

A22H-011

PROPERTIES & PROCESSING OF CAPA[®] THERMOPLASTICS

Perstorp Caprolactones have produced ϵ -caprolactone and its polymers at their Warrington plant since the mid 1970's.

The thermoplastic grades, the CAPA[®] 6000 series, find wide usage in a range of applications. The materials are readily processed, have wide compatibility with other polymers, are non-toxic and biodegradable, both aerobically and anaerobically.

These products are

- **Compatible with a Wide Range of Polymers**
- **Fully biodegradable**
- **Low Melting**
- **Non-Toxic**
- **Readily Processable**
- **Semi-Crystalline**

Applications

- **Adhesives**
- **Biodegradable Bottles**
- **Biodegradable Films**
- **Controlled Release of Drugs, Pesticides and Fertilisers**
- **Non Woven Fabrics**
- **Orthopaedic Casts**
- **Polymer Processing**
- **Synthetic Wound Dressings**

This datasheet summarises some of the physical properties and processing conditions for the CAPA[®] thermoplastic grades.

Typical Physical Properties of CAPA[®] Thermoplastics¹

Property	ASTM Test	CAPA [®] 6500	CAPA [®] 6800
Molecular Weight			
Mn	GPC, THF, 25°C	47500 ± 2000	69000 ± 1500
Mw	GPC, THF, 25°C	84500 ± 1000	120000 ± 2000
Mz	GPC, THF, 25°C	130000 ± 5000	178500
Polydispersity (Mw/Mn)		1.78	1.74
Melt Flow Index			
	D 1238		
80°C, 2.16kg, g/10 min		2.36	0.59
80°C, 21.6kg, g/10 min		34.6	9.56
190°C, 2.16kg, g/10 min		28	7.29
Thermal Analysis (DSC)			
Melting Point, °C		60-62	60-62
Heat Of Fusion, ΔHm, J/g		76.9	76.6
Crystallinity, %		56	56
Crystallisation Temperature, °C		25.2	27.4
Glass Transition Temperature, Tg, °C		-60	-60
Tensile Properties			
Yield Stress, σ _y , Mpa	D 412-87		
100mm/min		17.5	16
500mm/min		17.2	14
Modulus, E, Mpa	D 412-87		
1mm/min		470	440
10mm/min		430	500
Draw Stress, σ _d , MPa	D 412-87		
100mm/min		12.6	11.9
500mm/min		11.5	11
Draw Ratio, λ _d , x	D 412-87		
100mm/min		>4.2	4
Stress At Break, σ _b , Mpa	D 412-87		
100mm/min		29) 11	54
Strain At Break, ε _b , %	D 412-87		
100mm/min		>700	920
Flexural Modulus, E, MPa	D 790		
2mm/min		411	nd
Hardness			
	D 2240		
Shore A		95	94
Shore D		51	50
Viscosity			
Pa. sec, 70°C, 10/sec		2890	12650
Pa. sec, 100°C, 10/sec		1353	5780
Pa. sec, 150°C, 10/sec		443	1925

CAPA[®] 6500 is a 50000 molecular weight homopolymer which, because of its relatively low viscosity and melting point has found considerable use in the manufacture of orthopaedic casts, as an adhesive and is particularly suited for making injection moulded parts.

CAPA[®] 6800 is a higher viscosity material having a molecular weight of 80000, and is more suited to the manufacture of films and bottles.

