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DEVELOPMENT OF PAINT AND VARNISH REMOVERS

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FOREWORD

At the request of the Reardon Company the development of a paint and varnish remover suitable for trade sales was included in the project. Various formulas were developed and their effectiveness was compared with twenty-five commercial paint and varnish removers submitted by the Reardon Company. The comparative results may be found on the ensuing pages along with those formulations that show excellent promise for trade sales.

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DEVELOPMENT OF PAINT AND VARNISH REMOVERS

On August 24, 1954, twenty-five commercial paint and varnish removers were received from the Reardon Company. These were evaluated on various coatings that were immediately available in our laboratory. For the most part all the paint and varnish removers were satisfactory on oleoresinous and other common finishes. However, differences in performance were noticed when they were applied to panels finished with clear alkyd urea furniture varnishes (low-temperature bake (140°F)). These finishes are gaining widespread acceptance throughout the furniture field and will probably replace many of the well-known furniture finishes. No rubber base finishes were included in this evaluation.

PRELIMINARY COMPARATIVE RESULTS OF COMMERCIAL PAINT AND VARNISH REMOVERS

The comparative results of eighteen commercial paint and varnish removers applied on panels 1, 2, and 3 finished with clear alkyd urea furniture varnishes and aged since July, 1953, may be found in Table II. Each panel had a different varnish system, since each varnish had a different acid combination as a catalyst. It is interesting to note that none of the removers applied on panel 2 produced blistering or even softening of the film after 30 minutes of contact. Two removers, J. B. Day Company's Kut-Kote and National Chemical and Manufacturing Company's X-Cell-All gave satisfactory results on panel 1. All six of the removers applied to panel 3 gave satisfactory results. Since the system employed on panel 2 best withstood the action of the paint and varnish removers, a set of panels using this alkyd urea varnish system and acid catalyst combination was made. To promote the ultimate hardness that develops on aging, the panels were placed in the weatherometer for 75 hours without water spray. The effectiveness of all the paint and varnish removers was measured on these panels. Comparative results are listed under panels 4 and 5 in Table II. Eight of the removers, designated as formulas C, E, Q, S, T, U, V, and W (see Table I for listing of trade names and manufacturers), gave satisfactory results. These removers were chosen as standards with which our laboratory formulations would be compared.

PAINT AND VARNISH REMOVER FORMULATIONS

Results obtained using the commercial paint and varnish removers on the clear alkyd urea varnish panels showed that removers based on chlorinated solvents were more effective than those removers using acetone-methanol-benzol as a base. Since low toxicity is a requirement in any paint and varnish remover, Dow's methylene chloride was chosen as the chlorinated solvent to be used in our development work. Methylene chloride not only is nonflammable, but is one of the least toxic of the commercially available solvents. According to the Dow Chemical Company it presents only minor hazards to health.

Table III lists thirty-nine different laboratory paint and varnish remover formulations with their approximate raw material costs. All these are based on Dow's scrape-off type paint and varnish remover which uses methylene chloride, paraffin, methocel, and methanol. Various solvents were included in these formulations, since Dow's basic formulation did not give satisfactory results on an alkyd urea finish.

Evaluation of the preliminary laboratory formulations (formulas 1 through 12) indicated that effectiveness varied with humidity conditions. As a result, formula 13 was compounded with a small percentage of water. Comparison between formulas 13 and 3 showed that the addition of water increased the rate and degree of blistering. Since water was beneficial, most of the subsequent formulations were formulated with a small quantity. In some cases the addition of water resulted in an incompatible system with little improvement in effectiveness. Removers containing solvents, e.g., benzene, that have negligible solubility of water in themselves behave this way. On the other hand, removers containing solvents like carbitol whose solubility of water in itself is infinite are greatly improved by the addition of water. The quantity of water that can be added to any given remover system will be discussed under "Comparative Results".

In most cases the laboratory paint and varnish removers were formulated to a viscosity that would provide for satisfactory application to a vertical surface. The viscosities of laboratory formulas 1 through 39 are as follows:

Formula No.	Viscosity
1 - 16	Good
17	Low
18 - 22	Too low
23	Good
24 - 30	Too low
31 - 37	Excellent
38	Very low
39	Low

PROCEDURE

A satisfactory method for compounding the paint and varnish removers found in Table III is to add the components in the order listed below.

