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Resins for Reinforced Plastics

BAKELITE PLASTICS

BAKELITE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

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Laminating
Technical Release No. 11

PRE-MIX MOLDING WITH "BAKELITE" PHENOLIC RESIN BRLA-4717

Low-cost, high impact, pre-mix molding compounds can be made with BAKELITE phenolic resin BRLA-4717 and a variety of reinforcing materials. Having excellent curing speed, along with the high-temperature strength and good dimensional stability common to phenolic resins, solventless BRLA-4717 makes the advantages of pre-mix molding systems readily available.

Compression molding of pre-impregnated combinations of resin and reinforcing materials is commonly referred to as pre-mix molding. Essentially the process consists of mixing a thermosetting resin with fibrous reinforcing material and fillers, colorants, and other additives. When partially cured, or "B-staged," the mixture is termed a pre-mix compound, which at a later date can be formed or molded into the final product.

One advantage of pre-mix compounds based on BAKELITE phenolic resin BRLA-4717 is the variety of formulations possible, permitting compositions with properties tailored to fit specific applications. In addition, by the proper selection of ingredients, compounds can be formulated to effect economies in the production of end items. Since these compounds may be simply and rapidly mixed on the spot, costly stock piles of special material are eliminated. Less complex molding equipment, which means shorter tooling-up time, and molding cycles comparable to standard molding compounds are other advantages of pre-mix operations using BAKELITE phenolic resin BRLA-4717.

As a result of these properties, reinforced plastic molding to specifications is now made easier and at increased savings to the molder and his customer.

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Because reinforcing agents and fillers vary with each application, specific formulations and procedures of preparing pre-mixed molding compounds based on BRLA-4717 cannot be given. As fibrous reinforcement, a wide range of material, such as sisal, jute, asbestos, cotton, wood chips,

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The recommendations, test results, and suggestions are offered herein as a guide in the use of these materials and are not a guarantee to their performance. Each user must establish for himself the most suitable formulations, production methods, and control tests to ensure the uniformity and quality of his product.
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macerated textiles, and excelsior, are used in varying degrees. Finely divided mineral fillers at very high loadings have been used to produce the required flow characteristics and proper fiber segregation. Mechanical properties required in the specific molded parts and the configurations of the mold are items determining the composition of the molding material required. Thus, compounds may be designed for a specific type of mold, and a "general-purpose" compound may not exist in the commonly accepted manner.

PHYSICAL CHARACTERISTICS OF BRLA-4717

BAKELITE phenolic resin BRLA-4717 is a free-flowing, high-solids liquid resin, reddish-brown in color. The resin has low water miscibility and contains no added solvents. Typical properties of BRLA-4717 are shown in Table 1.

Table 1

PHYSICAL PROPERTIES OF "BAKELITE" PHENOLIC RESIN BRLA-4717

		Bakelite Test Method
Specific Gravity	1.22-1.24	WC-1-E/1
Viscosity, cst	1600-3600	WC-31-I
Solids Content, per cent	80-85	WC-86-E
Flash Point, deg. F.	above 100	WC-706 B (T.O.C.)
Storage Life	6 months at 40 deg. F. 2 months at 70 to 80 deg. F.	

REINFORCING MATERIALS

Many types of reinforcing materials are adaptable to pre-mix molding. The molder must choose the one which will best fit his individual needs. Table 2 lists some common reinforcing along with their basic characteristics and a partial list of suppliers.

Table 2

TYPICAL REINFORCING MATERIALS FOR PRE-MIX MOLDING COMPOUNDS

Material	Characteristics	Suppliers
Vegetable Fiber (e.g., Sisal)	Strength, low cost commensurate with strength	Columbian Rope Co. Auburn, N. Y. Union Fiber Co. Philadelphia, Pa. Plymouth Cordage Co. Plymouth, Mass.
Mineral Fiber (e.g., Asbestos, 1/4 in.)	Low cost, heat resistance, excellent molding characteristics	Johns-Manville Corp. New York, N. Y.
Synthetic Organic Fiber (e.g., DYNEL)	Chemical and water resistance, strength and surface quality	Textile Fibers Dept. Union Carbide Chemicals Co., Division of Union Carbide Corp., New York, N. Y.

