

Gas Separation Properties of Isophorone-Based Polyarylates

JAN JAGER* and ANTON J. J. HENDRIKS

Akzo Nobel Central Research, Location Arnhem, P.O. Box 9300, 6800 SB Arnhem, The Netherlands

SYNOPSIS

The oxygen and nitrogen permeability coefficients and oxygen/nitrogen selectivities of a series of isophorone-based polyarylates have been measured. The monomeric bisphenols used in this study are easily accessible in two steps from cheap, commercially available, isophorone (3,5,5-trimethyl-2-cyclohexen-1-one). The corresponding polyarylates can easily be prepared in high yield by means of the well-known interfacial polycondensation route. The effect of substituents (CH₃, Cl, or Br) on all positions ortho to both hydroxyl groups in the bisphenol and the influence of the terephthalic acid/isophthalic acid molar ratio in the polyarylate on the oxygen/nitrogen separation performance have been studied in detail. It has been found that the polyarylate with four bromine substituents displays a significantly increased oxygen and nitrogen permeability coefficient, combined with a high oxygen/nitrogen selectivity, relative to conventional polyarylates. Obviously, the bulky 3,3,5-trimethylcyclohexylidene moiety in the bisphenol has structural features that hinder an efficient chain packing and reduce polymer segmental mobility. A further improvement in the gas permeability of these polyarylates can be achieved when the bulky *t*-butyl group is introduced on the 5 position in isophthalic acid. For example, the polyarylate prepared from the isophorone-based bisphenol with four methyl substituents and 5-*t*-butylisophthalic acid is characterized by an oxygen permeability coefficient of 34.7 Barrer! © 1995 John Wiley & Sons, Inc.

INTRODUCTION

In the past few years membrane gas separation processes for binary gas mixtures have attracted considerable attention. These processes are used for both fundamental research and for industrial applications.¹ Excellent review articles on this subject have recently been published by Koros and Fleming,² Kesting and Fritzsche,³ and Stern.⁴ Some examples of membrane gas separation processes, practised on an industrial scale, include the separation of oxygen from nitrogen (oxygen or nitrogen enrichment), the separation of helium from nitrogen (helium recovery), or the separation of hydrogen from hydrocarbons (refinery hydrogen recovery). In the present work we will focus on the membrane separation of air in both its primary components oxygen and nitrogen. Nitrogen enrichment is of particular importance to a variety of industrial pro-

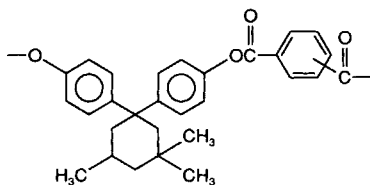
cesses (nitrogen blankets over air-sensitive materials for safety reasons) or to food storage and the preservation of perishable foods and flowers during transportation.⁵ Oxygen-enriched air has demonstrated potential applications in advanced combustion processes, e.g., diesel engines,⁶ or in medical use.⁷

Gas separation properties of glassy polymer membranes depend to a large extent on the class of polymer used in the separation process. In the past few years, polyimides (PI),⁸⁻¹⁷ polyamideimides (PAI),¹⁸ polycarbonates (PC),¹⁹⁻²⁸ polyester carbonates (PEC),²⁹⁻³¹ polyarylates (PAR),³²⁻³⁸ and other materials, have been documented in detail for oxygen/nitrogen separation processes. Several of these studies deal with polymer structure-property relationships in order to gain a better understanding of the polymeric structural variables influencing the gas separation properties of the polymer membrane. On the basis of this knowledge, new membrane materials could be "designed" with an improved gas separation performance.

The present study is concerned with gas separation properties of a family of polyarylates in which

* To whom correspondence should be addressed.

the isopropylidene moiety in bisphenol A polyarylates has been replaced by the bulky 3,3,5-trimethylcyclohexylidene moiety. This class of bisphenols is easily accessible in two steps (hydrogenation of isophorone followed by condensation with phenol) from cheap, commercially available, isophorone (3,5,5-trimethyl-2-cyclohexen-1-one). The polyarylates can be represented by the following general formula:



The effect of substituents (CH_3 , Cl, or Br) on all positions ortho to both hydroxyl groups in the bisphenol and the influence of the terephthalic acid/isophthalic acid molar ratio on the gas separation properties are discussed in terms of oxygen and nitrogen permeability coefficients and oxygen/nitrogen selectivities. Gas separation properties of these particular polyarylates will be compared with those of structurally comparable polyarylates described in the literature.

