Firestone
PLASTICS COMPANY

FPC
VINYL RE INS

FPC 470

FPC 470 is a versatile solution resin with ketone solubility, toluene and xylene tolerance, alkyd and extender resin compatibility and excellent adhesion. FPC 470 can be used in many new applications which were previously considered impractical for vinyl chloride resins. The usual qualities attributed to polyvinyl chloride resins are retained.

TYPICAL SOLUTION CHARACTERISTICS

Solubility: *(practical concentrations)*
Ketones (up to 45%)
Ketone (10%)/Toluene or Xylene (90%) blends
Ketone (70%)/Aliphatic (30%) blends
Ketone (70%)/Alcohol (30%) blends
Esters
Chlorinated hydrocarbons

Solution Techniques:
FPC 470 is easily dissolved by sifting the resin into the solvent under agitation. A small portion of the solvent can be held for addition after "cutting" to assure the development of high viscosity necessary for high shear during solvation. Mild heating and/or high shear agitation will reduce the mixing time. Agglomeration of resin particles must be prevented for minimum solvation time and agitation must be continued until solvation is complete. "Lacquer" type resins always show solubility and viscosity differences with variation in mixing (i.e., shear rate, time, temperature etc.). The solvent system will determine the viscosities, processing characteristics and drying schedules.

The time necessary for complete solution of the resin is usually diminished by utilizing a high shearing action mixer and/or gentle heating of the solution. The aforementioned technique is desirable in the higher per cent solids ranges.

FPC 470 solutions in methyl ethyl ketone show good aging stability up to 40% solids (wt. basis). Above this concentration solutions are possible, but viscosities show a steady increase upon aging. Solvents other than methyl ethyl ketone will show different maximum resin concentrations for stable viscosities on aging.

Formulating for "Rule 66" Solvent Regulation:
FPC 470 is well suited for compliance with solvent emission regulations. Most are based upon the original "Rule 66" enacted by Los Angeles County in July, 1966. Since these regulations limit the amount of branched ketones and aromatic diluents, vinyl solution resin formulating has become more difficult. Many of the non-restricted solvents have some deficiency in terms of cost, odor, or evaporation rate, while the non-restricted diluents are generally not very compatible with typical vinyl solution resins. FPC 470 is quite soluble in many of the weaker vinyl solvents and has a high level of tolerance for aliphatic hydrocarbons and low molecular weight alcohols which are replacing most of the usual aromatic (toluene or xylene) portion.

TYPICAL POLYMER PROPERTIES

Type ..... Vinyl chloride terpolymer
Form ..... Powder
Specific gravity 1.31
Solution bulking (gals./solid lb.) 0.091
Relative viscosity (1% in cyclohexanone) 1.35

FPC 470 is suitable for use under subpart F of the following F&DA regulations:

121-2514—Container Coatings
121-2520—Adhesives
121-2526—Paper Coatings for Aqueous or Fatty Foods
121-2550—Closures
121-2571—Paper Coatings for Dry Foods

The above reference is only to FPC 470 as supplied by the Firestone Plastics Company. All other ingredients used to further compound FPC 470 must have similar F&DA status for the composite product to meet the requirements of the regulations.

Chemicals Division, FIRESTONE PLASTICS COMPANY, Pottstown, Pa. 19464
DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY

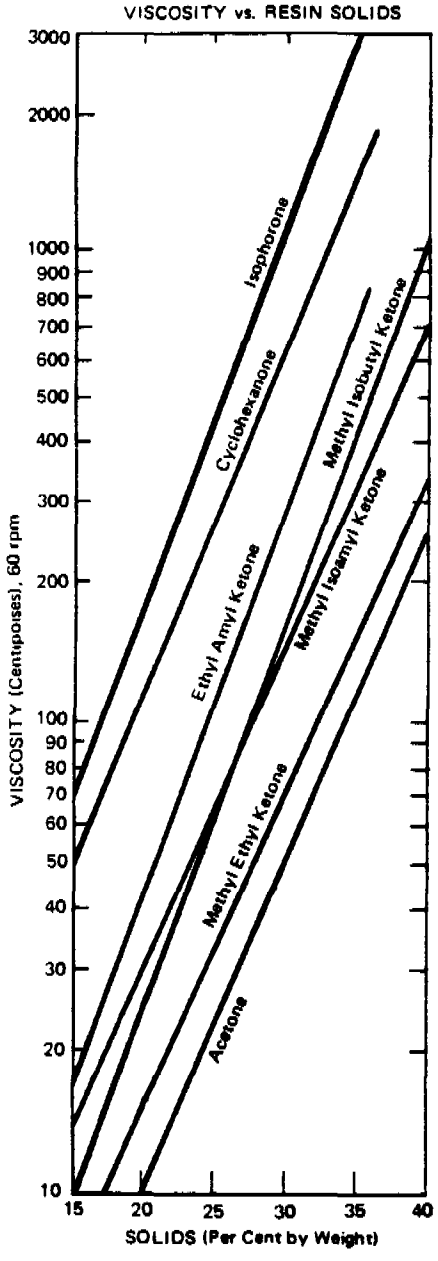
TYPICAL SOLUBILITY

The solubility data presented below are obtained from solutions made with minimum agitation at room temperature to obtain maximum viscosities. The viscosities were measured using the Brookfield Viscometer, LVF Model.