FILLERS

Table 3 lists some of the more popular fillers used in pre-mix molding with reinforced plastics

Table 3

TYPICAL FILLERS FOR MOLDING COMPOUNDS

Material	Supplier
"Wollanstonite" P-1	Godfrey L. Cabot, Inc. Boston, Massachusetts
"Silvacon 412"	Weyerhauser Timber Co. Tacoma, Washington
"Cab-O-Sil"	Godfrey L. Cabot, Inc. Boston, Massechusetts
Walnut Shell Flour	Industrial Flour Agrashell, Inc. Los Angeles, California
Asbestos 7 TF	Johns-Manville Corp. New York, N. Y.
"Surfex MM"	Diamond Alkali Co. New York, N. Y.
ASP-400 ASP-600	Superior Materials, Inc. New York, N. Y.
China Clay	Witco Chemical Co. New York, N. Y.
Wod Flour	Local Supplier

COLORANTS

Colorants can also be added to BRLA-4717 pre-mix molding compounds. The following is a partial list of colorants suppliers:

Dyes: General Dyestuff Co., A Sales Div. of General Aniline & Film Corp., New York, N. Y.
Allied Chemical and Dye Corp., New York, N. Y.
Calco Chemical Division, American Cyanamid Co., New York, N. Y.

Pigments: Ferro Corporation, Cleveland, Ohio
General Dyestuff Co., A Sales Div. of General Aniline & Film Corp., New York, N. Y.
Claremont Pigment Dispersion Corp., Brooklyn, N. Y.

Items molded from BRLA-4717 compounds can be spray-painted with BAKELITE epoxy-resin-based enamels.

EQUIPMENT

Mixing

When selecting a suitable mixer for preparing pre-mix molding compounds, the following points should be considered:

1. Proper capacity to handle the number of presses using the material.
2. Uniform mixing to ensure thorough dispersion of the ingredients. Improper dispersion results in weak resin-rich areas and non-uniform surface appearance in the final product.
3. Firm but gentle action to provide adequate mixing without crushing or shearing the reinforcing material. Too vigorous action results in a degradation of strength properties.
4. Adequate ventilation to carry off fumes and dust from mixed materials.
5. Some convenient method of heating the mixer, such as a circulating water or steam jacket.

The following companies offer mixers which are suitable for this work:

Baker-Perkins, Inc., Saginaw, Michigan
J. H. Day Co., Inc., Cincinnati, Ohio
Buffalo Machine and Foundry Corp., Buffalo, N. Y.
Beardsley & Piper, Div. of Pettibone Mulliken Corp., Chicago, Ill.

Pre-mix compounds are sometimes preformed before the final molding operation, by compressing in a suitable cavity, or by extrusion, while still warm, at the time of discharge from the mixing device.

FORMULATIONS AND PROCEDURES

The following are typical of pre-mix molding compounds based on BRLA-4717. The physical properties for each composition are listed in Table 4. Laboratory and field results have shown these formulations give an excellent combination of physical properties and working characteristics. However, since molding conditions, which affect mechanical properties, vary in each operation, the compositions are not meant to be specific working recommendations. The formulations are offered as "starting off" points to enable users to develop compounds to meet their particular requirements.

Formulation I

Material	Parts by Weight
BRLA-4717	37.4
Sisal, ½in.	19.4
"Silvacon 412"	38.0
Calcium Oxide	1.2
Aluminum Stearate	1.0
Hexa	1.5
Water	1.5

Formulation II

Material	Parts by Weight
BRLA-4717	45.0
Sisal, ½ in.	25.0
Walnut Shell Flour	27.6
Calcium Oxide	1.4
Zinc Stearate	1.0

Formulation III

Material	Parts by Weight
BRLA-4717	33.9
Sisal, ½ in.	21.0
Asbestos, 7 TF	23.5
"Surfex MM"	19.5
Calcium Oxide	1.1
Zinc Stearate	1.0