PROCESSING DATA

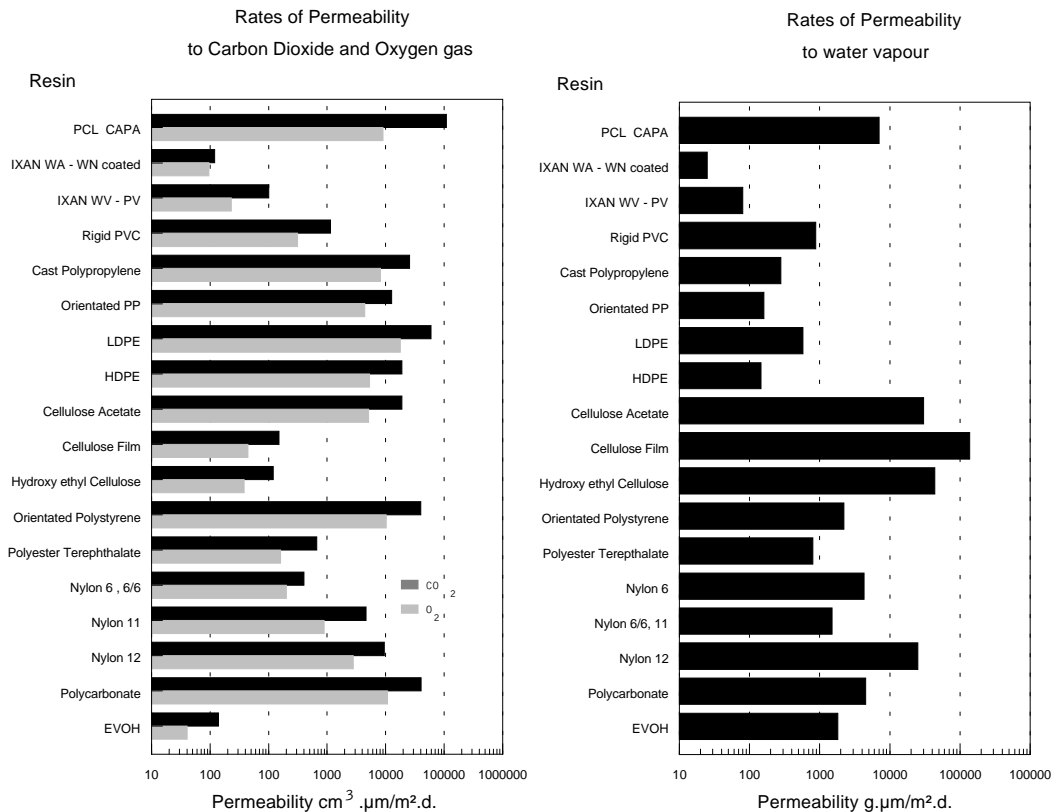
Methodology has been developed to produce films and bottles from CAPA® 6500 and 6800. The details of how to do this are given below.

Extrusion (Cast Films and Sheets)	CAPA® 6500	CAPA® 6800
Extruder type	single screw	single screw
Screw Type	two step, compression ratio 2.4 to 4, L/D 20 to 25	
Screw Speed	low	low
Temperature Profile		
feed zone	50°C or less	50°C
compression zone	70°C to 95°C	130°C to 165°C
metering zone	75°C to 105°C	140°C to 150°C
die zone	70°C to 120°C	140°C to 150°C
melt temperature at nozzle	70°C to 120°C	70°C to 120°C
Degassing	not necessary	not necessary
Chill roll	-4°C to 23°C preferably refrigerated	-4°C to 23°C preferably refrigerated
Film or Sheet Thickness	from 35µm to 3.5mm	from 35µm to 1.3mm

Extrusion Blow Moulding	CAPA® 6500	CAPA® 6800
Screw Type	L/D 20 compression ratio 2.8	L/D 20 compression ratio 2.8
Screw Speed	low	low
Temperature Profile		
feed zone	60°C at most	60°C at most
compression zone	60°C to 75°C	75°C
metering zone	60°C to 75°C	75°C to 100°C
die zone	62°C to 65°C	75°C to 100°C
mould	4°C to 20°C	4°C to 20°C
Die Design	preferably with a conically convergent mandrel	
Spigot Design	preferably with a conical tip	
Mould	small volumes (up to 100ml)	volumes up to 500ml
	effective and uniform cooling is recommended the use of mechanical injectors is recommended	
Blow Pressure	2 to 2.5 bar	2 to 2.5 bar
Cycle Time	9 to 20 secs	15 to 20 secs

Barrier Properties of CAPA® 6500 Film

The barrier properties of CAPA® 6500 film have been determined. For water permeability ASTM E96-66 was used, for Carbon Dioxide ASTM D 1434-75 and for Oxygen ASTM D 3985-81 was used. The results are presented graphically below in Figure 4.



The permeability to oxygen is not unlike medium density polyethylene, but is significantly higher for carbon dioxide and water.

POLYMER COMPATIBILITY

High molecular weight polycaprolactones have been shown to be compatible with the following polymers at the levels usually employed for masterbatch addition:

- | | |
|------------------------------------|--------------------------------|
| Polyethylene | Poly (vinyl butyral) |
| Polypropylene | Styrene/Methyl Methacrylate |
| P.V.C | Nylon |
| Vinyl Chloride/Vinylidene Chloride | Polybutadiene |
| A.B.S | Natural rubber gum |
| Ionomer | Styrene/butadiene |
| EVA | Ethylene/propylene terpolymer |
| Poly (vinyl acetate) | Butyl rubber gum |
| Nitrocellulose | Styrene-unsaturated polyesters |
| Styrene/acrylonitrile | Polyisobutylene |

High molecular weight polycaprolactones (CAPA® 6400 and 6500) are therefore potential dispersion media for the production of "universal masterbatches".



HANDLING AND STORAGE

CAPA[®] thermoplastics are supplied in quantities of 20 kg net multi-ply paper sacks on pallets of up to 1 MT. Bulk quantities can be supplied in 500 kg Big bags with top and bottom discharge options. CAPA[®] should be stored in a dry place away from sources of heat.

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