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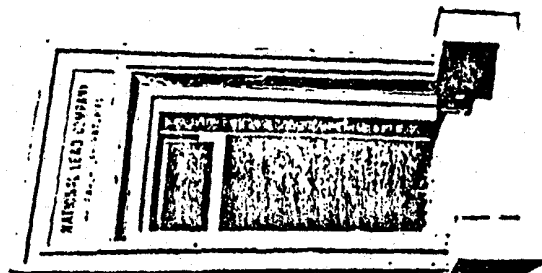
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Dutch Boy

Handbook on

STABILIZERS for VINYL RESINS



NATIONAL LEAD COMPANY

7-57-52

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Vinyl Stabilizers

During the past decade, the
the industry consuming vinyl has
phenomenal expansion. This has
materials and techniques for stabil-
of heat and light. Such effects, if
and physical properties sufficient
applications.

At the time of the publication
FOR VINYL STABILIZERS
"empirical art" rather than a true
of general improvements in the res,
the vinyl plastic industry. These
recognized need for plastic quality
and the application of vinyl plastic
indicated, have brought about a large
products. In the ten year period
in the production and consumption

Improvements in stabilizers are
some growth of the industry. We are
The first two editions of the "DU"
use of lead compounds. The present
a section on non-lead "DUTCH"
ization is not indicated, such as in

General formulations are given
practically every type of vinyl pro-
ducts 10 years of active field and la-
borative evaluation program of accu-
rate weathering program.
plasticizers and stabilizers from all
modern plastics research and devel-
Company has available complete
"DUTCH BOY" vinyl stabilizers
inquiries to our nearest branch or
be glad to call and discuss individ-

Stabilizers, J. C. and W. H. F. L. and F. C. C.
Stabilizers, J. C. and W. H. F. L. and F. C. C.
Stabilizers, J. C. and W. H. F. L. and F. C. C.

Lead Stabilizers
DYPHOS®
DITHAL®
DS-20®
LEADSTAR
LECTRO "W"
NORMASAL®
PLUSIBO-SIL® B
PLUSIBO-SIL® C
TRIBASE
TRIBASE-X

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FOREWORD

During the past decade, the plastics industry has grown rapidly. That part of the industry consuming vinyl chloride polymers and copolymers has reflected this phenomenal expansion. This has been due in no small measure to the development of materials and techniques for stabilization of vinyl plastics against the harmful effects of heat and light. Such effects, if not counteracted, would promote changes in color and physical properties sufficient to prevent use of vinyl plastics in many desirable applications.

At the time of the publication of our original "DUTCH BOY HANDBOOK FOR VINYL STABILIZERS" in 1949, stabilization was still more or less an "empirical art" rather than a true chemical science. This is no longer the case, because of general improvements in the resins, plasticizers, colorants and stabilizers available to the vinyl plastic industry. These improvements in raw materials coupled with the recognized need for plastic quality commensurate to the times, better compounding, and the application of vinyl plastics only in end-uses where this type of resin is indicated, have brought about a large increase in the production and sales of vinyl resin products. In the ten year period from 1945 to 1955, there has been a four-fold increase in the production and consumption of vinyl chloride resins.

Improvement in stabilizers and stabilizer techniques has kept pace with the volume growth of the industry. We are proud to have played a part in these advancements. The first two editions of the "DUTCH BOY" Stabilizer Handbook emphasized the use of lead compounds. The present edition has been increased in scope, and includes a section on non-lead "DUTCH BOY" stabilizers for applications where lead stabilization is not indicated, such as in clear or highly translucent stocks.

General formulations are given for a wide variety of end applications including practically every type of vinyl product. This expansion of the present handbook reflects 10 years of active field and laboratory experience, and is backed by a most extensive out-of-door weathering program.* This test program involves the evaluation of resins, plasticizers and stabilizers from all available world sources, kept current in a new and modern plastics research and development laboratory. In addition, the National Lead Company has available complete technical service laboratories, for the application of "DUTCH BOY" vinyl stabilizers and other chemicals in the plastics industry. Your inquiries to our nearest branch office are invited, and technical representations will be glad to call and discuss individual problems in detail.

*Hendricks, J. G. and White, F. L., *Ind. Eng. Chem.*, 48, 200 (1956).
Hendricks, J. G. and White, F. L., *Res. and Dev. Products*, 22, 600 (1957).
Hendricks, J. G., *Plastics Technology*, 1, No. 1, 10 (March 1958).

Lead Stabilizers

DYPHOS®
DYTHAL®
D6-35®
LEADSTAR
LECTRO "66"
NORMASAL®
PLUMBO-SIL® B
PLUMBO-SIL® C
TRIBASE
TRIBASE-E

Non-Lead Stabilizers

CALSTAR
CLARITE A
CLARITE B
CS-117
FLOMAX 25
MALZIN
PROVINITE A
PROVINITE B

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I. INTRODUCTION

Vinyl chloride was polymerized into resin by Repank in 1838. However, the commercial development of this resin in the United States did not start for nearly one hundred years. Until 1939, when the industry produced 1.2 million pounds, there was no appreciable volume used. During World War II, the need sprang up for an elastomeric synthetic with good sheeting characteristics and desirable extrudability. Vinyl chloride plastics filled this need admirably, and their use in raincoats, ground cloths, packaging, insulation, tubing, metal coating, and a multitude of similar products important to the armed forces, brought about a hundred-fold growth in the industry between 1940 and 1945.

In 1947, the first genuine post-war year, a rapidly expanding consumer market utilized 150 million pounds of vinyl plastics. The year 1948 brought a further expansion to over 215 million pounds. The present rate of increase indicates an output of between 700 million and 1 billion pounds by 1960.

This rapid expansion may be attributed primarily to the versatility of the thermoplastic vinyl chloride type resins. Modification of the vinyl resins through the use of chemical plasticizers, colorants, and fillers has offered a variety of rigid, semi-rigid and flexible products.

In addition to floor coverings and unbreakable records, uses for flexible plasticized vinyl compounds have been found in belting, upholstery, shoe uppers, luggage, packaging, protective sheets, raincoats, shower curtains, umbrellas, window curtains, garment bags, electrical tapes, electrical insulation, tubing and hose and many other varied products.

The wide range of usefulness makes apparent the necessity of maintaining the original physical properties required for the particular final application. There must be no discoloration or deterioration during the heat processing cycle, shelf life and ultimate consumer use.

This involves the employment of a diversity of raw materials to fulfill specific functions. Certain plasticizers give low temperature flexibility, non-inflammability, "drape," non-migration characteristics, resistance to lacquer hit and any number of further chemical and physical properties. Colorants, fillers and lubricants have been developed which will withstand a variety of processing and service conditions. The multitude of end uses has actually intensified the search for satisfactory component raw materials with which to modify the original vinyl chloride polymer. Even the polymers themselves have been modified by molecular weight variations, and by copolymerization with other materials.

To meet these many and varied present day requirements, a line of "DUTCH BOY" vinyl stabilizers has been developed. These "DUTCH BOY" products not only protect the resins themselves against degradation, but at the same time offer no interference with the other components of a particular vinyl plastic system.

"DUTCH BOY" vinyl stabilizers are also of interest in connection with polyvinylidene chloride, a close relative of the regular vinyl chloride type resins. These stabilizers have considerably improved the light and heat sensitivity of this resin.

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Federal and state safety authorities have become increasingly concerned in recent years over the necessity of flameproofing protective and decorative coatings, plastics and other articles used in places of public gathering. This has accelerated the development and application of the chlorinated paraffins of 40% to 70% chlorine content now produced by a number of manufacturers. Here again, "DUTCH BOY" stabilizers and their methods of application have played an important role.

As an added example, chlorinated styrene and chlorinated polyethylene seem to have useful possibilities and may require additional materials to give them heat and light stability. National Lead Company's research chemists are constantly at work along development lines, not only with the products covered in this Handbook but with stabilizers and chemical compounds for other chlorinated materials.

As heretofore indicating the useful life of a varnish or paint is one of its uses in many other cases whereby such compositions in order to intelligently analyze resin compositions. For vinyl materials herein treat designation includes the polyide with a lesser proportion vinyl acetate, vinylidene chloride.

X-ray studies and chemical analysis to be:

A. HEAT DEGRADATION

It is known that heat upward will produce a very yellow color, which quickly brown which may ultimately chloride during this reaction most part, from removal of carbon yielding the following:

Investigative work on this has confirmed the results. The characteristic light absorption curves are indicated and shown. The determination of absorption must show the shift of

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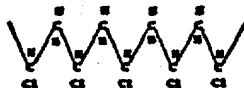
authorities have become increasingly concerned in recent years of public gathering. This has accelerated the development of chlorinated paraffins of 40% to 70% chlorine content of manufacturers. Here again, "DUTCH BOY" stabilization have played an important role.

chlorinated styrene and chlorinated polyethylene seem to may require additional materials to give them heat and id Company's research chemists are constantly at work only with the products covered in this Handbook but compounds for other chlorinated materials.

B. CHEMISTRY OF STABILIZATION

As heretofore indicated, the deleterious action of heat and light encountered during the useful life of a vinyl plastic product promotes changes in color and physical characteristics of the unstabilized vinyl composition which are sufficient to prohibit its use in many otherwise wholly desirable applications. The modes of chemical action whereby such compositions are degraded or may be stabilized must be considered in order to intelligently attack the problem of correctly formulating stable vinyl chloride resin compositions. For present purposes, it will be sufficient to define the resinous vinyl materials herein treated as polyvinyl chloride, with the understanding that this designation includes the polymer of vinyl chloride and the copolymers of vinyl chloride with a lesser proportion of some other vinyl functional unsaturated compound, i.e., vinyl acetate, vinylidene chloride, ethyl maleate, ethyl fumarate, etc.

X-ray studies and chemical analysis have demonstrated the structure of polyvinyl chloride to be:



6 darker red bands. From this it may be seen that longer heat treatment of polyvinyl chloride resin produces additional degradation and results in the formation of more numerous and longer polyene structures within the degraded polymer. (See Figure 1.)

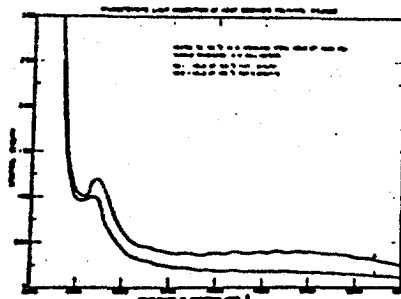


FIGURE 1

On this basis, it may be hypothesized that the simplest form of heat degradation of polyvinyl chloride proceeds through the splitting out, at random, of a hydrogen chloride unit, following which internal excitation from this initial unsaturated position tends to promote stepwise removal of additional hydrogen chloride units down the polymer chain. The presence of the hydrogen chloride released appears to favor conjugation. The resulting overall reaction gives rise to the formation of the color bearing polyene systems.

Actually the degradation mechanism is not so clear cut, and another sort of reaction is taking place simultaneously. The light absorption characteristics of heat degraded polyvinyl chloride show a strong peak at 2730 Å which is indicative of the presence of carbonyl groups. Comparison of these data with light data on known carbonyl unsaturated compounds has shown a great deal of similarity. These carbonyl containing systems can very readily form by oxidation of unsaturated structures produced during the primary dehydrochlorination degradation reaction. The possibility of such oxidative reactions is quite likely at the temperatures and pressures involved in commercial processing practices. The action of a number of materials generally harmful to polyvinyl chloride may also be explained through the concept of an auto-catalytic oxidation mechanism. Such materials include the higher valence compounds of iron, tin, cadmium, and other metals. The oxidation products may result in carbonyl structures which definitely contribute to the intensity of apparent color. Oxidation also will promote chain scission and cross linking.

The question of whether or not hydrogen chloride itself acts as an oxidation catalyst under purely thermal conditions was recently investigated in the National Lead Laboratories.⁶ These studies showed reasonably well that hydrogen chloride catalyzes the dehydrochlorination mechanism under strong heat conditions, but that it does not affect the oxidation reaction to a measurable extent.

In summary, it is felt that heat degradation of vinyl chloride type resins occurs through a dual mechanism of dehydrochlorination and oxidation. Under normal processing conditions, the former reaction (loss of hydrogen chloride) predominates because of the high temperatures involved.

cause of the driving force occurs as a secondary reaction. Under extreme catalytic action with the ultimate

B. LIGHT DEGRADATION

Polyvinyl chloride plastic and fabrication, and consequently when the finished sample within the ultra-violet range re-energize the polymer chain chlorination. Since ultra-violet degradation is probably producing additional polyene oxidation. In addition, hydrolysis of the double bonds under vinyl chloride type plastics is more typical of oxidation.

In this manner, the difference is evidenced. The dual mechanism of degradation. The degradation. As a result, oxidation and oxidation, will ever, good heat and light deviation from theory is between stabilizer and plastic and specific recommendations. For this reason, there can material may meet all the

C. REQUIREMENTS OF

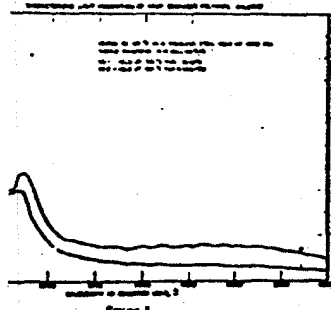
From a consideration of degradation of polyvinyl chloride, the requirements of an "ideal stabilizer" are:

- (1) Since the hydrogen chloride given evidence of degradation, it is not effectively so possible that this chemical is necessary to or ionizable and produces, and lead to lead compound in acceptor. While acceptors from the where lead compounds, for example, there are not all

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this it may be seen that longer heat treatment of polyvinyl chloride results in the formation of more conjugated structures within the degraded polymer. (See Figure 1.)



be hypothesized that the simplest form of heat degradation proceeds through the splitting out, at random, of a hydrogen which internal excitation from this initial unsaturated positive removal of additional hydrogen chloride with down removal of the hydrogen chloride released appears to favor overall reaction gives rise to the formation of the color

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that heat degradation of vinyl chloride type resins occurs of dehydrochlorination and oxidation. Under normal processing reaction (loss of hydrogen chloride) predominates (B. H. P. W., *Plastics*, 30, No. 6, 1949, 1950).

cause of the driving force of the heat energy put into the polymer, and oxidation occurs as a secondary reaction attacking the unsaturation developed in the polymer. Under extreme catalytic conditions, the oxidation may become the primary degradation action with the ultimate result of actual combustion.

B. LIGHT DEGRADATION

Polyvinyl chloride plastics are subjected to considerable heat during processing and fabrication, and consequently some measure of polymer unsaturation may be present when the finished compound is exposed to light. Such polymer systems absorb light within the ultra-violet range. The energy resulting from this absorption will act to re-energize the polymer chain and promote both oxidative degradation and dehydrochlorination. Since ultra-violet light is an oxidation catalyst, the oxidative type of degradation is probably predominant during the light aging life of the vinyl compound. Further split-out of hydrogen chloride will proceed to a somewhat lesser degree producing additional polymer unsaturation and increasing the possibility of even more oxidation. In addition, hydrogen chloride itself definitely catalyzes oxidative attack on the double bonds under exposure to ultra-violet light. Primary light failure of vinyl chloride type plastics will evidence itself more through embrittlement and tackiness typical of oxidation, with increased color formation as a secondary failure.

In this manner, the difference between light and heat induced degradation may be evidenced. The dual mechanism of oxidation and hydrogen chloride loss occurs in both types of degradation. The essential differences are in degree rather than type of degradation. As a result, the compound heat-stabilized against both dehydrochlorination and oxidation, will also be resistant to light and vice versa. In practice, however, good heat and light stability may not always be in parallel evidence. This deviation from theory is generally due to the interference of side reactions set up between stabilizer and plasticizer, colorant or filler. These reactions are under study and specific recommendations for various cases are made elsewhere in this manual. For this reason, there cannot be a universal stabilizer, no matter how well any one material may meet all the theoretical requirements for the ultimate in stabilization.

C. REQUIREMENTS OF AN IDEAL STABILIZER

From a consideration of the basic chemical reactions involved in heat and light degradation of polyvinyl chloride type resins, it is possible to postulate the requirements of an "ideal stabilizer" material, or combination of materials.

- (1) Since the hydrogen chloride released in the dehydrochlorination reaction has given evidence of possessing the auto-catalytic nature of the ultimate degradation, it is necessary to remove or chemically combine this material as effectively as possible. Where electrical properties are required, it is essential that this chemical combination not result in an electrolytic conductor, and it is necessary to combine the hydrogen chloride into an insoluble and non-ionizable product. Of all the metals known, only silver, mercurous mercury, and lead form insoluble chlorides. As a result, some form of reactive lead compound is the most suitable practical source of "hydrogen chloride acceptor." While lead compounds are the most suitable hydrogen chloride acceptors from the standpoint of chloride insolubility, there are some instances where lead compounds are not indicated, and other metal compounds, for example, those of boron, cadmium, tin and sodium are more desirable. There are still other applications where combinations of the above materials

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and wholly organic compounds, such as epoxides, act satisfactorily as hydrogen chloride acceptors.

(2) Since dehydrochlorination results in the formation of repeating unsaturation which acts to internally excite further hydrogen chloride evolution and the creation of more intense color bodies, it is desirable to modify these polyene structures by the use of a suitable "reactive molecule." It has been suggested that materials such as esters of maleic and acrylic acid may stabilize vinyl chloride type polymers by undergoing a modified Diels-Alder reaction with the heat-produced unsaturation. Such action would act to destroy the continuity of the conjugated unsaturated color producing systems and inhibit color formation. The break-up of these polyene groupings could reduce the possibility of extended internal excitation and generally inhibit the overall dehydrochlorination degradation process. Conceivably, such compounds as, for example, alkylated tin salts, tribasic lead maleate, dibasic lead phthalate, and dibasic lead phosphite, might exhibit properties and give such a "reactive molecule" stabilizing effect.

(3) Recent developments have indicated the great importance of oxidation as a factor in the degradation mechanism of polyvinyl chloride type plastics. This oxidation exhibits itself in the formation of color-bearing carbonyl structures in the degraded polymer, in the promotion of scission and cross-polymerization of the resin chains, and in the destruction of the plasticizer portion of the compounded vinyl plastic. Degradation of the plasticizer promotes brittleness and loss of plasticity, and may result in formation of oxidation products which detrimentally affect the degradation characteristics of the resin system. Oxidation, as demonstrated in the previous portions of this discussion, is a definite factor in both the heat and light stability patterns of the vinyl compound. As a result, the use of a suitable antioxidant will often be the determining factor between good stability and excellent stability in a particular vinyl compound. The concept of using antioxidants is not new to the vinyl chemist, but there have been no entirely satisfactory antioxidants available. Most typical antioxidants are organic in nature and exhibit poor heat and light sensitivity in their own right, and often, in obtaining effective antioxidant action will shift into molecular forms which are strong chromophores, exhibiting color to a greater extent than the degraded vinyl system itself. Several lead salts, e.g., normal lead salicylate (NORMSAL), and dibasic lead phosphite (DYPHOS), and a number of organic phosphites and phenols possess properties that make them ideally suited as "antioxidants" for vinyls.