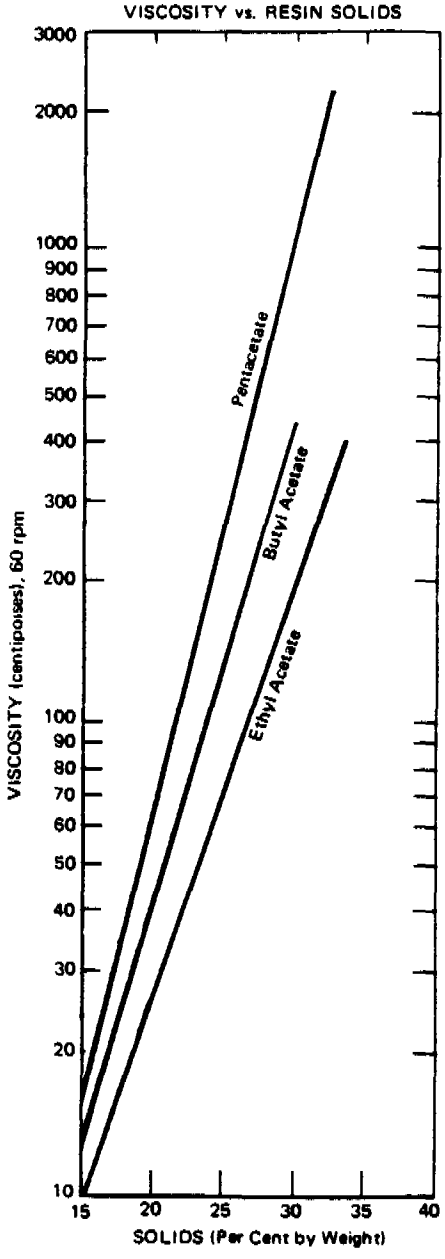
These solubility curves can be used as starting points for the development of coating formulations. They indicate typical values only and are not to be considered specifications.

Production mixing techniques sometimes fail to achieve the efficiency obtained in smaller units. It is recommended that clear solutions be filtered in order to remove unsolvated resin particles which could interfere with solution clarity and cause irregularities in the coating surface.

