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BUENOS AIRES 2023
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"The global engineering working for a better future world"

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Book of Abstracts

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Water influence on total annual cost for CO_2 separation through a two-stage membrane system.

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Carbon capture remains as one of the most promising alternatives to mitigate flue gas impact from installed plants. Several alternatives are being studied with different development levels. Membranes have been employed for gas separation in diverse industries; its application for carbon capture has been largely discussed. The mayor drawback of this technology lays on the high-energy requirement for driving force generation and its liability when treating humid gas. As a first approach to CO_2 separation, early works study binary gas mixtures as representative of flue gases. However, the presence of a little amount of H_2O may affect the separation in ways that need to be explored. In this work, an analysis on the impact of H_2O presence on the driving force and overall separation efficiency is carried out. A four-component flue gas mixture including H_2O and O_2 is considered for a more realistic approach. The process objective is to recover 90% of the incoming CO_2 and deliver a high purity permeate. Here a typical two-stage counter-current membrane system is studied (Figure 1). Each stage includes a feed compressor followed by a cooler, the first one is also connected to a vacuum pump on the permeate side and another cooler. An optimization program based on a previous model [1] modified to consider a four-component mixture is implemented in GAMS. Mass and energy transfer phenomena, investment and operative costs, among others, are represented by a set of algebraic equations. Three different driving force generation setups are considered: feed compression, permeate vacuum or a combination of both. Total annual cost (TAC) is selected as objective function to asses all the trade-offs between investment and operative costs, contrasting and accounting H_2O influence.

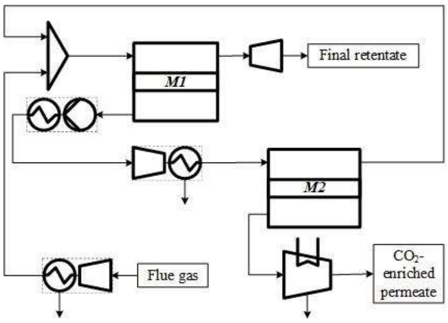

Figure 1 Two-stage system

The resulting optimal driving force generation strategy includes a combination of feed compression and permeate vacuum pumping fulfilling a 90% CO_2 recovery. In fact, the incidence of investment over TAC is much less pronounced that the costs related to energy consumption.

References

1. Mores, P. L., Arias, A. M., Scenna, N. J., Mussati, M. C., & Mussati, S. F. (2019). Cost-based comparison of multi-stage membrane configurations for carbon capture from flue gas of power plants. *International Journal of Greenhouse Gas Control*, *86*, 177-190.