UX-0011 # 18

THICKENING UCAR LATEXES WITH ASBESTOS PRODUCTS

by

S. Chwastiak
K. Park

March 6, 1968

BUSINESS CONFIDENTIAL

UNION CARBIDE CORPORATION
CHEMICALS AND PLASTICS

RESEARCH AND DEVELOPMENT DEPARTMENT

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S. Chwastiak
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Group Manager - R. G. Woolery

Project No. 697-N29

File No. 10

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THICKENING UCAR LATEXES WITH ASBESTOS PRODUCTS

SUMMARY

The thickening of UCAR Latexes 360 and 891 by R-G144, R-G244, and anionic asbestos was studied at addition levels of 1% and 2%. The maximum Brookfield viscosity obtained with UCAR Latex 360 was 2800 cps and it was 6700 cps with UCAR Latex 891. All of the thickened samples had characteristics of plastic flow in that they had apparent yield stresses and their shear rate - shear stress curve approached a linear relationship at high shear rates.

R-G244 and the anionic form of asbestos were more effective than R-G144 on a weight basis in thickening UCAR Latex 360, but the lower cost of R-G144 could make it the most economical thickener.

R-G144 did not thicken UCAR Latex 891 well at natural pH. In addition, it rapidly settled out of suspension. It was somewhat better as a thickener when the pH of the latex was increased to pH 8.

The best thickener for UCAR Latex 891 was the anionic form of asbestos which even thickened the natural (pH 3) latex well. R-G244 was also a good thickener for this latex, but increasing its pH to 8 enhanced the effectiveness of R-G244 significantly.

INTRODUCTION

R. E. Byrne called Dr. R. Stickel at the South Charleston Research Plant on October 5, 1967 concerning the use of asbestos products to thicken UCAR latexes. As a result of this conversation, two samples of latexes, UCAR 360 and UCAR 891, were sent by Mr. C. E. Metten who described their properties as follows:

	UCAR 360 Blend 27	UCAR 891 Blend 112
Solids, per cent	55	50.4
Brookfield visc., cps (No. 3 spindle at 60 rpm)	224	28

Mr. Metten requested that these latexes be thickened up to about 1500 centipoise. When these samples ran out, a 5-gallon container of each of the samples was then obtained by our Purchasing Department. These had the following properties:

	UCAR 360 Blend 85A (TS 54.7)		UCAR 891 Blend 139-A (TS 49.7)	
	Measured	Nominal*	Measured	Nominal*
Solids, per cent	-	55	-	50
Brookfield viscosity (No. 3 spindle at 60 rpm)	610	600	25	30
pH	-	4.4	-	3.0

*UCC Bulletin, "UCAR Latexes for the Textile Industry"

Since the viscosity of the second batch of UCAR Latex 360 was higher than that of the original submitted to us, it was diluted with a small amount of water, before use, to a viscosity of about 230 centipoise. Preliminary results of thickening UCAR Latex 360 were reported in a letter to Mr. Metten on December 11, 1967. A number of polymer treated products, R-G144 and R-G244 were shown to be suitable thickeners for UCAR Latex 360, with R-G244 being the most effective on a weight basis None of the asbestos products were reported to be satisfactory for UCAR Latex 891 since they all caused non-uniform coagulation.

This problem was discussed with Mr. Hans Knudsen at South Charleston and, following his advice, the asbestos products were premixed with a small amount of the latex into a smooth paste before diluting with enough pure latex to get the desired addition levels of asbestos. This procedure was satisfactory and thickening data were then obtained for UCAR Latex 891.

Only the thickening data for UCAR Latex 360 and UCAR Latex 891 by R-G144, R-G244, and an anionic form of asbestos are being included in this report. The first two products are commercially available, while the third could be made readily as a modification of R-G244.

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The descriptions of the materials used as thickeners follow:

Product	Description
R-G144	Lot 2625-9; high purity asbestos pellets, opened in a micropulverizer at Niagara Falls
R-G244	King City product, Bag 21D; standard polyester thickening test, 32,000 cps at 2 phr (2274-14)
Anionic asbestos	Niagara Falls pilot plant batch No. 88 (1730-78); standard polyester viscosity test, 25,000 cps at 2 phr

Any further work on thickening of latexes by polymer treated asbestos products will be done and reported by Dr. Kisoon Park at a later date.

DISCUSSION

Apparent viscosities were measured with a Brookfield LVT viscometer at various speeds. The samples were stirred by hand just before measurement and the viscometer readings after 30 seconds were recorded. With a few exceptions, this was a stable reading, i.e., not changing any further with time.