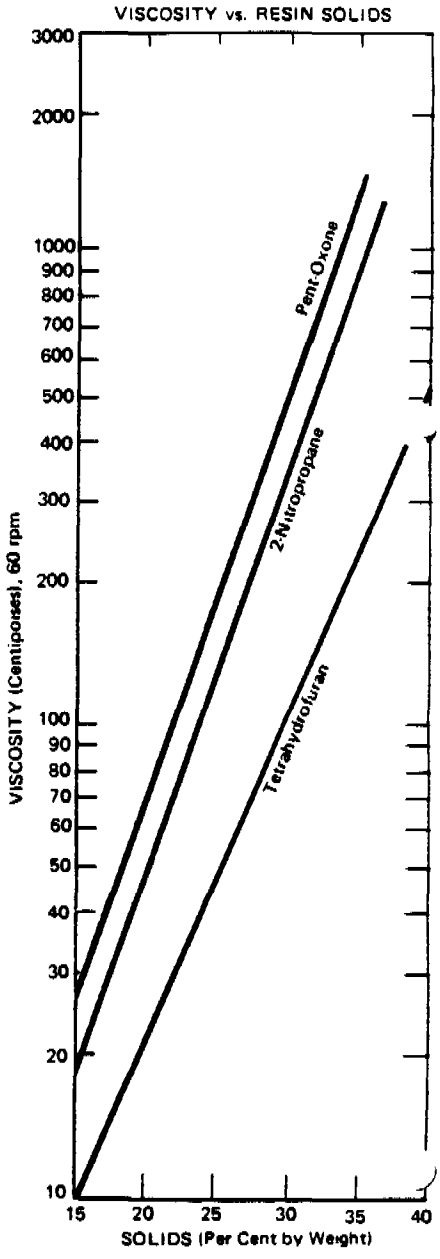
SOLUTION CHARACTERISTICS OF FPC 470 IN KETONE SOLVENTS



SOLUTION CHARACTERISTICS OF FPC 470 IN ACETATE SOLVENTS



SOLUTION CHARACTERISTICS OF FPC 470 IN SPECIAL SOLVENTS



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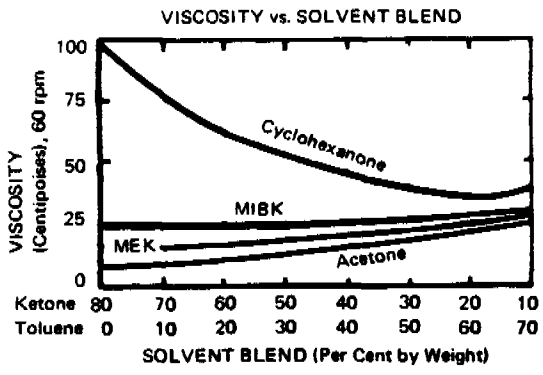
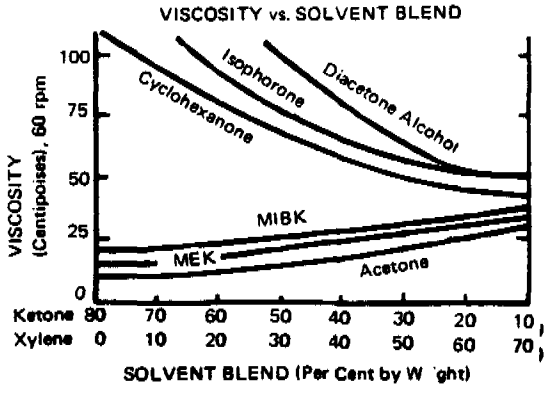
KETONE/AROMATIC SOLVENT SYSTEMS

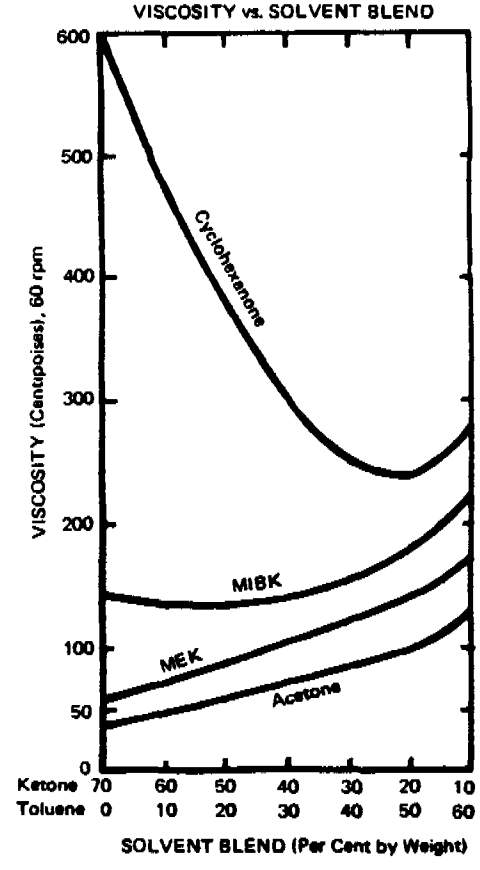
SOLUTION CHARACTERISTICS OF FPC 470 IN KETONE/TOLUENE BLENDS AT 20 PER CENT SOLIDS



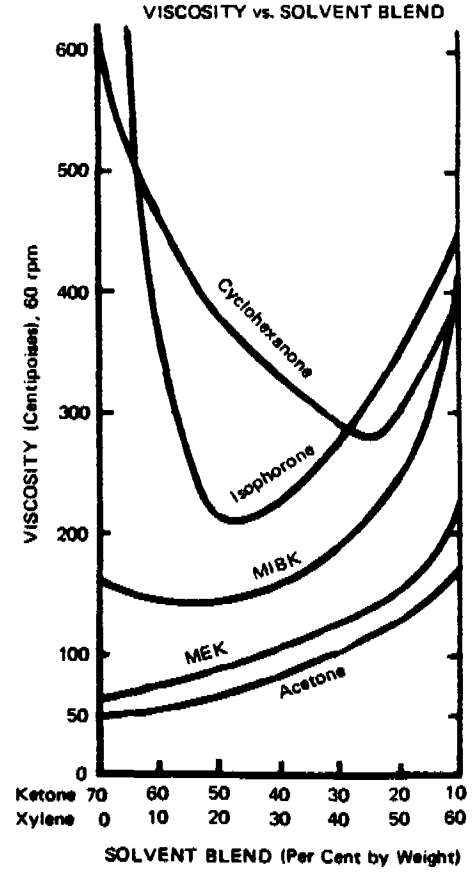
SOLUTION CHARACTERISTICS OF FPC 470 IN KETONE/XYLENE BLENDS AT 20 PER CENT SOLIDS



SOLUTION CHARACTERISTICS OF FPC 470 IN KETONE/TOLUENE BLENDS AT 30 PER CENT SOLIDS .



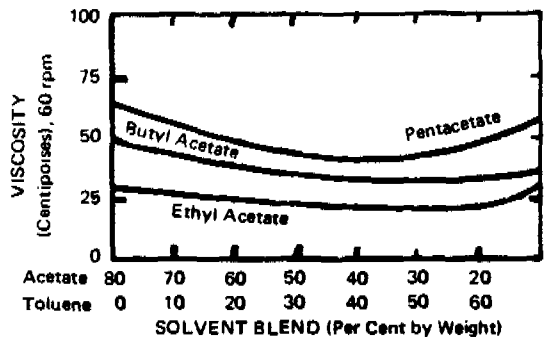
SOLUTION CHARACTERISTICS OF FPC 470 IN KETONE/XYLENE BLENDS AT 30 PER CENT SOLIDS