1. Prepare a stock solution of methylene chloride and paraffin by melting the paraffin over a water bath and adding it to the methylene chloride with adequate agitation.

2. To the stock solution add additional methylene chloride as required by the formulation (formulas 1 to 39).

3. Add the active solvent.

4. Add the methocel 4000 HG with agitation.

5. Add the methanol with agitation.

6. Add the water with agitation.

The above procedure was found to be very satisfactory in all cases. It probably could be varied to some extent without serious results. However, the water should be added after all the other components have been added. Addition of water prior to the methanol addition resulted in a system that appeared to be slightly incompatible.

DISCUSSION OF COMPARATIVE RESULTS OF COMMERCIAL PAINT AND VARNISH REMOVERS AND LABORATORY FORMULATIONS

Formulations 1 through 39 were evaluated on panels having the following varnish system: filler, clear alkyd urea sealer, clear alkyd urea topcoat.

Most of these formulations were applied on panel A. The results are reported in Table IV. It is interesting to note that formulas 1 through 9 gave satisfactory results with formulas 1, 3, 5, 6, 7, and 9 being the best. In each formulation 3 percent by weight of active solvent was used in place of methylene chloride. Formulas 10, 11, and 12 represent combinations of the better solvents. Only formula 10 gave unsatisfactory results.

Formulas 13, 17, 18, 19, 20, 21, 22, and 23 were formulated to determine if there was a limiting quantity of water that could be added to the remover before losing effectiveness. It was found that formula 18 containing 5% water was an effective organic film remover, while formula 21 containing 6% water produced no visible effect on the finish. No difference in effectiveness was observed between those formulas containing 1 to 5% water. Formula 17 containing 3% water did produce some incompatibility; that is, a layer formed at the surface, but this was overcome by adding additional methocel (formula 35). Each remover system containing a given solvent will tolerate a certain amount of water before losing effectiveness and at the same time becoming incompatible. This quantity of water was determined only on the remover system containing carbitol in which case incompatibility occurred before loss of effectiveness.

Formulas 24 through 30 are the same as some of the first formulas except for the addition of 2% water. These did not show up as well when applied to panel A because their viscosities had been decreased and as a result a much thinner coat had been applied. This thin coat evaporated too fast for the remover to be effective.

The best of the commercial paint and varnish removers (C, E, Q, S, T, U, V, W) and our own formulations, Table III, were applied on panel D and their effectiveness observed (see Table V).

All the removers were applied as a thick coat because this particular panel had two coats of lacquer sealer and alkyd urea sealer followed by one alkyd urea topcoat. Of the eight commercial paint and varnish removers that had appeared promising from their results on other panels, only three could be judged satisfactory. These are J. B. Day Company's Kut-Kote Remover, Universal Technical Products' Universal Remover, and Dux Paint and Chemical Company's Atomic Remover (C, T, and U). All the other commercial removers showed blistering of the finish, but the degree of blistering was very limited. The surface of Pittsburgh Plate Glass Company's Extra Potent Remover remained satisfactory for over an hour; however, it blistered only slightly during this time.

Formulas 23, 27, 28, 29, 35, 36, 37, and 39 of our own formulations were equivalent to or better than the best of the commercial paint and varnish removers tested. Formula 38, containing 10 percent by weight VM and P naphtha, was applied on panel D but with no results. A second heavy application 45 minutes after the first produced some blistering and lifting; however, the results after the two applications were similar to commercial removers classified as unsatisfactory.

CONCLUSIONS

Generally speaking all the formulations listed in Table III gave satisfactory results when applied on clear alkyd urea varnishes. However, some of the solvents such as carbitol, cellosolve acetate, tetralin, cyclohexanol, and furfural gave superior results in combination with a small percentage of water. A general formulation found to be very satisfactory is as follows:

	Parts by weight
Methylene chloride	177 to 172
Paraffin	2
Methocel 4000 HG	3 to 4
Methanol	12
Active solvent	6
Water	4 to 6

The average raw material cost for the above formulation, regardless of the active solvent used, is approximately $1.50 per gallon. This could probably be lowered somewhat by adding a diluent such as VM and P naphtha. However, it should be remembered that the addition of any diluent will necessitate increasing the methocel 4000 HG content to insure adequate viscosity.

If a solvent combination is used, a portion of this should be a glycol ether such as carbitol. It was found that carbitol in conjunction with water produced rapid blistering of the finish and at the same time excellent lifting.

