

UNION
CARBIDE

Calidria

***Resin-
Grade
144***

Asbestos

PLAINTIFF'S EXHIBIT

UC-3557

- Effective, low-cost thickening agent and thixotrope for epoxy resin systems
- Imparts excellent viscosity control to resin systems (coatings, adhesives, sealants, caulks, mastics)

UCC 007533

The logo for Calidria, featuring the word "Calidria" in a stylized, italicized serif font, enclosed within a white, curved, ribbon-like shape that is part of a larger black graphic element.

Resin-Grade 144

Asbestos

... a highly purified fiber product that is an effective, low-cost thickening agent and thixotrope for epoxy resin systems. By means of a special refining technique developed by UNION CARBIDE, CALIDRIA Resin-Grade 144 Asbestos is made completely grit-free and non-abrasive—this latter characteristic makes it especially valuable in spray application.

Other desirable features of CALIDRIA Resin-Grade 144 Asbestos include:

- Disperses easily in liquid resin or hardener with a "Cowles" Dissolver or similar mixers
- Overmixing will not destroy the thixotropy of the resin-asbestos mixture
- Epoxy systems containing CALIDRIA Resin-Grade 144 Asbestos have excellent aging characteristics
- Reduced dust
- Unlike other thixotropes, it is effective with amine hardeners
- CALIDRIA Resin-Grade 144 Asbestos is substantially lower in cost than commonly used refined silicas or modified clays
- No amine salts are necessary for viscosity build-up or thixotropic stabilization (with the exception of the low-viscosity, cycloaliphatic epoxides)

Typical physical properties

Specific Gravity.....	2.45
Moisture Content, % by wt.....	2.0, maximum
Surface Area, sq. meters per gram.....	60, appr.
Reflectance, G. E. Brightness.....	72-76
Nature of Surface Charge.....	Electropositive (cationic)
pH in Water.....	9.5
Bulking Value, gallons per 100 lb.....	4.8
Oil Absorption (DOP), pounds per 100 lb.....	120-140
Refractive Index, $n_D^{25^\circ \text{C}}$	1.54-1.56
Wet Bulk Density in Water, ml.	
as received, 20 g. per liter; 3-hr. settling.....	700
after dispersion, 2 g. per liter; 1-hr. settling.....	900-1,000
Dry Bulk Density, lb. per cubic foot.....	4
Shipping Density, lb. per cubic foot.....	12-14
Standard Package Weight, lb.....	35
% Magnetite.....	0.6
Screen Size, Typical; % plus 325 mesh.....	Nil
Fiber Diameter, microns.....	0.025
Length/Diameter, microns.....	200 avg. (1000 maximum)

IMPORTANT: This information is not to be taken as a warranty or representation for which we assume legal responsibility nor as permission or recommendation to practice any patented invention without a license. It is offered solely for your consideration, investigation, and verification.

BAKELITE, CALIDRIA and UNION CARBIDE are trade marks of Union Carbide Corporation, U. S. A.

© 1967, 1968, 1969 by Union Carbide Corporation.

Typical applications

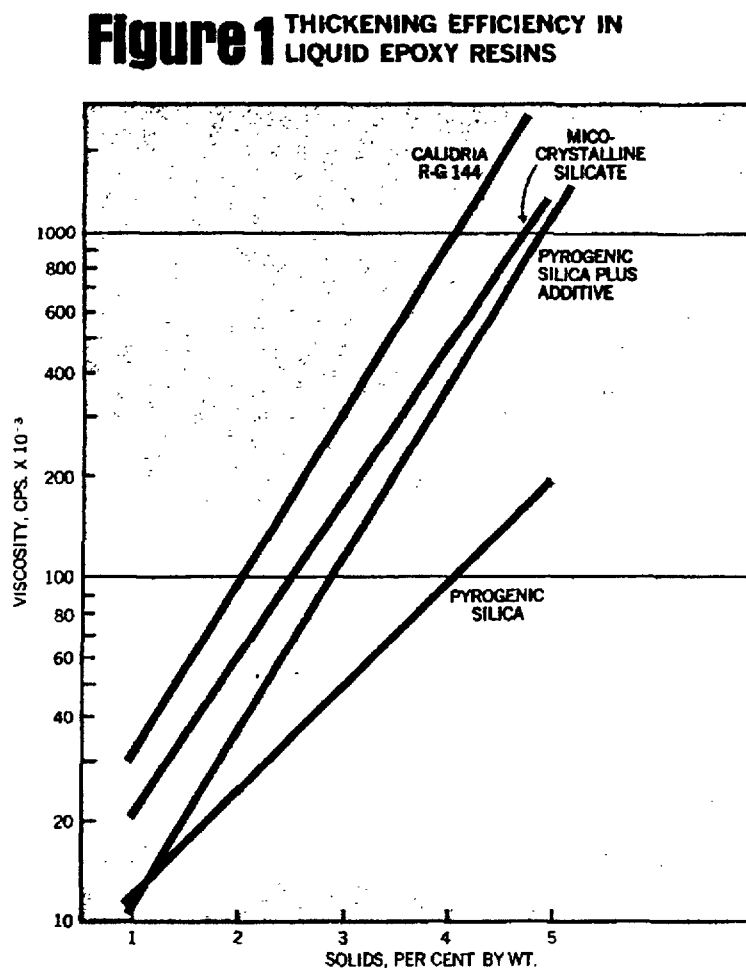
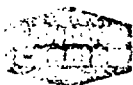