(4) Since exposure to light most generally occurs in the ultimate use of a polyvinyl chloride type plastic, the action of ultra-violet light in catalyzing the degradation of both resin and plasticizer must be effectively revised. It is most desirable to "screen out the ultra-violet light" by use of agents ranging from complex opacifiers which transmit little or no light (e.g., carbon black, titanium pigments) to complex organic compounds which absorb a portion of the ultra-violet band of incident light (e.g., phenyl salicylate and lead salicylate). In addition, the basic metallic oxides, such as dibasic lead stearate (LBS-207), appear to inhibit the effects of ultra-violet light in a manner not as yet determined.

The "four elements" of this postulated "ideal stabilization system" may be briefly summarized as:

1. Hydrogen chloride acceptor
2. Reactive difunctional molecule
3. Antioxidant
4. Ultra-violet light screen

III. APPLICATION

A. STABILIZER REACTION

The group of "DUCTO" has been found to have specific action either alone or in combination. Since all of these materials are "acid acceptors," and the vinyl compounds. Actually, lead as an "acid acceptor," acceptance, and various of a desirable stabilizer come light and color stable and

Basic lead carbonate is lead carbonate may be 85% but only 28-31% is PbO beyond this available "going." From this, it is then, reactive and safe PbO content. In the case of best only 28-31% safe PbO. The proper stabilizer for a vinyl is limited because of the chemical study of the chemical case the total, reactive, and

Electrical properties and dielectric materials is a prime example of a stabilization mechanism during processing and aging. Lead is the only economic For this purpose "DUCTO-66", TRIBASE-K and L

B. PLASTICIZER-STABILIZER

A stabilizer may vary the polymer, but in so doing plasticity or severe color to the average vinyl application. It is, therefore, necessary a desirable stabilizing effect interaction so as to have a degree of directing or modifying the plasticizer.

Stabilizer may be defined as the agent that causes stability in an otherwise unstable system, such as a polymer, by preventing or delaying the

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compounds, such as epoxides, act satisfactorily as hydrogenation reagents in the formation of repeating unsaturation allylic excise further hydrogen chloride split-out and the more color bodies, it is desirable to modify these polymers of a suitable "reactive molecule." It has been suggested as esters of maleic and acetic acid may stabilize vinyls by undergoing a modified Diels-Alder reaction with unsaturation. Such action would act to destroy the conjugated unsaturated carbon producing systems and inhibit a break-up of these polyene groupings could reduce the led internal excitation and generally inhibit the overall degradation process. Conceivably, such compounds as lead tin salts, tribasic lead maleate, dibasic lead phthalate, uphite, might exhibit properties and give such a "reactive" effects.

As have indicated the great importance of oxidation as a main mechanism of polyvinyl chloride type plastics. This itself in the formation of color-bearing carbonyl structural polymer, in the promotion of scission and cross-polymer chains, and in the destruction of the plasticizer emulsified vinyl plastic. Degradation of the plasticizer produces loss of plasticity, and may result in formation of oxidized, detrimentally affect the degradation characteristics of the plastic, as demonstrated in the previous portions of this article factor in both the heat and light stability pattern of the plastic.

As a result, the use of a suitable antioxidant will often factor between good stability and excellent stability in a polymer. The concept of using antioxidants is not new to us, there have been no entirely satisfactory antioxidants. Inorganic antioxidants are organic in nature and exhibit poor activity in their own right, and often, in obtaining effective antioxidant shift into molecular forms which are strong chemically to a greater extent than the degraded vinyl system alone, e.g., normal lead stearate (NORMASAL) and zinc (DYPHOS), and a number of organic phosphorus compounds that make them ideally suited as "antioxidants."

It must generally occur in the ultimate use of a poly-
 plastic, the action of ultra-violet light in catalyzing the
 resin and plasticizer must be effectively resisted. It is
 even so the ultra-violet light by use of agents ranging
 from which transmit little or no light (e.g., carbon blacks,
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 and of incident light (e.g., phenyl collectors and hard salts,
 the basic metallic soaps, such as dibasic lead stearate
 to inhibit the effects of ultra-violet light in a manner and

if this postulated "ideal stabilizer system" may be briefly

3. Antioxidant
4. Ultraviolet light screen

HL APPLICATION OF "DUTCH BOY" LEAD STABILIZERS

A. STABILIZED REACTIVITY

The group of "DUTCH BOY" lead stabilizers described in this section have each been found to have specific chemical and physical properties that make them useful, either alone or in combination, for one or more of the varied vinyl plastic applications. Since all of these materials are lead salts, they meet the basic requirement of being an "acid acceptor," and therefore contribute to the ultimate heat and light stability in vinyl compounds. Actually, litharge (PbO) would be the most efficient form of using lead as an "acid acceptor," but the nature of vinyl stabilization goes beyond mere acid acceptance, and various other chemical and physical actions must be incorporated into a desirable stabilizer compound or combination. It must be noted that litharge is not light and color stable and may be used only in certain black pigmented compounds.

Basic lead carbonate has long been an important paint pigment. Chemically, basic lead carbonate may be represented as $2\text{PbCO}_3 \cdot \text{Pb(OH)}_2$. The total PbO content is 85% but only 28-31% is in the available basic portion of the molecule. Reaction of PbO beyond this available 28-31% will evolve CO₂ and give the phenomenon of "gassing." From this, it may be seen that in a lead stabilizer there are two considerations, reactive and safe PbO content, which are, of course, both related to the total PbO content. In the case of basic lead carbonate there is 85% total and reactive PbO, but only 28-31% safe PbO. These considerations should be kept in mind in choosing the proper stabilizer for a vinyl compound. In many cases, the total reactive fillers must be limited because of the chemical nature of the plasticizer, colorants, and fillers used. A study of the chemical compositions of "D17C11 B03" lead stabilizers will indicate the total, reactive, and safe PbO in each of these materials.

Electrical properties are of prime importance for the many kinds of insulation and dielectric materials in which vinyl chloride resins are used. Such applications are a prime example of a situation where the lead stabilizer is most necessary. The stabilization mechanism proceeds by reaction with the hydrogen chloride released during processing and aging, and must result in an insoluble, non-miscible material. Lead is the only commercial material which forms an insoluble, non-miscible chloride. For this purpose "DUTCH BOV" TRIBASE, DYTICAL, DYPHOS, LECTRO "50", TRIBASE-E and US-207 have been found exceptionally desirable.

2. PLASTICIZER-STABILIZER INTERACTIONS

A stabilizer may very unsatisfactorily impact good heat and light sensitivity into the polymer, but in no doing, may react with the plasticizer and give rise to loss of plasticity or severe color formation or both. At the temperatures of processing used for the average vinyl applications, plasticizer-stabilizer-resin interaction is almost inevitable. It is, therefore, necessary to form reaction products which are non-colored and possess desirable stabilizing effect. In some cases, it is desirable to keep stabilizer-plasticizer interactions to an low a degree as possible. Some stabilizers may be added for the purpose of directing or modifying this plasticizer-stabilizer interaction (actually stabilizing the plasticizer).

*Fleming may be defined as the total radiation from the photo component of a photon or multi component substance. This action results in an energy perturbation within and a photon energy transfer is generally caused by disturbance of the system with light, cathode rays, x-rays, etc., excitation of excited electrons, rapid spin-outs of hydrogen atoms, or movement of soluble elements and substances, etc.

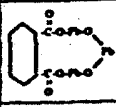
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TABLE OF PROPERTIES OF

PRODUCT	OTHERS	SYTHAL	DA-SOT	LEAD-TAR
COMPOSITION	Dibasic Lead Phosphate	Dibasic Lead Phthalate	Dibasic Lead Succinate	Normal Lead Succinate
FORMULA	$\text{PbO} \cdot \text{PbO} \cdot \text{P}_2\text{O}_5 \cdot 11\text{H}_2\text{O}$		$\text{PbO} \cdot \text{PbO} \cdot (\text{C}_4\text{H}_4\text{O}_4)_2$	$\text{PbO} \cdot \text{PbO} \cdot (\text{C}_4\text{H}_4\text{O}_4)_2$
MOLECULAR WEIGHT	743	818	1,228	774
BASIC LEAD CONTENT (% PbO)				
1. Total	98.8	79.8	53.3	29.5
2. Soluble	68	54.6	31.5	—
3. Insoluble	30.8	25.2	21.8	29.5
COLOR AND FORM	fine acidulous white crystals	dully yellow white crystalline powder	soft white powder (amorphous)	fine white powder (amorphous)
SOLUBLE CONTENT	11.2% phosphoric acid	19.3% phthalic anhydride	44.5% succinic acid	71.3% succinic acid
REFRACTIVE INDEX	2.25	1.99	1.60	1.58-1.60
SPECIFIC GRAVITY	6.94	4.6	2.82	1.60-1.62
SOLUBILITY	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents
RECOMMENDED APPLICATIONS				
1. Special	Anticorrosive base and light stabilizer for vinyls, especially with zinc stannate	Ground purpose light and heat stabilizer	Stabilizer and lubricant	Lubricant and supplementary stabilizer
2. Plastics Recommended*	Types I, III, IIIA, IV, V, VIA, IIA for electrical insulation	Types I, IIIA, IV, IIA for electrical insulation	Types I, IIIA & C, V, VIA	Types I, III, IV, V, VIA. Especially recommended for IIA
3. Suggested Formulations**	V, VII, XII, XVI, XVII, XXIII, XXIII, XXVIII, XL	IV, XI, XXII, XXV	I, III, IV, V, VII, IX, XI, XVI, XX, XXII, XXII, XXVIII, XXXII, XXXV, XXXIX	II, XII, XV, XXIX

*See page 12 or 25.
**See page 26 to 35.

"DUTCH BOY" LEAD STAB

LEAD-TAR	OTHERS
Lead Chloro-succinate Complex	Normal Lead Succinate
Complex structure	
—	481
47.5 36.1 36.1	46.5 — 46.5
fine white powder	soft creamy white crystalline powder
47% SO_2 , 5% Cl_2	52.4% stearic acid
2.1	1.78
4.0	2.36
insoluble in all common solvents	83% sol. in water; sol. in glycerol, glycol ethers, etc. sol. methyl and ethyl alcohol.
Economical stabilizer for vinyl electrical and colored plastics	Anticorrosive and light screening agent
Types I, IIIA & B, III, IV	Type II (Special for asbestos filler flame retardant, see page 36)
II, III, XXIII	XIV, XV

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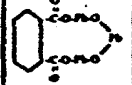
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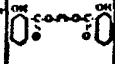
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TABLE OF PROPERTIES OF

"DUTCH BOY" LEAD STABILIZERS

	DYTHAL	DS-302	LEADTAR
	Dibasic Lead Phthalate	Dibasic Lead Sebacate	Normal Lead Sebacate
		$(\text{PbO})_2(\text{PbC}_{10}\text{H}_{17}\text{O}_2)_2$	$\text{Pb}(\text{C}_{10}\text{H}_{17}\text{O}_2)_2$
	818	1225	774
	79.8 54.6 79.8	55.3 31.5 55.3	29.5 — 29.5
	finely yellow white crystalline powder	soft white powder (amorphous)	fine white powder (amorphous)
	98.5% phthalic anhydride	46.5% sebacic acid	73.1% sebacic acid
	1.99	1.60	1.58-1.60
	4.6	2.02	1.40-1.42
	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents
lead and vinyl stabilizer	Greenish, purple light and heat stabilizer	Stabilizer and lubricant	Lubricant and supplementary stabilizer
IIIA, IA, IA, IA	Types I, IIIA, IV, IIA for electrical insulation	Types I, IIIA & C, V, VIA	Types I, III, IV, V, VIA, Especially recommended for IIIA
XVI, II, XX	IV, XI, XXIX, XXXV	I, III, IV, V, VII, IX, XI, XVI, XX, XXII, XXIII, XXVIII, XXXI, XXXII, XXXIII, XXXIV, XXXIX	II, XII, XV, XXIX

LEADTAR	MONOMERAL	PLI NBO-ML B	PLI NBO-ML C	TRIBANE	TRISANE E
Lead Chloro-arsenate Complex	Normal Lead Salicylate	Coprecipitated Lead Orthoarsenate and Salicylate	Coprecipitated Lead Orthoarsenate and Salicylate	Monohydrated Tribasic Lead Sulfate	Rare Lead Sulfate Sulfate
Complex structure		Complex structure	Complex structure	$\text{PbSO}_4 \cdot \text{H}_2\text{O}$	Complex structure
—	484	—	—	991	—
47.5 36.1 36.1	46.5 — 46.5	31 25-31 25-31	47 21-47 21-47	99 67.3 67.3	68 50.8 50.8
fine white powder	soft creamy white crystalline powder	soft white powder	soft white powder	fine white powder	fine white powder
47% Sb_2O_3 , 5% Cl	57.8% salicylic acid	42.6% CaO	38.5% SiO_2	81% SO_3	21.9% SiO_2 , 61% SO_3
2.1	1.78	1.58-1.60	1.58	2.1	2.1
4.8	2.36	3.3	2.76	7.1	5.55
insoluble in all common solvents	0.5% sol. in water; sol. in glycol, glycol ether, Et. al. methyl and vinyl alcohol.	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents	insoluble in all common solvents
Economical stabilizer for vinyl electrical and colored products	Anti-oxidant and heat screening agent	Translucent polyvinyl chloride resin	Translucent polyvinyl chloride resin (Specially treated for easy dispersion)	High quality electrical vinyl compounds	Economical electrical stabilizer for vinyl chloride
Types I, IIIA & B, III, IV	Type II (Special for asbestos filled flaring units, see page 34)	Types I, IIIA & B, III, IV	Types I, IIIA & B, III, IV	Types I, IIIA, IV, IIA for electrical insulation	Types I, IIIA, IV, IIA for electrical insulation
II, III, XXIII	XIV, XV		IX, XX, XXI, XXIII, XXVI, XXVII, XXXII	I, V, XV, XXXI, XXXV, XXXIX	I, II

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There are a great number of plasticizers, both primary and secondary, available to the vinyl compounder. For the sake of convenience, these materials have been classified into six major groups.

CLASSIFICATION OF VINYL PLASTICIZERS

- TYPE I Organic Ester Type** (Phthalates, adipates, azelates, sebacates, which do not contain ether linkages or aliphatic unsaturation)
 - A. Primary* type plasticizer
 - B. Primary type plasticizer of highest quality with special properties, such as low temperature flexibility or low volatility, etc.
- TYPE II Phosphate Type**
 - A. Aryl phosphates
 - B. Aryl-alkyl phosphates
 - C. Alkyl phosphates
- TYPE III Oil Type****
 - A. Organic ester epoxides
 - B. Ether esters (Polyethylene glycol esters, etc.)
 - C. Aliphatic unsaturated esters (Unsaturated oil derivatives)
- TYPE IV Polyester Type** (Polymeric, semi-polymeric)
- TYPE V Chlorinated Type** (Chlorinated paraffins and aromatics)
- TYPE VI Miscellaneous Type**
 - A. Hydrocarbons, nitriles, amides, etc.
 - B. Sulfur containing materials

C. RECOMMENDED LEAD STABILIZATION FOR VAHNN'S PLASTICIZER TYPES

Organic Ester Type

The plasticizers in Type I perform best in vinyl stocks which are stabilized with highly basic lead compounds, such as "DUTCH BOY" TRIBASE, DYTIAL, and DYPHOS. There is some interaction between plasticizer and stabilizer in any system, and the action of these stabilizers in forming stable non-reactive salts with the breakdown products from this group of plasticizers is unique. Actually, the development of "DUTCH BOY" DYTIAL (dibasic lead phthalate) as a vinyl stabilizer resulted from studies of the reaction of TRIBASE with phthalate type plasticizers. TRIBASE, DYTIAL, and DYPHOS are all outstanding for heat stability, but vary individually in their light stabilizing action. TRIBASE alone gives only fair light stability for the majority of plasticizers, but it is greatly improved by the co-use of "DUTCH BOY" DS-207 (0.5% to 1.0%, based on the weight of the resin). DYTIAL provides good light stability and is a highly satisfactory all-

*A primary plasticizer can be classified as a plasticizer which of itself will produce the required degree of flexibility in a vinyl plastic without the use of other plasticizers, stabilizers or lubricants. The use of such a primary plasticizer will give good ground properties to the vinyl compound. It is also desired to enable the primary plasticizer to combine with secondary plasticizers which would have the same or lower cost or more special demand or physical properties.

**An oil plasticizer is based on the consideration that both the slightly volatile or volatile component and the other linkage are stable against atmospheric oxygen and are subject to change and may have other physical properties in the vinyl compound, and as a result may open.

around stabilizer. Outdoor superior to all other stable

Phosphate Type

In Type II plasticizer stabilizer. Where the aryl ably cause formation of fr to either heat or light. This in the general case of aryl B or C, or "DUTCH BOY" of formulations with II A and II B) plasticizer the PLUMBO-SILs and lead stabilizers with a m instances, NORMASAL, products. In special cases used in electrical insulat DYPHOS, or DYTIAL used with such plasticizer primary requirements. D compounds containing large

Admittedly there are II plasticizers where lead non-lead stabilization with "APPLICATION OF" on page 17.