The flow properties were measured with a Fann-35 viscometer. Shear stress was measured both when increasing the shear rate between consecutive readings and when decreasing the shear rate. The data obtained in such a manner generally showed at least a small amount of thixotropic hysteresis, i.e., the up curves (increasing shear rate) were on the higher stress axes than the down curves (decreasing shear rate). The flow data shown in this report were obtained after shearing the sample at the highest shear rate reported in a given cycle until a steady reading was obtained, and then measuring the shear stress while decreasing the shear rate in steps every 15 seconds.

There are some differences in the flow data obtained on a given sample of thickened latex when rotor-bob combinations are changed. This undoubtedly is due to the non-Newtonian characteristics of the thickened latexes. The normal relationship between the rotor speed and the shear rate does not apply strictly in non-Newtonian systems. Thus, the greater the divergence from Newtonian flow, the greater is the discrepancy of the flow data obtained with different measuring combinations. However, the shape of the flow curve is felt to be accurately represented by the data obtained with any given rotor-bob measuring combination.

Thickening UCAR Latex 360

The effect of water on the apparent viscosity of pure UCAR 360 latex is shown in Figure 1. The data can be extrapolated to indicate that 6 to 7% water is needed to reduce the viscosity of bulk UCAR Latex 360 to that of the sample originally sent to us by Mr. Metten (Blend 27).

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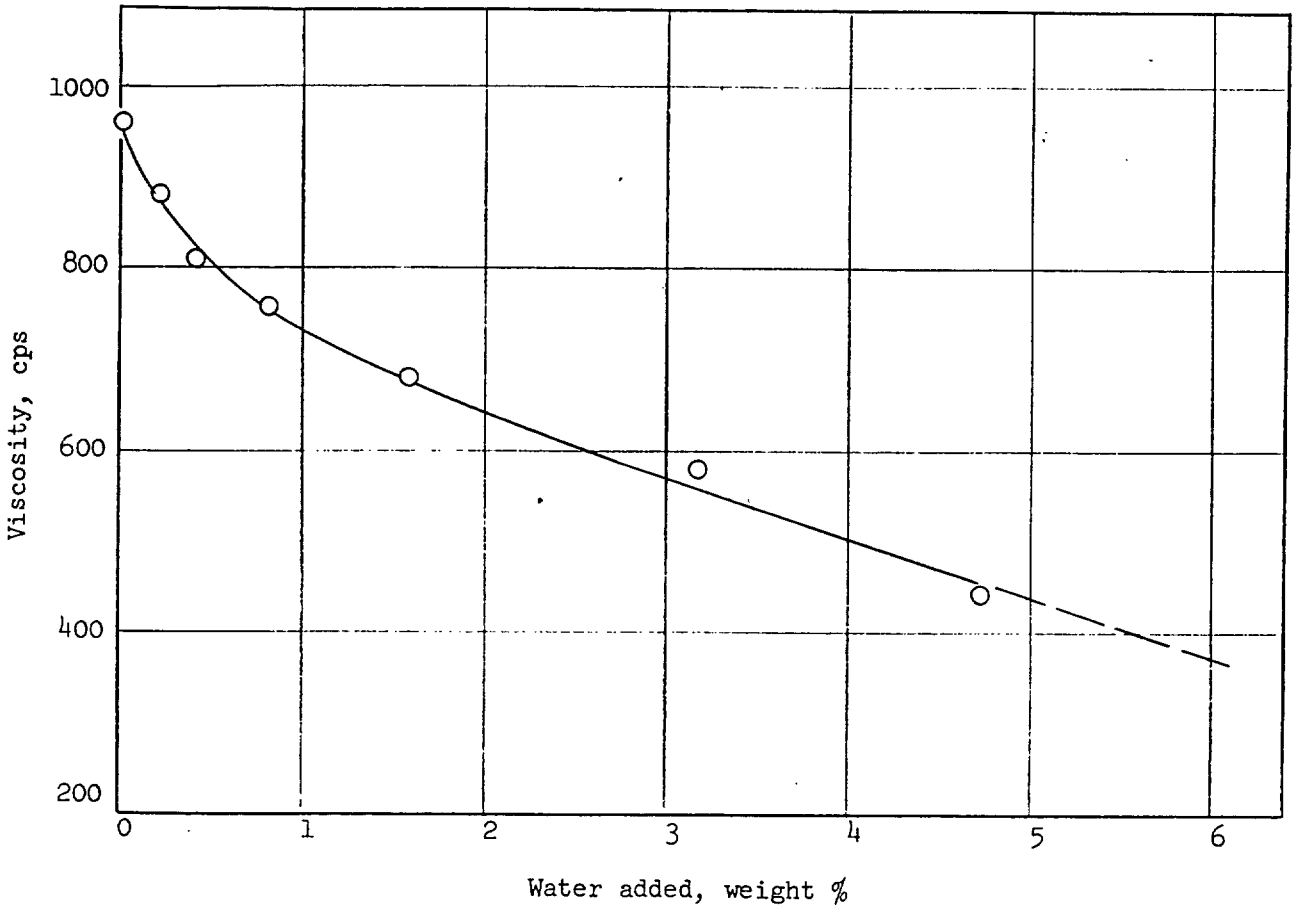