THEORY AND BACKGROUND²⁻⁴

Two major parameters can be identified in gas separation processes of binary gas mixtures by semi-permeable polymer membranes: (1) the permeability coefficient (P), and (2) the selectivity (α).

The permeation of gases or gas mixtures through an amorphous dense polymer membrane usually occurs by a solution-diffusion mechanism.³⁹⁻⁴¹ According to this mechanism, penetrant gas molecules dissolve first in the upstream membrane boundary. Then, these penetrant molecules diffuse through the dense membrane matrix by successive jumps. Ultimately, evaporation takes place from the downstream boundary of the membrane. The permeability coefficient of penetrant molecule A (P_A) can be expressed in terms of the mean diffusion coefficient (D_A) and the solubility coefficient (S_A).

$$P_A = D_A \times S_A \quad (1)$$

The permeability coefficient of penetrant molecule A (P_A) through a dense polymer membrane, having an effective membrane thickness of l , can be derived from the steady state flux, F_A :

$$P_A = F_A \times l / \Delta p \quad (2)$$

where, Δp is the partial pressure difference between the upstream and downstream pressure of penetrant molecules A across the membrane. Several methods have been devised to determine the permeability coefficient of gases through membranes and, thus, a number of different units have been used to express the permeability coefficients.⁴² In this article, the permeability coefficient is expressed in units of Barrers, where 1 Barrer is $10^{-10} \cdot [\text{cm}^3(\text{STP}) \cdot \text{cm} / \text{cm}^2 \cdot \text{s} \cdot \text{cmHg}]$.

The selectivity, $\alpha(A/B)$, or the so-called separation factor, of a dense polymer membrane between two penetrant gas molecules A and B is the ratio of the permeability coefficients of both penetrant gases. When the downstream pressure is negligible relative to the upstream pressure and when strong interactions between the polymer and both penetrant molecules are not observed, $\alpha(A/B)$ is almost equal to the "ideal" separation factor, $\alpha(A/B)^*$.⁴³ This ideal separation factor can be decomposed into contributions of solubility selectivities (S_A/S_B) and diffusivity selectivities (D_A/D_B). Therefore,

$$\alpha(A/B)^* = P_A/P_B = (S_A/S_B) \times (D_A/D_B) \quad (3)$$

The solubility selectivity (S_A/S_B) is determined primarily by the difference in inherent condensibility between both penetrant molecules A and B and by their interactions with the membrane boundary. The diffusivity selectivity (D_A/D_B) is determined by the ability of the polymer matrix to function as size and shape selective media through segmental mobility and intersegmental packing factors. In the absence of strong polymer-penetrant interactions, the diffusivity selectivity tends to be the major factor in the separation process. For commonly available polymers, it has been found that the permeability coefficient and the selectivity are interdependent. Higher gas permeability coefficients are usually accompanied by lower selectivities, and vice versa.⁴⁴ Therefore, in today's research, much attention is paid to find new polymeric materials that circumvent this general tendency.

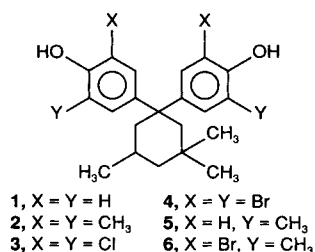
EXPERIMENTAL

Monomer Synthesis

Structures of the isophorone-based bisphenols (see Series 1), containing the 3,3,5-trimethylcyclohexylidene moiety, are given below. Various substituents