Oil Type

With the Type III A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, AA, AB, AC, AD, AE, AF, AG, AH, AI, AJ, AK, AL, AM, AN, AO, AP, AQ, AR, AS, AT, AU, AV, AW, AX, AY, AZ, BA, BB, BC, BD, BE, BF, BG, BH, BI, BJ, BK, BL, BM, BN, BO, BP, BQ, BR, BS, BT, BU, BV, BW, BX, BY, BZ, CA, CB, CC, CD, CE, CF, CG, CH, CI, CJ, CK, CL, CM, CN, CO, CP, CQ, CR, CS, CT, CU, CV, CW, CX, CY, CZ, DA, DB, DC, DD, DE, DF, DG, DH, DI, DJ, DK, DL, DM, DN, DO, DP, DQ, DR, DS, DT, DU, DV, DW, DX, DY, DZ, EA, EB, EC, ED, EE, EF, EG, EH, EI, EJ, EK, EL, EM, EN, EO, EP, EQ, ER, ES, ET, EU, EV, EW, EX, EY, EZ, FA, FB, FC, FD, FE, FF, FG, FH, FI, FJ, FK, FL, FM, FN, FO, FP, FQ, FR, FS, FT, FU, FV, FW, FX, FY, FZ, GA, GB, GC, GD, GE, GF, GG, GH, GI, GJ, GK, GL, GM, GN, GO, GP, GQ, GR, GS, GT, GU, GV, GW, GX, GY, GZ, HA, HB, HC, HD, HE, HF, HG, HH, HI, HJ, HK, HL, HM, HN, HO, HP, HQ, HR, HS, HT, HU, HV, HW, HX, HY, HZ, IA, IB, IC, ID, IE, IF, IG, IH, II, IJ, IK, IL, IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, JA, JB, JC, JD, JE, JF, JG, JH, JI, JJ, JK, JL, JM, JN, JO, JP, JQ, JR, JS, JT, JU, JV, JW, JX, JY, JZ, KA, KB, KC, KD, KE, KF, KG, KH, KI, KJ, KK, KL, KM, KN, KO, KP, KQ, KR, KS, KT, KU, KV, KW, KX, KY, KZ, LA, LB, LC, LD, LE, LF, LG, LH, LI, LJ, LK, LL, LM, LN, LO, LP, LQ, LR, LS, LT, LU, LV, LW, LX, LY, LZ, MA, MB, MC, MD, ME, MF, MG, MH, MI, MJ, MK, ML, MM, MN, MO, MP, MQ, MR, MS, MT, MU, MV, MW, MX, MY, MZ, NA, NB, NC, ND, NE, NF, NG, NH, NI, NJ, NK, NL, NM, NN, NO, NP, NQ, NR, NS, NT, NU, NV, NW, NX, NY, NZ, OA, OB, OC, OD, OE, OF, OG, OH, OI, OJ, OK, OL, OM, ON, OO, OP, OQ, OR, OS, OT, OU, OV, OW, OX, OY, OZ, PA, PB, PC, PD, PE, PF, PG, PH, PI, PJ, PK, PL, PM, PN, PO, PP, PQ, PR, PS, PT, PU, PV, PW, PX, PY, PZ, QA, QB, QC, QD, QE, QF, QG, QH, QI, QJ, QK, QL, QM, QN, QO, QP, QQ, QR, QS, QT, QU, QV, QW, QX, QY, QZ, RA, RB, RC, RD, RE, RF, RG, RH, RI, RJ, RK, RL, RM, RN, RO, RP, RQ, RR, RS, RT, RU, RV, RW, RX, RY, RZ, SA, SB, SC, SD, SE, SF, SG, SH, SI, SJ, SK, SL, SM, SN, SO, SP, SQ, SR, SS, ST, SU, SV, SW, SX, SY, SZ, TA, TB, TC, TD, TE, TF, TG, TH, TI, TJ, TK, TL, TM, TN, TO, TP, TQ, TR, TS, TT, TU, TV, TW, TX, TY, TZ, UA, UB, UC, UD, UE, UF, UG, UH, UI, UJ, UK, UL, UM, UN, UO, UP, UQ, UR, US, UT, UY, UZ, VA, VB, VC, VD, VE, VF, VG, VH, VI, VJ, VK, VL, VM, VN, VO, VP, VQ, VR, VS, VT, VU, VV, VW, VX, VY, VZ, WA, WB, WC, WD, WE, WF, WG, WH, WI, WJ, WK, WL, WM, WN, WO, WP, WQ, WR, WS, WT, WY, WZ, XA, XB, XC, XD, XE, XF, XG, XH, XI, XJ, XK, XL, XM, XN, XO, XP, XQ, XR, XS, XT, XU, XV, XW, XX, XY, XZ, YA, YB, YC, YD, YE, YF, YG, YH, YI, YJ, YK, YL, YM, YN, YO, YP, YQ, YR, YS, YT, YU, YV, YW, YX, YY, YZ, ZA, ZB, ZC, ZD, ZE, ZF, ZG, ZH, ZI, ZJ, ZK, ZL, ZM, ZN, ZO, ZP, ZQ, ZR, ZS, ZT, ZU, ZV, ZW, ZX, ZY, ZZ.

Though Types III B type of stabilizer, it is not

*Stabilizer and Plasticizer, and Type of Plasticizer may be defined as follows: (1) A plasticizer is a substance which is added to a polymer to increase its flexibility and is not a part of the polymer structure.

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of plasticizers, both primary and secondary, available or the sake of convenience, these materials have been used.

CLASSIFICATION OF VINYL PLASTICIZERS

Ester Type (Phthalates, adipates, azelates, sebacates, which do not contain either linkages or aliphatic unsaturation)

Alkyl type plasticizer

Alkyl type plasticizer of highest quality with special properties, such as low temperature flexibility or low volatility, etc.

Alkyl type

Alkyl phosphates

Alkyl phosphates

Alkyl phosphates

Alkyl phosphates

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Alkyl phosphates

around stabilizer. Outdoor weathering tests show conclusively that DYPHOS is superior to all other stabilizers with this group of plasticizers.*

Phosphate Type

In Type II plasticizers, the nature of the organic portion governs the choice of stabilizer. Where the aryl group is cresyl, the reactive basic lead stabilizers will probably cause formation of free cresylic acid and result in discoloration under exposure to either heat or light. This acid formation with resultant poor stability seems to apply in the general case of aryl phosphates. The use of "DUTCH BOY" PLUMB-O-SIL B or C, or "DUTCH BOY" LECTRO "60" has been found desirable for stabilization of formulations with aryl phosphate and mixed aryl-alkyl phosphate (Types II A and II B) plasticizers. This is an excellent illustration of the effectiveness of the PLUMB-O-SILs and LECTRO "60" in providing the desirable properties of lead stabilizers with a minimum of the apparent reactivity of basic lead. In some instances, NORMASAL appears to inhibit formation of cresylic acid and related products. In special cases, where the Type II A plasticizers (aryl phosphates) are used in electrical insulation compounds, TRIBASE, LECTRO "60", TRIBASE-E, DYPHOS, or DYTIAL are recommended. These basic lead stabilizers should be used with such plasticizers when excellent electrical properties in a stabilizer are the primary requirements. DYPHOS imparts the best heat and light stability to vinyl compounds containing large amounts of the alkyl phosphate (Type II C) plasticizers.

Admittedly there are several types of application involving the use of Type II plasticizers where lead stabilization is not indicated. Numerous examples of such non-lead stabilization with Type II plasticizers will be found in the section entitled "APPLICATION OF 'DUTCH BOY' NON-LEAD STABILIZERS" beginning on page 17.

Oil Type

With the Type III A plasticizers (organic ester epoxides), the basic lead stabilizers, DYPHOS, DYTIAL, TRIBASE, TRIBASE-E, and LECTRO "60" provide very good heat and light stability. It should be noted that "DUTCH BOY" LEADSTAR, normal lead stearate, is recommended rather than DS-207 when lubrication is desired in compounds containing these plasticizers.

In the case of stabilizable Types III B and III C plasticizers, basic lead appears to have a detrimental effect which is generally evidenced by poor heat aging properties. This is particularly apparent through the discoloration and occasionally more pronounced "spruing" of the vinyl compositions. LECTRO "60" is a notable exception to this rule. The shielded reactivity of LECTRO "60" and "DUTCH BOY" PLUMB-O-SIL B and C has been found particularly outstanding in both heat and light aging with plasticizers of this general type. In addition, any tendency towards spruing is inhibited, probably by adsorption on the activated silica gel of PLUMB-O-SIL. As a result, LECTRO "60" and PLUMB-O-SIL B and C provide the best stability for compounds in which Type III B or C plasticizers predominate, and also act as anti-blocking agents to reduce any tendency toward spruing.

Though Types III B and C plasticizers are difficult at best to stabilize with any type of stabilizer, it is sometimes necessary by reason of cost or other considerations to

*Standard and White, Ind. Eng. Chem., 46, 202 (1954).

Originals may be obtained in duplicate on the surface of one temperature of the vinyl plastic compound which is to be stabilized. LECTRO "60" is recommended at processing temperatures but has adequate heat stability at room temperature, 150° F. (60° C.) due to its unique formulation.

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use these materials for the good low temperature properties, hand, and drape, which they impart to vinyl products. Additional stabilization of Types III B and C plasticizers will be discussed in the "APPLICATION OF 'DUTCH BOY' NON-LEAD STABILIZERS" section.

Polyester Type

The Type IV plasticizers are widely used because of the permanence they impart to plastic compositions. Since any breakdown of the compound resulting in volatile and unstable degradation products would defeat the purpose of using polyester plasticizers, proper stabilization is especially important. The "DUTCH BOY" stabilizers, such as TRIBASE, DYTIAL, DYPHOS, TRIBASE-E and LECTRO "60" have adequate reserve basicity for long-term protection, and are especially beneficial with the polyester plasticizers. These five stabilizers are all good for heat stability, and they range from fair for TRIBASE-E and LECTRO "60" to outstanding for DYPHOS on light stability. When supplementary lubrication is required for these primary stabilizers in systems containing Type IV plasticizers, LEADSTAR is the recommended lubricant.

Chlorinated Type

The chlorinated type plasticizer (Type V) presents a special case. Chlorinated paraffins and aromatics have been particularly interesting to the vinyl compounder because of their low cost and excellent electrical and flameproofing properties. Their logical adaptation to vinyl compounding has always been seriously hindered by their well-known rapid and severe degradation characteristics. Pioneering work by the National Lead Company Research Laboratories* has shown that the advantages of using chloroparaffins can be realized through stabilization with "DUTCH BOY" DYPHOS. Effective stabilization with DYPHOS permits the use of chlorinated paraffins and aromatics in stocks which must have heat and light stability of a very high order, at a volume-cost reduction of as much as ten percent compared to other stocks of comparable quality. To properly stabilize compounds containing chlorinated hydrocarbons, it is necessary to consider that the entire resin-chlorinated hydrocarbon portion needs stabilizing. The necessity for using an additional amount of DYPHOS to compensate for the inclusion of a chlorine-containing secondary plasticizer is immediately apparent. The use of "DUTCH BOY" DS-207 was found to enhance the stabilizing action of DYPHOS appreciably.

Microkerosene Type

The hydrocarbon, nitrile, amide, and other Type VI A plasticizers present special problems in both stabilization and compatibility with the vinyl resins. It is for this reason that they are relegated to the role of secondary plasticizers. DYPHOS is the best stabilizer for these plasticizers because its excellent heat and light stabilizing action is supplemented by its role as an anti-oxidant. These plasticizers are readily oxidizable in the presence of heat and ultra-violet light, and the acidic by-products further aggravate the stability and spew resistance of the vinyl product.

The sulfur-containing plasticizers (Type VI B) undergo a chemical interaction with the lead stabilizers to form lead sulfide. For this reason, the "DUTCH BOY" Lead Stabilizers are not recommended with these plasticizers. We refer you to page 25 for a discussion of the use of "DUTCH BOY" FLUMAX 25 and NALZIN combinations with plasticizers of this type.

*Chemicals, White, and Polymers, Inc. (P.O. Box 2000, New York, N.Y.)

Mixtures of Plasticizer

In commercial practice one type of plasticizer is used using combinations of plasticizer availability, and specific plasticizers from Type IV to each general plasticizer system. In some cases, when the total highly basic stabilizer is a complete plasticizer system we use "DUTCH BOY" non-lead stabilizers.

D. LUBRICATION

For successful process use lubricants. Various lubricants, such as CALSTAR (calcium stearate), and "DUTCH BOY" four are all molten at processing temperatures (300-400 F.) and maintains a cooling history. Since DS-207 is become molten, it does not carry to the surface. The lubricant mentioned.

Stearic acid is less common in concentrations much over 100 ppm. CALSTAR (calcium stearate) releases the hydrogen chloride released. This reaction, of course, is primary stabilization. "DUTCH BOY" DS-207, from its structure, has more stearic acid is released. DS-207 is less prone to polymerization over these other materials, and rate 1700 out with the other "DUTCH BOY" and light resistance of the

E. STABILIZER TINTING

The ultimate applicant a high degree of translucent lead stabilizers are not so much so-called "clear" as greater than that contribute effect, the "DUTCH BOY" properties, it is well to do

*Testing strength is related directly to the amount of the compound. The compound is tested at approximately 100 ppm of the compound. It is tested with a standard method of testing strength.

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plasticizers (Type VI B) undergo a chemical interaction and lead to sulfide. For this reason, the "DUTCH BOY" is formulated with these plasticizers. We refer you to page 25 "DUTCH BOY" FLOMAX 25 and NALZIN combination.

*Timing strength is related directly to the difference in extensive index of velocity and pigment. The greater this difference, the greater is the amount of light and the more exposure between the aperture and pigment at 0.01 s. The data directly supports the subjective index of about 1.4, while velocity is about 1.0. The data also shows that the aperture is approximately 1.4 times as large as the pigment at 0.01 s. The data also shows that the aperture is approximately 1.4 times as large as the pigment at 0.01 s. The data also shows that the aperture is approximately 1.4 times as large as the pigment at 0.01 s.

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"DUTCH BOY" PLUMB-O-SIL B and C have refractive indices of 1.58 to 1.60 and will give a high degree of translucency with vinyl chloride type polymers (refractive index 1.58 to 1.60). When it is desirable to obtain strong vivid colors, the low tinting strength may be used advantageously. It is possible to obtain press-polished blacks which do not tend to show gray streaks, and vivid shades of red and other colors in this manner. "DUTCH BOY" DS-207 has a refractive index of 1.60 and does not contribute any apparent opacity when it is used in normal lubricant concentration. "DUTCH BOY" TRIBASE, DYTIAL, DYPHOS, TRIBASE-E and ELECTRO-60 have refractive indices of approximately 2.0 and contribute in some degree to the white pigment value of the compound.

F. EFFECT OF SPECIFIC GRAVITY

Specific gravity is another factor which must be considered. If the vinyl compound is formulated on a "pound" basis, and is sold to the consumer on a "pound" basis, specific gravity is not of any particular importance. In most cases, however, the formulator compounds by weight but his end-product is sold on a volume basis. As a result, one stabilizer may be more expensive than another, on a pound basis, but on a pound-volume consideration may be more economical to use. On this basis, "DUTCH BOY" PLUMB-O-SIL C (specific gravity 2.96), PLUMB-O-SIL B (specific gravity 3.3) and ELECTRO-60 (specific gravity 4.0) are among the most economical "DUTCH BOY" lead stabilizers which may be used in vinyls. Similarly, "DUTCH BOY" DYTIAL (specific gravity 4.6) is actually no more costly than "DUTCH BOY" TRIBASE (specific gravity 7.1), although there is a difference of cost per pound in these materials. This case is an example where quality may be obtained without sacrifice in cost considerations.

An additional advantage to be found with all the "DUTCH BOY" lead stabilizers is their non-marring characteristics. Since they are solid insoluble materials, they are not readily extracted by water, organic solvents, oils, etc., during their use and exposure. As indicated in the table of properties, basic lead salts are insoluble in all common solvents.

G. SUMMARY

In conclusion, it may be seen that several factors must be considered in choosing the correct lead stabilizer for the job. Some of the things to be considered include:

1. Degree of heat stability required.
2. Degree of light stability required.
3. Electrical properties.
4. Chemical characteristics of plasticizers used.
5. Lubrication desired.
6. Tinting strength.
7. Total, reactive, and safe basic lead content.
8. Specific gravity.

A number of specific applications will be indicated in the section on "PRACTICAL COMPOUNDING WITH 'DUTCH BOY' VINYL STABILIZERS," beginning on page 24.

IV. APPLICATION

"DUTCH BOY" lead for the vast majority of industry with "DUTCH BOY" utility and economy. In general, for certain end-use requiring ingredients. For cases where National Lead Company, of non-lead stabilizers. Pl stabilizers, both lead and effectively almost any type.

A. CONSIDERATIONS

There are four separate lead stabilizers may be used.

1. Clarity

There are some plastic greater than that available as PLUMB-O-SIL B or C. These are transparent colored types of belting, clear phone "DUTCH BOY" non-lead these classifications.

2. Staining

Some vinyl plastic products, other sulfides where the sulfide formation, leading to lead stabilizers are used. Tinting of the stocks. Another is wrapping paper and cardstock resistance is required, use Vinyl sheeting used as upholstery and table cloths, and where "DUTCH BOY" is used.

It should be emphasized desirable properties which very important advantages resistant to such, and it is up to which are the most important.

3. Toxicity

Only a very small percentage, included in this tubing. There are a great many, are still sometimes used as a safety measure. Example should avoided toys. In most cases possible, simply because one of plasticizers which are also may be achieved through

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"PLUMB-O-SIL B and C have refractive indices of 1.58 to 1.60 a degree of translucency with vinyl chloride type polymers (refractive index 1.40). When it is desirable to obtain strong vivid colors, the low tinting advantageously. It is possible to obtain press-polished blacks which gray streaks, and vivid shades of red and other colors in this manner. DS-207 has a refractive index of 1.60 and does not contribute any haze when it is used in normal lubricant concentration. "DUTCH BOY" IAL, DYPHOS, TRIBASE-E and ELECTRO-60 have refractive index 2.0 and contribute in some degree to the white pigment value

SPECIFIC GRAVITY

is another factor which must be considered. If the vinyl compound is used on a "pound" basis, and is sold to the consumer on a "pound" basis, specific gravity is of particular importance. In most cases, however, the formulation comes in a product which is sold on a volume basis. As a result, one stabilizer weighs more than another, on a pound basis, but on a pound-volume basis, it is economical to use. On this basis, "DUTCH BOY" PLUMB-O-SIL B (specific gravity 2.96), PLUMB-O-SIL C (specific gravity 3.1) and ELECTRO 4.0 are among the most economical "DUTCH BOY" lead stabilizers used in vinyls. Similarly, "DUTCH BOY" DYPHOS (specific gravity 2.96) is no more costly than "DUTCH BOY" TRIBASE (specific gravity 2.96) in these materials. This is a difference of cost per pound in these materials. This is a quality which may be obtained without sacrifice in cost considerations. It is to be found with all the "DUTCH BOY" lead stabilizers characteristics. Since they are solid insoluble materials, they are not soluble in water, organic solvents, oils, etc., during their use and even in the table of properties, basic lead salts are insoluble in all com-

It may be seen that several factors must be considered in choosing a stabilizer for the job. Some of the things to be considered include:

- stability required,
- stability required,
- cost,
- characteristics of plasticizers used,
- and.

and safe basic lead content.