FIGURE 1 - Viscosity of UCAR Latex 360 as a Function of Water Addition (Brookfield viscometer, Spindle No. 3 at 30 rpm)

The Brookfield viscosities at 60 rpm of the various UCAR Latex 360 samples are presented in Table I.

TABLE I

BROOKFIELD VISCOSITIES OF UCAR LATEX 360 SAMPLES

Notebook Reference	Sample	Viscosity at 60 rpm Spindle	cps
1750-60	Blend 27	3	240
2271-38	Bulk sample, Blend 85A	3	610
2271-39	Diluted bulk sample	3	220

The flow characteristics of Blend 27 and of the diluted bulk sample were also studied with the Fann viscometer. The flow data were similar for the two samples.

Asbestos products were mixed with the latex for 5 minutes using a low-speed Lightnin' mixer. Thickening data are given in Table II.

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TABLE II

THICKENING OF UCAR LATEX 360 (DILUTED)
BY ASBESTOS PRODUCTS

No.	Thickener		Brookfield Visc. at 60 rpm	
	Product	Amount, %	Spindle	cps
1	R-G144	1	3	420
2	R-G144	2	3	940
3	R-G244	1	3	640
4	R-G244	2	3	2300
5	Anionic asb.	1	3	490
6	Anionic asb.	2.2	4	2800

After 5 days of standing, the viscosities of the samples remained essentially unchanged.

R-G244 and the anionic form of asbestos are obviously more effective thickeners than R-G144 on a unit weight basis, although the relatively low cost of the latter could make its use more economical.

The flow curves for these suspensions are shown in Figure 2. They have some characteristics of plastic flow in that there are indications of slight yield stresses and that the flow curves tend to become linear in the higher shear rate region. All of the thickened latex samples show at least some thixotropic hysteresis. One hysteresis curve obtained with UCAR Latex 360 thickened with asbestos is shown in Figure 3.

It was originally feared that the cationic asbestos fibers (R-G144) and the anionic latex particles would form large flocs and separate from solution, but this did not happen. The most likely explanation is that the excess anionic surfactant present in UCAR Latex 360 adsorbs strongly on the asbestos and reverses its surface charge to negative. The similar charges on all of the particles prevent strong attraction to each other. The phenomenon of charge reversal of cationic asbestos by concentrated anionic surfactant solutions has often been observed. The less cationic R-G244 and the anionic asbestos forms apparently do not adsorb surfactant strongly, so they are not as highly negatively charged as the R-G144 asbestos when immersed in the latex suspension. Thus, they would interact more strongly with the latex particles, resulting in better thickening of the latex suspension.

