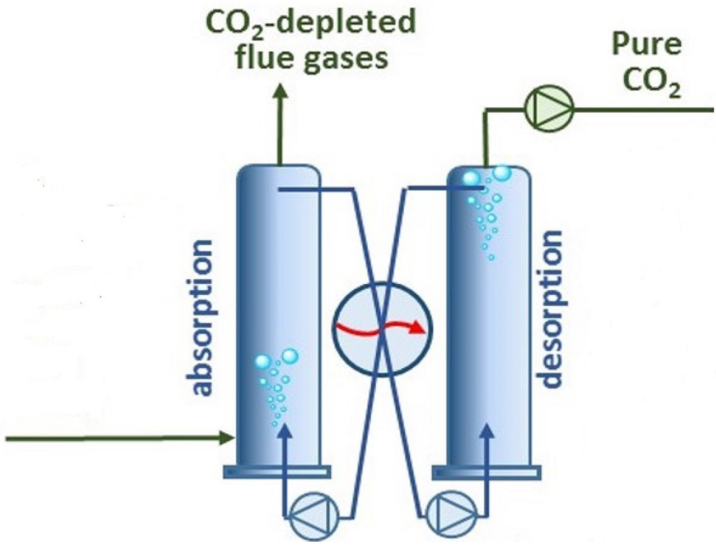
Developed for an efficient upgrading of biogas, the CO_2 recovery technology with ionic liquids allow for large scale application in cement, steel or chemical plants. Even CO_2 recovery from ambient air is possible. The process is adapted to the special characteristics of the tailor-made solvents through which the energy required can be lowered by up to 50 %. Moreover, oxygen-resistant liquids ensure a long lifetime in post-combustion processes. Compared to conventional gas scrubbers, the technology facilitates a less substantial retrofit of the production plant since it requires a fraction of process heat for an economical use. The demo-unit is able to treat 100 m^3/h of flue gas and delivers 16 kg/h of high-purity CO_2.

Process

The separation of CO_2 is done by chemical scrubbing using ionic liquids. These task-specific liquids are molten salts that are in liquid state at room temperature. Due to their ionic bond, the liquids do not evaporate and thus enable an energy-efficient regeneration by vacuum without discharge. Thereby, the energy demand is shifted from heat to electricity. The CO_2 separated reaches the high purity which is needed for the RECODE utilization paths.

CO_2 containing gas streams (flue gas, biogas, ambient air) are fed into the absorption column in which the liquid is loaded. Without feeding stripping gas, CO_2 is released from the liquid in the desorption column only by applying vacuum at 20 – 100 mbar. Liquid pumps and controllers ensure stable operation of the solvent cycle. Both columns operate at the same temperature level of 60 – 80 °C. This makes up for the low thermal energy required. A heat exchanger within the liquid cycle further economizes heat demand through the exchange of reaction heat of the absorption and desorption process. Within RECODE, the liquid is tailored for treating oxygen-rich flue gas streams to keep up operation of the absorption column at elevated temperature.

The process was developed by DVGW-Forschungsstelle (GER) in cooperation with chemical supplier IoLiTec (GER). The RECODE demonstration plant for separation of cement flue gas was designed and constructed by Hysytech (ITA).



Facts

- Up to 50 % lower energy consumption compared to amine scrubbing (benchmark)
- Lower life cycle cost compared to benchmark
- CO_2 separation efficiency of 80 %
- CO_2 purity of up to 99 vol-%
- Optimized degradation behavior
- No VOC (Volatile Organic Compounds) emissions
- Lower levels of request for heat integration at < 100 °C

Demo-unit for the treatment of 100 m^3/h of flue gas

Project

The Recode project answers the question how the cement industry can lower their carbon footprint: by enabling a circular-economy-approach. The CO_2 produced by cement manufacturing is re-used in significant part within the plant to produce better cement-related products entailing less energy intensity and reducing related CO_2 emissions. Moreover, CO_2 is used in various synthesis routes. Through electrocatalytic and catalytic pathways, formic acid, oxalic acid and glycine are produced to be used as hardening acceleration promoters or grinding aids.

For the past five years, the project consortium investigated all necessary sub-processes which then were upscaled to technically relevant size. Dedicated pilot plants were developed for all technologies and are demonstrated within a TRL 6 integrated system campaign at Kamari cement plant in Greece.

DVGW | ebi

Process Technology

HYSYTECH

Engineering Construction

io·li·tec Ionic Liquids Technologies

Ionic Liquids

iit ISTITUTO ITALIANO DI TECNOLOGIA

Project Coordination