A 1% paraffin content retarded evaporation sufficiently for those removers having satisfactory viscosity.

As shown in Table V, most of the best commercial paint and varnish removers produced blistering of the film within 5 to 6 minutes. However, they failed to give a completely blistered and lifted film within 8 minutes; as was the case with formulas 35, 36, and 37. This may well have been the result of too much diluent which decreases the overall effectiveness of paint and varnish removers.

TABLE I

COMMERCIAL PAINT AND VARNISH REMOVERS

Formula Reference Letter	Company	Trade Name
A	J. F. Kerns Company	Liquisan Stripper
B	Wilson-Imperial Company	Wonder Paste Special Remover
C	J. B. Day and Company	Kut-Kote Remover
D	Savogran Company	Strypeeze
E	National Chemical and Manufacturing Company	X-Cell-All (nonflammable)
F	Turco Products Incorporated	Striplac
G	W. M. Barr and Company	Strip-X
H	Pittsburgh Plate Glass Company	Paint and Varnish Remover (Liquid)
I	Wilson-Imperial Company	No-Wash Remover
J	Technical Color and Chemical Works	Red-Devil Liquid 99
K	Prudential Chemicals Manufacturers	Pronto
L	W. P. Fuller and Company	Conqueror Paint and Varnish Remover
M	Boyle-Midway Incorporated	Radiant Remover
N	W. M. Barr and Company	Klean-Strip
*O	National Chemical and Manufacturing Company	(a) Shure-Kutter (b) X-Cell-All (flammable)
P	Reliable Remover and Lacquer Corporation	Reliable Remover
Q	Bishop and Conklin Company	Paint and Varnish Remover
R	Samson Paint and Chemical Company	Instant Paint and Varnish Remover
S	Pittsburgh Plate Glass Company	Paint and Varnish Remover Extra Potent
T	Universal Technical Products Company	Universal Remover
U	Landon Products Incorporated	El-Pico
V	Dux Paints and Chemicals Incorporated	Atomic Remover
W	Certified Solvents Company	Certified Remover
X	Southern Lacquer and Paint Corporation	Protekto Coatings

*Shure-Kutter and X-Cell-All (flammable), both manufactured by the National Chemical and Manufacturing Company, have identical formulations.

TABLE II

COMPARATIVE RESULTS OF COMMERCIAL PAINT AND VARNISH REMOVERS SUBMITTED BY THE REARDON COMPANY

Panel No.	System	Formula Reference Letter*	Observations
1	Filler, alkyd urea sealer, alkyd urea topcoat. Air-dried since July, 1953.	A	Unsatisfactory; softens after 30 min
		B	Unsatisfactory; softens after 30 min
		C	Softens enough for removal after 30 min
		D	Unsatisfactory; no effect after 30 min
		E	Best of these six; softens enough for removal after 30 min
		F	Unsatisfactory; no effect after 30 min
2	Filler, alkyd urea sealer, alkyd urea topcoat. Air-dried since July, 1953.	G	Unsatisfactory; no blistering or softening of film after 30 min
		H	Unsatisfactory; no blistering or softening of film after 30 min
		I	Unsatisfactory; no blistering or softening of film after 30 min
		J	Unsatisfactory; no blistering or softening of film after 30 min
		K	Unsatisfactory; no blistering or softening of film after 30 min
		L	Unsatisfactory; no blistering or softening of film after 30 min
3	Filler, alkyd urea sealer, alkyd urea topcoat. Air-dried since July, 1953.	M	Appears to be satisfactory; complete removal after 30 min
		N	Appears to be good; complete removal after 10 min
		O	Appears to be satisfactory; complete removal after 30 min
		P	Appears to be satisfactory; complete removal after 30 min
		Q	Appears to be good; complete removal after 10 min
		R	Appears to be satisfactory; complete removal after 30 min

*Refer to Table I.