For applications will be indicated in the section on "PRACTICAL APPLICATIONS WITH 'DUTCH BOY' VINYL STABILIZERS," beginning

IV. APPLICATION OF "DUTCH BOY" NON-LEAD STABILIZERS

"DUTCH BOY" lead stabilizers provide the best heat and light stability available for the vast majority of vinyl plastic applications. The long experience of the vinyl industry with "DUTCH BOY" lead stabilizers has established their efficiency, versatility and economy. In general, it is necessary to utilize vinyl stabilizers, other than lead, for certain end-use requirements, or in conjunction with certain special compounding ingredients. For cases where lead stabilizers cannot be used, or are not desirable, the National Lead Company, through its Research Laboratories, has developed a new line of non-lead stabilizers. Proper application of appropriate "DUTCH BOY" vinyl stabilizers, both lead and non-lead, enables the vinyl plastics compounder to stabilize effectively almost any type of vinyl end-product he is called upon to produce.

A. CONSIDERATIONS IN CHOOSING NON-LEAD STABILIZERS

There are four separate reasons why application of the "DUTCH BOY" non-lead stabilizers may be necessary or desirable.

1. Clarity

There are some plastic end-products requiring a high degree of transparency, greater than that available through use of the highly translucent lead stabilizers, such as PLUMB-O-SIL B or C, DS-207, LEADSTAR, etc. Notable examples of such products are transparent calendared film and sheeting, extruded clear garden hose, certain types of belting, clear photograph records, plastics, organonics and solution castings. "DUTCH BOY" non-lead stabilizers may be used to advantage in clear products in all these classifications.

2. Staining

Some vinyl plastic products are used in atmospheres containing hydrogen sulfide or other sulfides where the possibility exists of reaction with the stabilizers used. Lead sulfide formation, leading to highly colored reaction products, is often observed when lead stabilizers are used. The result is the formation of brown, black, or yellow staining of the stock. Another frequent source of sulfide staining is the use of sulfide process wrapping paper and cardboard containers. In cases where a high degree of staining resistance is required, use of "DUTCH BOY" non-lead stabilizers is recommended. Vinyl sheeting used as upholstery, vinyl light gauge sheeting used for curtains, drop-curtains and table cloths, and stain resistant vinyl flooring are a few of the end-products where "DUTCH BOY" non-lead stabilizers may be used to advantage.

It should be emphasized, however, that stain resistance is only one of a great many desirable properties which must be built into quality vinyl products. Very often, some very important advantages may be compromised in formulation of a completely stain-resistant stock, and it is up to the good judgment of individual compounders to decide which are the most important properties for a particular end-use.

3. Toxicity

Only a very small percentage of vinyl plastic products are required to be completely non-toxic. Included in this group are food packaging film, and surgical and beverage tubing. There are a great many other products which, while not required to be non-toxic, are still sometimes formulated by manufacturers without use of lead stabilizers, as a safety measure. Examples of this type are vinyl baby clothing and accessories, and child molded toys. In most cases, complete non-toxicity in products is neither necessary nor possible, simply because the physical properties required are obtainable only through use of plasticizers which are not, in themselves, non-toxic in nature. Excellent stabilization may be achieved through the use of "DUTCH BOY" non-lead stabilizers, even

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though no toxicological clearance has been obtained for these stabilizers at the present time. The compounder must balance the anti-toxicity and stability requirements of the over-all vinyl compound in selecting not only the stabilizer but the other ingredients as well.

4. Interaction with Other Compounding Ingredients

As discussed in the section of this handbook dealing with "DUTCH BOY" lead stabilizers, a lead stabilizer system may be selected which will give excellent stabilization with almost all the compounding ingredients used in vinyl resins. There are, however, a few raw materials, especially plasticizers, which show up as best advantage when used in combination with "DUTCH BOY" non-lead stabilizers. Detailed information on this subject is contained in the section on "RECOMMENDED NON-LEAD STABILIZATION FOR VARIOUS PLASTICIZER TYPES."

B. "DUTCH BOY" NON-LEAD STABILIZERS

The "DUTCH BOY" non-lead stabilizers listed below are designed to fill the need for excellent stabilization in vinyl chloride products of all types. While the general recommendations concerning the best stabilizers to use in particular products are suitable for most cases, it should be borne in mind that plasticizer-stabilizer interaction, lubrication requirements, cost and other factors may affect the recommendations in each particular instance. Section VI of this handbook, "PRACTICAL COMPOUNDING WITH 'DUTCH BOY' VINYL STABILIZERS" gives many formulations for vinyl products which are representative of those that are successfully used in the industry. The formulations given in Section VI will provide an excellent starting point toward meeting specific needs for various compounds.

"DUTCH BOY" CLARITE is a barium-cadmium organic stabilizer which combines excellent heat stability with good light stability and clarity. The outstanding feature of CLARITE is its extremely high heat stability which is effective over long term conditions. It is well adapted for all types of molded and extruded products, such as belting, tubing, garden hose, profile extrusions, and injection moldings. The lubricating action of CLARITE is normally adequate for processing requirements without additional lubricants.

CLARITE is supplied as two components. CLARITE A is a white powder and CLARITE B is a clear liquid. CLARITE A should be used at a level of from 1.25% to 2%, based on the resin, depending on the particular combination of heat stability, clarity and lubricity desired. 1% of CLARITE B is customarily used with this level of CLARITE A. A special case, however, is the use of 2% of CLARITE A and 1% CALSTAR in vinyl flooring stocks. When asbestos filler is present, the requisite amount of "DUTCH BOY" NORMASAL should be added to the stock, as discussed in Section VI B.

In summary, CLARITE is recommended for extremely high heat, for extrusion and molding stocks, and in vinyl flooring compounds. In this same class of high heat, lubricating, barium-cadmium stabilizers, "DUTCH BOY" PROVINITE is preferred in stocks requiring maximum non-yellowing and superior light stability.

"DUTCH BOY" PROVINITE is a barium-cadmium organic complex supplied in a two-package system, which physically resembles CLARITE. Its stabilizing characteristics are different from CLARITE in several respects. While its heat stability is comparable, PROVINITE is readily distinguished by its stronger anti-oxidant action, its excellent light stability, and its exceptional freedom from yellowing. The strong stabilizing action of PROVINITE is shown by its usefulness at lower concentrations in the vinyl stock than conventional barium-cadmium soaps. PROVINITE has

slightly less lubricity than CLARITE, plasticizers.

PROVINITE stabilizers. Although stocks for insulating wire coatings.

PROVINITE calendared vinyl is essential. It may be 1% of PROVINITE A and 1% of B in clarity and less lubricating film stock. BOY" NALZIN

Barium-cadmium translucent compounds stain in contact with small amounts of oil of barium-cadmium the sulfur compound.

"DUTCH BOY" co-use with barium always be used in compounds can react.

The exact level large extent on the requirements, and cadmium content. NALZIN, based on resin) should be chosen from outside sources. PROVINITE A and A, 0.5% NALZIN should be used.

"DUTCH BOY" It is readily incorporated. "DUTCH BOY" shows very little heat sealing and is recommended for plasticity, low viscosity almost on a par with best exposure at conditions used in is remarkably good stocks. FLOMAX subject to requirement stabilized with 2.5 to 3% FLOMAX.

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rance has been obtained for these stabilizers at the present balance the non-toxicity and stability requirements of the selecting not only the stabilizer but the other ingredients

Compounding Ingredients

tion of this handbook dealing with "DUTCH BOY" lead system may be selected which will give excellent stabilizing ingredients used in vinyl resins. There are, especially plasticizers, which show up to best advantage with "DUTCH BOY" non-lead stabilizers. Detailed information in the section on "RECOMMENDED NON-LEAD STABILIZERS FOR VARIOUS PLASTICIZER TYPES."

LEAD STABILIZERS

non-lead stabilizers listed below are designed to fill the need in vinyl chloride products of all types. While the selecting the best stabilizers to use in particular products it should be borne in mind that plasticizer-stabilizer interaction, cost and other factors may affect the recommendations. Section VI of this handbook, "PRACTICAL COMPOUNDING VINYL STABILIZERS" gives many formulas which are representative of those that are successfully used in practice. Section VI will provide an excellent starting point for various compounds.

CLARITE is a barium-cadmium organic stabilizer which gives with good light stability and clarity. The outstanding extremely high heat stability which is effective over long periods for all types of molded and extruded products, such as, profile extrusions, and injection moldings. The lubricity is normally adequate for processing requirements without

the use of two components. CLARITE A is a white powder and CLARITE B should be used at a level of from 1.25% depending on the particular combination of heat stability. CLARITE B is customarily used with this level of heat, however, is the use of 2% of CLARITE A and 1% of CLARITE B. When asbestos filler is present, the requisite amount of TALC should be added to the stock, as discussed in

It is recommended for extremely high heat, for extrusion and sheeting compounds. In this same class of high heat stabilizers, "DUTCH BOY" PROVINITE is preferred for non-yellowing and superior light stability.

PROVINITE is a barium-cadmium organic complex supplied which physically resembles CLARITE. In stabilizing characteristics CLARITE in several respects. While its heat stability is not readily distinguished by its stronger anti-oxidant action, and its exceptional freedom from yellowing. The strong antioxidant action is shown by its usefulness at lower concentrations than conventional barium-cadmium compounds. PROVINITE has

slightly less lubricating action than CLARITE. It develops lower viscosity in plasticized than CLARITE, and is particularly recommended for use with easily oxidized plasticizers.

PROVINITE has the best electrical properties of the barium-cadmium type stabilizers. Although its electrical properties are not equal to the standard lead stabilizers, PROVINITE is highly satisfactory for clear and brightly colored jacketing stocks for instrument wires, novelty Christmas tree wire, and other low requirement wire coatings.

PROVINITE's combination of stabilizing properties is especially suitable for calendared vinyl stocks, where resistance to oxidation and sharp retention of color are essential. It may be used at concentrations ranging from 2% of PROVINITE A and 1% of PROVINITE B in high temperature sheeting stocks to as low as 0.75% of the A and 1% of B in this film. The use of the lower concentrations provides even better clarity and less lubrication than the conventional level of usage. An excellent non-staining film stock may be achieved through the use of a small quantity of "DUTCH BOY" NALZIN with PROVINITE, as described below.

Barium-cadmium organic stabilizers are well established for clear and highly translucent compositions. One serious limitation of these systems is their tendency to stain in contact with sulfur or sulfur-containing materials. It has long been known that small amounts of organic zinc compounds eliminate or minimize the staining tendency of barium-cadmium stabilizers. Presumably this is due to the preferential acceptance of the sulfur compounds by the organic zinc salt to form a soluble or light colored sulfide.

"DUTCH BOY" NALZIN is a zinc organic complex especially developed for co-use with barium-cadmium stabilizers to eliminate sulfur staining. NALZIN should always be used in accordance with recommendations, since in large amounts, zinc compounds can readily become degradation catalysts instead of stabilizers for vinyls.

The exact level of NALZIN needed in a particular formulation depends to a large extent on the level of the barium-cadmium stabilizer, the sulfur staining resistance requirements, and the processing conditions. The optimum ratio, based on barium-cadmium content, is approximately 15% NALZIN, based on FLOMAX 25, or 25% NALZIN, based on PROVINITE A. For example, 3% FLOMAX 25 (based on the resin) should be changed to 2.1% FLOMAX 25 with 0.5% NALZIN, where freedom from sulfide staining and optimum heat stability are required. Correspondingly, 2% PROVINITE A and 1% PROVINITE B should be changed to 1.5% PROVINITE A, 0.5% NALZIN, and 1% PROVINITE B (all on resin basis). Under no circumstances should NALZIN be used alone without supplementary stabilization.

"DUTCH BOY" FLOMAX 25 is a liquid barium-cadmium organic stabilizer. It is readily incorporated and imparts the highest degree of clarity of all of the "DUTCH BOY" stabilizers. FLOMAX 25 is entirely compatible with vinyls and it shows very little plating tendency. FLOMAX 25 gives vinyl film an ideal surface for heat sealing and printing, since it provides a dry and tack-free surface. It is recommended for plastic films, organosol and solution coatings because of its ready dispersibility, low viscosity, clarity and compatibility. The heat stability of FLOMAX 25 is almost on a par with the CLARITE-PROVINITE class of stabilizers for extended heat exposure at very high temperatures. It is excellent for the normal processing conditions used in calendaring, extrusion and dispersion resin fusion. The light stability is remarkably good, being equal to or better than that of PROVINITE. For most vinyl stocks, FLOMAX 25 is recommended at a level of approximately 3% on the resin, subject to requirements for special heat conditions. Vinyl film is generally successfully stabilized with 2.5% FLOMAX 25 together with about 0.5% tartaric acid. From 2% to 3% FLOMAX 25 is best for dispersion and solution vinyl resin systems.

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TABLE OF PROPERTIES OF

PRODUCT	CALSTAR	CLARITE		CLAR
		CLARITE A	CLARITE B	
COMPOSITION	Calcium Stearate	Barium-Calcium Organic Complex		Barium-Calcium Organic Complex
FORMULA	$C_{18}H_{35}O_2$	Complex Structure		Complex Structure
MOLECULAR WEIGHT	407	—	—	—
COLOR AND FORM	fine white powder	soft white powder	clear straw-colored liquid	creamy white paste
REFRACTIVE INDEX	1.52-1.53	1.56 max.	1.49	1.48
SPECIFIC GRAVITY	1.04-1.07	1.34	0.930	2.10
SOLUBILITY	insoluble in water and all common organic solvents	insoluble in all common solvents	insoluble in solvents at low concentrations with benzene, toluene, "Cellulose," etc.	soluble portion available in all common organic solvents
SPECIAL REMARKS		Supplied as a two part system General Recommendation: 1 part CLARITE A 1 part CLARITE B per 100 parts of resin		Supplied as a 20% white paste in THF (4,2-dichlorophenyl ether)
RECOMMENDED APPLICATIONS				
1. Spread	Lubricant with some low stabilizing properties for clear compounds	Heat and light stabilizer for resins and molded films, and rapid drying		Antioxidant light stabilizer for good weathering resistance
2. Plasticizer Recommendation*	Types I, II, III, IV, VI	Types I, II, III, IV		Types I, II, III, IV, VI
3. Suggested Formulations**	III, XIV, XXX, XXXIV	III, XIV, XXXIV		III

*for page 12 or 25.
**for page 26 or 27.

"DUTCH BOY" NONLEAD STABILIZER

FLORAX 20	FLORAX 20
Barium-Calcium Organic Complex	Zinc Organic Complex
Complex Structure	Complex Structure
—	—
Clear yellow liquid	Clear pale yellow liquid
1.48	1.48
1.48	1.48
insoluble in solvents of hydrocarbon solvents with benzene, toluene, "Cellulose," etc.	insoluble in solvents of hydrocarbon solvents with benzene, toluene, "Cellulose," etc.
Liquid stabilizer with very high clarity and excellent plastic resistance	Supplemental for improved weathering resistance
Types I, II, III, IV, VIA, VII with NALZEN	Types I, II, III, IV, V, VIA, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI, XVII, XVIII, XIX

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NOTICE: If the film image is less clear than this notice, it is due to the quality of the document being filmed

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TABLE OF PROPERTIES OF

"DUTCH BOY" NONLEAD STABILIZERS

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CLARITE		CL-157
CLARITE A	CLARITE B	
Barium-Cadmium Organic Complex		Barium-Sodium Organic Complex
Complex Structure		Complex Structure
—	—	—
soft white powder	clear straw-colored liquid	creamy white paste
1.56 max.	1.09	1.08
1.36	0.930	2.30
insoluble in all common solvents	miscible in mixtures of hydrocarbon solvents with bromine, nitro, "Cellulose," etc.	soluble portion available in all common organic solvents
Supplied in a two part system General Recommendation: 2 parts CLARITE A 1 part CLARITE B per 100 parts of resin		Supplied in a 20% methyl acetate in 100P (6-2 ethylhexyl phthalate)
Heat and light stabilizer for extruded and molded films, and vinyl flooring.		Antioxidant light stabilizer for good weathering resistance
Types I, II, III, IV		Types I, II, III, IV, VI
XIII, XIV, XXIV		XL

PROVINITE	
PROVINITE A	PROVINITE B
Barium-Cadmium Organic Complex	
Complex Structure	
—	—
Clear yellow liquid	Clear pale yellow liquid
1.48	1.46
1.88	0.916
1.31	0.995
insoluble in mixtures of hydrocarbon solvents with bromine, nitro, "Cellulose," etc.	insoluble in mixtures of hydrocarbon solvents with bromine, nitro, "Cellulose," etc.
Supplied in a two part system General Recommendation: 0.75 to 2 parts PROVINITE A 1 part PROVINITE B per 100 parts of resin	
Liquid stabilizer with very high clarity and excellent plating resistance.	Supplementary stabilizer for barium-cadmium types to resist sulfide stain.
Types I, II, III, IV, VIA; VII with NALZEN	Types I, II, III, IV, VI
VII, XVII, XVIII, XIX, XXI, XXV, XXVI, XXVIII, XL	VI, X, XXIV, XXV, XXVI

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"DUTCH BOY" CS-137, a barium-sodium organic complex, is an excellent anti-oxidant stabilizer for clear vinyl products. Normally, it is the first stabilizer that should be considered whenever exceptional light and outdoor weathering stability are desired. Used at normal concentrations in thin films, CS-137 will give as much as 2-3 years of outdoor stability without significant breakdown. This performance is considered outstanding for clear vinyl stocks. Used alone, CS-137 does not have the outstanding heat stability characteristic of CLARITE or PROVINITE. Hence its main use is in vinyl organosols and solution coatings over cloth or metal. It has also given very successful results in plastisol and thin calendared films requiring weathering resistance, especially with supplementary stabilizers to aid in withstanding the heat cycle. CS-137 has outstanding stain resistance. For ease in dispersion in some resins and solutions, it is supplied as a 70% solids paste in di-2-ethylhexyl phthalate (DOP).

"DUTCH BOY" CALSTAR, calcium stearate, is a lubricant and supplementary stabilizer for clear vinyl products. It is useful in calendared products and extrusions, and also as a mold release agent for plastisols and injection molded articles. In general, it should be used with the various "DUTCH BOY" non-lead stabilizers only to the extent that additional lubrication is required over that provided by the stabilizers themselves. This will vary with processing methods and speeds, and the "practical compounding" section illustrates its use in several specific applications. In a few products, such as some clear phonograph records, CALSTAR is used as the sole stabilizer. More often, however, an additional stabilizer will prove to be a very good investment.