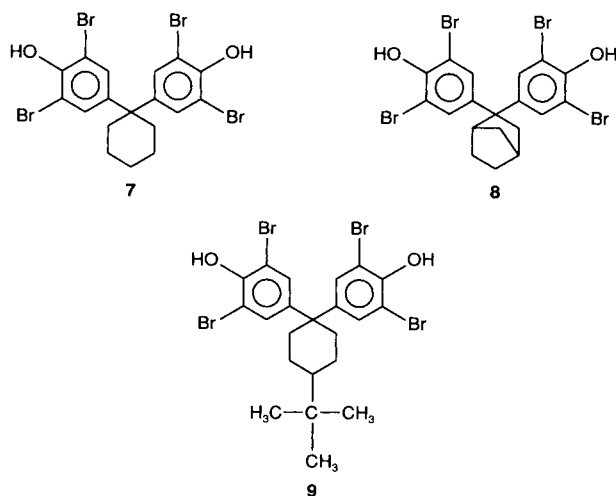
(CH₃, Cl, or Br) were introduced on all positions ortho to both hydroxyl groups in the bisphenol.

Series 1



In addition, tetrabrominated bisphenols of Series 2 have been prepared to have the disposal of some structural analogous polyarylates. Although most of the gas separation properties of these polyarylates have been described in the literature, we decided to determine the gas separation properties under the same conditions and on the same equipment as used for the abovementioned isophorone-based polyarylates of Series 1.

Series 2



Series 1

Bisphenol **1** (X = Y = H) can quite easily be prepared by a literature procedure in high yield from 3,3,5-trimethylcyclohexan-1-one (hydrogenated isophorone) in a reaction with excess of phenol and in the presence of an acid catalyst and a sulfur-containing cocatalyst.^{28,45} The bisphenol was purified by recrystallization from *p*-xylene (twice). A melting point of 207°C was measured (Lit. 205–207°C²⁸, 209–211°C⁴⁵). Bisphenols **2** (X = Y = CH₃) and **5** (X = H, Y = CH₃) could both be prepared by an analogous procedure using the corresponding methyl-substituted phenols, 2,6-dimethylphenol

(2,6-xylenol) and 2-methylphenol (*o*-cresol), respectively. Both methyl-substituted bisphenols were recrystallized twice from *p*-xylene. The melting point of the tetramethyl-substituted bisphenol **2** (X = Y = CH₃) was found to be 235°C, and that of the dimethyl-substituted bisphenol **5** (X = H, Y = CH₃) was 186°C. The tetrachlorinated bisphenol **3** (X = Y = Cl) and the tetrabrominated bisphenol **4** (X = Y = Br) were obtained in high yield from the abovementioned unsubstituted bisphenol **1** (X = Y = H) by simple chlorination in acetic acid or bromination in ethanol, respectively, according to literature procedures.⁴⁶ The dibromodimethyl-substituted bisphenol **6** (X = Br, Y = CH₃) was prepared by bromination of the dimethyl-substituted bisphenol **5**. All halogenated bisphenols were purified by recrystallization (twice) from acetic acid. The melting points of bisphenol **3** (X = Y = Cl), bisphenol **4** (X = Y = Br), and bisphenol **6** (X = Br, Y = CH₃) were 181°C, 199°C, and 201°C, respectively.

Series 2

The tetrabrominated bisphenols of Series 2 were also prepared by means of a two-step procedure from the corresponding cycloaliphatic ketones. In the first step, the unsubstituted bisphenols were prepared by acid-catalyzed condensation from the corresponding cycloaliphatic ketones and excess of phenol, bisphenol **7** was prepared from cyclohexanone,²³ bisphenol **8** from norcamphor,³⁵ and bisphenol **9** from 4-*t*-butylcyclohexanone.³⁶ Next, the bisphenols were allowed to react with bromine to yield the corresponding tetrabrominated bisphenol monomers.^{35,36} The resulting tetrabrominated bisphenol monomers were purified by recrystallization from acetic acid/water solvent mixtures. The melting point measured was 143°C for the tetrabrominated cyclohexane derivative (viz. bisphenol **7**), 184°C for the tetrabrominated norcamphor derivative (viz. bisphenol **8**), and 226°C for the tetrabrominated 4-*t*-butylcyclohexane derivative (viz. bisphenol **9**). Tetrabromobisphenol A (2,2-bis-(3,5-dibromo-4-hydroxyphenyl)propane, bisphenol **10**) was purchased from Riedel-de Haën. This material was used without further purification.

