FIRE RETARDANT FORMULATIONS HANDBOOK

WOOD • PAINTS • PLASTICS • RUBBER
TEXTILES • PAPER • BUILDING MATERIALS

VOLUME I
PROGRESS IN FIRE BETARDANCY SERIES

VIJAY MOHAN BHATNAGAR

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PREFACE

The activity and interest in fire retardants grows at an ever-increasing rate. A voluminous literature exists in fire retardant formulations. In preparing this book I have attempted to make the subject matter reflect the present state of knowledge and the most important developments in fire retardant formulations. This book is designed to gather together in one place these important formulations which are extensively used in research institutions and industries. I have provided references to each formula so that the user can explore given topic. Thus, another purpose of this book is to direct the researcher to the original formulation or literature. But at times, the original document may not be necessary. The formula may have the information being sought. In many instances, however, a copy of the original article may be needed.

It is hoped that this book will give the reader some picture of developments during recent years in our advancement or knowledge of fire retardant formulations. It is indeed almost impossible to include all the formulas scattered in thousands of literature articles. However, in the interest of future printings and editions, I should greatly appreciate any notices of error and suggestions for changes and additions.

It is a pleasure to acknowledge the inspiration of Reinhold Preik, President and General Manager of Iroquois Chemicals Ltd. I am indeed indebted to him for his advice, encouragement, and helpful comments in my work on fire retardants.

Vijay Mohan Bhatnagar

Cornwall, Ontario, Canada

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Intumescent Fire Retardant Paint

	/100 gal.	
	Ball Mill	Cowles
Add		
Mineral spirits	326.00	225.00
Chlorinated paraffin-70	80.00	80.00
Pliolite VTAC-L	100.00	100.00
Add and Grind		
Titanium dioxide RANC	90.00	90.00
Dipentaerythritol	75.00	75.00
Melamine	75.00	75.00
Phos-Chek P/30	250.00	250.00
Bentone-38	5.00	5.00
Stir in		
Mineral spirits	------	101.00
Methanol	2.00	2.00

PVC %	=	65.10
Wt. Solids %	=	67.20
Vol. Solids %	=	50.00
Viscosity	=	93.00 K.U.

For brush or roller application, no reduction is necessary. For air spray, reduce one gallon of material with one pint of VM - and P-naphtha. Airless spray requires no reduction.

Reference

Goodyear Chemicals Tech. Bul. PLS-50.

Fire Retardant Interior White Paint

	Pounds	Gallons	Lbs./Gal.
Rutile titanium calcium pigment	25.00	0.92	0.25
Rutile titanium dioxide	220.00	6.29	2.20
Blanc fixe	150.00	4.19	1.50
Surfax	285.00	12.83	2.85
Magnesium silicate	138.00	5.80	1.38
Antimony oxide	100.00	2.09	1.00
Long oil, soya modified alkyd, -70% solids	210.00	26.58	2.10
Chlorowax-70	70.00	5.08	0.70
Lead naphthenate, 24%	10.00	1.06	0.10
Cobalt naphthenate, 6%	1.30	0.16	0.01
Antiskinning agent	1.00	0.15	0.01
Mineral spirits	227.00	34.85	2.21

Reference
Diamond Alkali Co. Tech. Bul. TB-30.

Fire Retardant White Shingle Stain

	Pounds	Gallons
Rutile titanium dioxide	200.00	5.72
Antimony oxide	100.00	2.09
Aluminium stearate	3.00	0.36
Lecithin	3.00	0.34
Long oil, soya modified alkyd 70% solids	150.00	18.65
Chlorowax-70	100.00	7.28
Mineral spirits	422.00	64.47
Cobalt naphthenate, 6%	1.50	0.19
Lead naphthenate, 24%	3.00	0.31
Zinc naphthenate, 8%	5.00	0.59

Grind = 16 hours in pebble mill
Initial viscosity = Ford cup No. 4, 15 seconds

Reference
Diamond Alkali Co. Tech. Bul. TB-30.

Intumescent Fire Retardant Solvent-Based Paint

	Pounds	Gallons
Pure rutile titanium dioxide	210.02	6.07
Blanc fixe	171.00	4.66
Surfex	167.50	7.59
Magnesium silicate	110.90	4.61
Aluminum stearate	2.00	-----
Chlorowax-70	111.60	8.13
Dibasic ammonium phosphate	164.00	11.84
Oil modified alkyd-50% solids by weight	255.00	33.55
Lead naphthenate, 24%	4.00	0.43
Cobalt naphthenate, 6%	1.00	0.12
Mineral spirits	143.00	22.00
Dipentine	7.16	1.00

Reference
Diamond Alkali Co. Tech. Bul. TB-30.

