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MEMORANDUM REPORT NO. M-548

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VINYL COPOLYMER EMULSIONS IN LATEX WALL PAINT

Introduction:

The success of the butadiene/styrene latex wall paint has created interest in the development of other polymer dispersions for this use. The Dow Chemical Corporation has been actively promoting the use of their vinyl based Dow Latex #744B, and the B. F. Goodrich Chemical Co. submitted a variety of commercial and experimental vinyl chloride based resins.

The Dow Latex #744B is a vinyl chloride/vinylidene chloride resin, which requires plasticization to form a film at room temperature. When properly modified with an alkyd resin, it is recommended by Dow as a partial replacement for the butadiene/styrene vehicle now in use. This resin currently sells for 31¢ per pound of solids but due to its high specific gravity (1.48) it is an expensive replacement for a butadiene/styrene latex at the same price on a solids weight basis.

The samples submitted by the Goodrich Company were polymerically modified vinyl chloride resins which would form a film at room temperature. The exact composition of these resins is not known. These resins were evaluated in equal cost "Flow-Kote" formulas on the basis of Goodrich's estimated minimum cost of $.38 per pound of solids. Equal cost was maintained by increasing the pigment volume.

This work was done in 1952 and all references to "Flow-Kote" as a control refer to the 28% pigment volume product which was neither freeze-stable nor free from efflorescence.

Summary and Conclusions:

1. Most of the advantages introduced by the use of the Dow #744B/alkyd in place of butadiene/styrene can be attributed to the presence of the alkyd resin rather than the vinyl. Graphs will be presented that show the effect of each component on the properties of the paint. However, should any future change in the cost or supply situation of butadiene/styrene latex make it necessary, an acceptable emulsion wall finish could be made using this vehicle.

2. The resins submitted by the Goodrich Company did not make acceptable paint at the pigment volume levels necessary to maintain the cost comparable to the present butadiene/styrene paints. These pigment volume levels were so high that it is doubtful if butadiene/styrene or emulsified alkyd would have yielded satisfactory paints.

Action Proposed:

No further work on these vehicles for use in low gloss interior emulsion paints is planned.

Experimental Details:

Evaluation of Dow #744B

Preparation of Paints

An alkyd base was made by adding 10% Triton-X-100, driers and ammonia to the 100% alkyd resin. The required amount of the resin base was then dispersed in the casein solution (VM-5432-5/1/50) on an air mixer. The pigments were dispersed in water with the aid of the potassium tripolyphosphate. This was added to the emulsified alkyd, followed by the latices and letdown water.

Dow recommended that a 1 to 1.3 volume ratio be maintained between the alkyd and the 744B except that the alkyd concentration should not be less than 10% of the total. A 60/40 mixture of 512K/744B was included for information purposes. Following these recommendations the following series was made.

Code	Volume Composition of Vehicle Solids			
	Dow 744B	Alkyd	Dow 512-K	AN of Alkyd
P-100-U-22850	40	30	30	4.5
P-100-U-22852	25	19	55	"
P-100-U-22851	10	10	80	"
P-100-U-22853	40	-	60	-
P-100-U-22862	40	30	30	13.7
P-100-U-22864	25	19	55	"
P-100-U-22863	10	10	80	"
391-001	-	-	100	-

The alkyd recommended for use in this work is similar to our RC-268, except for a higher acid number. In this set both RC-268 and a higher acid analog (PRCU-22454) were used.

Testing and Results

These paints were tested for scrubability by the old standard Marshall Laboratory test and for both scrubability and cleanability by the proposed General Service Administration Specification Test (G.S.A. Spec. 828, August 20, 1951). The tests are briefly described in Appendix A.* The results are tabulated in Table I. These results show that the initial scrubability is adversely affected by increasing amounts of the alkyd/744B mixture. For practical purposes, this difference disappears after 2 weeks aging. Cleanability is also adversely affected by increasing amounts of the alkyd/744B mixture.

Application properties were adversely affected by the addition of 744B/RC-268, but were not affected by 744B/PRC-U-22454.

Freeze resistance was improved by the addition of the 744B/alkyd mixture.

Since some advantages were obtained by the use of the alkyd/744B mixture, a second experiment was designed to evaluate the effect of each component separately.

