

# Comparison of water and ethanol vapor sorption and transport in a polymer membrane

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## Introduction

Polymer materials to be used as protective packaging need to have their sorption and permeability characteristics measured in order to assess their suitability for their task. The IGA gravimetric sorption analyzer provides the ability to characterize and test new materials.

## Experimental Procedure

The membrane was directly suspended within the IGA-002 sample chamber. It was outgassed to high vacuum (<10<sup>-6</sup> mbar) at a temperature of 25 °C.

The sample was then studied isothermally at 25 °C by stepping up the pressure to measure the adsorption branch then stepping down the pressure to measure the desorption branch using water vapor as the sorbate. The sample was then outgassed a second time before an ethanol adsorption desorption study was performed.

The IGA method described in figure 1 was utilized to fit to the weight relaxation resulting from each of the pressure steps. The linear driving force (F1) model was utilised to predict asymptotic equilibrium points during this experiment.



The IGA gravimetric sorption analyser

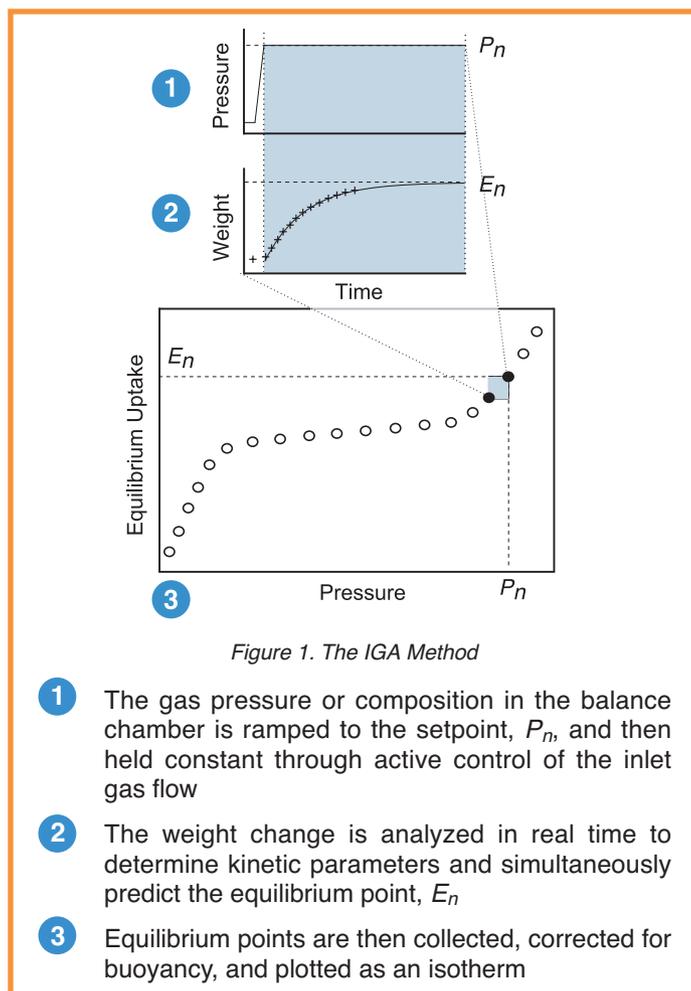
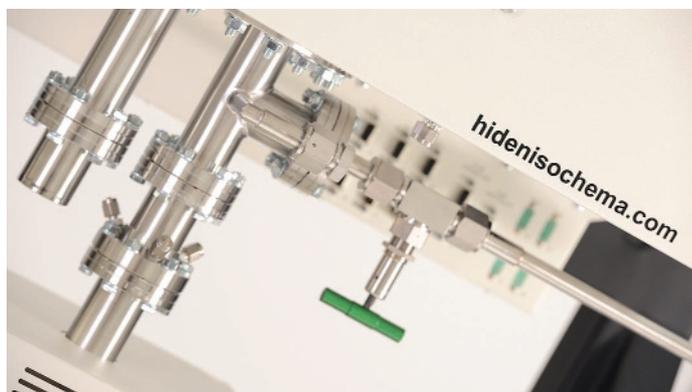


Figure 1. The IGA Method

- 1 The gas pressure or composition in the balance chamber is ramped to the setpoint,  $P_n$ , and then held constant through active control of the inlet gas flow
- 2 The weight change is analyzed in real time to determine kinetic parameters and simultaneously predict the equilibrium point,  $E_n$
- 3 Equilibrium points are then collected, corrected for buoyancy, and plotted as an isotherm

The IGA method predicts the point of equilibrium uptake from the fit and determines the rate constant of the adsorption  $k$  ( $k=1 / \text{time constant}$ ), it also ensures that each point on the isotherm is measured to the same accuracy and optimizes the use of instrument time.



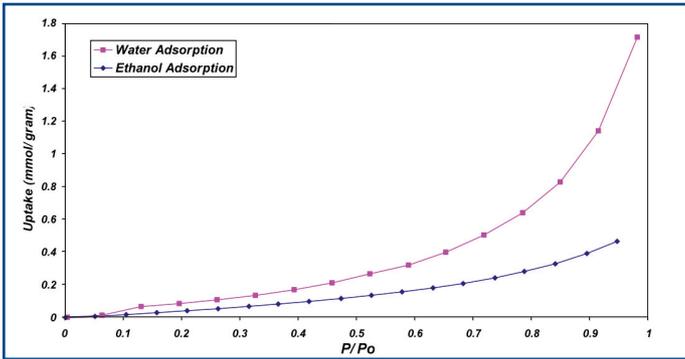


Figure 2: Vapour sorption uptake isotherm of membrane

Fig. 2 displays the adsorption isotherms measured for both water and ethanol on the membrane sample. It is evident that a higher concentration of water is found in the membrane than ethanol.

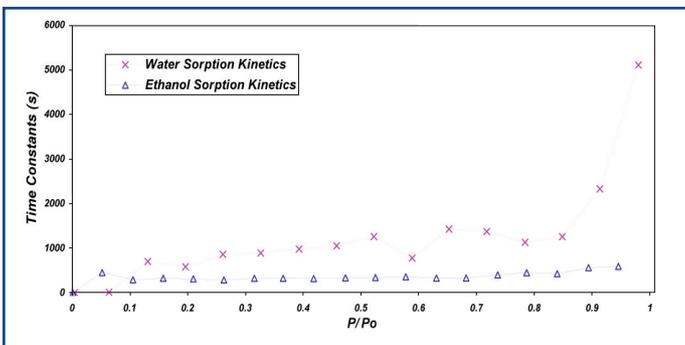


Figure 3: Kinetic study of water and ethanol vapour uptake

Fig. 3 displays the rate constants measured for each isotherm point shown in figure 1. It can be seen that the kinetics of water sorption are consistently slower between 0.05-0.92  $p/p_0$  than the ethanol sorption kinetics and strongly concentration dependent above  $p/p_0 = 0.85$ .

## Results and Discussion

This short study has demonstrated that the polymer membrane in question is more suitable to resisting ethanol breakthrough than water. However, the longer time constants regulating water diffusion show that the permeation rate for water is slower than with ethanol. Thus, the polymer membrane may be suitable for packaging where some moisture diffusion is not critical over short time-scales. As permeability depends on both the concentration and diffusion constants (which can be calculated from rate or time constants), the IGA is the perfect tool to investigate these factors independently.