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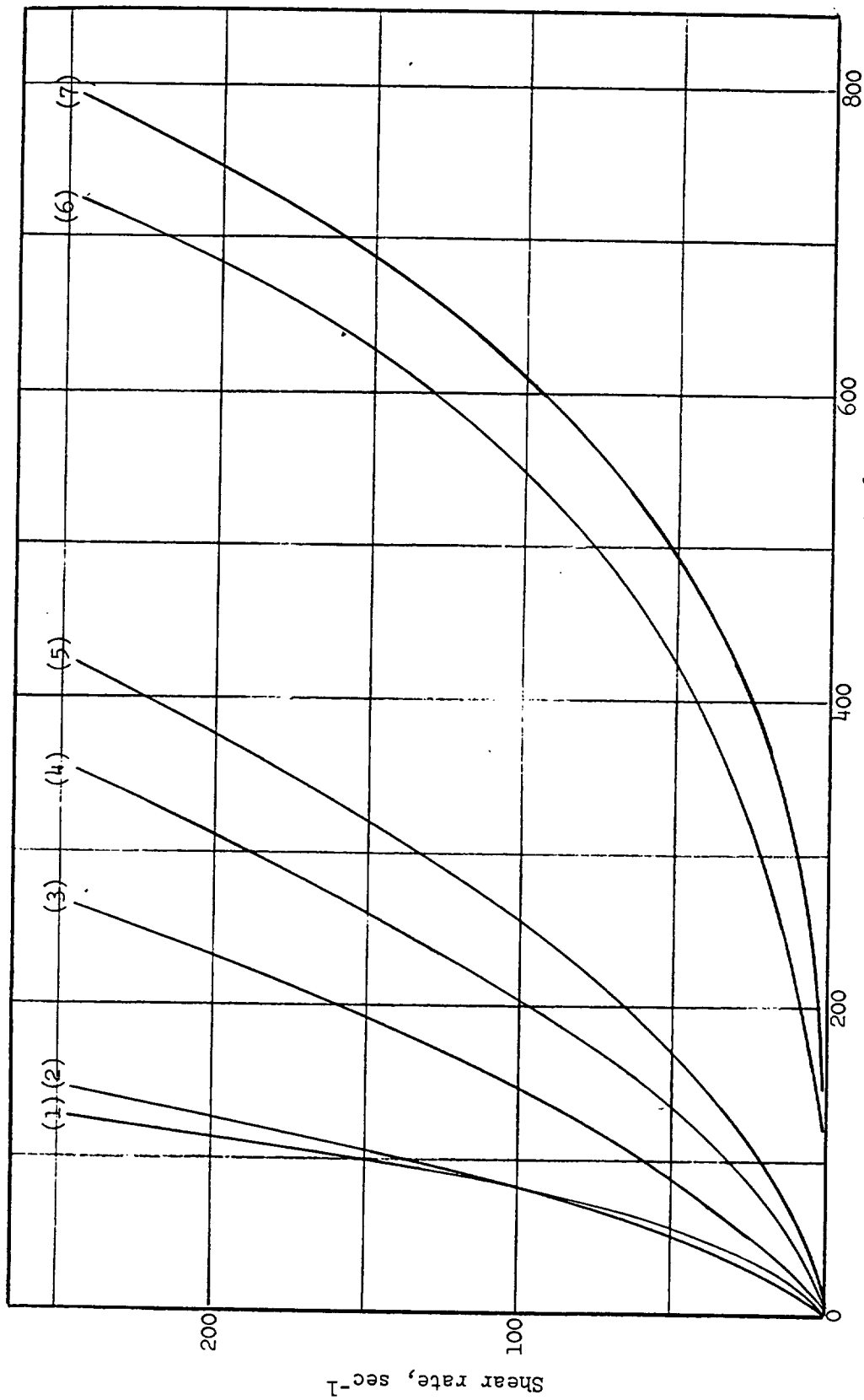


FIGURE 2 - Flow Properties of UCAR Latex 360 (Diluted) Thickened with Asbestos Products (Fann 35 Viscometer using Rotor-Bob R2-B2)

(1) Latex 360 (diluted); (2) Blend 27; (3) Anionic asbestos, 1%; (4) R-G244, 1%; (5) R-G144, 2%; (6) R-G244, 2%; (7) Anionic asbestos, 2%

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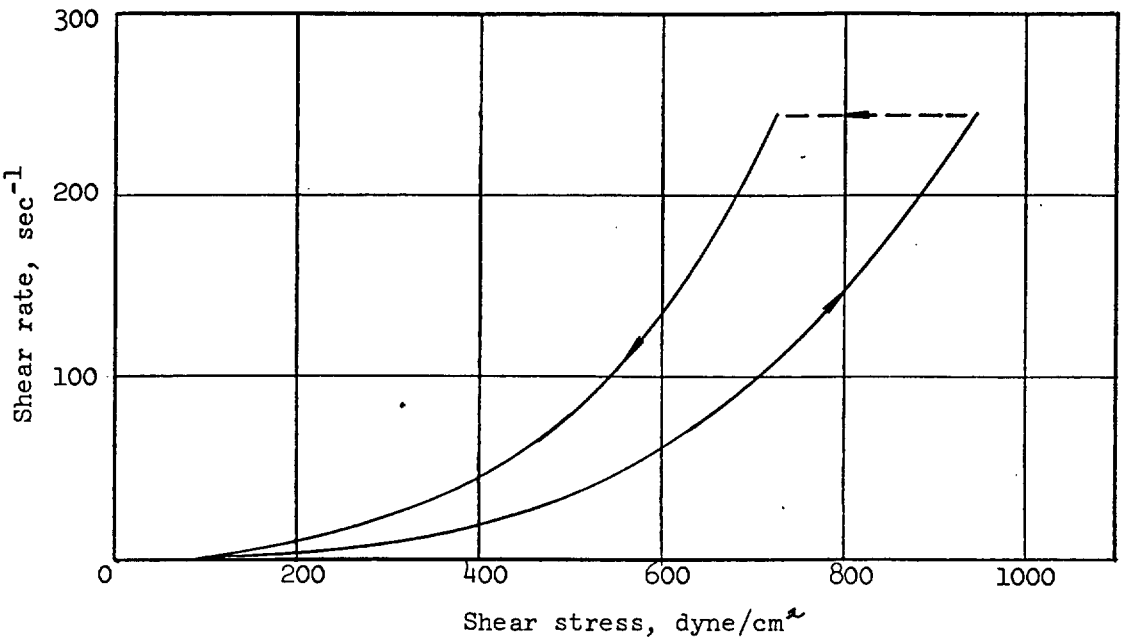


