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AUGUST 10-13, 1997

**University of Toronto
Toronto, Ontario
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- 29 Maccone, P., Apostolo, M., **Molecular Weight Distribution of Fluorinated Polymers with Long Chain Branching**
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- 31 D'Agnillo, L., Soares, J.B.P., Penlidis, A., **A Hierarchical Data Analysis of a Replicate Experiment in Polyethylene Synthesis with High-Temperature Gel Permeation Chromatography**
- 32 Soares, J.B.P., Abbott, R.F., Willis, J.N., Liu, X., **New Methodologies for Studying Multiple-Site-Type Catalysts for the Copolymerization of Olefins**
- 33 Ohtani, H., Nonobe, T., Tsuge, S., Kitayama, T., Hatada, K., **Stereoregularity of Poly(methyl methacrylate)s Studied by Pyrolysis-Gas Chromatography/Mass Spectroscopy**
- 34 Pagé, J.Y.S.D., Bonin, H.W., Bui, V.T., Bates, P.J., **Viscoelastic Analysis of Irradiated Polymer Resins (Polycarbonate, Polysulfone and Polyetheretherketone)**
- 35 Joly, C., Bliard, C., Espuche, E., Escoubès, M., **Acetylated Wheat Starch Membranes: Permeability Measurements**
- 36 Laignel, B., Bliard, C., Bourg, S., Nuzillard, J.M., Massiot, G., **Kinetics Study of Glucose Acetylation in Starch Polymers by Quantitative ^{13}C NMR Spectroscopy**
- 37 Vancso, G.J., Pearce, R., **Real-Time Imaging of Melting and Crystallization in Poly(Ethylene Oxide) by Atomic Force Microscopy with Lamellar Resolution**
- 38 Tanaka, M., Shimbo, K., Yamada, T., Ohfusa, Y., Taguchi, M., Suzuki, H., MacFarlane, J.D., **Development of Downsized Columns and System for GPC Analyses**
- 39 Fan, X-D., Deng, Y., Waterhouse, J., Pfromm, P., **Synthesis and Characterization of Soy-Based Copolyamides Consisting of Amino Acids or Soy-Protein**
- 40 Wong, W.S., Schmidt, S., Gillespie, D., **Application of SEC for the Characterization of Cellulose Materials**

Acetylated wheat starch membranes : Permeability measurements

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Introduction

Packaging industries require new biodegradable food-compatible films with low O₂ permeability and controlled H₂O flux. Biopolymers such as starch are chosen as raw materials because of their low cost, renewability, and local origin. The morphology and properties of these polymers can be affected by the humidity rate and it is important to know how moisture affects their gas permeability. In this study, wheat starch has been acetylated to a degree of substitution of 2.7 (1) and dissolved into chloroform with triacetin added as a plasticizer (28.5 % by weight of membrane). Clear and bright films were obtained by the tape-casting technique. Permeability measurements with water vapour were made and in addition, O₂ and CO₂ transport properties were studied for different relative humidity (R.H.) conditions in order to determine if gas selectivity changes with the hydration state of the film at 20 °C.

Water permeability

The specificity of this experiment is the acquisition of H₂O flux as a function of a large water pressure domain (figure 1).

