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APPENDICES

Appendix A Properties of Materials

The following materials were used for the determination of hydrogen and chlorine permeability coefficients.

A.1 Teflon

Common Names: Polytetrafluoroethylene, PTFE

Density = 2.280-2.290 2 g/cm^3

Viscosity (at 25°C) = 3000 centipoises

Upper Working Temperature = 260°C

Limiting Oxygen Index = 95%

Molecular Weight = 99.96

A.2 Derakane® 470-300

Common Name: Epoxy vinyl ester resin

Viscosity, cps at 25°C = 300

Specific gravity = 1.08

Tensile strength, psi at room temperature = 12,400

Tensile elongation, % at room temperature = 3.5

Heat Distortion Temperature, °F at 1.82Mpa applied stress = 152-305

A.3 Derakane® 8084

Common Name: Epoxy vinyl ester resin

Viscosity, cps at 25°C = 350

Specific gravity = 1.02

Tensile strength, psi at room temperature = 10,500

Tensile elongation, % at room temperature = 8.0/11.0

Heat Distortion Temperature, °F at 1.82Mpa applied stress = 85-175

Appendix B Properties of normal-hydrogen gas

Hydrogen gas was tested to determine the permeation of hydrogen to the test materials.

Normal-Hydrogen gas

Physical properties

Formula: H_2

Atomic number: Z=1

Molecular weight: 2.016 g/mole

Ionization potential: 15.427 eV

Density S.T.P: 0.08989 kg/m^3

@ Operational condition: 80°C and 1atm

Density: 0.06956 kg/m^3

Heat capacity at constant pressure (Cp): 3.452 kcal/kg K

Heat capacity at constant volume (Cv): 2.463 kcal/kg K

Viscosity: 9.92×10-5 poises

Thermal conductivity (k): 49.1276×10^{-5} cal/cm sec K

Melting point: -259.1°C

Boiling point: -252.7°C

Appendix C Permeability coefficients of Teflon

Teflon was used as supporting sheets for Derakane® sandwich membranes so its hydrogen and chlorine permeability coefficients must be determined. The resistance model described in chapter 2 (section 2.2.4) was used in order to calculate the permeability coefficients of Derakane®. Table A3 shows the hydrogen and chlorine permeability coefficients of different types of Teflon at 25, 50 and 80°C.

Table C3 H_2 and Cl_2 permeability coefficients of different types of Teflon® at different temperatures.

Gas Mixture	T (°C)	P_{H2}					P_{Cl2}	
		0.001 in. (1)*	0.001 in. (2)*	0.002 in.	Etched 0.002 in. (#1)**	Etched 0.002 in (#2)**	0.15 mm	0.002 in.
5% H_2 in Ar	25	4.98E-6	3.83E-6	3.49E-6	2.59E-6	2.66E-6	-	
	50	-	6.06E-6	6.20E-6	-	4.97E-6	-	
	80	2.18E-5	1.15E-5	1.20E-5	-	9.29E-6	-	
100 % Cl_2	25	-	-	-	-	-	1.06E-7	-
	50	-	-	-	-	-	1.45E-7	-
	80	-	-	-	-	-	1.86E-7	-
5% H_2 in Cl_2	80	-	-	3.50E-5	-	-	-	5.85E-8

Note: Unit of the permeability coefficients is cm^3(STP).cm.cm^{-2}.min^{-1}.atm.

*There were two lots of 0.001 in. thick Teflon® used and tested in this study.

** The etched Teflon® of 0.002 in. thick were tested twice (first in August and then in January) to verify the stability of the system.

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