

INDOFIL KM-323B

Acrylic impact modifier for Opaque Applications

1 INTRODUCTION

INDOFIL KM-323B is an all-acrylic Impact modifier designed primarily for use in rigid PVC applications which require resistance to weathering. Typical applications include PVC siding, rain gutters, pipe, and conduit for the building industry, foam and appliance housings. Compounding PVC with INDOFIL KM-323B produces a combination of high impact efficiency, good thermal stability, low die swell, and excellent retention of color and impact strength after prolonged outdoor exposure. Processing advantages with INDOFIL KM-323B include excellent resistance to plate-out, excellent profile stability at various output rates, and production of uniform surfaces with attractive appearance. INDOFIL KM-323B does not seriously impair the mechanical properties of PVC.

2. PHYSICAL CHARACTERISTICS

TABLE I

TYPICAL PHYSICAL PROPERTIES (These do not constitute specifications)	
Appearance	White, fine free-flowing powder with uniform particle size
Bulk Density, g/cc	0.38 to 0.40
Specific Gravity, @ 25 °C	1.10
Volatiles (%)	Max 1
Sieve Test Retention time	
60 mesh	Max 2
100 mesh	Max 20
200 mesh	Max 70

3 PERFORMANCE CHARACTERISTICS

3.1 Impact performance

The performance of INDOFIL KM-323B in several formulations and under various conditions was compared with that of chlorinated polyethylene (CPE).

Table II shows the efficiency of INDOFIL KM-323B as an impact modifier for compounds based on high molecular weight PVC resins (K value 67).

Table III compares the results of impact tests on barium cadmium stabilized formulations based on PVC resins of different molecular weights, one with K value 67 & the other with K value 60.

Table IV gives Izod impact strength at 0° C to 23°C. As the tables show, INDOFIL KM-323B consistently imparts better impact strength than CPE at the same use level and is a more efficient impact modifier.

The formulation used in all performance testing was:

PVC	100-X parts
Impact Modifier	X parts
Stabilizer System	see table II
Aluminium Stearate	1 part
Titanium Dioxide	8 parts

TABLE II

Izod Impact Strength Efficiency of Indofil KM-323B in Rigid PVC (K value 67)

System Stabilizer	% Modifier	Izod Impact Strength (ft.-lb/in)-1/8" bars with	
		Indofil KM-323B	CPE
Tin (2 phR)	0	0.9	-
	5	10.1	8.4
	8	22.4	22.7
	10	24.8	24.0
	15	27.5	24.3
Lead (4.5 phR)	0	1.1	-
	5	3.0	2.6
	8	18.0	15.0
	10	27.0	23.0
Barium Cadmium (3.5 phR)	0	1.1	-
	5	9.4	2.8
	8	20.1	20.0
	10	23.6	23.0

TABLE III

Izod Impact Strength Efficiency as a Function of PVC Resin Molecular Weight

Indofil KM-323B, Parts	CPE	Izod Impact Strength (ft.-lb/in) 1/8" bars	
		PVC (K value 67)	PVC (K value 62)
0	-	1.1	0.8
5	2.8	9.4	2.9
8	20.0	20.1	14.2
10	23.0	23.6	23.4

Barium-Cadmium Stabilizer System is used here. With Tin & Lead based systems, the values are still attractive.

TABLE IV

Izod Impact Strength as a Function of Temperature

Temperature	Izod Impact Strength (ft.-lb/in)-1/8" bars			
	23°C	16°C	10°C	0°C
Tin Stabilized (2 phR)				
Unmodified	0.9	0.5	0.4	0.4
INDOFIL KM-323B	26.5	8.0	3.4	2.2
CPE	24.5	12.0	3.6	2.3
Lead Stabilized (4.5 phR)				
Unmodified	1.1	0.6	0.5	0.4
INDOFIL KM-323B	27.0	11.8	3.5	2.2
CPE	23.0	10.9	2.7	1.9
Barium-Cadmium Stabilized (3.5 phR)				
Unmodified	1.1	0.6	0.4	0.4
INDOFIL KM-323B	27.0	14.8	4.1	2.6
CPE	23.0	15.0	3.6	2.6

Formulation : PVC (K value 69), 10% impact modifier

3.2 Physical Properties of PVC Products

Further test revealed that the physical properties of PVC formulations containing INDOFIL KM-323B are superior

to those modified with the same level of CPE. Table V summarizes the results of tests on tensile and flexural properties and data on the heat distortion temperature.