FIGURE 3 - Thixotropic Hysteresis of UCAR Latex 360 Thickened with 2 Per Cent R-G244 Asbestos

Thickening UCAR Latex 891

The asbestos products were mixed with a small amount of latex into a paste by hand, using a spatula, and then the paste was diluted with pure latex. The mixture was stirred with the Lightnin' mixer for 5 minutes.

The viscosities of both the pure latex and the thickened latex were found to be very pH dependent, so the pH was introduced as another variable in the tests. Since Mr. Metten originally reported that the latex is formulated at between pH 7 and 8, usually adjusted with ammonia, the viscosity values were measured both at the natural pH and at about pH 8.

The thickening data are given in Table III. It is seen that R-G144 does not thicken Latex 891 well at natural pH. In addition, significant settling occurred in a few hours. The settled material probably consisted of strongly coflocculated particles of negatively charged latex and positively charged asbestos fibers. Unlike UCAR Latex 360, Latex 891 does not contain any appreciable amount of soluble anionic surfactant, so the asbestos should remain positively charged in that medium.

At higher pH values, significantly better thickening was obtained and the suspensions appeared to be stable. The enhanced thickening by R-G144 at high pH could be due to the fact that the latex suspension itself shows markedly increased viscosity at higher pH values. It is seen from Table III that the apparent viscosity of pure latex increased from 29 to 246 centipoise as the pH increased from 3.0 (natural pH) to 8.3. Under these conditions, the charge on the asbestos particles should be significantly lower so the attraction between the latex particles and the asbestos fibers will be much less. This would allow more structure to develop among the asbestos fibers, causing an increase in the viscosity of the suspension.

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The anionic asbestos is seen to be the best thickener for UCAR Latex 891 since it is effective even at natural pH. R-G244 is also a good thickener for this latex, but increasing the pH is desirable to enhance its thickening power.

TABLE III

THICKENING UCAR LATEX 891(1) WITH ASBESTOS PRODUCTS

No.	Thickener Product	Thickener Amount, %	pH	Brookfield Visc. at 60 rpm Spindle	Brookfield Visc. at 60 rpm cps
1	None	-	nat. (3.0)	2	29(2)
2	"	-	" (3.0)	2	25
3	"	-	8.3	2	246
4	R-G144	1	3.1	2	32
5	"	1	8.0	2	410
6	"	2	3.5	2	40
7	"	2	8.2	3	770
8	R-G244	1	3.3	2	100
9	"	1	8.2	3	890
10	"	2	3.7	3	1100
11	"	2	7.5	4	3200
12	"	2	8.2	4	3900
13	Anionic	1	3.7	3 4	590 700
14	"	1	8.2	3 4	1100 1400
15	"	2	nat. (3.0)	4	3000
16	"	2	8.0	4	6700

(1) Blend 139-A, except for Entry No. 1

(2) Blend 112

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The viscosities of some of the samples were found to increase slightly with time. The data are given in Table V. It is seen that the greatest changes occur in the latex thickened with R-G144.