Intumescent Fire Retardant Resin Emulsion Type

	Pounds	Gallons
Chlorowax-70	100.00	7.30
Ethylene glycol	70.00	7.56
Daxad-30/Dewey and Almy	6.00	0.61
Titanium dioxide	156.50	4.48
Pentaerythritol	50.00	4.13
Dicyandiamide	100.00	8.59
Monobasic ammonium phosphate	260.00	17.35
Water	210.00	25.40
PVAC resin emulsion/Darex 61-L Dewey and Almy	221.00	24.58

Viscosity = 105 K.U.

The above formulation is best prepared by pebble mill grinding with everything in the grind except the PVAC resin. This paint is applied at a spreading rate of 125-150 square feet per gallon.

Reference
Diamond Alkali Co. Tech. Bul. TB-30.

Intumescent Fire Retardant Resin Emulsion Type

	Pounds	Gallons
Water	200.00	24.00
Monamulse LPP/Mona Industries	5.00	0.60
Monawet MM80/Mona Industries	1.00	0.10
Rutile pure titanium dioxide	100.00	3.10
Mona ammonium phosphate	300.00	22.50
Resimene 817-S/Monsanto	25.00	2.50
Dicyandiamide	100.00	8.70
Pentaerythritol	50.00	4.50
Chlorowax-70	60.00	4.37
CMC-70S/2% solution/...Hercules Co.	75.00	9.00

The above components are charged into a mixer in the order listed and mixed until a smooth homogeneous paste is obtained. The resulting paste is then ground and the following materials added slowly under agitation.

Water	40.00	4.80
Resyn 1066/Natl. Starch and Chem. Corp.	206.00	22.20
Dibutyl phthalate	12.00	1.37

The above paint can be protected with 0.03-0.08 Troysan PMA-30 based on total weight of paint.

The paint is for interior use and may be applied by brush, roller or spray. It should be applied at a rate of 150-200 square feet/gallon, preferably in two coats.

Reference

This formulation was developed by the National Starch and Chemical Corporation.
Diamond Alkali Co. Tech. Bul. TB-30.

Fire Retardant Clear Formulation

	Pounds	Gallons
Parlon 20 cps/Hercules Co.	238.00	17.40
Chlorowax-70	124.00	9.00
Chlorowax-40	61.60	6.40
Paraplex G-62/Rohm and Haas	42.20	5.03
Toluol	454.00	62.17

The above clear formulation will not support combustion. Reduced one to one by volume with toluol, it has shown merit as a dip coating for reducing the flammability of wooden shingles, canvas belting, composition board and similar materials.

Preliminary weatherometer tests show the above clear coating has good durability. Chlorowax-70 and chlorowax-40 are used with the chlorinated rubber in optimum ratio for maximum weather resistance. A polyester plasticizer has been incorporated at 10% by weight on vehicle solids to increase heat and light stability.

Reference

Diamond Alkali Co. Tech. Bul. TB-30.

Low Cost Fire Retardant Silicate Paint for Cellulosic Board

	Pounds	Gallons
Rutile pure titanium dioxide	112.50	3.21
Barytes	445.00	12.00
Diamond Non-Fer-Al precipitated	67.50	3.06
Chlorowax-70	66.50	4.85
Ethylene gylcol	56.20	6.00
Surfynol 102/Air-Reduction Co.	3.45	-----
Diamond grade 40 silicate	440.00	38.30
Water	16.70	2.00
120 Medium, CMC, 2% solution	79.00	9.42
Grind in Pebble Mill and Add		
Diamond grade 40 silicate	95.00	8.26
Polyvinyl acetate emulsion-Flexbond Colton chemical	116.50	12.90

Solids = 64%
Wt./gal. = 14:98

Reduce with water to approximately 20 sec. Ford cup No. 4 cup for spray application.

A two-coat system is suggested for maximum fire retardancy. Has washability properties superior to conventional water base fire retardant paints.

Reference

Diamond Alkali Co. Tech. Bul. 06-B-10.

Fire Retardant Clear Topcoats

	/100 gal.		
	Flat	Semi-gloss	Gloss
Mineral spirits	165.00	162.00	163.00
VM- and P-naphtha	380.00	375.00	377.00
Pliolite VTAC-L	76.00	81.00	85.00
Chlorowax-70	76.00	81.00	85.00
Firemaster T-23-P/Michigan	8.00	8.00	10.00
Celite 499	20.00	10.00	------
Solids % =	25	25	25

Clear topcoats may be applied by brush, air spray, roller or airless spray.

Reference

Goodyear Chemicals Tech. Bul. PLS-50.