Systematic Study of the 3 Component Vehicle

For this work, Dow's P-82-220-2 was selected as the base formula, since it contained a substantial amount of 744B and had a higher pigment volume (35%) than "Flow-Kote" (28%), which would accentuate failures of the vehicle. The higher acid number alkyd resin was used.

The vehicle composition of this paint was plotted on a triangular coordinate paper and a series of paints made varying the vehicle composition in all directions as shown in Figure 1.

This series was tested for cleanability and washability by the New Marshall Laboratory method.

The results from these tests and tests for freeze resistance, application properties, gloss uniformity, shelf stability, adhesion over spackle and efflorescence are given in Table I, and superimposed on composition plots in Figure II to show the change in properties with shifting compositions. These plots show rather clearly that scrubability, cleanability, freeze resistance and adhesion over spackle are adversely affected by increasing amounts of Dow Latex #744B. Application properties

* Appendix attached

are adversely affected by the use of alkyd resin. The efflorescence test did not establish any superiority which might be demonstrated by a 100% substitution for the butadiene/styrene.

In their presentation, Dow listed 5 properties which are benefitted by the use of Dow #744B. Properties are listed below with comments on our findings:

1. Non-yellowing. In Exposure Series #S-12804, paints from first part of this study show that all these paints are superior to a 100% butadiene/styrene paint but inferior to 621-847 Semi-Alkyd Solution Flat Wall Paint. The series has not yet shown differences between the various blends.

2. Better Odor. The odor difference is a matter of opinion. There is a change of odor with the use of different components, preference for one odor over another would be an individual matter.

3. Freedom from Efflorescence. This has not been substantiated, but since it is now possible to control it in butadiene/styrene paints, no importance can be attributed.

4. Good Freeze Resistance. This is another property which has been incorporated to the butadiene/styrene paint by other means. However, the improvement of freeze stability which this data attributes to the alkyd is more likely due to the large amount of wetting agent used in conjunction with the resin.

5. Better Adhesion and Hardness. No tests were made of these properties, but it is a generally accepted fact that adhesion of the butadiene/styrene can be improved by the addition of an alkyd.

Goodrich Latices

Goodrich Geon-652-F-1 in "Flow-Kote" formula

This resin is a commercially available vinyl base resin whose cost is $.38 per pound of solids. Specific gravity of the solid resin is 1.6. This resin was substituted in our regular "Flow-Kote" as a partial and complete replacement for the butadiene/styrene. It was also substituted in our vinyl acetate "Flow-Kote" formula. These paints were tested for scrubability and cleanability by the proposed General Service Administration Specification as outlined in Appendix A. These products were characterized by excellent scrub resistance. Application properties were poor in mixtures with butadiene/styrene but good to excellent when the vinyl resin was used alone.

However, the poor color, bad odor and poor cleanability together with the high cost of the resin per volume of solids

made these paints unattractive as a butadiene/styrene substitute.

Goodrich later submitted 7 vinyl based resins, some commercially available and some experimental. These resins, all film formers at room temperature, ranged in specific gravity from 1.6 to 1.21. Although a firm price was unavailable, Goodrich felt that the minimum price for any of them would be $.38 per pound of solids. These resins were substituted in our regular "Flow-Kote" formula upon a basis of equal cost per volume of solids by replacing vehicle with extender.

Tests of these paints showed that at the high pigment volumes necessary to maintain equal cost, they are entirely inadequate in scrub resistance and cleanability. Data of these tests is given in Table II. As stated in the conclusions, it is doubtful if any emulsion film formers would have given acceptable paints at these high pigment volumes. Goodrich agreed with these findings on the basis of their own tests.

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APPENDIX A

Testing Procedures

Scrubability and Cleanability

During the period of this work, the first proposed General Service Administration Specification for Latex paints was issued and a modification suitable for research work was developed in this laboratory. As a result, several different tests were used. A brief description of each method used is given below:

Method A. -Old Standard Marshall Laboratory Test

This consisted of a 4.2 mil drawdown on sand-blasted glass, primed with gray flat wall paint. Aging was usually two weeks. The panel was scrubbed on the standard Gardiner machine using a brush. A 1/2% detergent solution was used to keep the panel wet during the scrubbing operation.