TABLE V

Tensile and Flexural Properties, 10% Modifier

Modifier	Tensile Strength, Mpa	Tensile Modulus, Mpa	Flexural Strength, Mpa	Flexural Modulus, Mpa	Heat Distortion Temperature DTUL, °C (264 psi)
Unmodified	55	2580	80	3000	73
INDOFIL KM-323 B	46	2120	68	2500	72
CPE	43	2020	63	2380	71

Formulation : PVC (K value 69), Tin stabilised

3.3 Weatherability

The weatherability of vinyl compounds containing INDOFIL KM-323B is excellent.

Accelerated Weathering Tests

Samples of four different coloured stocks were exposed in a Xenon Arc Weatherometer for 1000 hours. The

compounds contained 15% impact modifier and a barium-cadmium stabilizer system. Table VI present the results of these tests. The compounds containing INDOFIL KM-323B showed no significant change in color, whereas the coloured compounds modified with CPE faded severely and the white specimens darkened noticeably within 500 hours.

TABLE VI

Xenon Arc Weatherometer - Accelerated Exposure Data

Color of stock	Modifier (15%)	Hours of Exposure					
		0		500		1000	
		Izod	Color	Izod	Color	Izod	Color
White	Unmodified	1.1	White	1.0	NSC ¹	1.0	NSC ¹
	INDOFIL KM-323B	27.0	White	26.0	NSC ¹	24.0	NSC ¹
	CPE	24.0	White	24.0	Lt. Tan	23.0	Lt. Tan
Green	INDOFIL KM-323B	24.0	Green	24.0	NSC ¹	24.0	NSC ¹
	CPE	26.0	Green	25.0	Fading White	25.0	Fading White
Blue	INDOFIL KM-323B	23.0	Blue	24.0	NSC ¹	23.0	NSC ¹
	CPE	24.0	Green	23.0	Fading White	23.0	Fading White
Brown	INDOFIL KM-323B	26.0	Brown	24.0	NSC ¹	25.0	NSC ¹
	CPE	26.0	Brown	25.0	Fading White	25.0	Fading White

NSC¹ : no significant color change

Formulation : PVC (K value 69), Barium-cadmium stabilizer system.

3.4 Processibility

Like the acrylic processing aids, such as INDOFIL K-120ND, INDOFIL KM-323B noticeably improves the processing characteristics - hot strength, elongation, and melt homogeneity - of rigid vinyl compounds. It can be used alone or combined with any of these acrylic processing aids to achieve exceptional processibility in high speed, high shear operations.

Since INDOFIL KM-323B causes little die swell and does not change significantly the melt viscosity of PVC, it should be a valuable ingredient in formulation for extruded profiles. Table IX shows the effect of impact modifiers on the melt viscosity of PVC.

4 APPLICATIONS

4.1 Formulating with INDOFIL KM-323B

Typical starting point formulations with INDOFIL KM-323B for extrusion and injection moulding are given below.

In preparing dry blends, proper mixing and dispersion of the ingredients is important. The following Henschel cycle has been used satisfactorily in this work :

Ingredient	Temperature
PVC	Room Temperature
Stabilizer	82°C
Lubricants	88°C
Modifiers	93°C
Pigment (TiO ₂)	93°C
Mix to	113°C to 116°C
Cool to	71°C

The stabilizer and lubricants are added before the modifier and pigment to achieve preferential coating of the PVC.

