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Hybrid absorber-membrane CO_2 capture

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While R&D in post-combustion CO_2 capture from coal-fired power plants delivers ever improving low energy solvents and process enhancements, current research into post-combustion capture from gas-fired power plants is however not so forthcoming. Still, gas-fired power generation is a major source of CO_2: 23% of total emissions in 2006 of the EU-27.[i] The impact and need for a gas-fired CCS solution is clear.

In this paper, an original (patent pending) solution for post-combustion CO_2 capture from gas-fired CO_2 sources is presented. In the scheme displayed below its three key elements are highlighted:

- Recycling: looping back a fraction of the flue gas to the gas turbine to roughly double the CO_2-concentration;
- Membrane preconcentration: applying CO_2-selective membranes sequentially leading to a CO_2-concentration of e.g. 50%;
- Absorber final capture: compressing this carbon dioxide rich flow and feed to a pressurized absorber where the CO_2 will be absorbed using a low energy consuming sorbent.

The three elements together offer an exciting new approach very suitable for their application. The low CO_2 concentration in the flue gas is raised by recycling, to such a point that membranes further concentration becomes feasible. Low contaminant content (e.g. SO_2 and particles) presents an excellent relatively mild environment for CO_2-selective membranes to operate in, which are elsewhere (e.g. coal-fired power plant flue gas) often troubled by durability issues. The absorber section, fed here with a preconcentrated CO_2 stream, is scaled down and less energy intensive.

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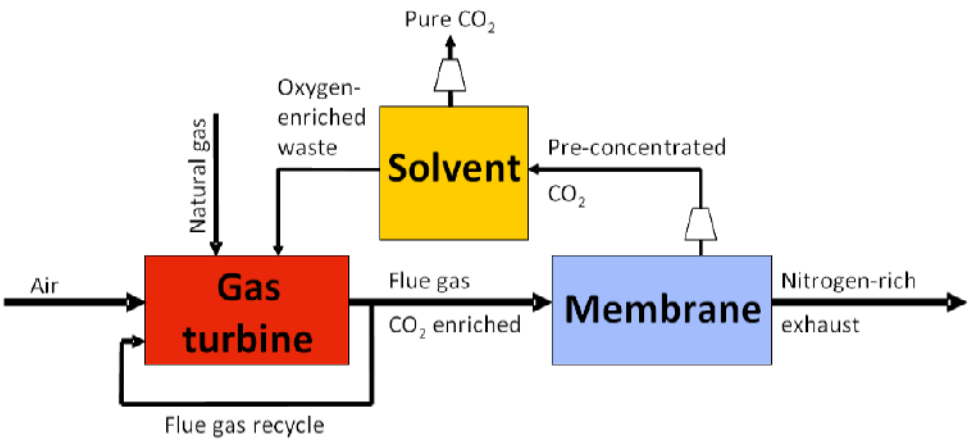

This paper describes the first R&D towards concretizing the novel concept. Identification and analysis of interfacial parameters led to preliminary designs. Operating conditions were established as much as possible. Based on this, crude solvent selection has started. Membrane performance and operation optimisation tests have yielded base values for modeling, which in turn focused on characterising the tradeoff between the various system parameters: purity and recovery of the membrane step, and the same for the absorber section. Gas turbine analysis provided insight in how (not) to operate and alter the gas turbine in the proposed system design. The main open issues are water vapour management and the detailed manner of compression and vacuum application. Also, experimental verification and fine-tuning has current focus.

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[i] Source: Eurostat