ACETATE/AROMATIC SOLVENT SYSTEMS

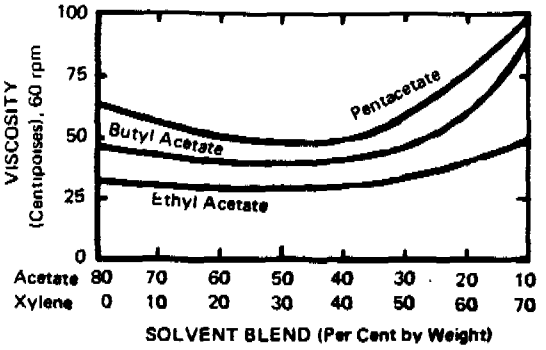
SOLUTION CHARACTERISTICS OF FPC 470 IN ACETATE/TOLUENE BLENDS AT 20 PER CENT SOLIDS

VISCOSITY vs. SOLVENT BLEND



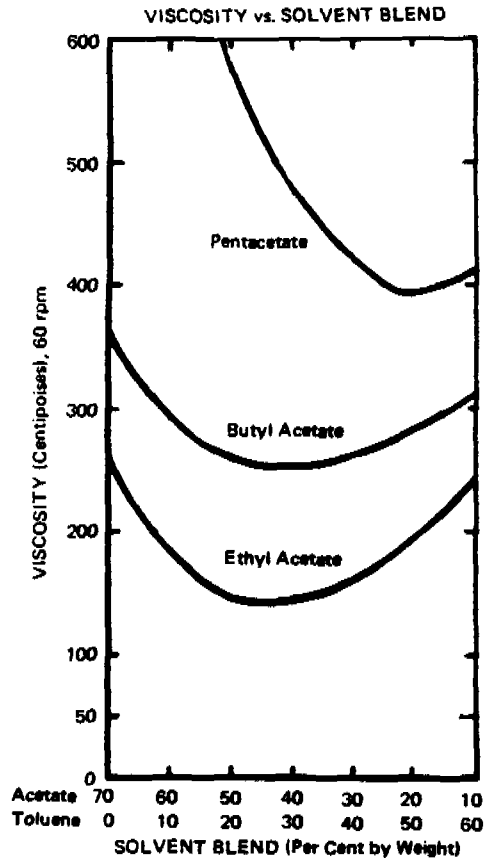
SOLUTION CHARACTERISTICS OF FPC 470 IN ACETATE/XYLENE BLENDS AT 20 PER CENT SOLIDS

VISCOSITY vs. SOLVENT BLEND



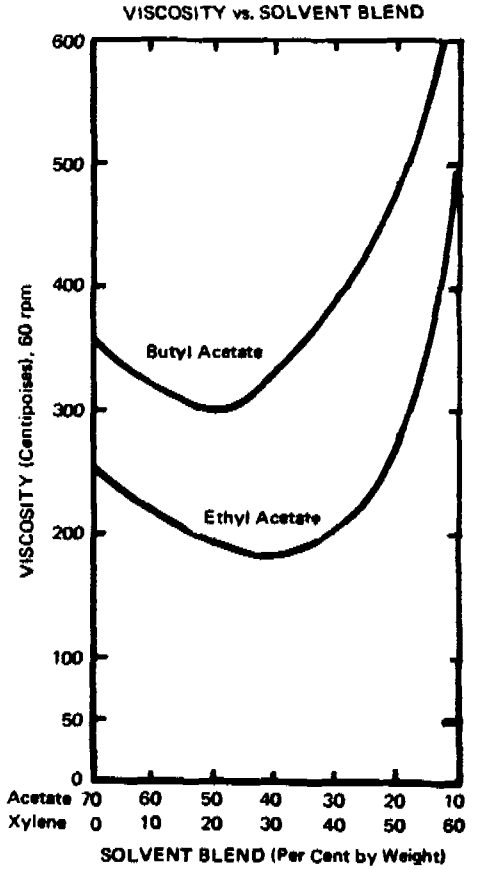
SOLUTION CHARACTERISTICS OF FPC 470 IN ACETATE/TOLUENE BLENDS AT 30 PER CENT SOLIDS

