1st Post Combustion Capture Conference

Progress, performance and pilot testing of post-combustion CO_2 capture membranes at six industrial test sites

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Although membrane-based post-combustion CCS technologies have long been identified as clearly having potential, widespread interest and industrial trials were lagging behind, mainly because of performance and durability issues and perceived system immaturity. However, focused international and interdisciplinary research and development has now succeeded in raising the technology readiness level (TRL) of this CO_2 capture technology from 1-2 to 6-7. A few years of intensified attention indeed allowed progressing steadily and successfully from paper concepts and preliminary lab experiments to the current stage of pilot testing at a sufficiently large scale in power plants. This paper gives an overview of the many successful development and pilot testing efforts, recently and in the near future, of two promising membranes developed in the NanoGLOWA[i] project: SPEEK on PPO / PES and PVAm on PSf. The possibilities and growing maturity of CCS membrane technology are clearly demonstrated. The door towards industrial application of membranes for CO_2 separation from flue gases is wide open.

At six geographically spread test sites, excellent results have been obtained or are expected, as will be shown. The performance and durability of the first membrane, a diffusion transport membrane consisting of sulfonated polyetheretherketone coating onto polyphenylene oxide or polyether sulfone (developed by the University of Twente), have been carefully optimised to the point of proceeding into application testing.

- Using the flue gas simulator at KEMA (The Netherlands), selectivity and permeance were measured while operating a custom-made hollow fibre membrane module to realistic flue gas. Furthermore, the effects on performance and durability of SO_2 and NO_x contamination was analysed.
- At the IEC coal-fired power plant in Ashkelon (Israel), numerous similar tests were carried out, under different conditions and with different membrane/module combinations. The results of these small-scale tests were satisfactory, even though conditions (e.g. humidity, SO_2 content) were harsh.
- At the E.ON coal-fired power plant in Gelsenkirchen (Germany), pilot testing will take place shortly, with a relatively large scale module to be tested continuously for months.

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Simultaneously, testing and development activities with a flat sheet fixed site carrier (FSC) membrane of polyvinylamine on a polysulfone support (developed by the University of Trondheim, NTNU) took place in full force as well, culminating in an excellent and rare combination of high selectivity, permeance and durability.

- In Warsaw (Poland), at the Industrial Chemistry Research Institute (IChP), a dedicated medium-scale test rig was constructed for fully conditioned accurate testing of these membranes. Accurate performance and durability assessment operating with carefully constructed artificial flue gas confirmed the promising properties determined at lab scale.
- Real flue gas testing in Borssele (The Netherlands) further confirmed the membranes' suitability. Experiments with and without flue gas filtering perfectly replicated the excellent artificial flue gas results under real flue gas conditions, which can be called a breakthrough.
- The EDP power plant in Sines (Portugal) will be the site of relatively large scale testing for up to six months. Design of the pilot membrane module and test rig are on track. Important information will be gathered about (combatting) fouling, pretreatment, energy use and extended durability, and as such the PVAm on PSf membrane and related technologies' maturity will be established.

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[i] *EU FP6 Integrated Project NanoGLOWA, a five-year project focusing on research and development of five fundamentally different types of CO_2-selective membranes for post-combustion carbon capture at coal-fired power plants.*