Method B. - The proposed General Service Administration Specification Test (August 20, 1951)

The test paint is applied by brush to an unprimed paper board panel at a rate of 250 sq. ft. per gallon and aged overnight. Part of the panels is scrubbed on the Gardiner machine using the brush and a 5% trisodium phosphate solution. The test is stopped after 300 cycles.

Cleanability was determined on another portion of the same panel. Stains of #1 lead pencil, #1 cup grease, black china marking pencil and a red marking pencil were applied. The stains were then coated with petroleum jelly and washed with a sponge on the Gardiner machine with a 5% ivory soap solution.

Method C - Marshall Laboratory Method

The paint is applied by brush to a paper board panel at 400 sq. ft./gallon. The board has been primed with a primer sealer and gray flat wall paint. After a week's aging, the panel is scrubbed on the Gardiner machine using the brush and a 5% trisodium phosphate solution. The cleanability test is run on another portion of the board prepared for scrubability. An ink stain, a black pigment smudge (W-215), #1 lead pencil marks and a smear of black tinted lard are applied and washed on the Gardiner machine using the sponge attachment. It is washed 50 cycles with a 1/2% soap solution, 50 cycles with a 5% trisodium phosphate solution, and 50 cycles using scouring powder. The stains removed after each 50-stroke interval are reported. The removal of all stains after 50 strokes is reported as excellent, between 50 and 100, good, 100 to 150, fair. Incomplete removal of stains after 150 cycles, poor.

Freeze Stability

These tests were run by 5 cycles of freezing at -10°F. and thawing at room temperature. The change in viscosity and the presence of grit were the properties which were judged.

Gloss Uniformity and Application Properties

The paints were applied to unprimed and self-primed boards with a 3 minute lap between the upper and lower portions. 85° gloss readings were taken on the upper, lower, and lapped areas of the board.

TABLE I

PROPERTIES OF PAINTS CONTAINING DOW LATEX 744B

Code	Vehicle Solids By Volume % 744B	% Alkyd	% 512-K	A.N. Of Alkyd	Pigment Volume	Scrubability Test A	Test B	Test C	Cleanability Test B	Test C	Application Properties	Gloss Uniformity	Adhesion over Spackle
P-100-U-22850	40	30	30	4.5	28	-	28	-	Poor	-	Fair	-	-
-22852	25	19	56	4.5	28	-	24	-	Poor	-	Fair	-	-
-22851	10	10	80	4.5	28	-	122	-	Good	-	Good	-	-
-22853	40	-	60	-	28	-	22	-	Poor	-	Fair	-	-
-22862	40	30	30	13.7	28	3000+	19	-	-	-	Good	-	-
-22864	25	19	56	13.7	28	3000+	60	-	-	-	Good	-	-
-22863	10	10	80	13.7	28	3000+	56	-	-	-	Good	-	-
391-001	-	-	100	-	28	3000+	650	-	Fair	-	Good	-	-
P-100-U-33889	40	30	30	13.7	35			1243	-	Poor	Poor	Fair	Fair
33890	20	30	50	13.7	35			3000	-	Excellent	Fair	Fair	Good
33891	40	10	50	13.7	35			1663	-	Good	Good	Good	Fair
33892	60	10	30	13.7	35			133	-	Fair	Good	Fair	Fair
33893	60	30	10	13.7	35			53	-	Poor	Poor	Poor	Poor
33894	40	50	10	13.7	35			162	-	Good	Poor	Poor	Fair
33895	20	50	30	13.7	35			1207	-	Fair	Fair	Good	Good
391-001	-	-	100	-	28			1702	-	Fair	Excellent	-	Good

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TABLE II

Code	Vehicle Composition by Volume % 652-F1	% 512-K	% Vinyl Acetate	Pigment Volume	Scrubability Test B	Cleanability Test B	Application Properties	Remarks
P-100-U-22848	30	70	-	28	300+	Fair	Good	
P-100-U-22849	60	40		28	300+	Poor	Good	
P-100-U-22835	100	-	-	28	300+	Poor	Excellent	
391-001	-	100	-	28	160+	Fair	Excellent	
P-100-U-22836	100	-	-	23	300	Fair	Good	This is the vinyl acetate "Flow-Kote formula
P-100-R-75939	-	-	100	23	62	Fair	Excellent	