VISCOSITY vs. SOLVENT BLEND



SOLUTION CHARACTERISTICS OF FPC 470 IN ACETATE/XYLENE BLENDS AT 30 PER CENT SOLIDS

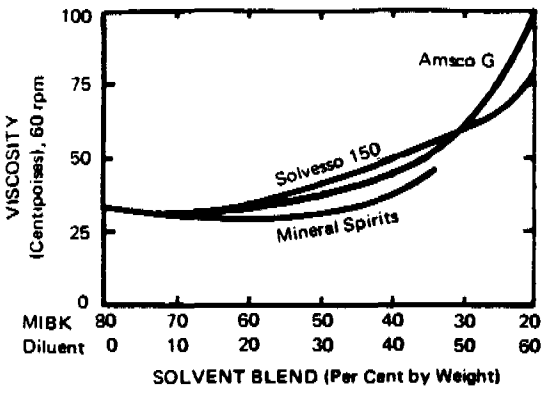
VISCOSITY vs. SOLVENT BLEND

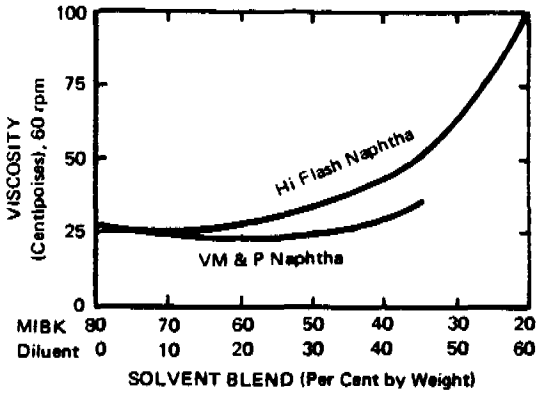


KETONE/DILUENT SOLVENT SYSTEMS

SOLUTION CHARACTERISTICS OF FPC 470 IN MIBK/DILUENT BLENDS AT 20 PER CENT SOLIDS

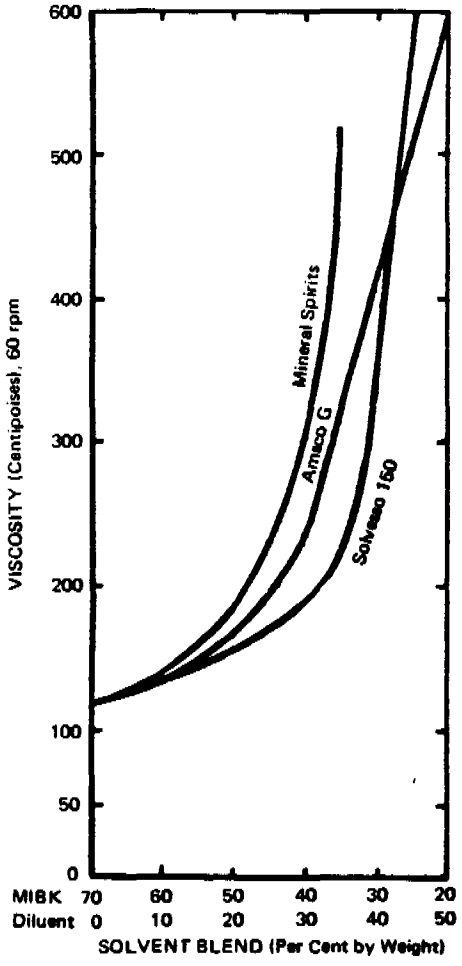
VISCOSITY vs. SOLVENT BLEND

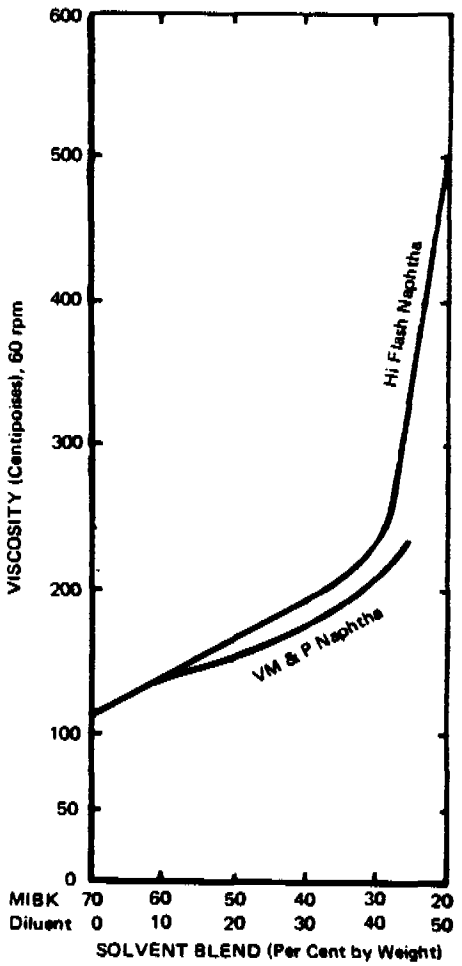




SOLUTION CHARACTERISTICS OF FPC 470 IN MIBK/DILUENT BLENDS AT 30 PER CENT SOLIDS

VISCOSITY vs. SOLVENT BLEND





COMPATIBILITY

FPC 470 exhibits solution compatibility and dry film compatibility with many conventional coating materials such as acrylics, vinyls, many alkyds, melamines, triazines, rosin derivatives, some epoxy resins, polyesters and most common vinyl plasticizers. This wide range of compatibility allows the formulation of coatings with unique combinations of properties heretofore unattainable.

Alkyds and many other varieties of resins are compatible with FPC 470. Film compatibility observations were made, using the following code:

C=good compatibility, clear and glossy films
I=incompatible

In some cases the solutions are slightly cloudy, but the dry film is clear and glossy. This is due to improved solvent balance. A 30% FPC 470 in MIBK solution was blended with the various materials. All blends were made on a weight basis and ratios shown are based on solids. FPC 470 is always shown first in the blend ratio.