Figure 1 illustrates the effective, low-cost thickening and viscosity control properties of CALIDRIA Resin-Grade 144 Asbestos in epoxy resin systems. It compares relative differences in viscosity of BAKELITE Epoxy Resin ERL-2774 solutions containing equivalent concentrations of CALIDRIA R-G 144 Asbestos, micro-crystalline silicate, and pyrogenic silica.

Figure 2 illustrates the ability of CALIDRIA R-G 144 Asbestos to control viscosity in two different solvent-epoxy systems used in many epoxy coatings and paints.



THE DISCOVERY COMPANY

PERFORMANCE DATA

Calidria **ASBESTOS**

COMPARATIVE PERFORMANCE CHARACTERISTICS OF *CALIDRIA* R-G 244/POLYESTER RESIN SYSTEMS

F-70-086

COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

CALIDRIA Resin-Grade 244 Asbestos, a new, modified asbestos fiber from UNION CARBIDE, developed for maximum thickening efficiency and thixotropy in polyester spray-up and hand lay-up laminating resins, is also an effective thickener for plastisols and organosols used in a broad variety of adhesives, coatings, mastics and sealants. In many systems, CALIDRIA Resin-Grade 244 Asbestos will not contribute color or opacity – a characteristic that makes it particularly attractive in polyester gel coats.

The distinctive characteristics of CALIDRIA Asbestos offer improved viscosity and thixotropic properties to polyester resin systems, superior to other commonly used thixotropic aids, at a considerable cost savings. On a pound-for-pound basis, CALIDRIA Resin-Grade 244 Asbestos has been found to contribute more than twice the viscosity of a typical pyrogenic silica. Savings up to 30 per cent or more are illustrated.

Though CALIDRIA Resin-Grade 244 Asbestos is designed for use in stir-in mixers, optimum efficiency and lowest cost are obtained through use of high-shear mixers such as "Cowles" Dissolvers, sonic dispersers and homogenizers.

Other desirable features of CALIDRIA Resin-Grade 244 Asbestos include:

- Ease of incorporation
- Reduced dust
- Clear, colorless products at low loadings
- Long term shelf life

IMPORTANT: This information is not to be taken as a warranty or representation for which we assume legal responsibility nor as permission or recommendation to practice any patented invention without a license. It is offered solely for your consideration, investigation, and verification.

COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

SCOPE

The rheological properties imparted by CALIDRIA R-G 244 Asbestos to polyester resin systems have been determined in a number of commercial laminating resins. Comparative evaluations of CALIDRIA R-G 244 versus pyrogenic silica have also con-

firmed the performance and economic advantages claimed for CALIDRIA R-G 244 Asbestos.

The following commercial polyester resins were used for these evaluations:

Polyester Resin	Manufacturer
"Hetron" 26869	Durez Div. of Hooker Chemicals Corp.
"Hetron" 17	Durez Div. of Hooker Chemicals Corp.
"Hetron" 130	Durez Div. of Hooker Chemicals Corp.
"Hetron" 19	Durez Div. of Hooker Chemicals Corp.
"Paraplex" 43	Rohm and Haas
"Marco" Resin	Marco Chemical Div. of W. R. Grace Co.
"Koplac" 1000-23	Koppers Company, Inc.
"Dion" DR-315	Diamond Alkali Company, Dion Polymer Prods.
Freeman Resin	Freeman Chemical Corporation

TEST PROCEDURE

To establish a sound and reliable basis for relative test comparisons, viscosities of the base resins were equated by the addition of styrene. CALIDRIA R-G 244 was evaluated in the resins at the 0.5, 1.0, 2.0 and 3.0 parts per 100 parts of resin (PHR). A commercial pyrogenic silica was used for comparative evaluations in several of the resins. Solids were incorporated by one of two procedures:

1. A high-shear laboratory "Homo-Mixer", with a 4-blade, 2-inch diameter impeller.

2. A low-shear "Lightnin'" Mixer, with a 6-paddle, 2-inch diameter impeller.

The degree of shear, implied herein, is in relative terms of impeller rpm. Mixing time was held constant at 3 minutes for all samples.

Viscosity measurements were obtained with a Brookfield Viscometer at 25°C. The samples were hand-stirred prior to measuring the viscosities.