TABLE V

EFFECT OF SETTING TIME ON VISCOSITY OF
UCAR LATEX 891 THICKENED WITH ASBESTOS PRODUCTS

No.	Description			Visc.(1), cps, after setting		
NB 2271	Thickener	Am't., %	pH(2)	0 Days	12 Days	19 Days
65-1	Anionic asb.	1	8.2	1,400	2,000	1,900
65-2	" "	2	nat.	2,600	3,300	3,000
65-3	" "	2	8.0	6,700	7,500	7,200
65-4	R-G244	1	8.0	1,000	1,300	1,400
65-5	"	2	8.0	3,900	4,600	4,500
65-6	R-G144	1	8.0	570	970	920
65-7	"	2	8.0	920	1,400	1,400

(1) Brookfield LVT viscometer, Spindle No. 4 at 60 rpm

(2) Adjusted with ammonium hydroxide

The flow characteristics of suspensions of lighter consistency are shown in Figure 4 using the rotor-bob measuring combination of R-1, B-1. For the suspensions of heavier consistency, another measuring combination had to be used (R-2, B-2) which limited the measurements to lower shear rates. These data are shown in Figure 5, and some are also included in Figure 4 (dashed curves). While there is not exact correspondence of data gathered with the two different measuring combinations, the flow curves are similar in shape. In all cases, the flow properties indicate that the thickened latexes are plastic(1) in nature, and that there is a small amount of thixotropic hysteresis present. This is illustrated in Figure 6 for one of the thickened samples. However, the thickened Latex 891 samples showed a smaller time dependent property than the thickened Latex 360 under the shearing process.

(1) A slight yield stress present, and the relationship between shear rate and shear stress approaches linearity at high shear rates.

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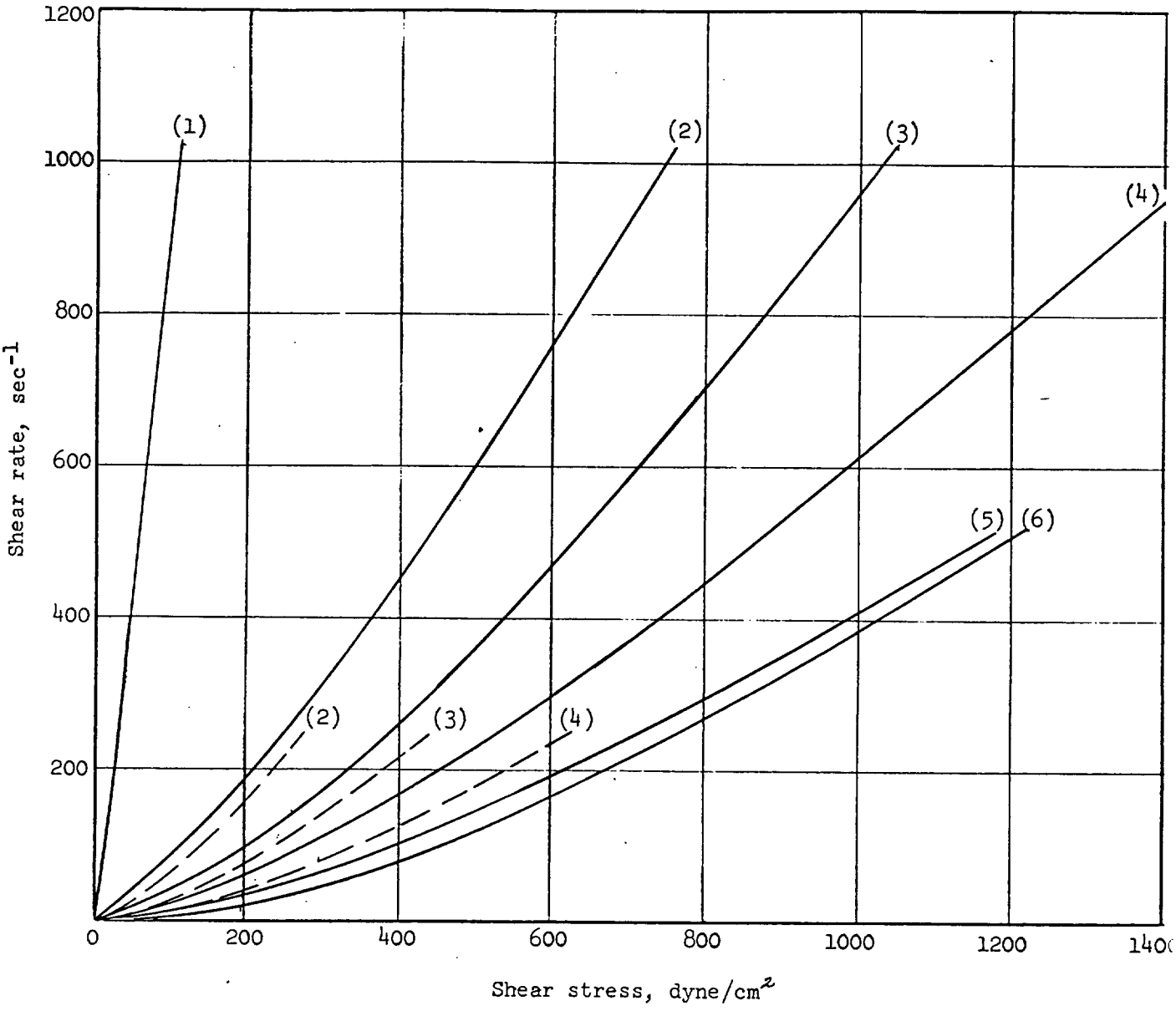