Rosin Ester Resins:
Generally compatible in all proportions.
("Neolyns" supplied by Hercules Powder Company)

Cellulose Type Resins:
Not generally compatible, some limited possibilities.

Epoxy Resins:
Liquid types are generally compatible while the solid resins are generally not compatible.

Plasticization:
FPC 470, being a highly soluble resin, is affected by plasticizer more readily than less soluble vinyl solution resins. Where 10 to 20 pph plasticizer are used with the conventional vinyl resins, only 5 to 10 pph plasticizer are necessary to obtain the same flexibility with FPC 470. For good aging characteristics a combination of polymeric and monomeric plasticizers has been found to be best. FPC 470 is compatible with most conventional plasticizers; however, epoxy-stabilizer type plasticizers may cause viscosity increases and even gelation.

COMPATIBILITY WITH OTHER VINYL RESINS

FPC 470 is compatible with the following vinyl, solution type resins:

FPC 481
FPC 450
FPC 497
FPC 454
FPC 471

FPC 470 is frequently used in combination with the aforementioned resins in order to improve adhesion to metals, and various other substrates.

FPC 470/Drying Oils:

Solids Ratio	5/1	1/1	1/5
Superb Soybean	C	C	I
H. B. Snowflake Soybean	C	C	C
Alkali Ref. Fish	C	C	I
Blown Fish	C	C	C
Safflower	C	I	I
Oiticia	C	C	I
H. B. Linseed	C	C	C
Raw Linseed	C	C	I
Superb Linseed	C	C	C

(above materials supplied by ADM Chemicals)

Acrylic Polymers:
Generally compatible in all proportions.
("Acryloids" supplied by Rohm & Haas Co.)
("Elvacites" supplied by duPont)

FPC 470/Amine Curing Resins:

Solids Ratio	2/1	5/1	10/1	20/1
Uformite F-240	C	C	C	C
Uformite MM-55	I	I	I	I
Uformite MX-61	C	C	C	C

(above materials supplied by Rohm & Haas Co.

Resimene 933	I	I	I	I

(above material supplied by Monsanto Company)

Solution Stability:
FPC 470 solutions show excellent can stability on prolonged shelf storage. Propylene oxid or epichlorohydrin should be included at approximately 1% by weight of the solvent system to prevent can corrosion and/or viscosity increase after aging.

Compounding materials often contain basic metals or other acid reactive ingredients which cause high formulation viscosities. These ingredients (including epoxy-containing plasticizers) can be neutralized with 2 pph (based on the reactive ingredient) of malic, malonic, n-butyl phosphoric, or trimesic acid. The acid must be dissolved in a solvent with mild heating, prior to being added to the formulation.

FPC 470/Alkyds (and similar type resins):

SUPPLIER NO.	TYPE	PHTHALIC	OIL	VOLATILE	3/1	1/1	1/3
P 296 60	Drying	24	65% – Soya	Mineral Spirits	C	C	C
P 661 70	Drying	24	65% – Soya	Xylol	C	C	C
OP 470 70	Drying	24	65% – Soya	Od. Min. Spirits	C	I	I
P 381 70	Drying	24	65% – Linseed	Mineral Spirits	C	C	C
P 670 55	Drying	30	56% – Linseed	VM & P Naphtha	C	C	C
P 671 50	Drying	30	56% – Linseed	Mineral Spirits	I	C	C
P 322 50	Drying	30	55% – Lin/Fish	Mineral Spirits	C	C	C
1331 60 EL	Drying	31	57% – Soya	Mineral Spirits	C	C	C
P 595 60	Drying	31	57% – Soya	Mineral Spirits	C	C	C
323 50	Drying	35	53% – Soya	Mineral Spirits	I	C	C
P 750 50	Drying	35	52% – Soya	VM & P Naphtha	I	C	C
P 776 45	Drying	35	52% – Soya/Fish	Mineral Spirits	C	C	C
P 531 50	Drying	35	52% – Ch. Wo.	Mineral Spirits	C	C	C
1334 40 EL	Drying	35	52% – Linseed	Mineral Spirits	C	C	C
1307 50 EL	Drying	42	41% – Soya	Xylol	C	C	I
1313 50 EL	Drying	42	41% – Linseed	H. F. Naphtha	I	C	I
P 710 50	Drying	42	36% – Cottonseed	Xylo But.	I	C	C
1303 50	Rosin Mod.	44	34% – Soya	Xylol	C	C	C
P 450 50	Rosin Mod.	20	50% – Lin/Fish	Mineral Spirits	C	I	C
1341 60	Phen+Rosin	27	28% – Linseed	H. F. Naphtha	C	C	C
1316 50	Phenolated	18	52% – Lin Ch. Wo.	Toluol	C	C	C
P 27 50	Phenolated	40	41% – Soya	Xylol	C	C	I
P 702 65	Non-Drying	37	52% – Cottonseed	Xylol	C	C	C
4255 50	Vinyl Toluene	–	–	–	I	I	I
4250 50	Styrenated	–	–	–	I	I	I
4280 50	Acrylic	–	Semi-oxidizing	Xylol	C	C	C
1344 60	Drying	24	Soya	Mineral Spirits	C	C	I
1344 70	Drying	24	Soya	Mineral Spirits	C	C	I
		(above materials supplied by Reichhold Chemical Co.)					
Duraplex C-55	Drying	32	50% – Castor	Xylene	C	C	C
Duraplex A-27	Drying	42	37% – Cottonseed	Xylene	C	C	C
Amberlac 292	Drying	Present	– Castor	Xylene	C	C	C
Duraplex ND-78	Non-Drying	43	33% – Coconut	Xylene	C	C	C
Duraplex ND-77B	Non-Drying	47	33% – Coconut	Xylene	C	C	I
		(above materials supplied by Rohm & Haas Co.)					