Chemical structures of bisphenols **1–9** were confirmed by ¹H- and ¹³C-NMR spectroscopy (Bruker AC-300), mass spectroscopy (Finnigan MAT 212), infrared spectroscopy (Perkin-Elmer IR spectrometer Model 580) and by elemental analyses. Melting points of the bisphenol monomers were measured

by the DSC technique, using a DuPont DSC 990 Thermal Analyzer.

Polymer Synthesis

All polyarylates were prepared by means of the interfacial polycondensation⁴⁷ route from the monomeric bisphenols with aromatic acid dichlorides, terephthaloyl dichloride (TDC), isophthaloyl dichloride (IDC), and mixtures of both acid dichlorides. Moreover, a few polyarylates have been prepared using 5-*t*-butylisophthaloyl dichloride (BIDC) instead of isophthaloyl dichloride (IDC). BIDC was prepared by means of a conventional procedure from the corresponding dicarboxylic acid and thionyl chloride.⁴⁸ In the interfacial polymerization route, dichloromethane (DCM) was used as the organic solvent and tetrabutylammonium bromide (TBAB) as the phase-transfer catalyst. All polyarylates were prepared using the same equipment and the same polymerisation conditions. Relative solution viscosities (η_{rel}) of all polyarylates were measured in *m*-cresol by means of a standard procedure (25°C, 1% mass/mass).

General procedure

In a 700-mL cylindrical flask fitted with a turbine stirrer was placed a solution of 0.096 mol of NaOH and 0.040 mol of a particular monomeric bisphenol in 260 mL of demineralized water. A solution of 1.290 mmol of TBAB catalyst in 60 mL of DCM was added. To the stirred solution was added all at once a solution of 0.040 mol of an acid dichloride in 100 mL of DCM. Moreover, 100 mL of DCM was used to rinse the additional funnel. Vigorous stirring was continued at 20°C for 40 min under nitrogen. When both layers had separated, the aqueous layer was decanted and the remaining viscous polymer solution in DCM was washed repeatedly with water to neutral. An additional 350 mL of DCM was added to lower the solution viscosity and the polymer was precipitated slowly in 2 L of methanol. The polymer was filtered and dried for 24 h under vacuum at 100°C. The resulting polymer was purified by reprecipitation from DCM/methanol, washed with methanol, and dried at 100°C under vacuum for 24 h. The polymer yield was nearly quantitative.

Film Preparation

Amorphous films of 50–70 μm thickness, used for the oxygen/nitrogen separation studies, were prepared from each of the polymers. Polyarylate, 2.5 g,

was dissolved in 50 mL of chloroform. This clear solution was filtered through a 10- μm filter to remove any particulates. About 14 g of this polymer solution was poured into a clean glass disk (diameter 13.5 cm). Chloroform was evaporated slowly for 48 h at room temperature. The film was removed from the disk and subsequently dried for 24 h in a vacuum oven at 190°C to remove any remaining solvent. The film thickness was measured by taking the reciprocal average of 13 determinations made uniformly on the film.

Gas Separation Measurements

Oxygen and nitrogen permeability coefficients and oxygen/nitrogen selectivities were measured using an Analytical Gas Permeability tester GPM-200 from the Lyssy Comp. Measurements took place under practically isostatic conditions with a helium carrier gas atmosphere on one side of the polyarylate membrane and the test gas on the other side. The measuring principle for flat membranes consists of placing the membrane in a measuring chamber that comprises an adequately tight sample holder in a thermostatically controlled environment and of ensuring an atmosphere of pure helium on one side of the membrane, whereas the other side of the membrane was purged with the test gas—in this case, atmospheric air. From the helium atmosphere, which is constantly circulated under the flat membrane, a small adequate volume is transferred by an automatically programmed injection system to a dual-column gas chromatograph and gas chromatographically analyzed from time to time at preset time intervals. The increase of peak areas on the gas chromatogram for the different gases is practically directly proportional to the permeated gas. Gas transport properties reported in this article are the average of duplicate measurements.