Fire Retardant Paints

Materials-Lbs./100 Gal.	A	B	C	D	E	F
Titanium-Ca rutile	400.00	347.60	212.20	400.00	347.60	212.20
Titanium oxide rutile	205.00	227.40	279.90	205.00	227.40	279.90
Antimony oxide	105.00	------	------	105.00	------	------
Antimony silico oxide	------	105.00	210.00	------	105.00	210.00
Aluminum stearate	18.00	18.00	18.00	18.00	18.00	18.00
Chlorinated alkyd solution, 60% NV	465.00	465.00	465.00	375.75	375.75	375.75
Chlorinated paraffin-70	------	------	------	66.00	66.00	66.00
Mineral spirits	150.00	150.00	150.00	187.00	187.00	187.00
Lead naphthenate, 24%	5.90	5.90	5.90	5.90	5.90	5.90
Cobalt naphthenate, 6%	2.40	2.40	2.40	2.40	2.40	2.40
Antiskinning	0.50	0.50	0.50	0.50	0.50	0.50

Reference

E.K. Zimmermann and W.A. Ingram, Pt. Varn. Prod. 51, No. 12, 71/1961.

Fire Retardant Paints-60% Pigment Volume

	Wt./100 gal., lb.	Vol., gal.
Total pigment/7.8% antimony trioxide by volume	853.50	26.96
Alkyd resin, 70% solids	229.00	29.00
Petroleum spirits	281.00	43.05
Lead naphthenate	7.80	0.81
Cobalt naphthenate	1.00	0.12
Manganese naphthenate	0.50	0.06

References

1. L.S. Birnbaum and M. Marlowitz, Ind. Eng. Chem. 40, 400/1948.
2. U.S. Navy Dept. Specification 52, P22A, June 15, 1946.

Fire Retardant Interior Paint

	Lbs./100 Gals.
Titanium dioxide	250.00
Titanium Ca pigment	235.00
Zinc oxide	170.00
Magnesium silicate	90.00
Antimony oxide	100.00
Aluminum stearate	8.50
Methyl violet toner/paste	0.20
Alkyd resin solution	229.00
Paint thinner	281.00
Lead naphthenate	7.80
cobalt naphthenate	1.00
Manganese naphthenate	0.50

Ingredients of Toner Paste:

Methyl violet toner dry	20.00
Alkyd resin solution	78.50
Zinc naphthenate	0.80

References

1. U.S. Dept. Def. Specification TT-2-0026b/DOD 24 August, 1961.
2. U.S. Fed. Supp. Serv., Gen. Serv. Adminst. Specification TT-P-34a, March 19, 1958.
3. U.S. Depts. Army, Navy and Air Force Specification JAN-P-702.

Fire Retardant Exterior Paint	
	Pounds
Basic carbonate white lead	1.66
Basic sulphate white lead	1.28
Zinc oxide	2.37
Titanium oxide	1.09
Extending and tinting colors	3.00
Raw linseed oil	3.38
Bodied linseed Z-2	1.13
Mineral spirits	0.82
Driers	0.31

Reference

U.S. Fed. Supp. Serv. Gen. Serv. Adminst. Specification TT-P-34a, March 19, 1958.

Fire Retardant HET Alkyd Paint	
	Lbs./100 Gal.
Titanium calcium pigment	395.00
Titanium dioxide	205.00
Antimony dioxide	105.00
Lemon chrome yellow	7.00
Iron blue	0.80
Aluminum stearate	18.00
Chlorinated alkyd resin/279 lbs N.V.	465.00
Petroleum spirits	150.00
Lead naphthenate	5.90
Cobalt naphthenate	2.40
Antiskinning agent	0.50

HET acid = A dibasic acid incorporating 54% by weight of stable chlorine. This ingredient makes possible the formulation of a decorative, corrosion-resistant coating with fire retardance/Hooker Chemical Corporation.

Reference

W.M. Ewalt and A.W. Hopton, Pt. Varn. Prod., November, 1961.

Intumescent Fire Retardant Interior Paints		
	Lb.	Gal.
Charge into Mixer-agitate		
Water	175.00	21.00
Monamulse LTP	2.00	0.20
Monawelt MM80	2.00	0.20
Titanox A 168 LO	50.00	1.50
Monoammonium phosphate	300.00	22.50
Resimene RH201S	35.00	3.50
Dicyadiamide	100.00	8.70
Pentaerythritol 200	50.00	4.50
Chlorowax-70	60.00	4.37
CMC-70HS/2% solution	25.00	3.00
Disperse in High-speed Mill and Add slowly with agitation		
Water	20.00	2.40
Resin 1066	206.00	22.20
Dibutyl phthalate	6.00	0.68

Charge components in the sequence shown above. Pigment paste should be smooth and homogeneous prior to grinding.

The amount of foam inhibitor will depend upon the particular manufacturing equipment employed. Use as little as possible to avoid crawling or fish eyes. Protect paint with 0.03-0.08% Troysan PMA-30 based on total weight of paint.