Table 4

PROPERTIES OF PRE-MIX MOLDING FORMULATIONS

Properties			Formulation I	Formulation II	Formulation III	A.S.T.M. Method
Molded Density			1.30-1.36	1.33-1.40	1.55-1.65	D792-50
Flexure Stress	at 25°C.,	psi	9,480	13,500	10,500	D790-49T
	at 100°C.,	psi	6,520	5,080	6,140	D790-49T
Flexure Modulus	at 25°C.,	psi x 10^6	1.10	1.24	1.35	D790-49T
	at 100°C.,	psi x 10^6	0.54	0.33	0.67	D790-49T
Tensile Stress	at 25°C.,	psi	4,930	3,940	3,860	D638-52T
Impact Strength	at 25°C.,	ft-lb.	1.77	1.42	1.56	D256-54T
		in.-notch				D570-54T
Water Absorption, %			0.93	0.70	0.59	
Heat Distortion, °C.			166	153	175	D648-45T

Shelf Life of Mixed Material—minimum of 2 months

Procedure—Preheat a Sigma, or similar type, mixer to about 260 degrees Fahrenheit. Add, in order, fillers, about one third of the sisal, and resin. Mix for five minutes. Then add the balance of sisal as rapidly as possible and continue mixing for a total of 30 to 60 minutes, depending on batch size. When hexa (hexamethylenetetramine) is used to catalyze the resin—as in Formulation I—it is first mixed with water to form a slurry and then added to the resin before the resin is introduced into the mix.

EFFECT OF FIBER LENGTH ON MECHANICAL PROPERTIES

A comparison of the resin segregation and flexural properties of pre-mix compounds reinforced with sisal of varying fiber lengths indicates three-quarter inch sisal results in optimum

properties. Both one-half inch and three-quarter inch sisal give a minimum of segregation and exceed the one-quarter inch and one-inch sisal in flexural strength and modulus of elasticity at room temperature.

EFFECT OF HEXA ON MIXING CYCLE

Hexa can be used to accelerate the mixing cycle for all the compounds given. For example, the curve in Table 5 was obtained by increasing the amount of hexa in Formulation I from 4 per cent, based on resin solids, to 12½ per cent. As the table indicates, increasing the hexa content reduces the kneading time.

TECHNICAL ASSISTANCE

Specific questions on formulations or applications may arise. Further information may be obtained by consulting Technical Representatives of Bakelite Company.

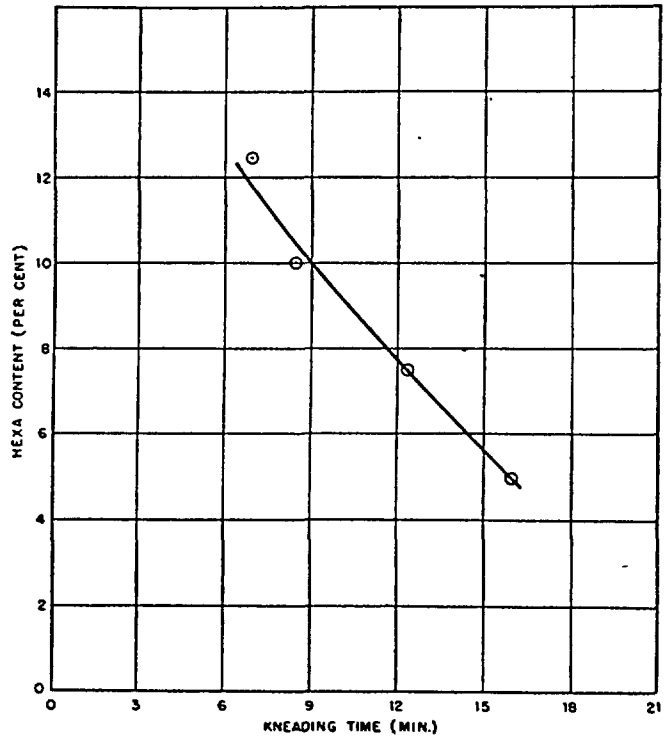

TABLE 5

RELATIONSHIP OF HEXA CONTENT TO KNEADING TIME
(AT 20 SECONDS CLOSING TIME)



District Sales Offices

Atlanta 3, Ga.	57 Forsyth Street
Boston 94, Mass.	300 First Avenue, Needham Hgts.
Chicago 1, Ill.	230 No. Michigan Avenue
Cincinnati 6, Ohio	2330 Victory Parkway
Cleveland 14, Ohio	1300 Lakeside Avenue, N. E.
Clifton, New Jersey	1051 Bloomfield Avenue
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St. Louis 22, Mo.	122 No. Kirkwood Road
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