RESULTS AND DISCUSSION

Nearly all polyarylates could, without any problem, be prepared by means of the interfacial polymerization route from the corresponding monomeric bisphenol and terephthaloyl dichloride (TDC), isophthaloyl dichloride (IDC), or mixtures of terephthaloyl dichloride and isophthaloyl dichloride (TDC/IDC molar ratios 75/25, 50/50, or 25/75). The polyarylate from the unsubstituted bisphenol 1 ($X=Y=H$) and terephthaloyl dichloride could not be prepared through the interfacial polymerization route because the polymer precipitated from

Table I Oxygen and Nitrogen Permeability Coefficients and Oxygen/Nitrogen Selectivities for Polyarylates of Series 1 (bisphenols 1–6)

Bisphenol	X	Y	TDC/IDC ^a	η_{rel}	$P(O_2)$ (Barrer)	$P(N_2)$ (Barrer)	$\alpha(O_2/N_2)$
1	H	H	75/25	2.14	6.8	1.6	4.2
			50/50	2.24	5.8	1.3	4.4
			25/75	2.89	5.4	1.2	4.7
			0/100	1.57	4.4	0.9	4.9
2	CH ₃	CH ₃	100/0	3.41	22.7	5.5	4.1
			50/50	2.88	18.6	4.1	4.5
			0/100	1.84	13.7	2.8	5.0
3	Cl	Cl	100/0	2.87	11.7	2.4	4.9
			50/50	2.70	9.3	1.8	5.3
			0/100	2.26	6.6	1.1	5.9
4	Br	Br	100/0	2.57	11.8	2.3	5.2
			50/50	1.86	7.5	1.3	6.0
			0/100	1.77	6.2	1.0	6.2
5	H	CH ₃	100/0	3.34	4.4	0.9	5.1
			50/50	3.36	2.8	0.5	5.5
			0/100	2.98	2.3	0.4	5.6
6	Br	CH ₃	100/0	1.82	12.3	2.5	4.9
			50/50	1.75	8.7	1.6	5.3
			0/100	1.54	6.8	1.2	5.6

^a TDC/IDC = terephthalic acid/isophthalic acid molar ratio.

the reaction mixture during polymerization, probably due to crystallization. Table I gives oxygen and nitrogen permeability coefficients, $P(O_2)$ and $P(N_2)$, as well as oxygen/nitrogen selectivities, $\alpha(O_2/N_2)$, for all isophorone-based polyarylates of Series 1. The relationship between the oxygen/nitrogen selectivity and the corresponding oxygen permeability coefficient is graphically shown in Figure 1 for polyarylates of Series 1. Obviously, for each bisphenol, an increase of the terephthalic acid content in the polyarylate is accompanied by an increase in both the oxygen and nitrogen permeability coefficients and, as expected, by a decrease in the oxy-

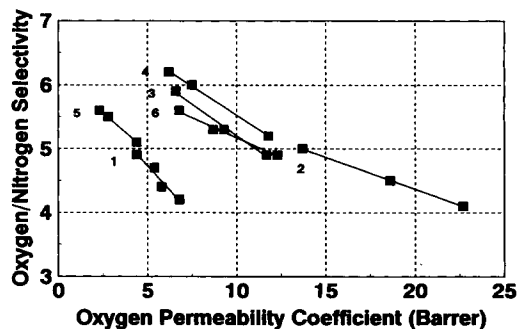


Figure 1 Dependence of the oxygen/nitrogen selectivity [$\alpha(O_2/N_2)$] on the oxygen permeability coefficient [$P(O_2)$] of polyarylates of Series 1 (bisphenols 1–6).

gen/nitrogen selectivity. The same dependence was recently reported by Pessan and Koros³³ for bisphenol A polyarylates. A clear explanation for this behavior is not yet available. It was postulated³³ that the distribution of the fractional-free volume (FFV) could be the determining factor for the observed behaviour.