TABLE II (Continued)

Panel No.	System	Formula Reference Letter*	Observations		
			Viscosity	Blistering	Removal
4 Top (T)	No filler, lacquer sealer, alkyd urea sealer, lacquer sealer, alkyd urea sealer, alkyd urea topcoat. Removers applied for 1/2 hour. Varnish removed from 1/2 of the section; remaining left as is to indicate the degree of blistering.	G	Too thin	None	None
		H	Too thin	None	None
		I	Too thin	None	None
		J	Too thin	None	None
		K	Too thin	None	None
		L	Too thin	None	None
		C	Too viscous	50%	Some
		E	Excellent	90%	Complete
4 Bottom (B)	No filler, lacquer sealer, alkyd urea sealer, lacquer sealer, alkyd urea sealer, alkyd topcoat. Removers applied for 1/2 hour. Varnish removed from 1/2 of the section; remaining left as is to indicate the degree of blistering.	M	Too thin	Along edges	Fair
		N	Little thin	2%	Very slight
		O	Too thin	None	None
		P	Too thin	None	None
		Q	Good	30%	Some
		R	Too thin	None	None
		S	Good	5%	Very slight
		T	Good	100%	Complete
5 Top (T)	Filler, lacquer sealer, alkyd urea sealer, alkyd urea topcoat. Aged 75 hours in weatherometer without water spray to thoroughly dry.	A	Too thin	Slight	None
		B	Good	Slight	Slight
		D	Good	Slight	Slight
		F	Good	None	None
		U	Too thin	50%	Fair
		V	Too viscous	85%	Fair
		W	Good	95%	Complete
		X	Too thin	Along edges	Slight

*Refer to Table I.

TABLE III

BASIC PAINT AND VARNISH FORMULAS

	1	2	3	4	5	6	7	8	9	10
	Parts by weight									
Methylene chloride	177	177	177	177	177	177	177	177	177	175
Paraffin (50-52°C mp)	2	2	2	2	2	2	2	2	2	2
Methocel 4000 HG	3	3	3	3	3	3	3	3	3	3
Methanol	12	12	12	12	12	12	12	12	12	12
Mesityl oxide	6									
Isophorone		6								
Carbitol			6		3					
Tetralin				6	3					4
Cellosolve acetate						6				
Dioxane							6			
Furfural								6		4
Benzene									6	
Water										
Cyclohexanol										
Tergitol NPX										
Raw material cost/gal as of October 1, 1954	$1.47	$1.51	$1.51	$1.53	$1.52	$1.49	$1.53	$1.48	$1.45	$1.51
	11	12	13	14	15	16	17	18	19	20
Methylene chloride	177	177	175	177	175	177	171	167	161	155
Paraffin (50-52°C mp)	2	2	2	2	2	2	2	2	2	2
Methocel 4000 HG	3	3	3	3	3	3	3	3	3	3
Methanol	12	12	12	12	12	12	12	12	12	12
Mesityl oxide										
Isophorone										
Carbitol	4	4	6		3	6	6	6	6	6
Tetralin										
Cellosolve acetate										
Dioxane										
Furfural	4									
Benzene		4								
Water			2		2		6	10	16	22
Cyclohexanol				6	3					
Tergitol NPX						0.2				
Raw material cost/gal October 1, 1954	$1.49	$1.47	$1.48	$1.52	$1.49	$1.51	$1.45	$1.41	$1.35	$1.30

TABLE III (Continued)

	21	22	23	24	25	26	27	28	29	30
	Parts by weight									
Methylene chloride	165	163	173	177	177	177	177	175	177	177
Paraffin (50-52°C mp)	2	2	2	2	2	2	2	2	2	2
Methocel 4000 HG	3	3	3	3	3	3	3	3	3	3
Methanol	12	12	12	12	12	12	12	12	12	12
Mesityl oxide				6						
Isophorone					6					
Carbitol	6	6	6						4	4
Tetralin						6		4		
Cellosolve acetate										
Dioxane										
Furfural							6	4	4	
Benzene										4
Water	12	14	4	4	4	4	4	4	4	4
Cyclohexanol										
Tergitol NPX										
Raw material cost/gal as of October 1, 1954	$1.39	$1.37	$1.46	$1.44	$1.47	$1.51	$1.45	$1.49	$1.46	$1.44
	31	32	33	34	35	36	37	38	39	
Methylene chloride	173	173	173	173	170	172	173	152	172	
Paraffin (50-52°C mp)	2	2	2	2	2	2	2	2	2	
Methocel 4000 HG	3	3	3	3	4	4	3	4	4	
Methanol	12	12	12	12	12	12	12	12	12	
Mesityl oxide										
Isophorone										
Carbitol	3				6	3		6		
Tetralin	3					3				
Cellosolve acetate		6							6	
Dioxane			6							
Furfural										
Benzene				6						
Water	4	4	4	4	6	4	4	4	4	
Cyclohexanol							6			
Naphtha								20		
Raw material cost/gal as of October 1, 1954	$1.48	$1.46	$1.49	$1.41	$1.48	$1.51	$1.49	$1.29	$1.49	

TABLE IV

COMPARATIVE RESULTS ON LABORATORY PAINT AND VARNISH FORMULATIONS

Panel A

System: Filler, alkyd urea sealer, alkyd urea topcoat. In weatherometer 75 hours without water spray to thoroughly dry.