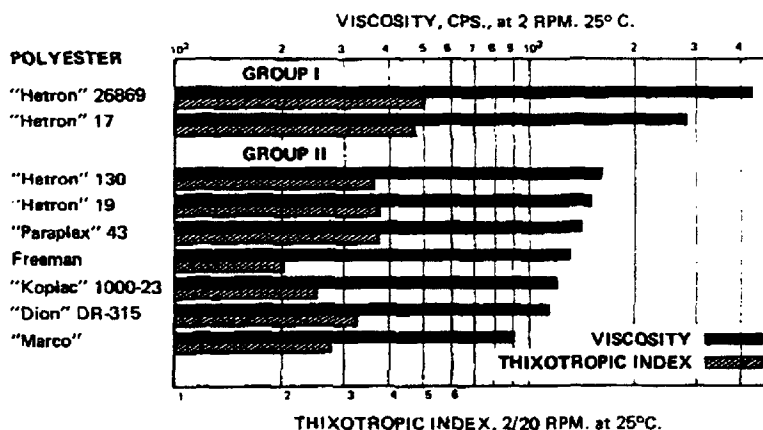
COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

PERFORMANCE CHARACTERISTICS

The comparative rheological properties of these commercial polyester resins containing CALIDRIA R-G 244 Asbestos are shown in

the bar graph, Figure 1. Viscosities are those determined at 2 rpm. Thixotropic Index is based on the 2/20 rpm. viscosities.

FIGURE 1
VISCOSITY AND THIXOTROPIC INDEX DATA
COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA
R-G 244 ASBESTOS IN VARIOUS COMMERCIAL POLYESTER
RESINS AT 0.5 PHR ADDITION



Polyester base resins: adjusted to 100 cps. with styrene.

Mixing: "Lightnin'" Mixer, 6-paddle,

2-inch diameter impeller. Mixed for 3 minutes at 1600 rpm.

PROMOTED POLYESTER RESINS

Unlike most other thixotropes, CALIDRIA R-G 244 does not normally require polar additives such as glycol derivatives for viscosity build-up or thixotropic stabilization. However, in some promoted resins, particularly those containing cobalt-type

accelerators, nominal additions of ethylene glycol or similar additives will improve the viscosity, thixotropy, and stability of CALIDRIA R-G 244 dispersions significantly. This is illustrated in Table 1.

TABLE 1
Viscosity of CALIDRIA R-G 244/Promoted Polyester (*) Resin Systems

CALIDRIA R-G 244 (PHR)	Ethylene Glycol (PHR)	Viscosity, cps., at 25° C.		Thixotropic Index at 2 and 20 rpm.
		2 rpm.	20 rpm.	
0.75	—	800	560	1.4
0.75	0.30	1600	630	2.5
(*) "Silmer Resin" J-3798 — Vistron Corporation Base viscosity 165 cps. CALIDRIA R-G 244 incorporated with "Homo-Mixer" at 5000 rpm. for 3 minutes				