C. PLASTICIZER-STABILIZER INTERACTION

Effective and economical application of non-lead stabilizers is similar to the use of the lead stabilizers, in that the nature of the entire vinyl plastic system determines the best stabilizer, or combination of stabilizers, to accomplish the intended purpose. Actually, all of the compounding ingredients, including resin, plasticizers, fillers and colorants, have a bearing on proper choice of stabilizer. Of all the factors involved, however, the plasticizer system is by far the most important. Plasticizers vary considerably in their ability to withstand processing heat and attack by breakdown products of the vinyl resin. In some cases, the proper non-lead stabilizers actually inhibit breakdown of plasticizers. In other words, they stabilize the plasticizer as well as the resin, just as is the case in lead stabilization. In other instances, plasticizers in the systems are sufficiently stable to heat and light conditions so that all that is required of a good non-lead stabilizer is to do its primary job of stabilizing the resin. There are cases, however, where stabilizers do react unfavorably with plasticizers of certain types. This chemical interaction is sometimes observed as severe color formation, or as loss of plasticity, as evidenced by physical measurements, such as the hardness or modulus of the stock. The effects of stabilizer-plasticizer interaction are also made apparent by the plasticizer becoming incompatible. This is sometimes evidenced by blotting or severe spewing, or by the reaction products catalyzing the degradation of the resin.

Proper choice of "DUTCH BOY" non-lead stabilizers will give very effective stabilization in stocks containing practically all types of plasticizers. As discussed previously in the lead stabilizer section of this handbook, plasticizers may be divided into several distinct types or groups according to their chemical nature and properties. For convenience in the discussion of recommendations of "DUTCH BOY" non-lead stabilizers with various plasticizers, the plasticizer table on page 12 is reproduced here.

CLASSIFICATION

TYPE I Organic

- A. Phosphate
- B. Phosphate
- C. Phosphate

TYPE II Phosphate

- A. Ar
- B. Ar
- C. Ar

TYPE III Oil Type

- A. Oil
- B. Oil
- C. Oil

TYPE IV Polymeric

TYPE V Chlorinated

TYPE VI Miscellaneous

- A. H
- B. S

B. RECOMMENDED NON-LEAD TYPES

Organic Ester Type

Plasticizers of Type I perform best performance is obtained with CLARITE. PROVINITE is governed chiefly by the type clarity requirements. For CLARITE is suggested; for PROVINITE would be selected; for maximum advantages and recommendations section.

Where outstanding weathering vinyl solution coatings contain be used in conjunction with

Phosphate Type

As mentioned previously, factory stabilization. "DUTCH BOY" are exceptionally effective plasticizers, with PROVINITE any of the barium-cadmium small amount of opacified

"All plasticizer should not be classified as lead plasticizer unless the amount of lead present will give good ground processing conditions with secondary plasticizer properties.

"This classification is based on the amount of lead present in the plasticizer. Plasticizers containing less than 0.1% lead are considered non-lead plasticizers.

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barium-cadmium organic complex, is an excellent vinyl product. Normally, it is the first stabilizer that is used in thin films. CS-137 will give as much as 2-3 percent breakdown. This performance is considered good alone. CS-137 does not have the outstanding WHITE or PROVINITE. Hence its main use is in films over cloth or metal. It has also given very good calendar films requiring weathering resistance, films to aid in withstanding the heat cycle. CS-137, in dispersion in paste resins and solutions, is in 2-ethylhexyl phthalate (LOP).

Calcium stearate, is a lubricant and supplementary. It is useful in calendar products and extrusions, plastisols and injection molded articles. In general, "DUTCH BOY" non-lead stabilizers only to the is required over that provided by the stabilizers exceeding methods and speeds, and the "practical" use in several specific applications. In a few nograph records, CALSTAR is used as the sole additional stabilizer will prove to be a very good

INTERACTION

selection of non-lead stabilizers is similar to the use of the entire vinyl plastic system determines the stabilizers, to accomplish the intended purpose. Ingredients, including resin, plasticizers, fillers and choice of stabilizer. Of all the factors involved, far the most important. Plasticizers vary considerably in heat and attack by breakdown products of the non-lead stabilizers actually inhibit breakdown of the plasticizer as well as the resin, just as in some cases, plasticizers in the systems are sufficiently at all that is required of a good non-lead stabilizer on the resin. There are cases, however, where plasticizers of certain types. This chemical cause color formation, or as loss of plasticity, as such as the hardness or modulus of the rock. Interaction are also made apparent by the plasticizers evidenced by blocking or severe spitting, or degradation of the resin.

"DT" non-lead stabilizers will give very effective practically all types of plasticizers. As discussed in this handbook, plasticizers may be divided according to their chemical nature and properties. Recommendations of "DUTCH BOY" non-lead plasticizers table on page 12 is reproduced here.

CLASSIFICATION OF VINYL PLASTICIZERS

- TYPE I Organic Ester Type** (Phthalates, adipates, sebacates, which do not contain ether linkages or aliphatic unsaturation)
- A. Primary type plasticizer
 - B. Primary type plasticizer of highest quality with special properties such as low temperature flexibility or low volatility, etc.
- TYPE II Phosphate Type**
- A. Aryl phosphates
 - B. Aryl-alkyl phosphates
 - C. Alkyl phosphates
- TYPE III Oil Type**
- A. Organic ester epoxides
 - B. Ether esters (Polyethylene glycol esters, etc.)
 - C. Aliphatic unsaturated esters (Unsaturated oil derivatives)
- TYPE IV Polyester Type** (Polymeric, semi-polymeric)
- TYPE V Chlorinated Type** (Chlorinated paraffins and aromatics)
- TYPE VI Miscellaneous Type**
- A. Hydrocarbons, nitriles, amides, etc.
 - B. Sulfur containing materials

D. RECOMMENDED NON-LEAD STABILIZATION FOR VARIOUS PLASTICIZER TYPES

Organic Ester Type

Plasticizers of Type I present relatively few problems in stabilizer choice. Excellent performance is obtained by the use of the barium-cadmium organic stabilizers such as CLARITE, PROVINITE, and FLOMAX 25. The choice among these stabilizers is governed chiefly by the type of products being manufactured and their stability and clarity requirements. For example, for maximum heat stability PROVINITE or CLARITE is suggested; for maximum light stability PROVINITE or FLOMAX 25 would be selected; for maximum clarity FLOMAX 25 is recommended. The specific advantages and recommendations for these stabilizers were outlined earlier in this section.

Where outstanding weathering resistance is desired in films, organosol coatings and vinyl solution castings containing Type I plasticizers, "DUTCH BOY" CS-137 should be used in conjunction with PROVINITE or FLOMAX 25.

Phosphate Type

As mentioned previously, the Type II plasticizers often present a problem in satisfactory stabilization. "DUTCH BOY" PROVINITE, CLARITE, and FLOMAX 25 are exceptionally effective in promoting high heat and light stability in Type II plasticizers, with PROVINITE the best of this group by a small margin. Whenever any of the barium-cadmium stabilizers are employed with phosphate plasticizers, a small amount of epoxidized plasticizer (Type III A) adds to heat stability.

*A plasticizer may be classified as a phosphate which of itself will produce the required degree of stability in a film plastic without the presence of stabilizers. However, the use of only a plasticizer will give good general properties to the vinyl compound. It is also desirable to make the plasticizer compatible with secondary plasticizers which would have the effect of lower cost or more rapid chemical or physical changes.

Another classification is based on the consideration that both the plasticizer and the stabilizer must be stable under the conditions of use. Plasticizers containing these groups are subject to cleavage and may have this stability depending on the vinyl compound, and as a result may split.

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The use of CS-137 with Type II plasticizers gives only fair heat and light stability. Where it is desired to get very good weathering resistance in stocks containing 20% or more of Type II plasticizers, the co-use of CS-137 and PROVINITE is recommended.

Oil Type

The plasticizers of Type III fall naturally into three distinct groups. Stabilization of Type III A (organic ester epoxides) is a somewhat different problem from the other two groups, III B and III C. In many cases, use of small amounts of Type III A plasticizers (less than 10% of the vinyl resin content) actually improves the stabilizing properties of barium-cadmium stabilizers. This tendency is of greater importance in copolymer resins than in homopolymer resins, and is especially useful in vinyl chloride resins of lower molecular weight. Their advantage is also greater in heat stability than in stability toward light and outdoor weathering. "DUTCH BOY" PROVINITE, CLARITE, and FLOMAX 25 are especially recommended with plasticizers of Type III A.

Type III B (ether ester) and Type III C (unsaturated ester) plasticizers respond to very similar stabilizing techniques. "DUTCH BOY" CS-137 imparts a high degree of light resistance to Type III B and III C plasticizers, and provides excellent stabilization against outdoor weathering. "DUTCH BOY" PROVINITE serves as an excellent primary stabilizer in conjunction with CS-137 in calendared stocks containing Type III B and III C plasticizers. "DUTCH BOY" CLARITE performs similarly in extruded and highly loaded semi-rigid applications. In some products where absolute clarity is not essential, many compounders prefer to use PLUMBO-SIL B or C along with a supplementary clear stabilizer such as CS-137, or a tin stabilizer, to enhance the light stability. These systems have proved to be very versatile and practical, especially when high amounts of Type III B and III C plasticizers are used, and when plasticizer migration is troublesome.

Polyester Type

The stabilization of vinyl stocks containing Type IV plasticizers parallels to some extent the stabilization techniques used with Type I (monomeric ester) plasticizers. The major differences are due to the necessity to combat oxidation and cross-linking, usually observed in vinyl products as a tendency on the part of the plasticizer to react or spew, or in the case of light exposure, to develop spot degradation or embrittlement. "DUTCH BOY" PROVINITE and FLOMAX 25 provide excellent heat and light stability with Type IV plasticizers, with PROVINITE being the stronger of the two. Some excellent results have been obtained using "DUTCH BOY" CS-137 in stocks for outdoor use that contain appreciable quantities of polyester plasticizers. This is due to the antioxidant characteristics of CS-137.

Chlorinated Type

The Type V plasticizers (chlorinated paraffin and aromatics) as mentioned on page 14, present a special stabilization problem where "DUTCH BOY" DYPHOS, used in combination with "DUTCH BOY" DS-207, gives a degree of stabilization far above that of other systems tested. While the various non-lead stabilizers help Type V plasticizers to a minor extent, the non-lead stabilizers are not generally recommended with chlorinated type plasticizers.

Monoamine Type

The limitations of the Type VI A plasticizers (the hydrocarbons, amines, oxides, etc.) with respect to compatibility and stability during exposure to heat and light call for special stabilization. As discussed on page 14, DYPHOS is the best all-around stabilizer for compounds containing these plasticizers. However, if clarity is essential,

a combination of CS-137 and CS-137 and the excellent light to "stabilize" both the vinyl re-

A combination of "DUTCH BOY" recommended for stabilizing (sulfoxide-containing materials), this combination does not use plasticizers. CS-137 is also a light stabilizer. It is recommended FLOMAX 25 in those vinyl weathering and ultra-violet light or better could release CALSTAR is very efficient.

Mixtures of Plasticizer Type

It should be remembered several plasticizers, often of desired in various products. Techniques are concerned in the mixture of plasticizers will be used if each plasticizer contains a large amount of a or difficult to stabilize, it is plasticizer content were of the "BOY" non-lead stabilizers in Compounding" gives many b

E. LUBRICATING PROPERTIES

Two of the "DUTCH BOY" PROVINITE, possess sufficient lubrication is not normally a lubricity. Among the non-lead overall lubricants. The lubrication barium-cadmium compounds, by CALSTAR is definitely a stabilizer.

F. OTHER CONSIDERATIONS

"DUTCH BOY" non-lead unique requirements of high viscosity compounds in electroplating and mandatory for this application, however, "DUTCH BOY" PROVINITE such as in clear, highly colored

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with Type II plasticizers gives only fair heat and light stability. In very good weathering resistance in stocks containing 20% or more, the co-use of CS-137 and PROVINITE is recommended.

Type III fall naturally into three distinct groups. Stabilization ester epoxides is a somewhat different problem from the other III C. In many cases, use of small amounts of Type III A plus of the vinyl resin content actually improves the stabilizing tinium stabilizers. This tendency is of greater importance in in homopolymer resins, and is especially useful in vinyl molecular weight. Their advantage is also greater in heat toward light and outdoor weathering. "DUTCH BOY" TE, and FLOMAX 25 are especially recommended with A.

ries) and Type III C (unsaturated ester) plasticizers respond g techniques. "DUTCH BOY" CS-137 imparts a high degree e III B and III C plasticizers, and provides excellent stabil-weathering. "DUTCH BOY" PROVINITE serves as an ter in conjunction with CS-137 in calendar stocks containing azinizers. "DUTCH BOY" CLARITE performs similarly in led semi-rigid applications. In some products where absolute ay compounds prefer to use PLUMB-O-SIL B or C along or stabilizer such as CS-137, or a tin stabilizer, to enhance the tem have proved to be very versatile and practical, especially pe III B and III C plasticizers are used, and when plasticizer

vinyl stocks containing Type IV plasticizers parallels to some chniques used with Type I (monomeric, ester) plasticizers. e due to the necessity to combat oxidation and cross-linking, products as a tendency on the part of the plasticizer to react light exposure, to develop upon degradation or embrittlement. INITE and FLOMAX 25 provide excellent heat and light lasticizers, with PROVINITE being the stronger of the two. re been obtained using "DUTCH BOY" CS-137 in stocks a appreciable quantities of polyester plasticizers. This is due cristics of CS-137.

ers (chlorinated paraffins and aromatics) as mentioned on stabilization problem where "DUTCH BOY" DYPHOS, "DUTCH BOY" DS-207, gives a degree of stabilization for used. While the various non-lead stabilizers help Type V et, the non-lead stabilizers are not generally recommended icizers.

r Type VI A plasticizers (the hydrocarbons, aliphatic, amides, stability and stability during exposure to heat and light call As discussed on page 14, DYPHOS is the best all-around containing these plasticizers. However, if clarity is essential,

a combination of CS-137 and FLOMAX 25 is suggested. The anti-oxidizing action of CS-137 and the excellent light stability of this stabilizer combination will greatly help to "stabilize" both the vinyl resin and Type VI A plasticizers.

A combination of "DUTCH BOY" NALZIN and FLOMAX 25 is especially recommended for stabilizing vinyl compounds containing Type VI B plasticizers (sulfur-containing materials). In addition to its very good all-around stabilizing action, this combination does not cause undesirable sulfide staining in the presence of these plasticizers. CS-137 is also resistant to sulfide staining, as well as being an excellent light stabilizer. It is recommended as a secondary stabilizer with PROVINITE or FLOMAX 25 in those vinyl compounds which must have extreme resistance to outdoor weathering and ultra-violet light. When added lubrication is desired for easier processing or better mold release in compounds containing the Type VI B plasticizers, CALSTAR is very efficient.

Mixtures of Plasticizer Types

It should be remembered that the usual practice in vinyl compounding is to use several plasticizers, often of several types or groups, to get the specific properties desired in various products. The contribution of each plasticizer as far as stabilization techniques are concerned is generally additive. Thus, the stabilizer system used for a mixture of plasticizers will be made up of proportional amounts of the stabilizer that would be used if each plasticizer were considered alone. Very often, where a formulation contains a large amount of a plasticizer other than Type I, which tends to be reactive or difficult to stabilize, it is necessary to select a stabilizer system as if the entire plasticizer content were of this order of reactivity. In this respect, use of "DUTCH BOY" non-lead stabilizers is similar to lead stabilization. The section on "Practical Compounding" gives many helpful stabilizer suggestions for specific cases.

E. LUBRICATING PROPERTIES

Two of the "DUTCH BOY" barium-cadmium stabilizers, CLARITE and PROVINITE, possess sufficient lubricating properties of themselves, so that supplementary lubrication is not normally required for most applications. FLOMAX 25 has no lubricity. Among the non-lead stabilizers, "DUTCH BOY" CALSTAR is the best overall lubricant. The lubricating properties of CALSTAR are superior to those of the barium-cadmium compounds. On the other hand, the best stability protection afforded by CALSTAR is definitely inferior to that of the other "DUTCH BOY" non-lead stabilizers.

F. OTHER CONSIDERATIONS

"DUTCH BOY" non-lead stabilizers are not suitable for primary insulation. The unique requirement of high volume resistivity makes complete absence of soluble or ionizable compounds in electrical formulations desirable. Lead stabilizers are considered mandatory for this application. For secondary insulation or jacketing stocks, however, "DUTCH BOY" PROVINITE can be used when special effects are required, such as in clear, highly colored insulation machines.

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V. INCORPORATION OF VINYL STABILIZERS

Although the necessity for the incorporation of stabilizers into vinyl products is well recognized, it is not as generally realized that the proper dispersion or incorporation of stabilizer is required for the promotion of maximum ultimate stability.

The degree of stability obtained in any one system will depend upon the amount and type of stabilizer used. Nevertheless, without proper dispersion of such stabilizer, degradation of any vinyl product will occur more rapidly, resulting in loss in flexibility, change in color and other physical changes. Extreme cases of poor dispersion of the various incorporated materials are usually indicated by visible spots or specks in the finished product. This phenomenon, of course, is seldom encountered in any commercially acceptable product, but even without the appearance of spotting, the required degree of stabilizer dispersion still may be unsatisfactory.

Due to the random nature of vinyl degradation, change in color often occurs in localized areas on the surface and at the edges where more severe exposure conditions are encountered. Such failure, which may be attributed in part to "localized stabilizer exhaustion," shows the necessity of having sufficient stabilizer evenly dispersed throughout the plastic compound to inhibit such localized degradation to the maximum degree. It may be easily shown that the degree of dispersion of the stabilizer will markedly affect the ultimate stability of the vinyl compound. Comparison of the stability of two compounds, one having excellent distribution of the stabilizer, and the other having poor distribution, will show that a multi-fold increase in ultimate stability will be the result of more effective mixing.

There are a number of processing techniques used in the industry to obtain proper stabilizer dispersion. Although the compound which is to be further processed by calendaring, extruding, injection molding, or compression molding, may be mixed and fused in one step on a two-roll mill or Banbury mixer, more satisfactory dispersion is obtained by using a two-step process which includes premixing and fusing. Premixing may be accomplished by thoroughly blending all the dry ingredients such as resin, stabilizer, filler and pigments, in dough mixers, ribbon blenders, pug mixers or tumbling blenders. The dry mix is then carefully wetted with plasticizer by stepwise incorporation. This premix may then be fused in the usual processing equipment.

Barium-cadmium stabilizers such as "DUTCH BOY" CLARITE and PROVINITE are each supplied as two-component systems; CLARITE A and PROVINITE A are dry powders, while CLARITE B and PROVINITE B are liquids. These stabilizers can be best incorporated by adding the dry powder to the other dry ingredients such as resin, filler and pigments in the premixing operation. The liquid portion of the stabilizer is added along with the plasticizer during the wetting of the dry mix. "DUTCH BOY" FLOMAX 25 and NALZIN are entirely liquid, and consequently provide maximum dispersion ease. They are easily blended with the plasticizer.

