GREENMANTRA® TECHNOLOGIES

Performance Advantages of CERANOVUS® A120 PE Wax Compounded with Post-Consumer Recycled HDPE

GREENMANTRA® combines TECHNOLOGY with SUSTAINABILITY to create unique CERANOVUS® A Series Polyethylene and Polypropylene Waxes from recycled plastics.

GreenMantra® Technologies has verified the performance advantages of **CERANOVUS® A120** Polyethylene Wax when compounded at 2% and 4% levels, respectively, with a fractional melt post consumer recycled HDPE resin.

TYPICAL PROPERTIES OF CERANOVUS® A120 PE WAX

Density (g/cm³) ASTM D1298	Drop Point (°C) ASTM D3954	Penetration @ 25°C in dmm ASTM D1321	Viscosity cps @ 140°C BROOKFIELD
0.93	122	2	700

CERANOVUS® A120 Polyethylene Wax delivers the following physical property benefits and operational improvements in extrusion, injection molding and blow molding processes:

- Increases Melt Flow Rates by > 30+ %
- Maintains Flexural Modulus, Tensile Strength, IZOD and Density while significantly improving Elongation
- Reduces back pressure by 10% correlating to less equipment wear
- Improves throughput by > 25+ % with no increase in energy requirements

These enhanced physical properties and optimized processing conditions were confirmed by a third party testing facility.* The actual results are shown in the tables below.

Table 1, Physical Properties of HDPE Compounded with CERANOVUS® A120 PE Wax

Formulation and Performance Variables	Control	Sample 1	Sample 2
Post Consumer Recycled HDPE %	100	98	96
CERANOVUS® A120 PE Wax %	0	2	4
Pellet Melt Flow Rate (g/10min)	0.40	0.63	0.63
Pellet Melt Flow (% relative to Control)	-	58%	58%
Part Melt Flow Rate (g/10min)	0.38	053	053
Part Melt Flow (% relative to Control)	-	39%	39%
Density (lbs/in³)	0.95	0.95	0.95
IZOD (lb-ft/in)	10.20	11.44	10.20
Flexural Modulus (PSI)	164,447	168,343	166,538
Tensile Strength @ Yield (PSI)	3805	3921	3921
Elongation Average	374%	444%	607%
Elongation Increase (% relative to Control)	-	19%	62%

Formulation and Trial Conditions:

Post Consumer Recycled HDPE pellets with 0%, 2%, and 4% **CERANOVUS® A120** PE wax were extruded and then injection-molded into parts and bottles

Performance Advantages:

- Pellet melt flow rate increased by 58% and part melt flow rate increased by 39%
- Maintained Flexural Modulus, Tensile Strength, IZOD and Density
- Elongation improved by 19% and 62%, respectively
- Drop testing of bottles demonstrated reduced breakage by over 50%

*Plastics Forming Enterprises LLC, Amherst, NH

Table 2, Processing Results at Constant Screw Speed and Constant Feed Rate

Formulation and Performance Variables	Control	Sample 1	Sample 2
Post Consumer Recycled HDPE %	100	98	96
CERANOVUS® A120 PE Wax %	0	2	4
Constant Extruder Screw RPM	125	125	125
Temperature (°C)	121	121	121
Fractional Melt Flow Rate (g/10min)	0.47	0.62	0.67
Melt Flow (% relative to Control)	-	32%	42%
Average Pressure (PSI)	1769	1595	1566
Pressure (% relative to Control)	-	-10%	-10%
Average Energy Usage (kW/hr)	69	55	59
Energy Usage (% relative to Control)	-	-20%	-14%
Average Throughput (lbs/hr)	289	293	285
Throughput (% relative to Control)	-	2%	-1%
Energy Use per Pound (kW/lbs)	0.24	0.19	0.21
Energy Use Change (% relative to Control)	-	-21%	-13%

Formulation and Trial Conditions:

CERANOVUS® A120 PE wax added at 2% and 4% to Post Consumer Recycled HDPE

Steady-state extrusion with constant screw speed of 125 RPM

Feed rate of 290 lbs/hr

Performance Advantages:

- Improved melt flow rate by 32-42%
- Decreased back pressure by 10%, correlating to less equpment wear and tear
- Reduced average energy requirements by 13 - 21% while maintaining throughput

IMPROVE PERFORMANCE

REDUCE COSTS

ENHANCE SUSTAINABILITY

Table 3, Processing Results at Varying Screw Speeds to Maintain Constant Back Pressure

Formulation and Performance Variables	Control	Sample 1	Sample 2
Post Consumer Recycled HDPE %	100	98	96
CERANOVUS® A120 PE Wax %	0	2	4
Extruder Screw RPM = 122 Back Pressure	125	165	170
Temperature (°C)	120	120	120
Fractional Melt Flow Rate (g/10min)	0.47	0.63	0.63
Melt Flow (% relative to Control)	-	34%	34%
Average Pressure (PSI)	1769	1827	1798
Pressure (% relative to Control)	-	3%	2%
Average Energy Usage (kW/hr)	69	72	70
Energy Usage (% relative to Control)	-	6%	2%
Average Throughput (lbs/hr)	289	366	370
Throughput (% relative to Control)	-	27%	28%
Energy Use per Pound (kW/lbs)	0.24	0.20	0.20
Energy Use Change (% relative to Control)	-	-16%	-16%

Formulation and Trial Conditions:

CERANOVUS® A120 PE wax added at 2% and 4% to Post Consumer Recycled HDPE

Varied extruder screw speed to maintain constant 122 PSI back pressure

Performance Advantages:

- Increased the melt flow rate by 34%
- Increased throughput by approx. 27% while maintaining average hourly energy consumption
- Reduced overall energy requirements per unit output by approx. 16%

Products containing **CERANOVUS A Series** waxes contribute towards LEED certification and credits programs.

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MADE WITH 100% RECYCLED CONTENT
PRE-CONSUMER AND POST-CONSUMER

CERANOVUS A Series polyethylene and polypropylene waxes are made from 100% post consumer recycled plastics as certified by SCS Global Services