Replacement of the isopropylidene moiety in bisphenol A by the bulky 3,3,5-trimethylcyclohexylidene moiety has a pronounced effect on the gas separation properties of the polyarylate. For example, the unsubstituted polyarylate [viz. bisphenol 1 ($X=Y=H$)], having a TDC/IDC molar ratio of 0/100, is characterized by an oxygen permeability coefficient of 4.4 Barrer and an oxygen/nitrogen selectivity of 4.9. By contrast, the bisphenol A polyarylate, having the same TDC/IDC molar ratio of 0/100, has an oxygen permeability coefficient of only 1.45 Barrer and an oxygen/nitrogen selectivity of 5.34 (measurements at 2 atm).³³ Likewise, Schmidhauser and Longley reported⁴⁹ an oxygen permeability coefficient of 1.81 Barrer for the bisphenol A polyarylate, having a TDC/IDC molar ratio of 50/50, whereas an oxygen permeability of 5.8 Barrer was measured for the corresponding isophorone-based polyarylate. Most probably, the significant increase in permeability coefficients of the isophorone-based polyarylates is caused by a lack of effi-

cient chain packing and reduction of the segmental mobility due to the presence of the bulky 3,3,5-trimethylcyclohexylidene moiety in the polymer main chain.

Introduction of four methyl substituents on the ortho positions to both hydroxyl groups in the bisphenol (viz. bisphenol **2**; X=Y=CH₃) has a tremendous effect on both oxygen and nitrogen permeability coefficients, e.g., $P(O_2) = 22.7$ Barrer at a TDC/IDC molar ratio of 100/0. Remarkably, tetramethyl substitution has only a minor effect on the oxygen/nitrogen selectivity relative to the unsubstituted polyarylates from bisphenol **1** (X=Y=H). Introduction of only two methyl substituents (viz. bisphenol **5**; X=H, Y=CH₃) reduces the oxygen permeability coefficients relative to the unsubstituted polyarylate from bisphenol **1** (X=Y=H) by a factor of about 2, the corresponding oxygen/nitrogen selectivities increase. The same behavior has been observed for methyl-substituted polycarbonates.^{23,49} The polycarbonate from bisphenol A has an oxygen permeability coefficient of 1.38 Barrer, and the corresponding tetramethyl-substituted polycarbonate has a permeability coefficient of 5.94 Barrer. On the other hand, the corresponding dimethyl-substituted polycarbonate has an oxygen permeability coefficient of only 0.30 Barrer. Introduction of two additional bromine atoms into the dimethyl-substituted polyarylate only improves the oxygen permeability coefficient.

The tetrachlorinated polyarylate (viz. bisphenol **3**) and the tetrabrominated polyarylate (viz. bisphenol **4**) are characterized by both a higher oxygen permeability coefficient and a higher oxygen/nitrogen selectivity. A similar simultaneous increase of both parameters was recently observed by Hellums²⁵ upon bromination of the hexafluorobisphenol A polycarbonate. The highest oxygen/nitrogen selectivity was found for the tetrabrominated isophorone-

based polyarylate having a TDC/IDC molar ratio of 0/100: $\alpha(O_2/N_2) = 6.2$. This polyarylate still has an oxygen permeability coefficient of 6.2 Barrer. In conclusion, for the substituted isophorone-based polyarylates, taking equal TDC/IDC molar ratios, the oxygen permeability coefficient and the oxygen/nitrogen selectivity rank as follows:

oxygen permeability coefficient:

tetramethyl > tetrachloro
> tetrabromo > unsubstituted

oxygen/nitrogen selectivity:

tetrabromo > tetrachloro
> tetramethyl \approx unsubstituted

The same trend in gas separation properties has been found earlier for substituted polycarbonates.³⁰