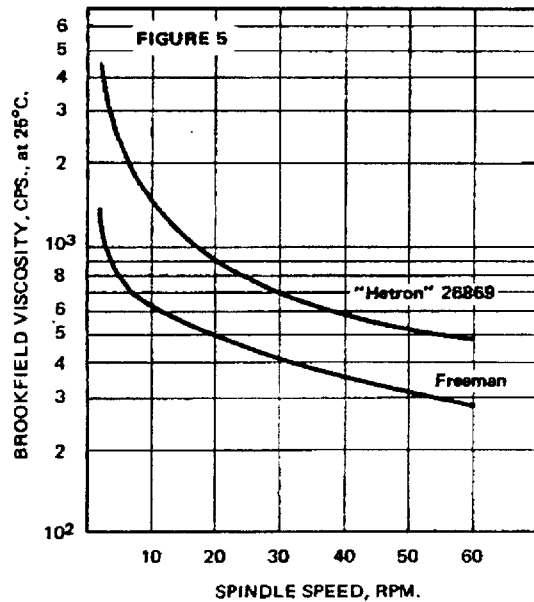
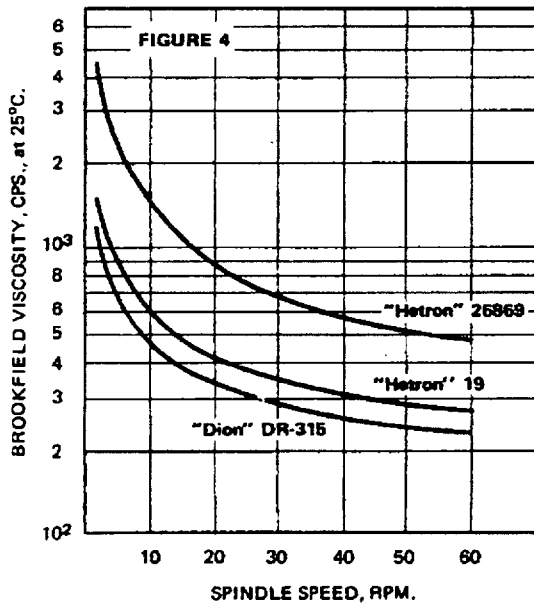
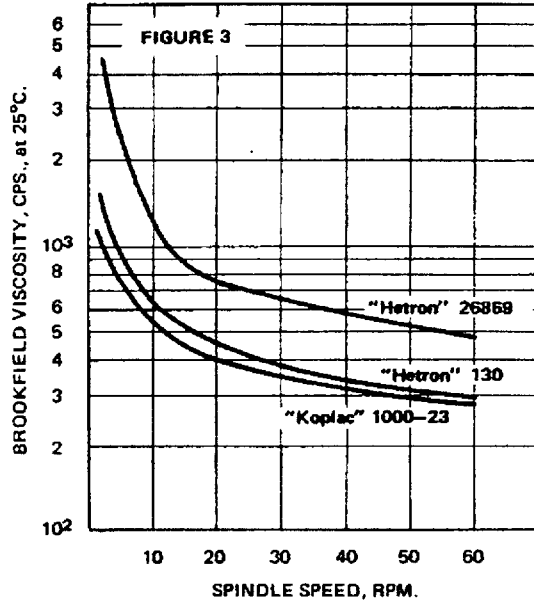
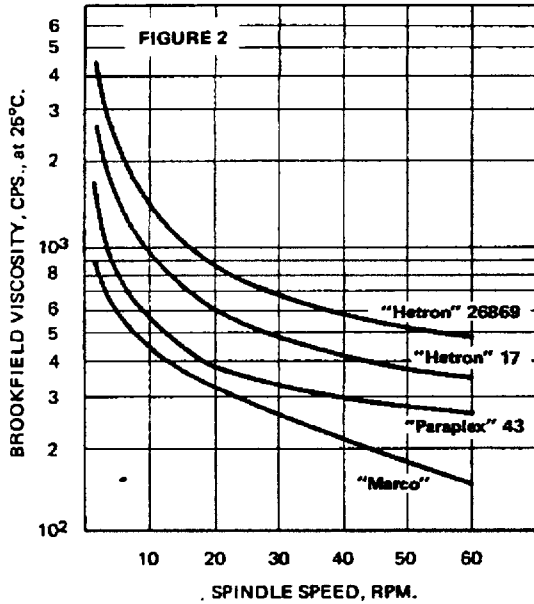
COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

RELATIVE VISCOSITIES

Figures 2 through 5 compare the relative viscosities of the various polyester resins over a range of 2 to 60 rpm.; each containing 0.5

PHR of CALIDRIA R-G 244 Asbestos. "Hetron" 26869 is used as the standard for comparison.

FIGURES 2 THROUGH 5 – COMPARISON OF RELATIVE VISCOSITIES



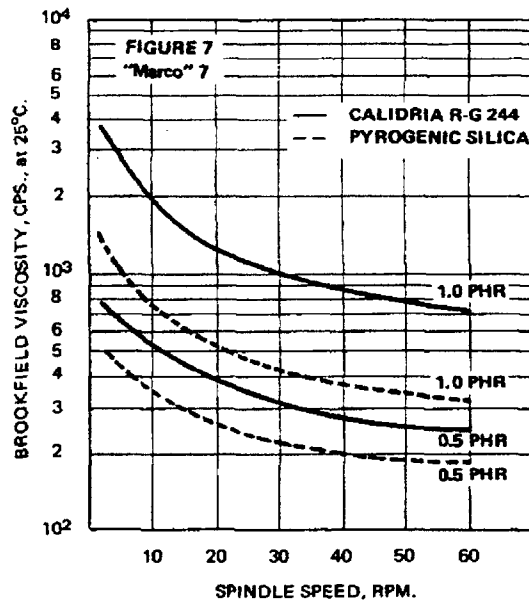
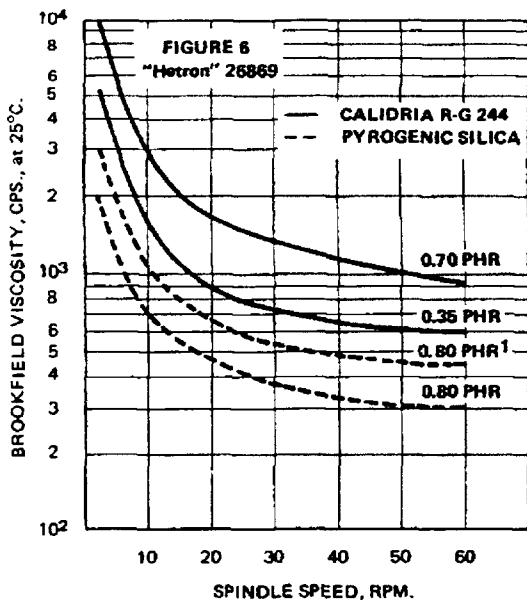
COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