Additional methods cycles. They shorten the temperatures and insure. Notable among these is "DUTCH BOY" PLU ing materials of this type will be found very useful.

The technique of in the degree of dispersion batching insure this need in a more uniform product paste is a very obvious dispersed in plasticizer ball mill. The dispersion may be utilized in many

Other methods of utilize organosol, plastic pre-dispersed stabilizer needed for the total use

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RATION OF VINYL STABILIZERS

the incorporation of stabilizers into vinyl products is really realized that the proper dispersion or incorporation of the promotion of maximum ultimate stability.

used in any one system will depend upon the amount of stabilizer, without proper dispersion of such stabilizer, will occur more rapidly, resulting in loss in flexibility, color changes. Extreme cases of poor dispersion of the stabilizer are indicated by visible spots or specks in the material, of course, is seldom encountered in any commercial product without the appearance of spotting, the required stability may be unsatisfactory.

if vinyl degradation, change in color often occurs in the edges where more severe exposure conditions exist which may be attributed in part to "localized stabilizer deficiency" having sufficient stabilizer evenly dispersed throughout the material such localized degradation to the maximum degree. The degree of dispersion of the stabilizer will markedly affect the stability of the vinyl compound. Comparison of the stability of two materials having different distribution of the stabilizer, and the other having a multi-fold increase in ultimate stability will be the

mixing techniques used in the industry to obtain proper dispersion of compounds which is to be further processed by molding, or compression molding, may be mixed and all or Banbury mixer, more satisfactory dispersion is obtained which includes premixing and fusing. Premixing involves blending all the dry ingredients such as resin, fillers, pigments, ribbon blenders, pug mixers or other carefully wetted with plasticizer by separate means then be forced in the usual processing equipment.

such as "DUTCH BOY" CLARITE and PROVINO-component systems; CLARITE A and PROVINO-B, CLARITE B and PROVINO-B are liquids, incorporated by adding the dry powder to the other dry ingredients in the premixing operation. The liquid stabilizers are dispersed during the wetting of the resin and plasticizer. MAX 25 and NALZIN are entirely liquid, and combine with the resin. They are easily blended with the plasticizer.

Additional methods have been utilized to obtain shorter pre-mixing and fusing cycles. They shorten the time in which the plastic compound will be subjected to high temperatures and insure more complete wetting of stabilizer and resin by the plasticizer. Notable among these is the use of stabilizers specially treated for ease of dispersion. "DUTCH BOY" PLUMBO-SIL C, TRIBASE-E and LECTRO "60" are outstanding materials of this type, and they wet and disperse very easily in plastic mixes. They will be found very useful in all applications where stabilizer dispersion is a problem.

The technique of masterbatching has been very successfully employed in obtaining the degree of dispersion necessary for better ultimate stability. Not only does masterbatching insure this necessary dispersion, but it also allows easier handling and results in a more uniform product. The dispersion of stabilizer in plasticizer to form a stabilizer paste is a very obvious method of masterbatching. In this method, the stabilizer is dispersed in plasticizer by grinding on a three-roll paint mill, in a colloid mill, or in a ball mill. The dispersion of stabilizer in resin has also been successfully employed and may be utilized in masterbatch chip form, or may be made into a solvated semi-paste.

Other methods of processing vinyls, such as coating, dipping and casting, which utilize organosols, plastisols and emulsion dispersions, have also successfully utilized pre-dispersed stabilizers. Actually, masterbatches may cut the required grinding time needed for the total organosol or plastisol.

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VL PRACTICAL COMPOUNDING WITH "DUTCH BOY" VINYL STABILIZERS

The foregoing material has been of a general nature. An attempt has been made to indicate how specific physical and chemical properties of the "DUTCH BOY" vinyl stabilizers might be most efficiently and effectively utilized. The information that follows is of a more specific nature and illustrates the application of the "DUTCH BOY" vinyl stabilizer in a number of practical end uses in the vinyl plastics field. The compounds suggested are by no means the only ones that would possess the properties sought for a particular use. In many instances, other similarly modified compositions may offer advantages in quality, cost and manufacturing ease over the ones suggested herein. There is no intention to recommend one available compound raw material over another in any particular application. The entire purpose is to illustrate correct general techniques in utilizing "DUTCH BOY" vinyl stabilizers.

In the formulations given, various component raw materials will be indicated by generic classes rather than by brand or chemical names. In all cases the resin described may be either a polymer of vinyl chloride, or a copolymer of vinyl chloride with any of the numerous monofunctional unsaturated materials in use today. Colorants will be omitted from these formulations altogether, although they do constitute a definite factor in the stabilization characteristics of the vinyl compound. Fillers will be indicated as "filler," with the choice of the numerous materials available left to the discretion of the compounder.

Plasticizer will be indicated by symbols from the plasticizer classification table shown on pages 12 and 21.

The stabilizer will be specifically indicated from the "DUTCH BOY" series. In cases where some other commercially available stabilizer would be helpful in conjunction with "DUTCH BOY" vinyl stabilizers, there will merely be indicated as "supplementary stabilizer."

A. EXTRUSION COMPOUNDS

There are two general methods of preparing extrusion compounds for the actual extrusion operation itself. These are dry blender pre-mixing and hot fluxing. The dry mixing is carried out by adding the various dry compounds, i.e., resin, stabilizer, colorant and filler, to a blender where thorough mixing produces fair relative dispersion. The plasticizer is heated and sprayed into the powder mix with continuous agitation. The semi-swollen plastic pre-mix may then be directly extruded. Although the heat involved in this mixing operation is fairly low and the stabilizer is a less important factor at this point, the higher temperatures required for fluxing and extrusion of a dry mixed compound make a stabilizer of ultimate great importance for this process. Extrusion compounds of this sort are sometimes handled by two extruders in series. The first extruder acts to flux and complete the mixing of the vinyl compound, while the second extruder yields the finished product. Temperatures involved range from 320° to 375° F. for cycles up to forty-five minutes.

Hot fluxed compounds may be prepared by adding a well pre-blended stock to a Banbury mixer at temperatures of 300° to 400° F. for cycles of four to eight minutes. The Banbury compound is then transferred to a hot two-roll plastic warm-up mill where it is slabbed off for pelletizing. These pellets are used cold to feed the extruder. Another technique is to use the hot compound from the two-roll plastic mill and actually hot-

stripfeed the extruder. Temperatures are encountered during warm-up mill for a longer period.

The entire fluxing and hot plastics mill. Cycles up to forty minutes under such conditions. It may range up to 375° F., but is compounded.

Electrical Compounds

Two broad classes of compounds are used for wire coating, and protection of primary insulate conductors to provide electrical insulation resistance, and the long-term exposure to heat and fillers are incorporated to increase fifteen percent by weight are used lower the heat stability. A high wire from cutting through the

In primary insulation "D-60" and DYTIAL have a stabilizing action and electrical is not generally required.

"DUTCH BOY" TRI-BLA 89%, of which 67% is reactive electrical characteristics with a any danger of color instability, electrical stabilizer for primary

"DUTCH BOY" TRI-BLA containing 68% total PbO, of electrical properties of the compound the reserve heat stability carbonate and other similar pig (5.5) makes this material an compounds.

"DUTCH BOY" LECTRO excellent electrical properties of LECTRO "60" has outstanding on long-term water immersion as TW wire where good but LECTRO "60" can be used polymeric, phosphorus and an gray (4.0) makes LECTRO for primary insulation.

"DUTCH BOY" DYTIAL is a reactive PbO, compound and is particularly useful in h

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PRACTICAL COMPOUNDING WITH "DUTCH BOY" VINYL STABILIZERS

ial has been of a general nature. An attempt has been made to illustrate the physical and chemical properties of the "DUTCH BOY" vinyl stabilizers efficiently and effectively utilized. The information that is given in this nature and illustrates the application of the "DUTCH BOY" stabilizers in a number of practical end uses in the vinyl plastics field. The by no means the only ones that would possess the properties of the "DUTCH BOY" stabilizers. In many instances, other similarly modified compositions may be used, but the quality, cost and manufacturing ease over the ones suggested on so recommend one available component raw material over another. The entire purpose is to illustrate correct general application of "DUTCH BOY" vinyl stabilizers.

Even, various component raw materials will be indicated by brand or chemical names. In all cases the resin described is of vinyl chloride, or a copolymer of vinyl chloride with any other unsaturated materials in use today. Colorants will be indicated as such, although they do constitute a definite factor in the vinyl compound. Fillers will be indicated as such of the numerous materials available left to the discretion of the user.

indicated by symbols from the plasticizer classification table

specifically indicated from the "DUTCH BOY" series. In commercially available stabilizer would be helpful in conjunction with "DUTCH BOY" vinyl stabilizers, these will merely be indicated as "supplemental".

METHODS

Methods of preparing extrusion compounds for the actual use are dry blender pre-mixing and hot mixing. The dry blending of the various dry compounds, i.e., resin, stabilizer, filler, etc., where thorough mixing produces fair relative dispersion. The mixture may then be directly extruded. Although the heat of extrusion is fairly low and the stabilizer is a less important factor in the extrusion process, the temperature of extrusion is of great importance for this process. The extrusion is sometimes handled by two extruders in series. The first extruder completes the mixing of the vinyl compound, while the second extruder finishes the product. Temperatures involved range from 120° to 150° F. for five minutes.

The compound may be prepared by adding a well pre-blended stock to a barrel of 300° to 350° F. for cycles of four to eight minutes, then transferred to a hot two-roll plastic warm-up mill where the compound is fed into the extruder. Another compound from the two-roll plastic mill and actually has

stripped the extruder. Temperatures of 300° to 350° F. for periods of ten to thirty minutes are encountered during such operations. Hot-urified stock may stay on the warm-up mill for a longer period, but is compensated by a shorter cycle in the extruder.

The entire mixing and mixing may be carried out directly on a large two-roll hot plastics mill. Cycles up to thirty minutes at temperatures of 300° to 350° F. are encountered under such conditions. Temperatures in the extruder for hot mixed compounds may range up to 375° F., but generally for shorter periods than required for dry mixed compounds.

Electrical Compounds

Two broad classes of compounds are employed in the electrical field, primary insulation for wire coating, and jacketing or secondary insulation for the mechanical protection of primary insulated wires. Primary insulation, applied directly over the conductor to provide electrical protection for the system, must necessarily have a high insulation resistance, and the maintenance of flexibility and electrical properties during long-term exposure to heat and moisture is of paramount importance. Selected clay fillers are incorporated to increase insulation resistance, but amounts higher than ten to fifteen percent by weight are usually avoided so as not to impair physical properties and lower the heat stability. A high resistance to deformation is desirable in preventing the wire from cutting through the insulation during handling and installation.

In primary insulation "DUTCH BOY" TRIBASE, TRIBASE-E, LECTRO "60" and DYTIAL have been found exceptionally desirable, since their heat stabilizing action and electrical properties are outstanding, and unusual light stability is not generally required.

"DUTCH BOY" TRIBASE (PbO-PbSO₄-H₂O) has a total PbO content of 89%, of which 67% is reactive and safe. This high basic lead content affords excellent electrical characteristics with most of the commonly used electrical plasticizers without any danger of color instability, gassing, or moisture pick-up. TRIBASE is the quality electrical stabilizer for primary insulation.

"DUTCH BOY" TRIBASE-E is a specially prepared basic lead silicate sulfate containing 66% total PbO, of which 50.8% is safe and reactive PbO. It gives excellent electrical properties of the same order of magnitude as TRIBASE, but it does not possess the reserve heat stability of TRIBASE, although it is superior to basic lead carbonate and other similar pigment materials. The low specific gravity of TRIBASE-E (5.5) makes this material an economical, general stabilizer for primary insulation compounds.

"DUTCH BOY" LECTRO "60" is a lead chlorosulfate complex which possesses excellent electrical properties and good heat stability combined with ready dispersibility. LECTRO "60" has outstanding moisture resistance and retention of electrical properties on long-term water immersion. It is particularly recommended for applications, such as TV wire where good long term water immersion characteristics are essential. LECTRO "60" can be used with a wide range of plasticizers including certain polymeric, phosphoric and unsaturated or other esters. In addition, its low specific gravity (4.0) makes LECTRO "60" the most economical "DUTCH BOY" stabilizer for primary insulation.

"DUTCH BOY" DYTIAL, with a total PbO content of 79.5% of which 54.6% is safe reactive PbO, compares favorably with TRIBASE in stabilizing vinyl insulation, and is particularly useful in high-temperature appliance wire formulations. In fact,

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DYTHAL is the best available stabilizer for coping with the high extrusion temperatures employed and the rigorous heat history encountered in the subsequent use of 90° C. to 165° C. appliance wire insulation. This appears to be due to the unusually low reactivity of DYTHAL with plasticizers under strong heat conditions as compared to the other highly basic lead stabilizers.

"DUTCH BOY" DS-207 provides an effective boost in stabilizing action for all electrical stocks as a supplement to the primary stabilizer. It provides lubrication without incompatibility, and improves electrical properties during prolonged water immersion conditions.

Secondary insulating or jacketing stocks are compounded with somewhat less emphasis on maximum insulation resistance, since mechanical protection is their primary function. Jacketing stocks are usually applied in thicker wall section than primary stocks, and for this reason they must be more flexible. Other prime requisites are toughness, abrasion resistance, and flame resistance. The stabilization requirements differ somewhat due to the greater exposure to light and oxidative attack. The best stabilizing action and electrical properties of TRIBASE, TRIBASE-E and LECTRO "60" are nicely supplemented with a small addition of DS-207, giving a good general-purpose heat and light resistance suitable for jacketing. Where actual outdoor service will be encountered, the use of "DUTCH BOY" DYPHOS and DS-207 is almost mandatory in vinyl electrical stocks of all non-black types.

"DUTCH BOY" PLUMB-O-SIL B and C, low sodium content, complex precipitates of lead orthosilicate and silica gel have good electrical characteristics in vinyl chloride polymers. While they have somewhat less heat stability reserve than the more basic stabilizers, their low tinting strength, prevention of specking, and low reactivity towards plasticizers and colorants are unique for a number of special electrical applications. Christmas tree wiring, ornamental fixture and appliance cords, and aircraft wire, where special color effects and transparency are desirable, can be compounded to best advantage with PLUMB-O-SIL B or PLUMB-O-SIL C. The good electrical characteristics of these PLUMB-O-SILs, combined with their low specific gravities (1.3 and 2.0 respectively), make these materials economical stabilizers which can be used in vinyl electrical applications.

"DUTCH BOY" PROVINITE possesses outstanding heat stability and good light stability. It is particularly well suited for use in jacketing stocks where clarity or bright colors are desired and where the greater insulation resistance of lead stabilizers is not required.

Special stabilizer consideration should be given whenever the chlorinated paraffin or aromatic plasticizers are used for their excellent electrical properties in vinyl insulation. The choice of DYPHOS is mandatory in such compounds to stabilize both the vinyl resin and plasticizer, as discussed on page 14.

FORMULA I

Standard General Purpose Insulation (Primary or Jacket)

Resin	100
Type I A Plasticizer	50
Filler	10-20
TRIBASE or TRIBASE-E	7
DS-207	0.4

FORMULA II

Low-Cost

Resin	
Type I A Plasticizer	
Type I A Plasticizer	
Type III A Plasticizer	
Type V Plasticizer	
Type VI A Plasticizer	
Filler	
TRIBASE-E or LEADSTAR	

FORMULA III

TV

Resin	
Type I A Plasticizer	
Type IV Plasticizer	
Filler	
LECTRO "60"	
DS-207	

FORMULA IV

High Temperature

Resin	
Type I B Plasticizer	
Type IV Plasticizer	
Filler	
DYTHAL	
DS-207	

FORMULA V

Resin	
Type I A Plasticizer	
Type I B Plasticizer	
Filler	
TRIBASE or E	
DS-207	

Specifically formulated for outdoor use

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able stabilizer for coping with the high extrusion temperatures heat history encountered in the subsequent use of wire insulation. This appears to be due to the unusually low th plasticizers under strong heat conditions as compared d stabilizers.

07 provides an effective boost in stabilizing action for all current as the primary stabilizer. It provides lubrication d improves electrical properties during prolonged water

r jacketing stocks are compounded with somewhat less ation resistance, since mechanical protection is their pri- ks are usually applied in thicker wall section than primary y must be more flexible. Other prime requisites are tough- d flame resistance. The stabilization requirements differ exposure to light and oxidative attack. The heat stabilizing ies of TRIBASE, TRIBASE-E and LECTRO "60" are small addition of DS-207, giving a good general-purpose able for jacketing. Where actual outdoor service will be TCII BOY™ DYPHOS and DS-207 is almost mandatory all non-black types.

MB-O-SIL B and C, low sodium content, complex pre- and silica gel have good electrical characteristics in vinyl y have somewhat less heat stability reserve than the more ating strength, prevention of spewing, and low reactivity 200 are unique for a number of special electrical applica- ornamental fixture and appliance cords, and aircraft wire, d transparency are desirable, can be compounded to best SIL B or PLUMBO-SIL C. The good electrical charac- SILA, combined with their low specific gravities (3.3 and e materials economical stabilizers which can be used in

INITE possesses outstanding heat stability and good light ined for use in jacketing stocks where clarity or bright e greater insulation resistance of lead stabilizers is not

ion should be given whenever the chlorinated paraffin l for their excellent electrical properties in vinyl insu- is mandatory in such compounds to stabilize both the covered on page 14.

4 Purpose Insulation (Primary or Jacket)

.....	100
stabilizer.....	50
.....	10-20
TRIBASE-E.....	7
.....	0-1

FORMULA II

Low-Cost General Purpose Insulation

Resin	100
Type I A Plasticizer	27
Type I A Plasticizer (low cost)	15
Type III A Plasticizer	8
Type V Plasticizer	5
Type VI A Plasticizer	5
Filler	25
TRIBASE-E or LECTRO "60"	7
LEADSTAR	1

FORMULA III

TW Type Insulation (60° C.)

Resin	100
Type I A Plasticizer	40
Type IV Plasticizer	7-12
Filler	10-15
LECTRO "60"	7
DS-207	0-1

FORMULA IV

High Temperature Appliance Type Insulation (105° C.)