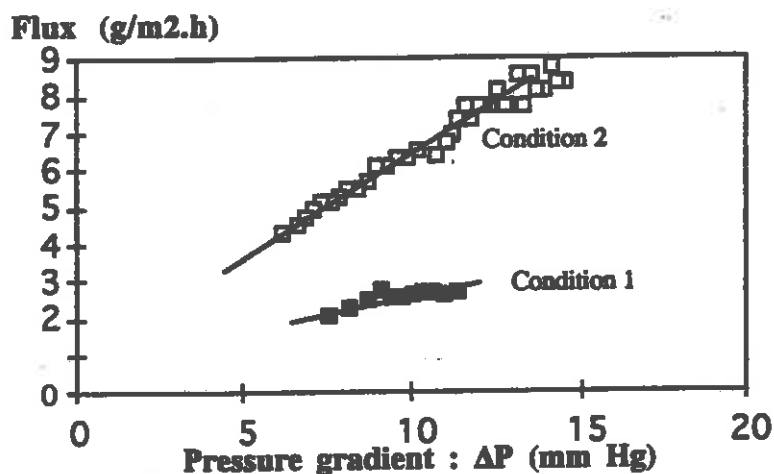


Figure 1 : Influence of the initial conditions on the water flux

Two initial film hydration conditions (1 and 2 in table 1) have been chosen in order to study the influence of plastification by water on water transport properties. These conditions are as follows : the upstream water pressure (P₁) is equal to 12.5 and 18.4 mm Hg for the initial conditions 1 and 2. The downstream pressure (P₂) is always equal to 0 at initial time.

As shown in Figure 1, for part of the water transfer, the flux decreases in proportion to the pressure gradient but the slopes differ. In the first condition, the membrane was submitted to an average relative humidity varying from 30 to 40 %, and for the second, one of between 60 and 80 %.

For these two hydration states, the results show a measurable modification of the transport properties (figure 1) : the flux is 2.5 times higher for hydration condition 2 and the permeability coefficients (table 1) are in a good agreement with literature values obtained for acetylated amylose (2). The diffusion coefficients reported in table 1 show no significant plastification effect on this material (factor 1.6).

Initial conditions (mmHg)	Permeability coefficients (Barrers) from 20 to 50% of the total transfer	Diffusion coefficients from 0 to 50% of the total transfer (10 ⁻¹⁰ cm ² .s ⁻¹)
Cond 1 : P ₁ = 12.5 / P ₂ = 0	9 900	59
Cond 2 : P ₁ = 18.4 / P ₂ = 0	24 600	95

Table 1 : Water permeability and diffusion coefficients as a function of the initial conditions
(P₁ = upstream pressure / P₂ = downstream pressure)

Gas permeability at varying hydration rates :

Two gases are involved in the "breathing" of packaged aliments : O₂ and CO₂. In this study, CO₂/O₂ selectivity is studied as a function of relative humidity. The permeability coefficients (Pe) and diffusion coefficients (D) are presented in table 2. Comparison of the results obtained at 0 and 60% R.H., shows that the selectivity is only slightly affected by this R.H. increase. CO₂/O₂ selectivity decreases from 1.8 to 1.3.

		0 % R.H.	60 % R.H.	95 % R.H.
CO ₂	Pe (Barrers)	27	36	42
	D (10 ⁻¹⁰ cm ² /s)	345	-	-
O ₂	Pe (Barrers)	15	25	-
	D(10 ⁻¹⁰ cm ² /s)	321	-	-

Table 2 : Permeability coefficients at varying hydration rates

The diffusion coefficients are not given at 60 and 95 % (± 5 %) R.H because of the low definition of the non steady state region of the permeation curve. No values are reported for oxygen permeation at high humidity rates because the flux tended towards very low values. It appears that water sorbed in the membrane is close to liquid state (3, 4), disturbing significantly the O₂ permeation and therefore the selectivity.

Conclusion

Permeation measurements have been made for acetylated starch (DS 2.7) plasticized with triacetin. The measured CO₂/O₂ selectivities are low and seem to be only slightly dependent on film hydration until 60 % R.H. and are significantly enhanced for 95 -100 % R.H. Therefore, further experiments are necessary to study how gas transport properties and selectivity are influenced by the triacetin content and the degree of substitution of the acetylation treatment.

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References

- 1) B. Laignel, C. Bliard, J. M. Nuzillard, G. Massiot, *Carbohydr. Res.*, **298** (1997) 251
- 2) A.T. Gros, R. O. Feuge, *J. Am. Oil. Chem. Soc.* **39** (1962) 19
- 3) C. Joly, R. Gauthier, M. Escoubes, *J. Appli. Polym. Sci.*, **61** (1996) 57
- 4) C. Fringant, J. Desbrières, M. Milas, M. Rinaudo, C. Joly, M. Escoubes, *Int. J. Bio. Macrom.*, **18** (1996) 281