CALIDRIA R-G 244 ASBESTOS VS. PYROGENIC SILICA

A comparison of the relative performances of CALIDRIA R-G 244 Asbestos and pyrogenic silica is shown in Figures 6 through 9. The thickeners were incorporated with a high shear "Homo-Mixer", for 3 minutes, at 5000 rpm. Four polyester resins, ranging from high to medium low performance (see Figure

1, page 4), were selected for this comparative evaluation. In all resins, the performance of CALIDRIA R-G 244 Asbestos was superior to pyrogenic silica for promoting viscosity and thixotropy. In addition, significant economic advantages became apparent.

FIGURES 6 AND 7
COMPARISON OF RELATIVE PERFORMANCES OF CALIDRIA R-G 244
AND PYROGENIC SILICA WITH "Hetron" 26869 AND "Marco" 7



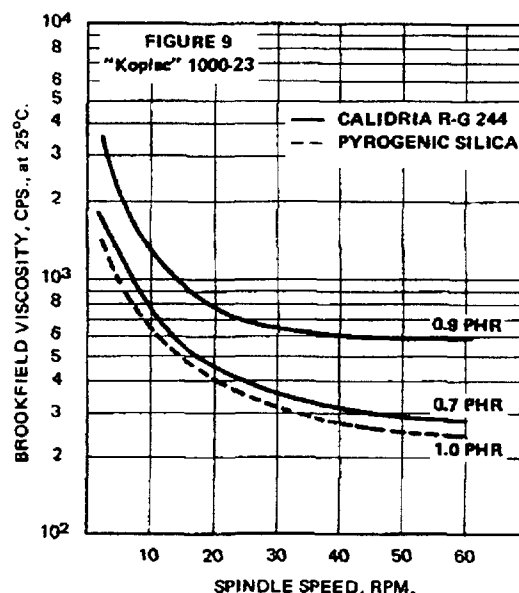
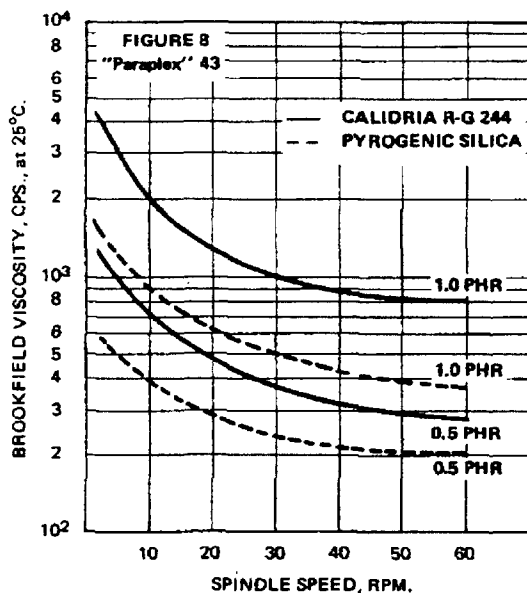
NOTE:

Polyester resins were initially adjusted to a Brookfield viscosity of 100 cps. with styrene.

Mixing: "Homo-Mixer" at 5000 rpm. for 3 minutes.

COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

FIGURES 8 AND 9
COMPARISON OF RELATIVE PERFORMANCES OF CALIDRIA R-G 244
AND PYROGENIC SILICA WITH "Paraplex" 43 AND "Koplac" 1000-23



NOTE:

Polyester resins were initially adjusted to a Brookfield viscosity of 100 cps. with styrene.

Mixing: "Homo-Mixer" at 5000 rpm. for 3 minutes.