Resin	100
Type I B Plasticizer	15
Type IV Plasticizer	45
Filler	10-20
DYTHAL	7
DS-207	0-1

FORMULA V

Low Temperature Jacketing

Resin	100
Type I A Plasticizer	40
Type I B Plasticizer	20
Filler	0-10
TRIBASE or DYPHOS	0
DS-207	0-1

Quantity recommended for rubber compound

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FORMULA VI

Clear Jacketing for Special Purposes

Resin	100
Type I A Plasticizer	25
Type II A Plasticizer	25
Type III A Plasticizer	5
PROVINITE A	2
PROVINITE B	1

Non-Electrical Extrusion Compounds

Extrusion compounds are used in a variety of specialized non-electrical applications such as garden hose, clothesline, wetting, gasketing, etc. The type of stabilization required is dictated by such end-use requirements as heat and light stability, clarity and cost. The following formulations may be modified for specialized uses by varying filler and plasticizer contents to obtain the desired physical properties and processing characteristics. Where stiffer stocks are formulated with lower plasticizer amounts, the extrusion heat history becomes more severe, and higher proportions of stabilizer must be used for adequate protection. The inclusion of a flame polishing operation will constitute an additional high heat cycle and require additional stabilization.

"DUTCH BOY" TRIBASE and TRIBANE-E are recommended for general purpose opaque extrusions. The high basic lead content of these stabilizers contributes a high order of heat stability. When particularly severe conditions are encountered, such as high extrusion temperatures, "DUTCH BOY" DYTIAL is the logical choice. DYTIAL also contributes good all-purpose light stability. "DUTCH BOY" DYPHOS is the outstanding stabilizer for applications such as opaque garden hose and spline, where protection against the deleterious effects of ultra-violet light on outdoor exposure is essential.

"DUTCH BOY" PLUMB-O-SH, B and C are used in applications requiring transparency or bright colors. In addition to their low tinting strength, their low specific gravities recommend them for low cost applications.

"DUTCH BOY" CLARITE has proven to be particularly well suited for clear profile extrusions, such as gasketing, wetting, spline, etc.

Where maximum clarity and non-yellowing are desired "DUTCH BOY" FLOMAX 25 should be used. Its good heat and light stability, combined with exceptional ease of incorporation recommend it especially for clear garden hose.

For extrusion stocks which will be resistant to sulfide staining, a combination of either FLOMAX 25 or CLARITE, with NALZIN, is recommended.

"DUTCH BOY" DS-207, dibasic lead stearate, increases the stability of an extrusion compound while providing lubrication without incompatibility. LEAINSTAR, normal lead stearate, is suggested when greater lubricity is desired in extruding highly filled compounds. "DUTCH BOY" CALSTAR provides effective lubrication with "DUTCH BOY" non-lead stabilizers.

FORMULA VII

Resin	
Type I A Plasticizer	
Type II A Plasticizer	
Type III A Plasticizer	
Type III B Plasticizer	
FLOMAX 25	
Seracic Acid	

FORMULA VIII

Resin	
Type I A Plasticizer	
Type II A Plasticizer	
Type III B Plasticizer	
Filler	
DYPHOS	
DS-207	

FORMULA IX

Translucent or Clear	
Resin	
Type I A Plasticizer	
Type II B Plasticizer	
Type III B Plasticizer	
PLUMB-O-SH	
DS-207	

FORMULA X

Resin	
Type I A Plasticizer	
Type II B Plasticizer	
Type III A Plasticizer	
PROVINITE	
NALZIN	

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NOTICE: If the film image is less clear than this notice, it is due to the quality of the document being filmed

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For Jacketing for Special Purpose

.....	100
Plasticizer.....	25
Plasticizer.....	25
Plasticizer.....	5
FEA.....	2
FE B.....	1

a Compounds

are used in a variety of specialized non-electrical applications: hotlining, wetting, gasketing, etc. The type of stabilization and use requirements as heat and light stability, clarity and actions may be modified for specialized uses by varying filler to obtain the desired physical properties and processing or such are formulated with lower plasticizer amounts, the more severe, and higher proportions of stabilizer must section. The inclusion of a flame polishing operation will give heat cycle and require additional stabilization.

TRIBASE and TRIBASE-E are recommended for general use. The high basic lead content of these stabilizers contributes to clarity. When particularly severe conditions are encountered, peroxide, "DUTCH BOY" DYTIAL, is the logical choice, good all-purpose light stability. "DUTCH BOY" DYPHOR for applications such as opaque garden hose and splines, to deflection effects of ultra-violet light on outdoor exposure.

PLUMBO-SIL B and C are used in applications requiring clarity. In addition to their low tinting strength, their low specific gravity for low cost applications.

ARITE has proven to be particularly well suited for clear gasketing, wetting, splines, etc.

Clarity and non-yellowing are desired "DUTCH BOY" FLO-11 gives good heat and light stability, combined with exceptional strength is especially for clear garden hose.

which will be resistant to sulfide staining, a combination of ARITE, with NALZIN, is recommended.

LEADSTAR, dibasic lead stearate, increases the stability of an extruding lubrication without incompatibility. LEADSTAR, added when greater lubricity is desired in extruding highly filled "DUTCH BOY" CALSTAR provides effective lubrication with no stabilizers.

FORMULA VII

Clear Garden Hose

Resin.....	100
Type I A Plasticizer.....	25
Type I A Plasticizer (low cost).....	15
Type III A Plasticizer.....	5
Type III B Plasticizer.....	10
FLOMAX 25.....	2.5
Sebacic Acid.....	0.5

FORMULA VIII

Opaque Garden Hose

Resin.....	100
Type I A Plasticizer.....	25
Type I A Plasticizer (low cost).....	15
Type III B Plasticizer.....	20
Filter.....	20-40
DYPHOS.....	4
DS-207.....	0.5-1

FORMULA IX

Translucent or Brightly Colored Baking (Flame Resistant)

Resin.....	100
Type I A Plasticizer.....	25
Type II B Plasticizer.....	15
Type III B Plasticizer.....	15
PLUMBO-SIL C.....	4
DS-207.....	0.5-1

FORMULA X

Clear Non-Staining Wetting

Resin.....	100
Type I A Plasticizer.....	20
Type I B Plasticizer.....	20
Type II B Plasticizer.....	15
Type III A Plasticizer.....	5
PROVINITE A.....	1
PROVINITE B.....	1
NALZIN.....	0.25

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FORMULA XI

Refrigerator Gasketing

Resin	100
Type I A Plasticizer	30
Type I B Plasticizer	15
Type IV Plasticizer	15
Filler	5-10
DYTHAL	5
DS-207	0.5-1

FORMULA XII

Spline or Other Channel Extrusions

Resin	100
Type I A Plasticizer	25
Type I A Plasticizer (low cost)	15
Type IV Plasticizer	15
Filler	10
DYPHOS	5
LEADSTAR	1

B. HIGHLY FILLED SEMIRIGID COMPOUNDS FOR FLOOR TILE, TABLE TOPS AND COVE MOLDING

This special class of vinyl products includes floor tile, table tops, and cove molding. The high filler content calls for careful compounding and processing techniques. Proper fusing in the processing step and dimensional stability in the finished product require that larger amounts of stabilizers be employed in these compounds. FORMULA XIII shows a typical standard semi-rigid stock which does not contain asbestos. CLARITE A, used alone, supplies excellent heat stability in compounds of this type. It processes smoothly, and its good clarity allows maximum freedom in vivid color choices. Best results are obtained by using a small amount of CALSTAR with the CLARITE A, as shown in the illustration.

Asbestos is commonly used as a filler in semi-rigid compounds because of its excellent contribution to dimensional stability and wearing characteristics, but it poses a distinct stabilization problem. Discoloration due to iron and other impurities in the asbestos is prevented by the use of "DUTCH BOY" NORMASAL. The amount of NORMASAL required is 5% of the amount of asbestos present. The color stabilizing action of NORMASAL with asbestos fillers is specific, and it is not duplicated by any other commercial stabilizers.

"DUTCH BOY" NORMASAL for standard illustrated in FORMULA necessary for these systems formulation.

In heavy duty applications, the more basic stabilizers E, and LECTRO "60" are desired, as has been discussed NORMASAL and TRIB

FORMULA XIII

Resin	100
Type I A Plasticizer	25
Type I A Plasticizer (low cost)	15
Type IV Plasticizer	15
Filler	10
DYPHOS	5
LEADSTAR	1

FORMULA XIV

Resin	100
Type I A Plasticizer	25
Type III A Plasticizer	15
Asbestos Filler	10
Filler	10
TITANOX	5
NORMASAL	5
CLARITE	5
CALSTAR	1

FORMULA XV

Resin (special vinyl)	100
Type I A Plasticizer	25
Type I B Plasticizer	15
Type V Plasticizer	15
Asbestos Filler	10
Filler	10
TITANOX	5
NORMASAL	5
TRIBASE	5
LEADSTAR	1

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Refrigerator Coasting

.....	100
Plasticizer.....	30
Plasticizer.....	15
Plasticizer.....	15
.....	5-10
.....	5
.....	0.5-1

Use of Other Chemical Extrusions

.....	100
Plasticizer.....	25
Plasticizer (low cost).....	15
Plasticizer.....	15
.....	10
.....	5
.....	1

SEMI-RIGID COMPOUNDS FOR FLOOR TILE, TABLE TOPS

Products includes floor tile, table tops, and cover molding, or careful compounding and processing techniques. Proper and dimensional stability in the finished product require care be employed in these compounds. FORMULA XIII is rigid stock which does not contain asbestos. CLARITE best heat stability in compounds of this type. It processes by allows maximum freedom in vivid color choices. Best a small amount of CALSTAR with the CLARITE A, as

ed as a filler in semi-rigid compounds because of its excellent stability and wearing characteristics, but it poses a distinct hazard due to iron and other impurities in the asbestos is DUTCH BOY NORMASAL. The amount of NORMASAL amount of asbestos present. The color stabilizing action of a filler is specific, and it is not duplicated by any other

"DUTCH BOY" CLARITE A is highly recommended in conjunction with NORMASAL for standard asbestos-filled stocks. Application of this principle is illustrated in FORMULA XIV. CLARITE provides the additional heat stability necessary for these systems, particularly when Type II plasticizers are used in the formulation.

In heavy duty applications, where more stringent requirements for heat stability exist, the more basic stabilizers such as TRIBASE, DYTHAL, DYPHOS, TRIBASE-E, and LECTRO "60" are used, the selection depending on the heat and light stability desired, as has been discussed previously. FORMULA XV illustrates the use of NORMASAL and TRIBASE for primary heat stability of an asbestos-filled stock.

FORMULA XIII

Standard Semi-Rigid (Non-Asbestos)

Resin.....	100
Type I A Plasticizer.....	35
Type III A Plasticizer.....	5
Filler.....	200
CLARITE A.....	2
CALSTAR.....	1

FORMULA XIV

Standard Asbestos Semi-Rigid

Resin.....	100
Type I A Plasticizer.....	60
Type III A Plasticizer.....	10
Asbestos Filler.....	140
Filler.....	120
TITANOX RA-50.....	25
NORMASAL.....	7
CLARITE A.....	2
CALSTAR.....	1

FORMULA XV

Heavy Duty Asbestos Semi-Rigid

Resin (special low molecular weight vinyl copolymer).....	100
Type I A Plasticizer.....	20
Type I B Plasticizer.....	5
Type V Plasticizer.....	10
Asbestos Filler.....	100
Filler.....	220
TITANOX RA-50.....	10
NORMASAL.....	6
TRIBASE.....	2
LEADSTAR.....	1

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C. RIGID COMPOUNDS

The development of special high molecular weight vinyl resins by the resin manufacturers has made it possible to extrude and calender rigid compositions. Products such as pipe and fittings, signs and advertising displays, and panels for construction of buildings, office partitions, breezeways, etc., are attractive and serviceable when made from rigid vinyls.

Stabilization is a problem because processing temperatures range from 350° F. to 390° F. The best development of physical properties and maximum impact strength is obtained with a mixture of 2% DYPHOS and 2% DS-207, as illustrated in the formula below. In a number of industrial applications, the use of larger proportions of TRI-BASE or DYTIAL in combination with DS-207 has also proven valuable.

FORMULA XVI

Rigid Formulation for Extrusion, Molding or Calendering*

Resin**	100
Type I A Plasticizer	0-10***
DYPHOS	2
DS-207	2

D. CALENDERED SHEETINGS

Calendered stocks for supported and unsupported film and flexible sheeting are produced by first thoroughly preblending the component ingredients in a dough mixer, ribbon blender, etc. The preblend is then fluxed in a Hanbury mixer for periods of four to eight minutes at temperatures of 320° to 350° F. The Hanbury stock is transferred to mixing and warm-up two-roll plastic mills where either hot strips or hot rolled slabs are fed to the calender. Stocks are maintained at 320° to 350° F. on the open mill for periods of ten to twenty-five minutes. The entire fluxing and mixing cycle may be carried out in one operation on a hot two-roll plastic mill at temperatures of 320° to 350° F. for fifteen to thirty minute periods. Many processors prefer to put the plastic stock through a screen before the final warm-up mill operation. The time in these warmers will range from five to ten minutes, and high heats to 380° F. may be built up. Calendering is carried out on three- or four-roll stock calenders or on the Z-type four-roll calender. Calenders are operated at temperatures of 320° to 360° F., but plastic working banks between the rolls will average ten to twenty degrees higher in temperature than the rolls themselves due to frictional heat build-up. A three-roll calender will not give as extended heat exposure as the four-roll type. The four-roll Z-calenders run the stock through at greater speed than the four-roll vertical stack calender, and the heat exposure cycle is accordingly reduced. However, the working banks of the Z-calender are only exposed to a 90° air surface and tend to hold in more heat than on the vertical calender, which should equalize the heat history between these types of equipment to some degree. The reworking of trim, either by direct hot addition to the feed banks, or by addition of a fixed percentage to the original virgin batch, will act to multiply this heat history.

Compounding practice for calendered stocks varies according to processing conditions in use, and the type of film or sheeting being produced. The following formulations are indicative of the variety of compounds that make up stocks which must meet many

* All stabilizers shown also inherent in this formulation is derived, up to 25 parts of Type I B plasticizer, based on the resin, may be added.
** High molecular weight polyvinyl chloride resin.
*** Up to 10 percent of other plasticizer (such as butyl) may also be added for better processing.

requirements. Proper as previously outlined, using processing and reworking

For outstanding clarity FLOMAX 25 is the first tributed by FLOMAX 2 with a wide range of plastic enables the compounder MAX 25 is entirely liquid to disperse. FLOMAX 25 is often a valuable aid in

"DUTCH BOY" P and other high quality applications combination of heat and above that of FLOMAX equal to FLOMAX 25. F yellowing. Of itself, P4 stock. When formulation determine whether any ad

Where complete freedom NALZIN may be combined amounts of NALZIN of non-staining stocks are

"DUTCH BOY" P stabilizers in the entire plasticizers and colorants PLUMB-O-SIL C is particularly helpful. The adjusting strength, plasticizer attractive for both transfer in most types of sheeting same properties are desired

For opaque film, stabilizers are outstanding greater reserve heat especially suited for heat temperature calendering also provide strong heat sticulary recommended for

Careful control of stabilizing action and use The lubricating action of advantage in conjunction with suitable quantities of organic BOY LEADSTAR is p

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Special high molecular weight vinyl resins by the resin manufacturer to extrude and calender rigid compositions. Products for advertising displays, and panels for construction of brocades, etc., are attractive and serviceable when made

them because processing temperatures range from 350° F. to tens of physical properties and maximum impact strength is 2% DYPHOS and 2% DS-207, as illustrated in the formula. Industrial applications, the use of larger proportions of TRI combination with DS-207 has also proven valuable.

tion for Extrusion, Molding or Calendaring*

.....	100
.....	0-10***
.....	2
.....	2

OUNDS

supported and unsupported film and flexible sheeting are y preblending the component ingredients in a dough mixer, blend is then fused in a Banbury mixer for periods of four tures of 320° to 350° F. The Banbury stock is transferred to roll plastic mills where either hot strips or hot rolled slabs cks are maintained at 320° to 350° F. on the open mill for minutes. The entire mixing and rolling cycle may be carried t two-roll plastic mill at temperatures of 320° to 350° F. for ide. Many processors prefer to put the plastic stock through m-up mill operation. The time in these extruders will range ed high heat to 300° F. may be built up. Calendaring is roll stock calendars or on the Z-type four-roll calendar. peratures of 320° to 340° F., but plastic working banks en to twenty degrees higher in temperature than the rolls rest build-up. A three-roll calendar will not give as four-roll type. The four-roll Z-calenders run the stock be four-roll vertical stock calendar, and the heat exposure (however, the working banks of the Z-calender are only d tend to hold in more heat than on the vertical calendar, history between these types of equipment to some degree, by direct heat addition to the feed banks, or by addition gual virgin batch, will act to multiply this heat history. e calendar stock varies according to processing condi- on sheeting being produced. The following formulations of components that make up stocks which must meet many

the formulation is based, up to 20 parts of Type II B plasticizer, based on the stock.

and plasticizer.

and plasticizer are given here for the reader's reference.

requirements. Proper stabilization follows the general principles which have been previously outlined, using the more basic stabilizers where maximum heat stability for processing and reworking is needed.

For outstanding clarity and resistance to yellowing and plate out, "DUTCH BOY" FLOMAX 25 is the first choice for film or sheeting. The heat and light stability contributed by FLOMAX 25 is of a high order. FLOMAX 25 can be successfully used with a wide range of plasticizers, including the more sensitive types, and consequently enables the compounder to formulate with the widest possible latitude. Since FLOMAX 25 is entirely liquid, it is also the easiest of all the "DUTCH BOY" stabilizers to disperse. FLOMAX 25 has no lubricating properties. A small amount of stearic acid is often a valuable aid in processing.

"DUTCH BOY" PROVINITE is recommended for the heavier type of sheeting and other high quality applications, where a clear stabilizer is required with an excellent combination of heat and light stability. The heat stability of PROVINITE is slightly above that of FLOMAX 25, while PROVINITE's light stabilizing action is nearly equal to FLOMAX 25. PROVINITE combines high clarity with good resistance to yellowing. Of itself, PROVINITE has a definite lubricating action in vinyl plastic stocks. When formulations are based on PROVINITE, the individual case will determine whether any additional lubricants will be required.

Where complete freedom from sulfide staining is mandatory, "DUTCH BOY" NALZIN may be combined with either FLOMAX 25 or PROVINITE. Recommended amounts of NALZIN are discussed in detail on page 19, and several examples of non-staining stocks are shown in the formulations below.

"DUTCH BOY" PLUMBO-SIL's are among the most versatile and popular stabilizers in the entire field of calendared vinyl products. If sensitive and reactive plasticizers and colorants are present, the ability of both PLUMBO-SIL B and PLUMBO-SIL C to provide excellent stability with a minimum of reactivity is extremely helpful. The additional properties of PLUMBO-SIL B or C, such as low tinning strength, plasticizer spew absorption, and low volume cost, make them especially attractive for both translucent and opaque film. They are widely used and recommended in most types of sheeting such as whites, blacks, pastels, and vivid colors, where the same properties are desired.