	Vehicle	Density of Solid Vehicle				
P-100-U-22854	575x8	1.30	56	24	Good	Poor	
22855	450x155	1.21	52	14	*	Poor	
22856	652-F1	1.60	63	36	Fair	Fair	
22857	250x31	1.61	63	30	Fair	Fair	* This indicates that film failure occurred too rapidly to permit determination of cleanability
22858	PX-45	1.38	58	16	*	Poor	
22859	450x153	1.38	58	46	Fair	Poor	
22860	450x167	1.37	58	18	Fair	Poor	
22861	576	1.30	56	10	*	Poor	

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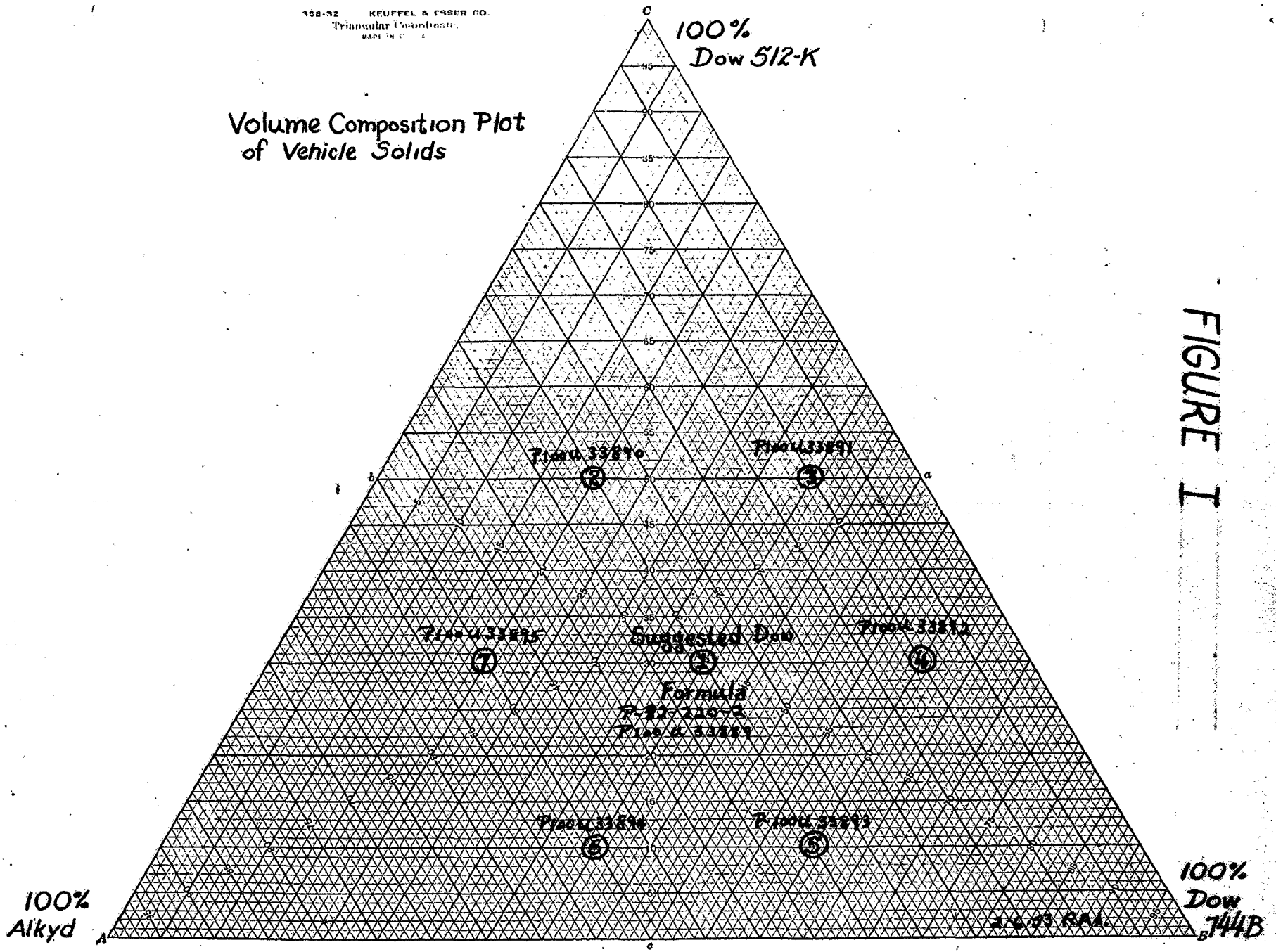

