

SKY GREEN

Glycol Modified Copolyesters for Extrusion-Blow Moulding

www.skygreen.co.kr

The information in this document is provided in good faith and is based on our present state of knowledge. It is intended to provide general notes on the introduction, properties, processing and use of our products. It should not therefore be construed as guaranteeing any specific properties of the products described or their suitability for any particular application.

INTRODUCTION

SKYGREEN is the trade name for a range of glycol modified transparent amorphous Polyester polymers manufactured by SK Chemicals.

The following SKYGREEN products can be used to produce a wide range of high-quality containers using the extrusion-blow moulding (EBM) process:

SKYGREEN S2008 – a PETG polymer used to produce containers up to 0.5 litres in volume.

SKYGREEN KN100 – a PETG polymer with properties similar to S2008 but with enhanced optical quality.

SKYGREEN H2003 – a PETG polymer with improved melt strength able to produce larger containers.

SKYGREEN JN100 – a PCTG polymer with improved impact strength and chemical resistance over KN100.

This document contains recommendations concerning the processing and use of the above SKYGREEN products for extrusion-blow moulding applications.

The properties of SKYGREEN can be characterised as follows:

- Excellent impact strength and chemical resistance.
- Exceptional transparency, clarity and high surface gloss.
- Good thermal and dimensional stability with low shrinkage.
- Does not stress whiten.
- Sterilisable by γ -radiation or ethylene oxide (ETO).

Other SKYGREEN products are available for use in the injection moulding, sheet extrusion and tube or profile extrusion processes.

The following recommendations are given in good faith, but due to wide variations in both processing equipment and product design it is not possible here to provide accurate information for any particular situation. To discuss any particular manufacturing process the customer is invited to contact the SK Chemicals Technical Service Team, details of which are contained at the end of this document.

WHAT IS SKYGREEN?

SKYGREEN is a transparent amorphous copolyester produced by the reaction of terephthalic acid (TPA) with ethylene glycol (EG) in which a certain amount of the ethylene glycol is replaced with cyclohexane dimethanol (CHDM) – see Fig 1. The addition of CHDM prevents crystallisation, leading to improved processability combined with outstanding toughness, clarity and chemical resistance.

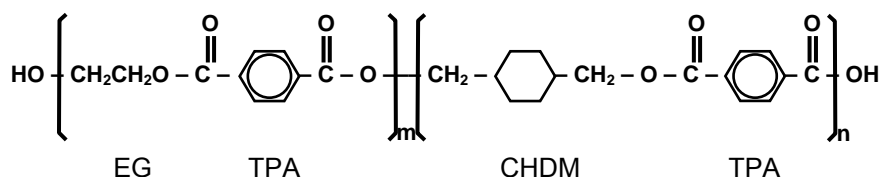


Fig. 1 – SKYGREEN

SKYGREEN AND THE ENVIRONMENT

SKYGREEN:

- consists of only Carbon (C), Hydrogen (H₂), and Oxygen (O₂).
- is totally recycleable.
- is inert when used for landfill.
- combustion products are only water vapour, carbon dioxide, and carbon monoxide.



TYPICAL PROPERTIES

Property	Test Method	Unit	S & K series	H series	J series
PHYSICAL PROPERTIES					
Specific Gravity	ASTM D1505	-	1.27	1.27	1.23
Mould Shrinkage	ASTM D955	%	0.2-0.5	0.2-0.5	0.2-0.6
Rockwell Hardness	ASTM D785	R-scale	108	106	105
Water Absorption	ASTM D570	%	0.13	-	0.13
MECHANICAL PROPERTIES					
Tensile Strength @ yield	ASTM D638	MPa	50	50	45
Tensile Elongation @ break	ASTM D638	%	180	110	340
Flexural Strength	ASTM D790	MPa	69	73	67
Flexural Modulus	ASTM D790	MPa	2100	2250	1800
Izod Impact Strength	ASTM D256 notch, 23°C	J/m	105	94	No break
THERMAL PROPERTIES					
Heat Distortion Temperature	ASTM D 648 @ 0.46MPa	°C	70	67	74
Vicat Softening Temperature	ASTM D1525 @ 1kg load	°C	85	-	86
Glass Transition Temp. (Tg)	DSC Method	°C	80	-	85
OPTICAL PROPERTIES					
Haze	ASTM D1003	%	<1	<1	<1
Total Transmittance	ASTM D1003	%	90	90	91