FIGURE 4 - Flow Properties of UCAR Latex 891 Thickened with Asbestos Products (Fann 35 viscometer: solid curves, R1-B1; dashed curves, R2-B2)

(1) UCAR Latex 891; (2) Anionic asbestos, 1%, natural pH;

(3) R-G144, 1%, pH 8.2; (4) R-G144, 2%, pH 8.2; (5) R-G244, 1%, pH 8.2;

(6) Anionic asbestos, 1%, pH 8.0

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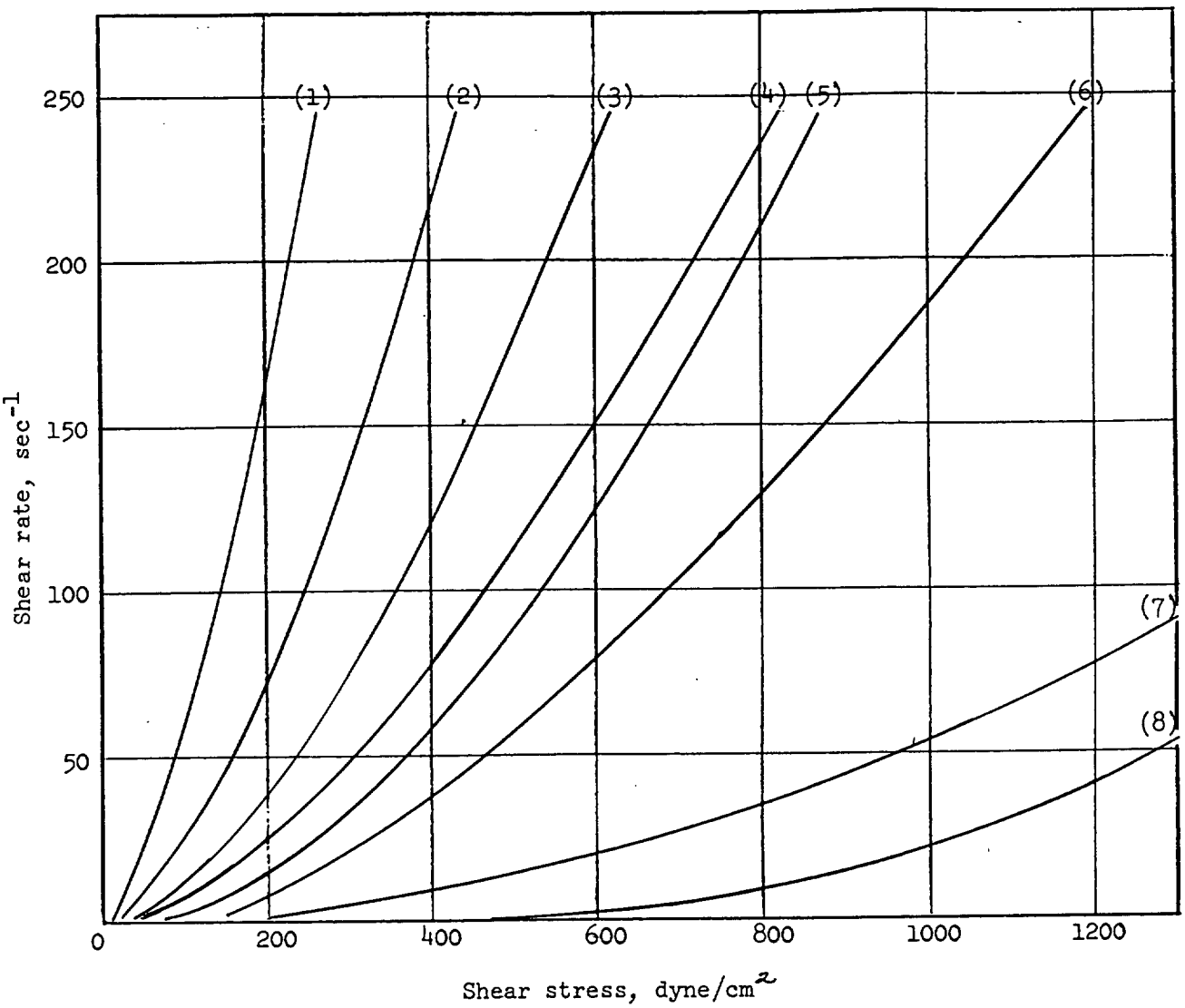