Pigmentation:

FPC 470 is reactive with basic pigments, however high purity red lead can be used if handled judiciously. The following list illustrates typical FPC 470 pigment compatibility.

PIGMENT TYPE	FPC 470 COMPATIBILITY
Titanium dioxide	Compatible
Zinc	Reactive
Lead	Reactive
Lead chromate	Borderline
Talc	Compatible
Silica	Compatible
Mica	Compatible
Clay	Compatible
Asbestos	Reactive
Calcium carbonate	Borderline
Carbon black	Compatible
Iron oxide (pure)	Compatible
Cadmium	Compatible
Mercadmium	Compatible
Toluidene	Compatible
Phthalocyanine green	Borderline
Phthalocyanine blue	Borderline
Iron blue	Compatible
Molybdate	Compatible
Benzidine	Reactive
Strontium chromate	Compatible
Chromium phosphate	Compatible
Iron phosphate	Compatible

FPC 470 has adhesion for metals and many other surfaces. This adhesion characteristic is obtained through the acidic nature of the resin. The acidic condition of the resin reduces the compatibility with many pigments, especially those made with basic metals, such as zinc, lead, etc. Some apparently inert pigments contain small amounts of impurities which are basic, thus causing reactivity with FPC 470. Phthalocyanine blue is an example. This means that only the purest type pigments should be used. In some cases, the same type pigment obtained from different suppliers will show varying reactivities due to different impurity concentrations.

Where a specific reactive color pigment must be used, the reactivity can be reduced drastically with the addition of malic, malonic or n-butyl phosphoric acids. Small amounts of reactive impurities in a color pigment can be neutralized with these acids and thus reduce the viscosities of the formulation. The acid must be dissolved in an appropriate solvent, such as methyl ethyl ketone, Cellosolve, etc. The acid solution can then be added to the FPC 470 solution, even before the pigments are present. The acid should be in a concentration of 2 pph (based on the reactive impurities or the reactive pigment).

VISCOSITY STABILITY OF FPC 470 WITH ALUMINUM PIGMENTS

We have evaluated the shelf aging characteristics of various FPC 470/aluminum pigmented solutions at elevated and room temperatures. The solutions were prepared in a formulation as indicated in Table I. Storage was in metal cans.

Accelerated aging characteristics were studied at 60° C in 4 oz. jars. These data are presented also in Table I. The shear rate under consideration is 30 rpm on the Brookfield Viscometer, LVF Model (#2 Spindle).

TABLE I

FPC 470	25	25	25	25	25	25	25	25
MIBK	25	25	25	25	25	25	25	25
Toluene	49	49	49	49	49	49	49	49
Propylene Oxide	1	1	1	1	1	1	1	1
Di Phenyl Guanidine	0.2	0.2	0.1	0.2	0.5	1	0.5	1
Alcoa 209	20				10	10		
Alcoa HF-905		20						
Alcoa 1571			10				10	10
Alcoa 1593				15				
Initial 30 rpm visc.-cps	138	126	84	104	228	292	140	210
ROOM TEMPERATURE SHELF AGING – METAL CANS								
Visc.– 3 mos.-cps.	116	110	98	148	Gelled	Gelled	414	258
6 mos.-cps.	122	112	110	196			840	396
9 mos.-cps.	156	138	136	302			3400	Gelled
12 mos.-cps.	156	140	144	474			Gelled	
ACCELERATED AGING VISCOSITY, 60° C., 4 OZ. GLASS JARS								
Visc.–1 wk.-cps.	108	124	100	180				
2 wks.-cps.	940	Gel	Gel	Gel				
3 wks.-cps.	Gel							

Driers:
Driers, being basic metals, are often subject to reactivity with the carboxyl acid of FPC 470. Alkyds containing driers should be observed carefully to be sure the apparent incompatibility is not due to the drier instead of the alkyd. Exkin #2 (Nuodex Co.) has been found effective in controlling drier reactivity. Additional information is available on request.