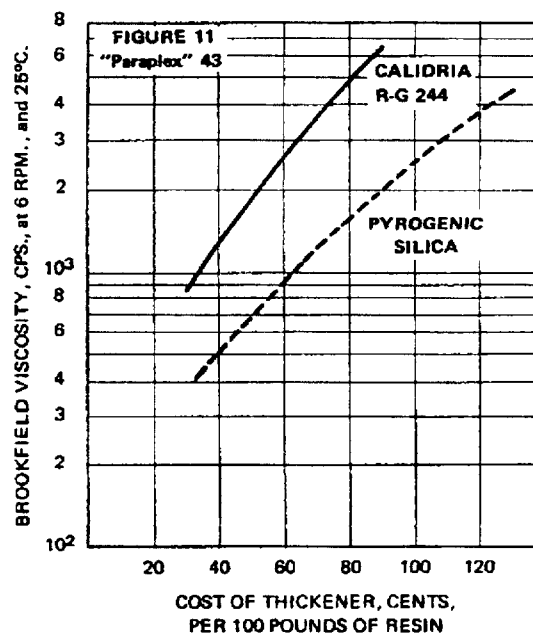
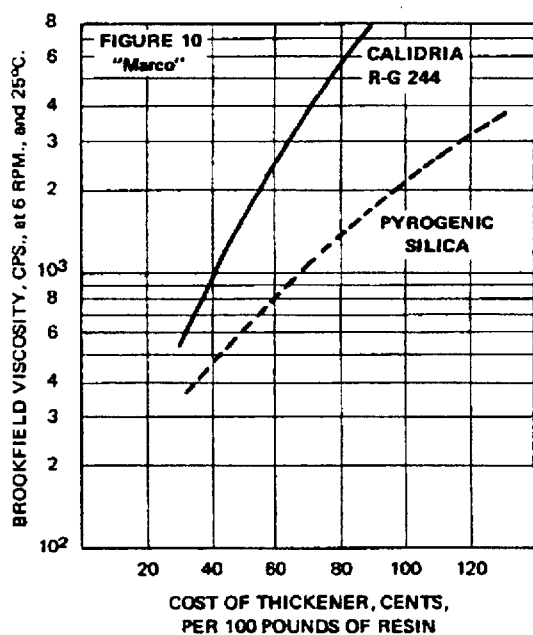
COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

VISCOSITY VS. COST

Figures 10 and 11 compare the viscosities obtained at 6 rpm., on various additive concentrations vs. the relative cost of the thickeners per 100 pounds of the polyester base resins. From these comparative tests and the relative thixotropic properties shown in

Figure 16, page 11, it can be concluded that CALIDRIA Resin-Grade 244 Asbestos will provide, on the average, viscosities equivalent to pyrogenic silica, at approximately one-half the cost.

FIGURES 10 AND 11
COMPARISON OF VISCOSITIES VS. RELATIVE COST OF THICKENERS



SHEAR EFFECTS ON RHEOLOGICAL PROPERTIES

The effects of shear on the rheological properties of CALIDRIA R-G 244 Asbestos and pyrogenic silica in polyesters are shown in Figures 12 to 15. "Paraplex" 43 and "Marco" resins, considered to be typical of most polyester systems, were selected for these tests. Although results obtained with laboratory equipment cannot be assumed to predict optimum conditions for production facilities,

these data do indicate that pyrogenic silica is more shear dependent than CALIDRIA R-G 244. On this basis, it can be concluded that pyrogenic silica requires relatively higher levels of energy to develop optimum rheological properties, in polymer suspensions, equivalent to those obtainable with CALIDRIA R-G 244 Asbestos.

COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

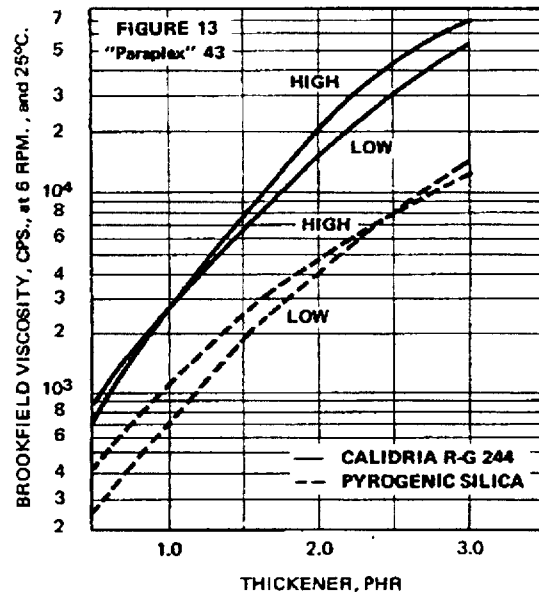
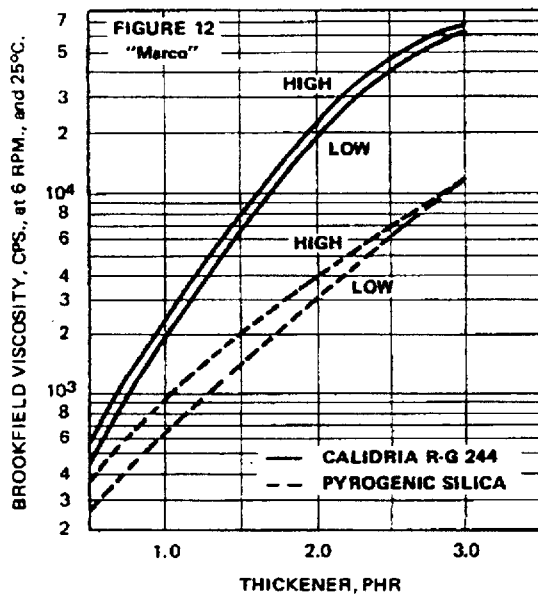
HIGH AND LOW SHEAR MIXING VS. SOLIDS CONTENT

The viscosity vs. solids content experimental results shown in Figures 12 and 13 below were obtained with both high and low shear mixing equipment, using the following

standard testing conditions. The initial viscosity of each of the polyester base resins was adjusted to 100 cps. with styrene.