A. Profile (Barium-Cadmium Stabilized)

	Parts
PVC (K value 67)	96.0
INDOFIL K-120 ND	1.0
INDOFIL KM-323B	3.0
Ba - Cd Stabiliser	4.0
Calcium Stearate	1.5
Titanium Dioxide	3.0

B. Profile and Type I improved Pipe (Tin Stabilized)

	Single Screw Parts	Multi-Screw Parts
PVC (K value 67)	100.0	100.0
INDOFIL K-120 ND	1.5	-
INDOFIL KM-323B	5.0	5.0
Tin Stabiliser	2.0	0.5
Aluminium TM-181	1.5	0.8
Polyethylene wax	0.1	1.0
Titanium Dioxide	3.0	3.0
Carbon Black	0.2	0.2



C. Type II Pipe (Tin Stabilized)

	Single Screw Parts	Multi-Screw Parts
PVC (K value 69)	100.0	100.0
INDOFIL K-120 ND	2.0	1.0
INDOFIL KM-323B	8.0	8.0
Tin stabiliser	1.5	0.5
Calcium Stearate	1.5	0.8
Polyethylene wax	0.1	1.0
Aristowax 165	-	1.0
Titanium Dioxide	3.0	3.0
Carbon Black	0.2	0.2

D. Injection Moulded Pipe Fittings (Type I Improved)

	Parts
PVC (K value 60)	100.0
INDOFIL K-120 ND	2.0
INDOFIL KM-323B	3 to 5.0
Tin stabiliser	2.0
Calcium Stearate	2.0
Polyethylene wax	0.1
Titanium Dioxide	3.0
Carbon Black	0.2

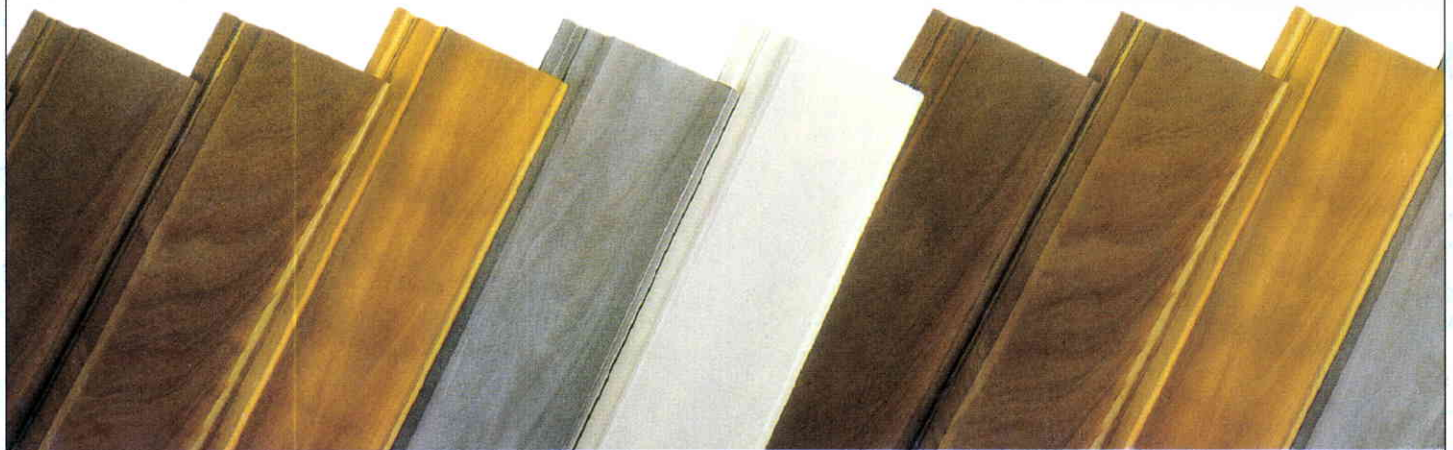
E. Injection Moulded Pipe Fittings (Type II) and Gas Transmission Pipe

	Parts
PVC (K value 60)	100.0
INDOFIL K-120 ND	2.0
INDOFIL KM-323B	8.0
Tin Stabiliser	2.0
Calcium Stearate	2.0
Polyethylene wax	0.1
Titanium Dioxide	3.0
Carbon Black	0.2

F. Injection Moulding with Pellets

	Parts
PVC (K value 52)	85.0
INDOFIL PMA 175	1 to 3.0
INDOFIL KM-323B	15.0
Tin stabilizer	2.0
Glyceryl Monostearate	1.8
Titanium Dioxide	3.0

Better Profiles With INDOFIL KM-353 B



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