FILM PROPERTIES

Transparent
Air drying–thermoplastic
Adhesion to metal
Adhesion to porous substrates
Adhesion to alkyd surfaces
Chemical resistant
Heat and light stable
Abrasion resistant
Weather resistant

Adhesion:
FPC 470 coatings have good adhesion to metal, vinyl and alkyd type surfaces. This allows FPC 470 to be used as a top coat over old paint surfaces, vinyl compounds such as floor coverings, "wash primer," and conventional alkyd type primers. A proper solvent balance will eliminate "lifting" of the alkyd substrate, thus permitting formulation of a variety of protective coatings for the maintenance and industrial field.

Stability:
FPC 470 coatings show a distinct improvement in weatherability over conventional vinyl chloride solution resins. Exterior coatings should be pigmented for optimum results.

FPC 470 coatings are transparent even though the solution may be slightly cloudy or amber in some solvents. Films of FPC 470 show only slight yellowing on glass at 180°C. for 1 hour in a forced air oven. All vinyl chloride polymers are subject to the catalytic action of iron which promotes resin degradation. One very effective stabiliztion system which can be used to control catalytic degradation includes 10 pph epoxy type plasticizer and 1 pph liquid tin. The epoxy cannot be used alone (see "Compatibility").

A wash primer base coat forms an excellent insulating barrier between steel and FPC 470 coatings. FPC 470 has excellent adhesion to wash primer.

Chemical Resistance:
The chemical resistance of FPC 470 is typical of polyvinyl chloride solution resins; however, being acidic in nature, this resin exhibits caustic reactivity. For chemical resistance, a top coat of FPC 471 or FPC 450 should be used.

An example of a multi-resin solution resin coating system is shown below. This coating system is a "Heavy Duty" air drying type. This system has been in service in the Firestone Plastics Company's Pottstown Plant in air conditioning units for over five years. These units have large metal pans which contain constantly circulating water. The coating system must be 5 mils (minimum) thick. The durability will be increased in direct proportion to the increased thickness.

The following formulations show basic solution resin systems, Pigmentation, plasticization and stabilization have not been included, due to the many variations required by specific applications.

TOP COAT	Parts by Weight
FPC 450	18
Toluene	25
MEK	57

This higher viscosity coating must be applied by spray (pressure) over the following "Intermediate/Prime Coat" system. Thickness of 5 to 50 mils can be obtained to meet the specific exposure conditions. Adequate air drying must be allowed, especially in the case of thick coats. Pigments, plasticizers and stabilizers must be selected for the specific exposure conditions.

INTERMEDIATE COAT	Parts by Weight
FPC 450 Top coat (above)	85
Prime Coat (below)	100

FPC 470 and FPC 450 coatings are blended to increase the solvent resistance and allow the application of the top coat. Where only minimum adhesion is required, this intermediate coat may be used as the prime coat.

PRIME COAT	Parts by Weight
FPC 470	25
MIBK	25
Xylene	49
Propylene Oxide	1

This system will find its best applications where the most important requirements are:

Weathering
Continuous water immersion
Chemical immersions
Fume exposures
Excessive abrasion resistance
Flexibility to resist cracking and tearing under vibration and bending.

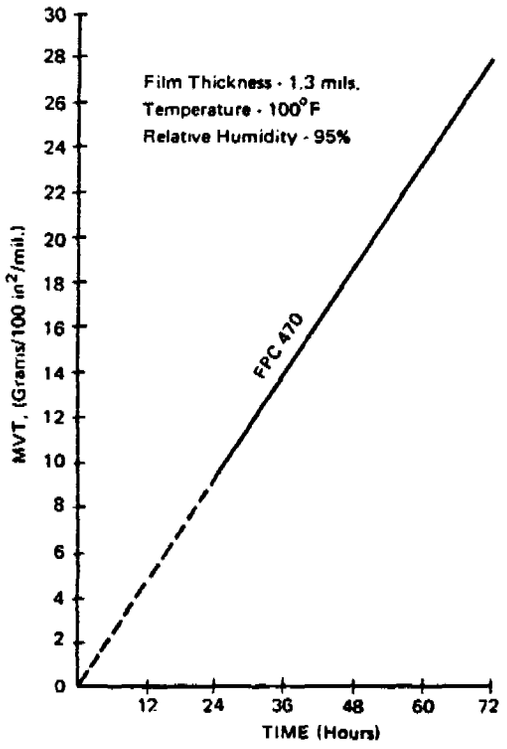
It should be remembered that in some cases a coating will transmit a gas which has a corrosive effect on the metal substrate, while having no effect on the coating itself. This phenomenon is dependent on gas transmission and should not be interpreted as a coating failure.

EVALUATION FORMULATION
The following solution can be made quickly and used "as is," or as a base to which pigments, plasticizers etc. may be added. It is used as one of our quality control solutions for FPC 470.

	Parts by Weight
FPC 470	25
MIBK	25
Aromatic (Toluene or Xylene)	49
Propylene Oxide	1

FPC 470 coatings will adhere to most surfaces such as metal, wood and even old paint. Conventional top coat type pigments can be used in the primer with good results. Strontium Chromate is the only "basic" primer pigment which can be used with "acidic" FPC 470, if reactivity is to be avoided.

MOISTURE VAPOR TRANSMISSION vs. TIME



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