	High-Shear "Homo-Mixer"	Low-Shear "Lightnin'" Mixer
Mixing Time, minutes	3	3
Mixing Blades and Size	4 - 2-inch diameter	6 (paddle) - 2-inch diameter
Mixing Speed, rpm.	5000	1600 (tip speed 800 to 900 rpm.)

FIGURES 12 AND 13
VISCOSITY VS. THICKENER CONCENTRATION
RELATIVE EFFECT OF HIGH AND LOW SHEAR MIXING



COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

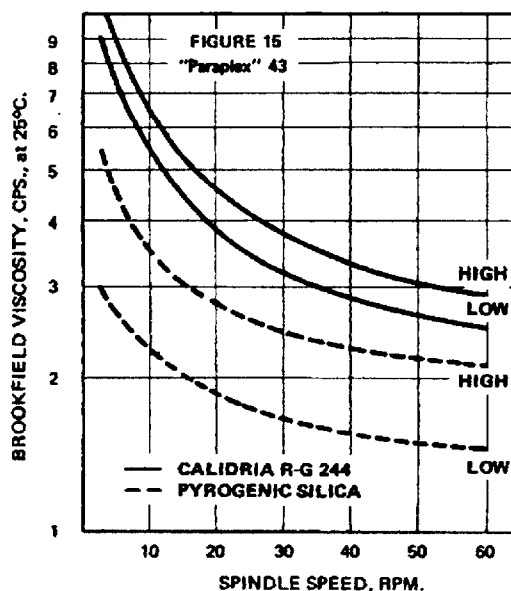
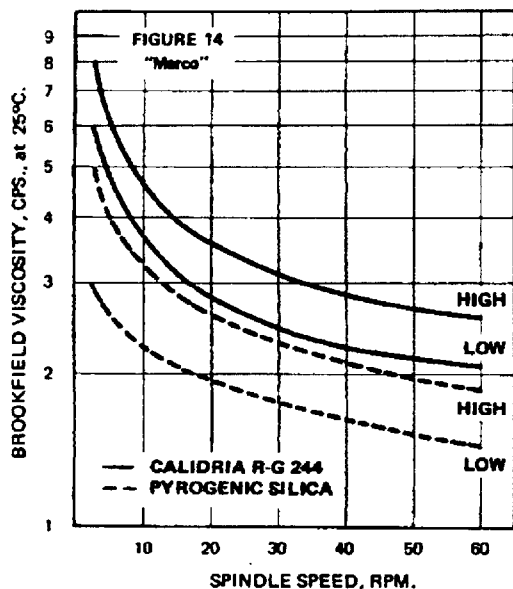
VISCOSITY VS. SHEAR RATE

Viscosities determined at 25°C., over a range of spindle speeds, from 2 to 60 rpm, on "Marco" and "Paraplex" 43 polyesters, containing 0.5 PHR of the thickeners, indicate that CALIDRIA R-G 244 Asbestos, again, maintains a relatively higher degree of thickening efficiency than pyrogenic silica, Figures

14 and 15.

It is evident from these results that pyrogenic silica is more shear dependent than CALIDRIA R-G 244 Asbestos and requires higher levels of energy to develop satisfactory rheological properties for polymer suspensions.

FIGURES 14 AND 15
VISCOSITIES AT VARIOUS SHEAR RATES
VS. EFFECT OF HIGH AND LOW SHEAR MIXING
OF POLYESTERS CONTAINING 0.5 PHR OF THICKENERS