Reference

F.P. Liberti, Pt. Varn. Prod., November, 1961.

Fire Retardant Latex Paint

	Weight %
Paint Dispersions	
Water	29.07
Aerosol OT-100	0.16
Emulphor EL-719	0.16
Whiting	24.93
Clay	4.98
Titanium dioxide	2.49
Mica/water ground	2.49
Fire Retardant	
FR-28/Special sodium borate	4.57
Water	16.61
Water Emulsion	
Vinylite WC-130/Polyvinyl acetate, Balelite PVAC, 58.2% solids	13.29
Tricresyl phosphate	1.25

PH	=	7.8
Solid %	=	48.7
Density	=	10.3 lbs/gal.
Water content	=	51.3%/some dilution may be required, 1 to 5%, depending on the spray equipment used.
Latex solids on basis of dry paint	=	15.8%

Reference

Pt. Varn. Prod., November, 1961

Intumescent Fire Retardant Exterior Paint

	Pounds
Titanium dioxide	100.00
Zinc borate	292.00
Blanc fixe	148.00
Lead sulphate	168.50
Lead carbonate	168.50
Zinc oxide	95.00
Refined linseed oil	170.00
Isano oil	170.00
Chlorinated paraffin, 70%	70.00
Polyamide resin 93/General Mills, 40% solution	160.00
Cobalt naphthenate, 2%	5.50
Lead naphthenate, 8%	24.00
Manganese naphthenate, 2%	3.50
Mineral spirits	20.00

PVC = 34%
Wt./gal. = 15.9 lb
Viscosity = 98 K.U.

References

1. Pt. Varn. Prod., November, 1961
2. T.M. Murray, F. Liberti and A.O. Allen, Adv. Chem. Ser. 1953.

Intumescent Fire Retardant Interior Paint

	Pounds
Titanium dioxide	144.00
Starch	57.50
Ammonium phosphate	330.00
Aminoacetic acid	61.50
10 cps chlorinated rubber	119.00
Alkyd resin solution 50%	115.00
Hi-flash naphtha	206.00
Silicon resin solution 60%	8.20
Hi-flash naphtha	82.50

PVC = 67%
Wt./gal. = 11.2 lb
Viscosity = 112 K.U.

References

1. Pt. Varn. Prod. November, 1961
2. T.M. Murray, F. Liberti and A.O. Allen, Adv. Chem. Ser. 1953.

Intumescent Fire Retardant Paint		
	Lbs.	Gals.
Anatase titanium dioxide	100.00	3.14
Lead zinc oxide, 35%	429.00	8.85
Magnesium silicate	136.25	5.73
Precipitated calcium carbonate	181.50	8.25
Antimony trioxide	100.00	2.05
Chlorowax-70	181.50	13.29
Alkali refined linseed oil	238.00	30.85
Kettle bodied linseed oil	72.50	9.48
Japan drier	23.38	3.12
Turpentine substitute	99.40	15.24

Reference
Pt. Varn. Prod. November, 1961.

Fire Retardant Interior Flat Semi-Gloss Finish		
	Lbs.	Gals.
Rutile titanium dioxide	220.00	6.29
Barium sulphate	360.00	10.05
Magnesium silicate	115.00	4.83
Antimony oxide	100.00	2.09
Long oil alkyd of Z1-Z3 body, 60% solids	318.00	41.59
Chlorowax-70	126.00	9.16
Lead naphthenate, 24%	8.70	0.92
Cobalt naphthenate, 6%	2.00	0.25
Manganese naphthenate, 6%	1.00	0.12
Mineral spirits	163.00	24.70

Reference
Pt. Varn. Prod. November, 1961.

Fire Retardant Shingle Stain

	Lbs.	Gals.
Red iron oxide	140.00	3.26
Antimony trioxide	100.00	2.09
Barium sulphate	100.00	2.79
Asbestine	80.00	3.36
Aluminum stearate	4.00	0.40
Chlorowax-40	32.00	3.33
Chlorowax-70, 60% solids in mineral spirits	217.00	22.77
Mineral spirits	403.00	62.00

Reference
Pt. Varn. Prod. November, 1961.

Intumescent Fire Retardant Unplasticized Latex Paint

	% Solids	Dry	Wet
Water	------	-----	42.30
Monoammonium phosphate	100.00	56.00	56.00
Dicyandiamide	100.00	10.00	10.00
Pentaerythritol	100.00	22.00	22.00
Titanium dioxide rutile	100.00	12.00	12.00
Dow Latex 744-B	50.00	25.00	50.00

% Total solids = 65
% Binder solids = 20

Slurry all the ingredients together except the latex and pass through a high-speed stone mill.

Add the latex to the pigment slip with moderate agitation.

Reference
Pt. Varn. Prod. November, 1961.