Carbon dioxide emitted from cement industries represent 30% of the total annual CO2 emitted from industrial sectors. Approximately 2/3 of the CO2 emission is a result of the limestone calcination and 1/3 from the combustion of fuels.

For industrial applications, Carbon Capture and Storage (CCS) is one option for reducing these harmful CO2 emissions. Another option on which we are focusing in this work is the utilization of CO2 for its conversion into valuable products, namely Carbon Capture and Re-Use (CCRU).

The post-combustion CO2 capture system is an end of pipe technology where the CO2 in the flue gas is captured at the outlet of the industrial process. A hybrid technology is an intermediate solution between the oxyfuel and the post combustion carbon capture process.

The oxyfuel combustion capture system consists on realizing the combustion of fuels with only oxygen, so an air separation step is required. This technique leads to a high purity level of CO2 at the outlet of the process but an important cost to separate the oxygen from nitrogen is involved.

A gas treatment chain is necessary for capturing and purifying the gas at the outlet of a cement manufacturing process in order to obtain a purity level of CO2 suitable for its valorization.

The pure gas enters the dehydration unit composed by a Temperature Swing Adsorption (TSA) dual-bed where water is absorbed at high pressure (30 bar) onto a solid adsorbent which can be silica gel, activated alumina or molecular sieve alumina.

The gas is compressed and purified in a first unit called "sour compresison unit". The CO2 is separated from its NOx and SOx components.

The third and last step is called the cryogenic unit, it freezes the CO2 purity of the final product and the CO2 recovery of the overall process. The gas coming from the dehydration unit is cooled and flashed in a first flash at 30 bar. The vapor stream is then cooled and flashed anew in a second flash with a lowest temperature of -50°C to avoid the formation of dry ice (solid CO2) at this pressure. Liquid streams from both flashes are mixed and compressed to 110 bar for transport or storage.

The authors acknowledge the European Cement Research Academy (ECRA) for the technical and financial supports accorded to the ECRA Academic Chair.