Formula No.*	Percent Blistering	Observations
1	80	Satisfactory remover
2	60	Satisfactory remover
3	80	Satisfactory remover; very fast action
4	70	Satisfactory remover
5	100	Satisfactory remover; very fast action; complete blistering
6	90	Satisfactory remover
7	95	Satisfactory remover; very fast action
8	50	Satisfactory remover
9	85	Satisfactory remover; very fast action
10	10	Unsatisfactory remover
11	80	Satisfactory remover
12	65	Satisfactory remover
13	95	Satisfactory remover; very fast action; better puffing (lifting) than 3; water contributes to overall action
14	100	Satisfactory remover; very fast action; complete blistering
15	100	Satisfactory remover; very fast action; excellent lifting
16	85	Satisfactory remover
17	100	Satisfactory remover; very fast action
18	95	Satisfactory remover; very fast action; viscosity quite low; evaporates too fast; application on a "wet" day
19	None	Unsatisfactory remover
20	None	Unsatisfactory remover
21	None	Unsatisfactory remover
22	None	Unsatisfactory remover
18	95	Satisfactory remover; application on a "dry" day; action slightly slower with decreasing humidity
24	None	Unsatisfactory remover
25	None	Unsatisfactory remover
26	None	Unsatisfactory remover
27	30	Fast action
28	40	Fast action
29	5	
30	25	Fast action

Note: All removers applied uniformly for comparison purposes except 24 through 30. Formulas 24 through 30 were applied in a thinner coat. The addition of 2% water resulted in too low viscosity.

*Refer to Table III.

TABLE V

COMPARISON OF COMMERCIAL AND LABORATORY COMPOUNDED PAINT AND VARNISH REMOVERS

Panel D

System: No filler, lacquer sealer, alkyd urea sealer, lacquer sealer, alkyd urea sealer, alkyd urea topcoat. In the weatherometer 75 hours without water spray to thoroughly dry.

Formula Reference	Viscosity	Minutes Before First Blister	Percent Blistering	Observations
C*	Too viscous	5	65	Satisfactory remover
E	Good	5	25	Unsatisfactory remover
Q	Good	5	30	Unsatisfactory remover
S	Good	7+	20	Unsatisfactory remover; film remains wet for more than 1 hour and is oily
T	Good	6	90	Good remover; good blistering
U	Too thin	10	10	Unsatisfactory remover
V	Too viscous	5	90	Good remover; fair blistering
W	Good	4	25	Unsatisfactory remover
39**	Too thin	4	95	Very satisfactory remover, but low viscosity
36	Little thin	5	100	Excellent remover; rapid acting; 1 minute for complete blistering
37	Very good	4	95	Excellent remover
3	Good	8	85	Good remover, but dries too rapidly
13	Good	6	85	Good remover, but dries too rapidly
23	Good	6	90	Good remover
17	Little thin	6	85	Good remover
35	Very good	5	100	Excellent remover
27	Little thin	6	100	Excellent remover
9	Good	9	10	Unsatisfactory remover
5	Good	5	30	Unsatisfactory remover
6	Good	8	5	Unsatisfactory remover
15	Good	5	35	Unsatisfactory remover
28	Too thin	4	90	Very satisfactory remover, but low viscosity
29	Too thin	4	90	Very satisfactory remover, but low viscosity
38	Very thin		None	One heavy application no effect
14	Too viscous	5	15	Unsatisfactory remover
38	Very thin		60	First heavy application no effect; second heavy application 45 minutes after first produced some blistering and lifting; result after two applications is similar to commercial removers classified as unsatisfactory

*Refer to Table I.

**Refer to Table III.

Note: All removers applied liberally but uniformly for comparison purposes.