CHEMICAL RESISTANCE

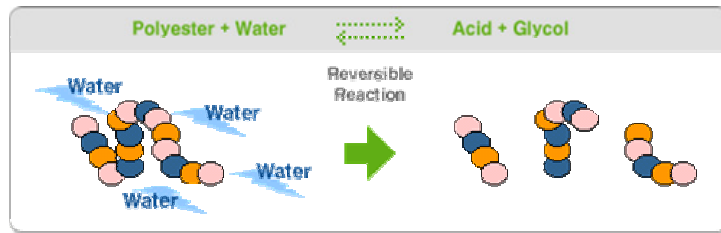
Type	Tested	Concentration (%)	Time (days)	SKYGREEN S, K, H series	SKYGREEN J series
Inorganic Acid	Sulfuric acid	20	28	Fair	Good
Organic Acids	Acetic acid	5	7	Good	Good
	Citric acid	5	28	Good	Good
		10	7	Fair	Good
Inorganic Alkalis	Sodium Hydroxide	10	7	Good	Good
Alcohols	Ethyl alcohol	50	7	Good	Good
	Benzyl alcohol	50	28	Good	Good
		100	28	Fair	Good
Aromatic Hydrocarbons	Toluene	100	7	Poor	Poor
		100	28	Poor	Poor
Aliphatic Hydrocarbons	Hexane	100	7	Fair	Good
	Heptane	100	28	Good	Good
Ketone	Acetone	100	7	Poor	Poor
		100	28	Poor	Poor
Other Chemicals	Olive oil	100	7	Fair	Good
	Gasoline	100	28	Poor	Good
	Water	100	28	Good	Good

Temperature: 23°C

Good: Clear, No visible effect, **Fair:** Slight colour change, **Poor:** Discolouring, Whitening, Swelling, Crazing

DRYING

SKYGREEN has a tendency to absorb atmospheric moisture, which can cause hydrolytic degradation during processing. This results in a decrease in molecular weight of the resin and in a reduction of the physical properties of the final product.



In order to avoid this degradation, SKYGREEN should be sufficiently dried to a moisture level of less than 500 parts per million (ppm) before processing. The drying operation is most efficiently performed by using a commercially available recirculating, dehumidified hot air drying system similar to that shown in Fig 2. Further details of suppliers of suitable drying equipment can be obtained from the SKYGREEN Technical Service Team. The optimum drying conditions for SKYGREEN are as follows:

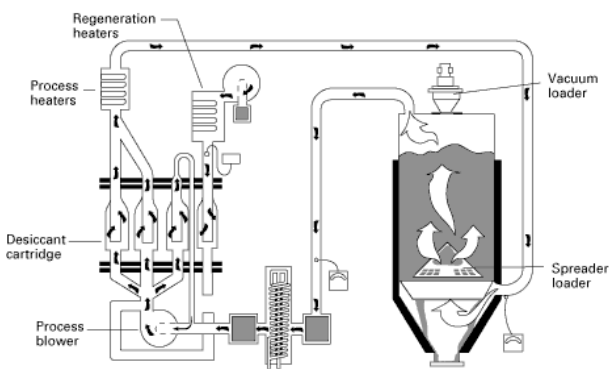


Fig. 2 – Typical drying system

Drying temperature	65°C (70°C for J Series)
Drying time	6 to 12 hours
Air flow of dry air	> 0.065 m ³ /min per kg/h
Dew point of dry air	< -30°C, preferably -40°C
Residual moisture content	<0.05% (500 ppm)
Drying hopper capacity	6 to 12 times extruder output per hour
Height / diameter ratio	> 2:1, 3:1 is better for plug flow
Insulation	Insulate well to improve energy efficiency
Monitoring	Inlet air temperature & dew point

EXTRUSION-BLOW MOULDING

SKYGREEN offers the high melt viscosity and non-crystalline properties required for successful extrusion-blow moulding. The following processing data are based on those used to produce extrusion-blow moulded containers in the SKYGREEN R&D Laboratory:

Material		SKYGREEN S, K & H Series	SKYGREEN J Series
Screw Design	Screw type	Low shear, barrier flight type is preferred to avoid shear and thermal degradation. L/D: 24:1 or greater, Compression ratio: 2.5:1 to 3:1	
	Screw diam. / speed	50 mm / 30 rpm	
	Tip	Maddock mixing is better for removal of gels & unmelts	
General	Mould temperature	12° to 20°C (54° to 68 °F)	
	Usage of regrind	Contents of regrind: < 20%. Dry before processing. Filter fines to prevent fish-eyes	
Barrel Temperatures	Zone 1	195°C (383°F)	200°C (392°F)
	Zone 2	210°C (410°F)	215°C (420°F)
	Zone 3	210°C (410°F)	215°C (420°F)
	Zone 4	210°C (410°F)	215°C (420°F)
Connector Temp.	Adapter	200°C (392°F)	205°C (400°F)
Die Temperatures	Head	185°C (365°F)	190°C (375°F)
	Die Tip	195°C (383°F)	200°C (392°F)
	Melt Temperature	225°C (437°F)	230°C (445°F)
	Melt Pressure	130 bar	

- On machine shut-down it is recommended that purging materials such as PP or PE should not be used. Just increase the extruder and die temperatures by 20°C and drain as much material as possible from the extruder and die.
- If extrusion is stopped for more than about 15 to 20 minutes, the extruder temperatures should be reduced to about 150°C in order to reduce excessive degradation of the polymer.
- When restarting the machine, or on initial start-up, extrusion should be begun as soon as possible after the extruder reaches the set temperatures.
- Additional heating of the die may be needed when starting extrusion.

SKYGREEN TECHNICAL SERVICE

Should further technical information or assistance be required please do not hesitate to contact a member of the SKYGREEN Technical Service Team – contact details below, or visit the SKYGREEN web pages at www.skygreen.co.kr