# Modelling hybrid membrane processes for $CO_2$ Capture from Flue Gas

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Abstract

A model was developed for the prediction of separation performance of hybrid membrane processes in which resistive characteristics of dense polymeric phases are combined with capacitive characteristics of inorganic adsorption materials, integrated in the same membrane. In the pseudo-steady-state process the flue gas is fed to the system in a continuous fashion, while the permeate is collected by means of a swing in pressure downstream the membrane. Times of steps in cyclic pressure variation of permeate pressure can be varied in order to favor resistive, rather than capacitive characteristics of the membrane, in determining the performance of the process.

The model developed allows for the representation the variation in $CO_2$ recovery and produce purity which are obtained as function of times set-up for the different steps in the process cycle. The model also allows to account for the effect of permeability of dense polymer to different gases and corresponding solubility in adsorbent material.

Results from the use of the model demonstrate the flexibility inherent to the process, in which process parameters can be easily adjusted to insure the target value for $CO_2$ recovery or product purity, while load may vary, in terms of feed flow rate or composition. The latter characteristics, together with simplicity and modularity, which are typical of membrane plants, make the hybrid process particularly interesting in the treatment of flue gas from small scale point sources.

Data retrieved through the use of the model developed are essential to perform the economical analysis of alternatives in the set-up of the hybrid process and thus to optimize its design after the definition of target performances for recovery and condition of $CO_2$ stream retrieved.

**Keywords:** *Modelling, $CO_2$ capture, flue gas, gas separation technologies, hybrid membrane process*