FIGURE 1

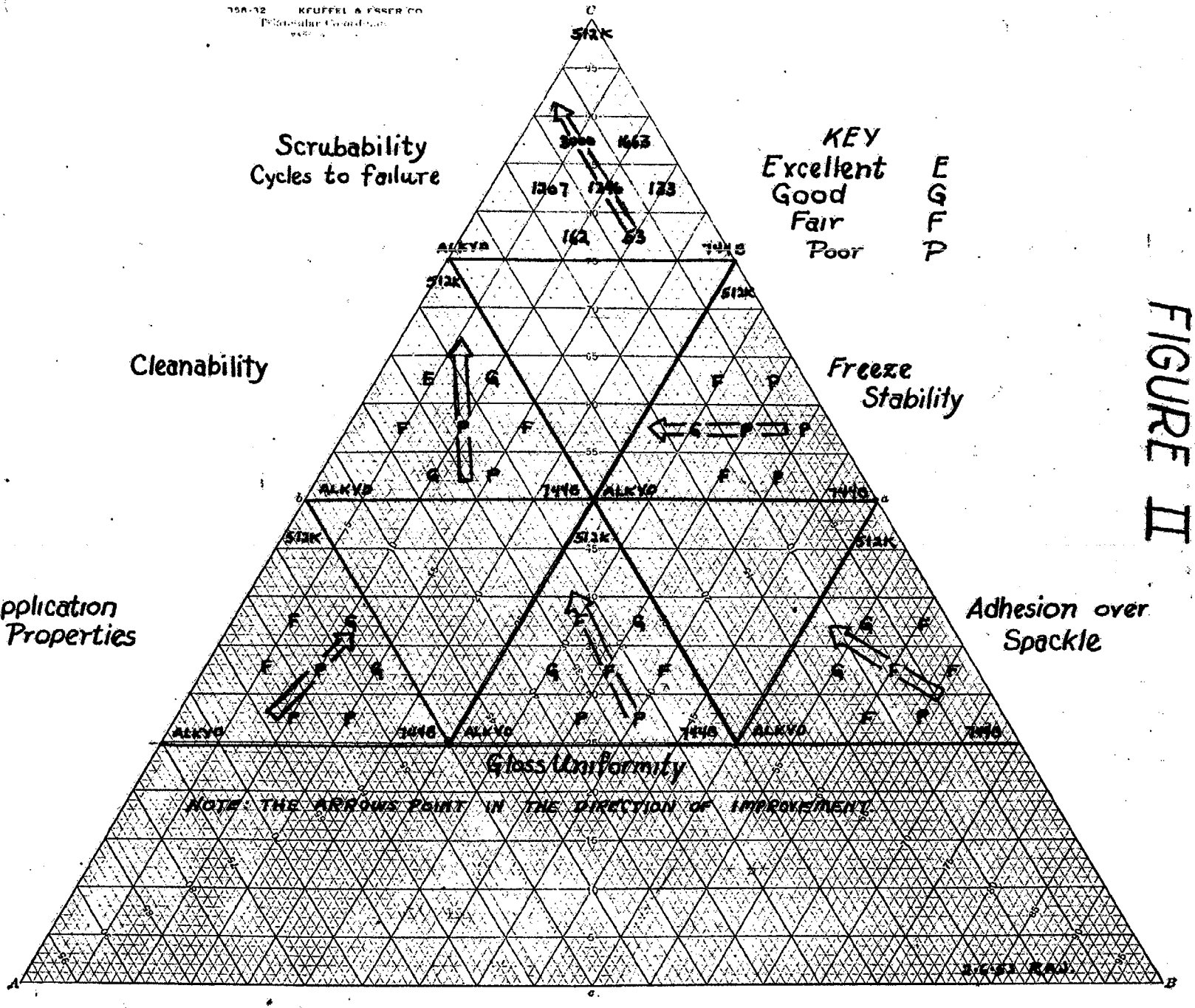

FIGURE II