

# NOMEX® TYPE 992

Type 992 is a low-density pressboard which is designed for applications requiring a combination of electrical, mechanical and forming characteristics, such as barrier, gap spacers, end fillers, core tubes, and coil yokes. Non-electrical applications include thermal barriers and gaskets. Type 992 offers a balance of superior formability, outstanding saturability and strong thermal performance, along with good electrical properties. This cost-effective pressboard product should only be used where the superior electrical properties of Type 993 are not required. Type 992 is available in two thicknesses – 1.6 and 3.2 mm (63 and 125 mil).

## Electrical properties

The typical electrical property values for Type 992 pressboard are shown in Tables I and II. The AC Rapid Rise dielectric strength data of Tables I and II represent voltage stress levels withstood for 10 to 20 second time periods at a frequency of 60 Hz. These values differ from long-term strength potential.

DuPont recommends that continuous stresses in dry-type transformers not exceed 1.6 kV/mm (40V/mil) to minimize the risk of partial discharges (corona). The Full Wave Impulse dielectric strength data of Tables I and II were generated on flat sheets, such as in layer and barrier applications. The geometry of the system has an effect on the actual impulse strength values of the material. The dielectric strength data are typical values and not recommended for design purposes. Design values can be supplied upon request. The electrical

properties are enhanced in oil due to the excellent impregnability of Type 992. Type 992 will pick up 100 to 110% oil by weight, as is shown in Table III. The effects of temperature on dielectric strength and dielectric constant are shown for Type 410 paper in Figure 1 of the Type 410 data sheet. Since Type 992 pressboard is chemically identical to Type 410 paper (differing only in structure), its electrical properties will react similarly to temperature changes up to and including 220°C.

## TECHNICAL DATA SHEET

### PLEASE NOTE:

The properties in this data sheet are typical, or average values and should not be used as specification limits. Unless otherwise noted, all properties were measured in air under "standard" conditions (in equilibrium at 23°C, 50% relative humidity). Note that, like other products of boardmaking technology, NOMEX® brand pressboards have somewhat different properties in the boardmaking machine direction (MD) compared to the cross direction (XD). In some applications it may be necessary to orient the board in the optimum direction to obtain its maximum potential performance.

Table I – TYPICAL ELECTRICAL PROPERTIES IN AIR

Nominal Thickness (mm)	1.6	3.2
Dielectric Strength - AC rapid rise <sup>1)</sup> (kV/mm)	16	14
Dielectric Strength - Full wave impulse <sup>2)</sup> (kV/mm)	27	32
Dielectric Constant <sup>3)</sup> at 60 Hz	1.7	1.7
Dissipation Factor <sup>3)</sup> at 60 Hz (x10 <sup>-3</sup> )	10	20

Values shown above were measured at 23°C after drying at 120°C until bone dry

<sup>1)</sup> ASTM D-149, 50 mm electrodes, rapid rise; corresponds with IEC 243-1, subclause 9.1, except for electrode set-up of 50 mm

<sup>2)</sup> ASTM D-3426

<sup>3)</sup> ASTM D-150

Table II – TYPICAL ELECTRICAL PROPERTIES IN OIL

Nominal Thickness (mm)		1.6	3.2
Dielectric Strength - AC rapid rise <sup>1)</sup> (kV/mm)		31	26
Dielectric Strength - Full wave impulse <sup>2)</sup> (kV/mm)		71	63
Dielectric Constant <sup>3)</sup> at 60 Hz	20°C	2.8	3.0
	90°C	2.8	3.0
	130°C	2.8	3.0
Dissipation Factor <sup>3)</sup> at 60 Hz (x10 <sup>-3</sup> )	20°C	3	4
	90°C	3	3
	130°C	4	4
Volume Resistivity <sup>4)</sup> (ohm-m)	20°C	10 <sup>15</sup>	10 <sup>15</sup>
	90°C	10 <sup>14</sup>	10 <sup>14</sup>
	130°C	10 <sup>13</sup>	10 <sup>13</sup>

<sup>1)</sup> ASTM D-149, 50 mm electrodes, rapid rise; corresponds with IEC 243-1, subclause 9.1, except for electrode set-up of 50 mm

<sup>2)</sup> ASTM D-3426

<sup>3)</sup> ASTM D-150

<sup>4)</sup> ASTM D-257

## Mechanical properties

The typical mechanical property values for Type 992 pressboard are shown in Table III. The effects of temperature on tensile strength and elongation are illustrated for Type 410 paper in Figure 5 of the Type 410 data sheet. The effects of short-term exposure to temperatures up to and including 220°C will be similar for Type 992 pressboard. In addition, however, the tensile strength of NOMEX® Type 992 can be significantly increased through heat-treatment under certain specific conditions.

## Thermal properties

Arrhenius plots of thermal aging behavior for NOMEX® brand materials are exemplified by Figures 7, 8 and 9 of the Type 410 data sheet. Similar aging of Type 992 pressboard at elevated temperatures has resulted in its recognition as a 220°C insulating material.

The thermal conductivity of 3.2 mm (125 mil) Type 992 pressboard is 73 mW/meter°K at 150°C. DuPont has also tested the thermal conductivity of this product impregnated

with various types of transformer fluids. This data is available upon request.

For thermal barrier applications, trade-supplied metallized versions of Type 992 are available if appropriate for the design.

## Chemical stability

The compatibility of NOMEX® brand paper and pressboard with virtually all classes of electrical varnishes and adhesives (polyimides, silicones, epoxies, polyesters, acrylics, phenolics, synthetic rubbers, etc.), as well as other components of electrical equipment, is

demonstrated by the many UL-recognized systems which include NOMEX® materials, as well as longstanding commercial experience. NOMEX® papers and pressboards are also compatible with transformer fluids, including mineral and silicone oils and other synthetics.

The Limiting Oxygen Index (LOI - ASTM D-2863) of 3.2 mm (125 mil) Type 992 pressboard at room temperature is 29%. Materials with LOI above 20.8% (ambient air) will not support combustion. The room temperature LOI of 1.6 mm (63 mil) Type 992 pressboard is 28%.

Table III – TYPICAL MECHANICAL PROPERTIES

Nominal Thickness	(mm)		1.6	3.2
Typical Thickness <sup>1)</sup>	(mm)		1.6	3.1
	(mils)		63	123
Basis Weight <sup>2)</sup>	(g/m <sup>2</sup> )		810	1630
Density <sup>3)</sup>	(g/cm <sup>3</sup> )		0.52	0.53
Tensile Strength <sup>4)</sup>	(N/cm <sup>2</sup> )	MD	2200	2400
		XD	1800	1900
Elongation <sup>4)</sup>	(%)	MD	9.1	10.2
		XD	9.4	10.4
Shrinkage <sup>2)</sup> at 105°C	(%)	MD	0.4	0.5
		XD	0.7	0.7
Shrinkage <sup>2)</sup> at 240°C	(%)	MD	0.9	1.2
		XD	1.4	1.3
Oil Absorption <sup>2)</sup>	(%)		110	100

<sup>1)</sup>ASTM D-374, method D, using 17 N/cm<sup>2</sup>    <sup>2)</sup>ASTM D-3392    <sup>3)</sup>Calculated number using basis weight and thickness  
<sup>4)</sup>ASTM D-828

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