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# The impact of toluene and xylene on the performance of cellulose triacetate membranes for natural gas sweetening

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## Abstract

The presence of condensable aromatic hydrocarbons in raw natural gas streams creates a significant challenge for acid gas removal through membrane separation. In this work, the impact of toluene and xylene on the gas separation performance of cellulose triacetate (CTA) membranes was studied. When operating at low $CO_2$ partial pressures (0.75 Bar), both toluene and xylene reduced the permeation of $CO_2$ at low vapour activities, due to competitive sorption and the pore-filling or anti-plasticisation effect. Conversely, at vapour activities greater than 0.5, toluene caused membrane plasticisation, possibly coupled with a decrease in crystallinity. On the other hand, when operating at 7.5 Bar $CO_2$ pressure, plasticisation was observed at a lower vapour activity of 0.3 for both toluene and xylene. This study shows that two penetrants can influence the plasticisation behaviour in a co-operative manner that cannot be described by a simple additive model. The study also shows that the permeabilities of toluene and xylene are comparable with that of methane.

Keywords: Cellulose triacetate; BTEX; methane; carbon dioxide.



## 1. Introduction

Natural gas will become the second largest energy resource globally within the next few decades [1, 2]. Raw natural gas contains condensable hydrocarbons, acid gases and impurities that require pre-treatment to meet consumer specifications and for pipeline transport. A range of separation technologies have been commercialised for natural gas processing, with membrane gas separation commercially proven for natural gas sweetening (acidic gas removal). Cellulose triacetate (CTA) membranes are the market leaders for gas sweetening membranes, because of their low cost, durability and competitive gas separation performance [3, 4].

Condensable aromatic hydrocarbons, known as BTEX (Benzene, Toluene, Ethylbenzene and Xylene) are present in raw natural gas at concentrations ranging from 200 to 3000 ppm,