FIGURE 5 - Flow Properties of UCAR Latex 891 Thickened with Asbestos Products (Fann 35 viscometer, R2-B2 rotor-bob combination)

(1) Anionic asbestos, 1%, natural pH; (2) R-G144, 1%, pH 8.2; (3) R-G144, 2%, pH 8.2; (4) R-G244, 1%, pH 8.2; (5) Anionic asbestos, 1%, pH 8.0; (6) Anionic asbestos, 2%, natural pH; (7) R-G244, 2%, pH 8.2; (8) Anionic asbestos, 2%, pH 8.0

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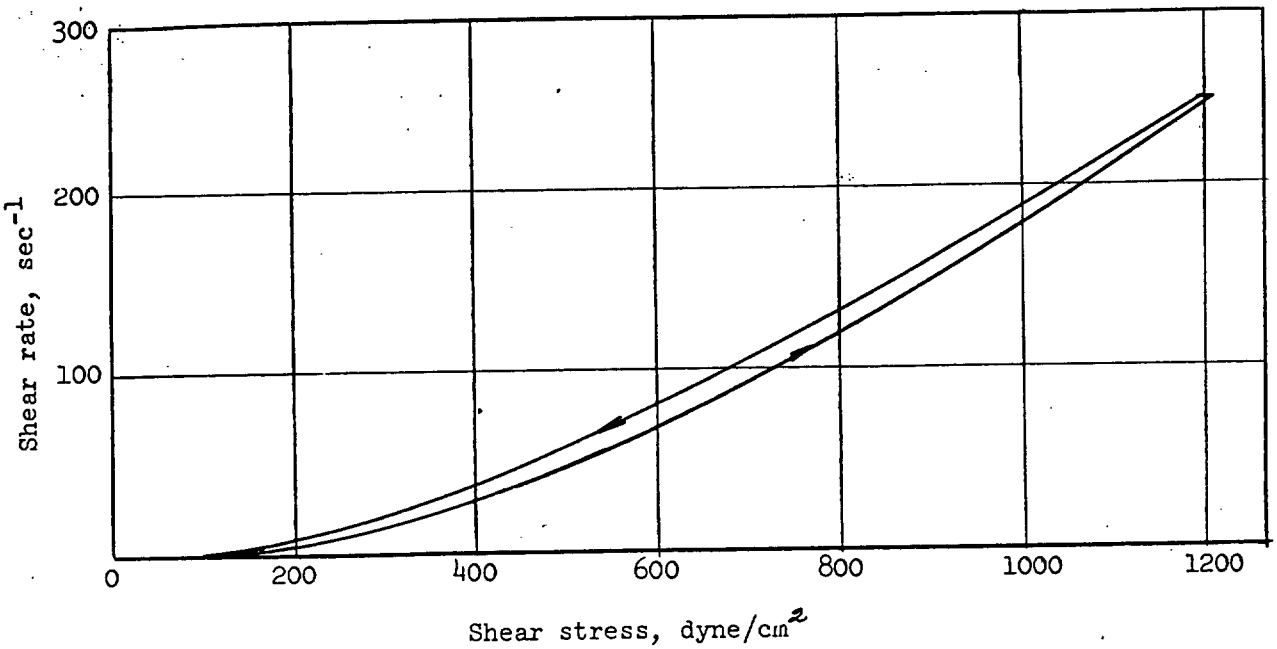


FIGURE 6 - Thixotropic Hysteresis of UCAR Latex 891 Thickened with 2 Per Cent Anionic Asbestos at Natural pH

CONCLUSIONS

Chrysotile asbestos or a chemically modified form of asbestos can be used thicken UCAR Latexes 360 and 891. The modified forms, R-G244 asbestos or anionic asbestos, are better thickeners than the unmodified asbestos (R-G144) on a unit weig basis, but the lower cost of the latter could make it the most economic of the three products for general use.

S. Chwastiak
S. Chwastiak

Kisoon Park
K. Park

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