A few tetrabrominated polyarylates, using bisphenol monomers from Series 2, have been prepared for reference. Oxygen and nitrogen permeability coefficients and oxygen/nitrogen selectivities are collected in Table II. Clearly, the introduction of three methyl groups at the 3,3,5-positions of the cyclohexylidene moiety has a remarkable effect on the gas permeability coefficients. The tetrabrominated polyarylate from bisphenol **7**, having a TDC/IDC molar ratio of 50/50, has an oxygen permeability coefficient of only 1.1 Barrer. As expected, a rather high value for the oxygen/nitrogen selectivity ($\alpha(O_2/N_2) = 7.3$) has been found for this polymer. Note that the polyarylate from tetrabromobisphenol A (viz. bisphenol **10**), having a TDC/IDC molar ratio of 50/50, has an oxygen permeability coefficient of 1.7 Barrer and an oxygen/nitrogen selectivity of 7.4. Introduction of a "methylene bridge" into the

Table II Oxygen and Nitrogen Permeability Coefficients and Oxygen/Nitrogen Selectivities for Polyarylates of Series 2 (bisphenols 7–10)

Bisphenol	X	Y	TDC/IDC ^a	η_{rel}	$P(O_2)$ (Barrer)	$P(N_2)$ (Barrer)	$\alpha(O_2/N_2)$
4	Br	Br	50/50	1.86	7.5	1.3	6.0
7	Br	Br	50/50	2.34	1.1	0.15	7.3
8^b	Br	Br	50/50	2.09	3.5	0.6	6.3
9^c	Br	Br	50/50	1.85	6.5	1.1	5.7
10	Br	Br	50/50	2.20	1.7	0.23	7.4

^a TDC/IDC = terephthalic acid/isophthalic acid molar ratio.

^b Literature values²⁵; $P(O_2) = 3.1$ Barrer, $\alpha(O_2/N_2) = 7.3$.

^c No permeation data reported in Ref. 36.

Table III Oxygen and Nitrogen Permeability Coefficients and Oxygen/Nitrogen Selectivities of Polyarylates Containing Isophthalic Acid and 5-*t*-Butylisophthalic Acid

Bisphenol	X	Y	IDC			BIDC		
			η_{rel}	$P(O_2)$ (Barrer)	$\alpha(O_2/N_2)$	η_{rel}	$P(O_2)$ (Barrer)	$\alpha(O_2/N_2)$
2	CH ₃	CH ₃	1.84	13.7	5.0	2.13	34.7	4.1
4	Br	Br	1.77	6.2	6.2	1.81	15.5	5.0

cyclohexylidene moiety (the norcamphor moiety, viz. bisphenol **8**), results in a limited improvement of the oxygen permeability coefficient ($P(O_2) = 3.5$ Barrer, Lit.³⁵ $P(O_2) = 3.1$ Barrer). The same trend in permeability coefficients has been found before for unsubstituted polycarbonates.²⁴ Interestingly, introduction of a bulky *t*-butyl group on the 4 position of the cyclohexylidene moiety (viz. bisphenol **9**) also leads to a rather large improvement in the oxygen permeability coefficient [$P(O_2) = 6.5$ Barrer].

Moreover, the bulky *t*-butyl group can also be introduced within the dicarboxylic acid part of the polyarylate. Therefore, two tetrasubstituted (CH₃ and Br substituents) isophorone-based polyarylates have been prepared with the 5-*t*-butylisophthalic dichloride (BIDC). Gas separation properties of these materials are collected in Table III, together with those found for the corresponding isophthalic acid-based polyarylates. Clearly, the *t*-butyl group further improves the high values for the oxygen permeability coefficients found for polyarylates from both bisphenols **2** and **4**. In the case of the tetramethyl-substituted isophorone-based bisphenol (viz. bisphenol **2**) an oxygen permeability coefficient of 34.7 Barrer has been found! Remarkably, for both bisphenols **2** and **4** the oxygen permeability coefficient increases by a factor of 2.5 upon introduction of the *t*-butyl group on the 5-position of isophthalic acid.

CONCLUSIONS

Isophorone-based polyarylates, discussed in this article, can quite easily be prepared from cheap, commercially available, isophorone. It has been observed that the 3,3,5-trimethylcyclohexylidene moiety has a significant effect on the gas transport properties of the polymers. The highest oxygen permeability coefficient, $P(O_2) = 34.7$ Barrer, has been observed for the polyarylate prepared from the isophorone-based bisphenol with four methyl substituents and 5-*t*-butylisophthalic acid.

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