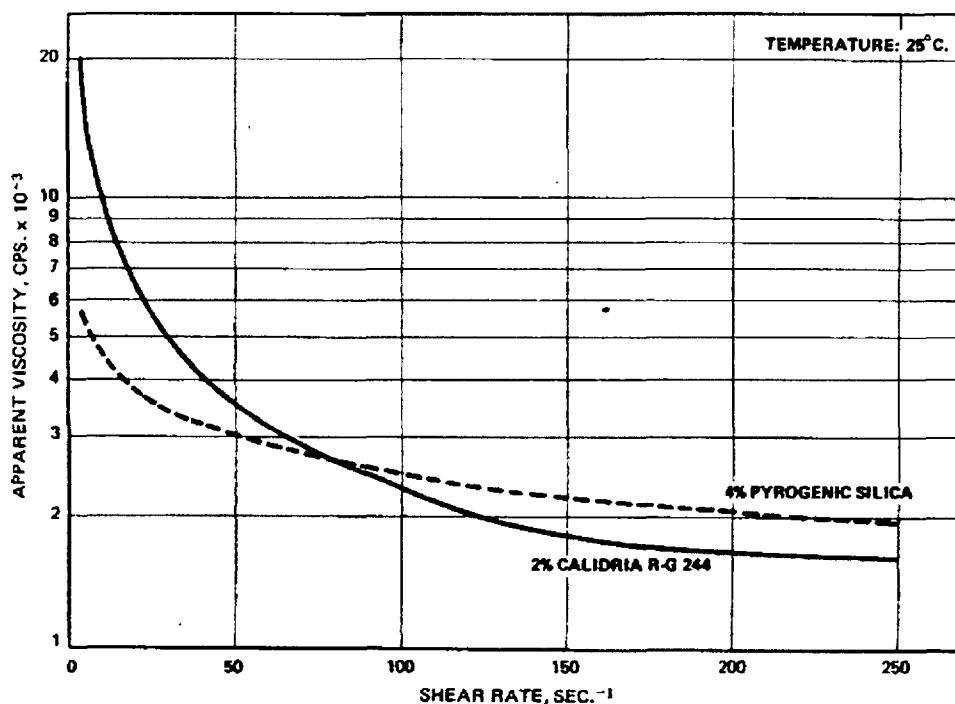
COMPARATIVE PERFORMANCE CHARACTERISTICS OF CALIDRIA R-G 244/POLYESTER RESIN SYSTEMS

EFFECT OF SHEAR RATE ON THIXOTROPIC PROPERTIES

CALIDRIA R-G 244 Asbestos provides exceptional rheological characteristics to polyester resins as shown in Figure 16. As indicated, a more fluid system for better spraying and brushing performance is avail-

able at one-half the concentration using CALIDRIA R-G 244 as compared to pyrogenic silica, yet sag resistance and viscosity are higher as the shear rate is reduced.

FIGURE 18
COMPARATIVE THIXOTROPIC CHARACTERISTICS
CALIDRIA R-G 244 VS. PYROGENIC SILICA



NOTE:

These data were developed for a "Paraplex" 43 polyester resin (Rohm and Haas) with 10 per cent by weight of styrene added. Instrumentation was with a Haake "Rotovisco", using measuring system SV 11.

Any of our offices below will be glad to give you complete information on properties, applications, and prices of "Calidria" asbestos.



Marketing and Technical Center

Niagara Falls, New York 14302

P. O. Box 579

716-285-3311

Plant

King City, California 93930

P. O. Box K

408-385-5961

Sales Offices

Atlanta, Georgia 30329	17 Executive Park Dr.	404-633-6161
Baltimore, Maryland 21207	Beltway Bldg. 6707 Whitestone Rd.	301-944-8211
Boston, Massachusetts 02194	300 First Ave., Needham Heights	617-444-5400
Buffalo, New York 14225	3343 Harlem Rd.	716-837-6450
Charlotte, North Carolina 28210	6230 Fairview Rd.	704-364-1400
Chicago, Illinois 60606	120 South Riverside Plaza	312-822-7000
Cincinnati, Ohio 45227	West Street and Madisonville Rd.	513-272-0206
Cleveland, Ohio 44114	1300 Lakeside Ave., N.E.	216-621-4202
Clifton, New Jersey 07012	935 Allwood Rd.	201-778-2900
Dallas, Texas 75207	2710 Stemmons Freeway	214-631-0010
Detroit (Southfield, Michigan Sales Office)		313-354-0800
Houston, Texas 77027	3737 Greenway Plaza Dr.	713-621-1000
Indianapolis (Cincinnati, Ohio Sales Office)		317-255-3181
Kansas City (St. Louis, Mo. Sales Office)		913-362-2200
Los Angeles, California 90058	2770 Leonis Blvd.	213-583-3061
Memphis (Atlanta, Ga. Sales Office)		901-396-5375
Minneapolis, Minnesota 55416	3030 Excelsior Blvd.	612-927-4221
Moorestown, New Jersey 08057	Route 38 and Pleasant Valley Rd.	609-235-6200
New York, New York 10017	270 Park Ave.	212-551-8423
Philadelphia (Moorestown, New Jersey Sales Office)		215-923-3200
Pittsburgh, Pennsylvania 15220	P'kway Center, 875 Greentree Rd.	412-922-5700
Southfield, Michigan 48075	26500 Northwestern Highway	313-354-0800
St. Louis, Missouri 63105	10 South Brentwood Blvd.	314-726-0324
San Francisco, California 94106	One California St.	415-982-1360
Seattle, Washington 96118	4726 Rainier Ave., South	206-723-8660



THE DISCOVERY COMPANY

UNION CARBIDE CORPORATION
MINING AND METALS DIVISION
270 PARK AVENUE, NEW YORK, N. Y. 10017