For opaque film, and white pastel sheeting, the "DUTCH BOY" basic lead stabilizers are outstanding. DYTIAL and DYPHOS are used for products requiring greater reserve heat stability combined with excellent light stability. They are especially suited for heavier sheeting, where strong stabilization is needed for high-temperature calendaring and reworking cycles. TRIBASE and LECTRO "60" will also provide strong heat stability. LECTRO "60" and the PLUMBO-SIL's are particularly recommended for economy in opaque film and sheeting applications.

Careful control of calendaring conditions is greatly improved through the heat stabilizing action and uniform non-melting character of "DUTCH BOY" DS-207. The lubricating action of DS-207 in opaque and translucent stocks is employed to advantage in conjunction with any of the "DUTCH BOY" stabilizers. When appreciable quantities of organic ester epoxide plasticizers are present, the use of "DUTCH BOY" LEADSTAR is preferred as the lubricant.

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Film (Two to Ten Mils Thick)

Special characteristics to be kept in mind include flame resistance, heat sealing and printability.

CLEAR FILM

FORMULA XVII

High Quality Clear*

Resin	100
Type I A Plasticizer	20
Type I B Plasticizer	15
Type III A Plasticizer	5
Type IV Plasticizer	10
FLOMAX 25	2.5
Stearic Acid	0.5

FORMULA XVIII

High Quality Clear Non-Shading

Resin	100
Type I A Plasticizer	20
Type I B Plasticizer	15
Type III A Plasticizer	5
Type IV Plasticizer	10
FLOMAX 25	2.5
NALZIN	0.5
Stearic Acid	0.5

FORMULA XIX

Low Cost Clear

Resin	100
Type I A Plasticizer	15
Type I A Plasticizer (low cost)	17
Type II A Plasticizer	10
Type III A Plasticizer	5
FLOMAX 25	2.5
Stearic Acid	0.5

*This formulation is not flame resistant. The same excellent method of improving flame resistance in clear vinyl compounds is through substitution of some Type II plasticizer for an equivalent amount of the other plasticizers.

Useful for standard frost

FORMULA XX

High Quality

Resin	
Type I A Plasticizer	
Type I B Plasticizer	
Type II B Plasticizer	
Type IV Plasticizer	
PLUMB-O-SIL	
DS-207	
Supplementary	

FORMULA XXI

Resin	
Type I A Plasticizer	
Type I A Plasticizer	
Type II A Plasticizer	
Type III A Plasticizer	
PLUMB-O-SIL	
FLOMAX 25	

These stocks may be made II or Type V plasticizer, or both

FORMULA XXII

Resin	
Type I A Plasticizer	
Type I B Plasticizer	
Type IV Plasticizer	
DYPHOS	
DS-207	

FORMULA XXIII

Resin	
Type I A Plasticizer	
Type I A Plasticizer	
Type II A Plasticizer	
Type III C Plasticizer	
Filler	
PLUMB-O-SIL	
LECTRO "66"	
DS-207	

*This stock is especially recommended for use

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CLEAR FILM

High Quality Clear*

Resin.....	100
Type I A Plasticizer.....	20
Type I B Plasticizer.....	15
Type II B Plasticizer.....	5
Type IV Plasticizer.....	10
PLUMB-O-SIL C.....	2.5
DS-217.....	0.5

Quality Clear Non-Staining

Resin.....	100
Type I A Plasticizer.....	20
Type I B Plasticizer.....	15
Type II B Plasticizer.....	5
Type IV Plasticizer.....	10
PLUMB-O-SIL C.....	2.5
DS-217.....	0.5
Supplementary Stabilizer.....	0.5

Low Cost Clear

Resin.....	100
Type I A Plasticizer.....	15
Type I A Plasticizer (low cost).....	17
Type II A Plasticizer.....	10
Type III A Plasticizer.....	5
PLUMB-O-SIL C.....	2.5
DS-217.....	0.5

*These amounts are based on the assumption that the resin is of the highest quality and that the plasticizers are of the highest quality.

TRANSLUCENT FILM

Useful for standard frosted finish or vivid blacks and colors.

FORMULA XX

High Quality Translucent (Flame Resistant)

Resin.....	100
Type I A Plasticizer.....	20
Type I B Plasticizer.....	15
Type II B Plasticizer.....	10
Type IV Plasticizer.....	5
PLUMB-O-SIL C.....	2.5
DS-217.....	0.25-1
Supplementary Stabilizer.....	0.5-1

FORMULA XXI

Low Cost Translucent

Resin.....	100
Type I A Plasticizer.....	15
Type I A Plasticizer (low cost).....	17
Type II A Plasticizer.....	10
Type III A Plasticizer.....	5
PLUMB-O-SIL C.....	3
FLUMAX 25.....	1

OPAQUE FILM

These stocks may be made flame resistant either by including 8 to 10 parts of Type II or Type V plasticizer, or by the use of 3-5% antimony oxide, based on the resin.

FORMULA XXII

High Quality Opaque*

Resin.....	100
Type I A Plasticizer.....	25
Type I B Plasticizer.....	15
Type IV Plasticizer.....	10
DYPHOS.....	5
DS-217.....	0.5-1

FORMULA XXIII

Low Cost Opaque

Resin.....	100
Type I A Plasticizer.....	15
Type I A Plasticizer (low cost).....	20
Type II A Plasticizer.....	10
Type III C Plasticizer.....	10
Filter.....	10-20
PLUMB-O-SIL C.....	3
LECTRO "65".....	2
DS-217.....	1

*This stock is especially recommended for outdoor marketing applications.

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Flexible Sheet (Twelve to Twenty-two Mils Thick)
Special problems involved include heat sealing, printability, and need for embossing and press polishing.

FORMULA XXIV

High Quality Clear (Flame Resistant)

Resin	100
Type I A Plasticizer	10
Type I B Plasticizer	15
Type II B Plasticizer	10
Type III A Plasticizer	5
Type IV Plasticizer	10
PROVINITE A	2
PROVINITE B	1

FORMULA XXV

High Quality Clear Non-Sealing

Resin	100
Type I A Plasticizer	20
Type I B Plasticizer	15
Type III A Plasticizer	5
Type IV Plasticizer	15
FLOMAX 25	3
NALZIN	0.5

FORMULA XXVI

High Quality Base for Black and Vird Colors
(Flame Resistant)

Resin	100
Type I A Plasticizer	15
Type I B Plasticizer	10
Type II B Plasticizer	10
Type III A Plasticizer	5
Type III B Plasticizer	5
Type IV Plasticizer	10
PLUMB-O-SIL C	3
PROVINITE A	2
PROVINITE B	1

FORMULA XXVII

Low Cost Base for Black and Vird Colors
(Flame Resistant)

Resin	100
Type I A Plasticizer	20
Type II B Plasticizer	13
Type III A Plasticizer	10
Type III B Plasticizer	10
Type V Plasticizer	5
PLUMB-O-SIL C	3
FLOMAX 25	2

FORMULA XXVIII
High Quality

Resin	
Type I A Plasticizer	
Type I B Plasticizer	
Type II B Plasticizer	
Type IV Plasticizer	
DYPIHOS	
DS-207	

FORMULA XXIX
Low Quality

Resin	
Type I A Plasticizer	
Type I B Plasticizer	
Type III A Plasticizer	
Type III C Plasticizer	
Type V Plasticizer	
Fiber	
PLUMB-O-SIL	
DYTHAL	
LEADSTAR	

E. MOLDING COMPOUNDS

Compression Molding

Molding of vinyl chloride based unbreakable vinyl resin molecular weight copolymer to reduce "tag" characteristics, good wear resistance and reduce in vinyl records containing full fidelity of reproduction in record manufacturers. When transparent CALSTAR is the logical choice.

The compounds may be preblend the ingredients then before any final operations a minute cycle at temperatures of 200° to 250° of the preblend compound. The warm extruder (plasticizer) two-roll calendar. The addition averaging five to ten degrees below the softening point of the compound may be broken into individual heating and mixing operations cycle at 200° to 250° to the two-roll calendar as best suited from the mold, and to run by hand into biscuits.

*This work is currently recommended for being used in the laboratory and not for use in the factory.

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to Twenty-two Mils Thick)
include heat sealing, printability, and need for emboss-

Quality Clear (Flame Resistant)	100
acet.	15
acet.	15
cizer.	10
cizer.	5
ter.	10
ter.	2
ter.	1

Quality Clear Non-Staining	100
acet.	20
acet.	15
cizer.	8
er.	15
er.	3
er.	0.5

Base for Blacks and Violet Colors (Flame Resistant)	100
acet.	15
acet.	10
acet.	10
acet.	5
acet.	8
er.	10
er.	3
er.	2
er.	1

Base for Blacks and Violet Colors (Flame Resistant)	100
acet.	20
acet.	15
acet.	10
cizer.	10
cizer.	10
er.	5
er.	3
er.	2

FORMULA XXVIII High Quality Base for Whites and Patches* (Flame Resistant)

Resin	100
Type I A Plasticizer	23
Type I B Plasticizer	15
Type II B Plasticizer	10
Type IV Plasticizer	10
DYTHIOS	5
DS-207	0.5-1

FORMULA XXIX Low Cost Base for Whites and Patches

Resin	100
Type I A Plasticizer	10
Type I A Plasticizer (low cost)	20
Type III A Plasticizer	10
Type III C Plasticizer	15
Type V Plasticizer	5
Filler	10-40
PLUMBO-SIL C	4
DYTHIAL	2
LEADSTAR	0.5-1

E. MOLDING COMPOUNDS Compression Molding

Molding of vinyl chloride resins has been primarily in the field of compression molded unbreakable vinyl records. These vinyl compounds are based on the lower molecular weight copolymer resins and are used with very little plasticizer, if any, to reduce "grain" characteristics. Any tendency to such "buttery" qualities will promote poor wear resistance and reduce high fidelity. The use of "DUTCH BOY" DS-207, in Vinyl records containing fillers, has been found to promote the maximum degree of fidelity of reproduction in lateral phonograph records thus far measured by independent manufacturers. When transparent rigid recordings are desired, "DUTCH BOY" CALSTAR is the logical choice for a lubricant-stabilizer.

The compounds may be mixed by several procedures. In general, it is desirable to preblend the ingredients thoroughly in a ribbon blender, tumble, or dough mixer before any forming operations are carried out. Use of a Banbury mixer in a four to eight minute cycle at temperatures of 275° to 300° F. will give satisfactory mixing and flaring of the preblend compound. The Banbury mixed stock is then directly transferred to a warm extruder (plasticizer type), where the resultant extruded web is fed into a two-roll calendar. The additional cycle may take four to ten minutes at temperatures averaging five to ten degrees higher than in the Banbury. The stock is stored in bins or sections by a rotary marker as it leaves the calendar. After a cooling cycle, the marked web may be broken into individual bins. A few elaborate schemes are to carry out the entire flaring and mixing operation on a hot two-roll plastic mill in a ten to twenty minute cycle at 270° to 310° F. The hot stock is taken from the mill in slabs and fed to the two-roll calendar as before. An additional alternate procedure is to pelletize the stock from the mill, and to extrude a sufficiently wide web which may be marked or cut by hand into bins.

*Dutch Boy is a registered trademark of the American Cyanamid Company.
When used in the manufacture of a record, it is found that an excess weight of Dutch Boy will cause the stock to completely adhere to the original shape, resulting in permanent deformation.

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The cold biscuits are placed on hot steam tables before the actual record pressing is made. The temperatures of these tables range from 260° to 300° F. In unusual cases an occasional biscuit may be left on them for several hours. Normally this preheat cycle will last from ten to thirty minutes, depending on the efficiency of the press operator. The actual pressing of the preheated biscuits is carried out in a chrome or nickel faced copper record-stamper mold in a fifteen to thirty second press cycle at temperatures of 300° to 350° F. Some manufacturers by-pass the use of biscuits and granulate a Babbury and mill mixed compound into molding powder. The molding powder is preheated, weighed out and molded in a forty-five to sixty second cycle at 300° to 350° F. The relatively short heat history in the molding operation is compensated by the pressure used.

FORMULA XXIV

Abstract

Resin (low swelling)

70% Chlorinated
Filler
Carnauba Wax
Carbon Black
DS-207
DYPHOS

Injection Molding

Injection molding of the successful in the automotive the expansion of vinyl resins. of satisfactory stabilizers. T molding. Small pellets of the slabbed off a hot two-roll p Banbury mixer or hot plastic Injection molding temperatures as thirty thousand p

For clear injection mold heat stability and clarity. Opaque compounds during stresses heat protection of

For best lubricating and
biastium with the basic lo
CLARITE or the mber "D"
lubricant for clear molded

An alternate injection of plantlets using fertilization plantlets may be injection as those described above, but through flushing and full of

FORMULA XXV

This translation is suitable for high ability boys playing records and more quiet children's records. They are made from the two translations of the first and second company records described above. They are made from the two translations of the first and second company records described above. They are made from the two translations of the first and second company records described above.

□

Resin
Type I A P
Type II B
Type III A
Type IV P
CLARITE
CLARITE
CALSTAR

Thanks based on the new broadcast
program and others, but many have
of a one-minute morning show segment.

NOTICE: If the film image is less clear than this notice, it is due to the quality of the document being filmed

placed on hot steam tables before the actual record pressing is if these tables range from 260° to 300° F. In unusual cases on left on them for several hours. Normally this preheat cycle y minutes, depending on the efficiency of the press operator. preheated biscuits is carried out in a chrome or nickel faced id in a fifteen to thirty second press cycle at temperatures of ufacturers by-pass the use of biscuits and granulate a Banbury d into molding powder. The molding powder is preheated, in a forty-five to sixty second cycle at 300° to 350° F. The y in the molding operation is intensified by the pressure used.

VYL RECORD FORMULATIONS

Transparent Record Formulation*

molecular weight vinyl chloride copolymers)	97.5-97.8
Wax or substitute	0.5-1.0
	0.5
	1.5

Low Filler Content Records**

molecular weight vinyl chloride copolymers)	75
B Plasticizer	4
	16
Wax or substitute	1
sch	2
	2
	1

Low Cost Record Formulation***

molecular weight vinyl chloride copolymers)	38
Plasticizer****	5
Plasticizer (solid)	1.5
Plasticizer	1
	52.5
Wax or substitute	0.5
	1.5

Substitute long phasing records and some quality children's records. They are made on low cost vinyl chloride copolymers and are made on a good quality 4 inch children's record. The low filler records are made on the standard 4 inch records and in the market. They are made on the 10 inch records of popular and semi-popular records. They are made on the 10 inch records of popular and semi-popular records. They are made on the 10 inch records of popular and semi-popular records.

FORMULA XXXIII

Alternate Low Cost Record Formulation*

Resin (low molecular weight vinyl chloride copolymers)	30
70% Chlorinated Paraffin	15
Filler	51
Carbazole Wax or substitute	0.5
Carbon Black	1
DS-207	1.5
DYPHOS	1

Injection Molding

Injection molding of flexible parts from plasticized vinyl chloride resins has been successful in the summative equipment field. It is one of the promising outlets for the expansion of vinyl resins. This development has been contingent upon the availability of satisfactory stabilizers. Two major techniques are currently utilized for injection molding. Small pellets of fused material may be prepared by granulating compounds slabbled off a hot two-roll plastic mill. The original fusing is carried out by using a Banbury mixer or hot plastic mill in the time and heat cycles described previously. Injection molding temperatures of 300° to 360° F., over short time cycles, at pressures of fifteen to thirty thousand pounds per square inch are required.

For clear injection molding formulations, CLARITE is recommended for its high heat stability and clarity. DYTHAL or TRIBASE should be used for stabilizing opaque compounds during the vigorous heat cycle. These two stabilizers offer the greatest heat protection of the basic lead materials.

For best lubricating and mold release properties, DS-207 should be used in combination with the basic lead stabilizers. If additional lubricity is required with CLARITE or the other "DUTCH BOY" non-lead stabilizers, CALSTAR is the best lubricant for clear molded products.

An alternate injection molding procedure can be based on the injection molding of plastics using formulations that will be discussed in the following section. The plastics may be injection molded at the same temperatures and at lower pressures than those described above, but will require considerably longer time cycles to obtain thorough fusing and full development of physical properties.

FORMULA XXXIV

Clear Injection Molding Formulation**

Resin	100
Type I A Plasticizer	25
Type II B Plasticizer	15
Type III A Plasticizer	8
Type IV Plasticizer	12
CLARITE A	3
CLARITE B	1.5
CALSTAR	1

*Based on the use of these stabilizers as substitutes for the 10 inch records of popular and semi-popular records. They are made on low cost vinyl chloride copolymers and are made on a good quality 4 inch children's record. The low filler records are made on the standard 4 inch records and in the market. They are made on the 10 inch records of popular and semi-popular records. They are made on the 10 inch records of popular and semi-popular records.

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FORMULA XXXIV

Opaque Injection Molding Formulation

Resin	100
Type I A Plasticizer	30
Type II B Plasticizer	15
Type IV Plasticizer	15
Filler	10-20
DYTHIAL or TRIBASE	7
DS-207	2

F. PLASTISOLS AND ORGANOSOLS

The development of polyvinyl chloride type resins of particle size, shape and nature which permit formation of a workable plasticizer-resin paste has led to new product developments in a number of fields. Mixing the usual calendaring resin in the ratio of about two parts resin to one part plasticizer yields a dry dough which cannot be easily spread or molded under low pressure. The "paste resin," on the other hand, is not solvated by the common plasticizers at room temperature. Syrupy pastes are formed even by simple mixing, although mechanical grinding may be helpful. These resin-plasticizer pastes are referred to as plastisols. Use of a volatile non-solvating diluent or thinner acts to reduce the viscosity of these pastes and promotes greater ease of handling in the final application. These diluent-plasticizer-resin systems are referred to as organosols.

Since these paste resins can be formulated in two different ways, namely the plastisol and organosol systems, a wide variety of products of varying hardness is possible in the field of "slush" molding, and spread and dip coating. Films may be cast in one application in thicknesses of four to twenty mils with plastisols. Thinner films are more satisfactorily formed from organosol systems. Coating of fabrics and papers may also be carried out from either plastisols or organosols depending on the thickness and hardness required for the final coating. Cast films and coating compounds must be heat-treated to promote the fusion of the plasticizer-resin systems and drive off any volatile solvents. Temperatures of 325° to 375° F. for one-half to five minutes are required. The longer times and higher temperatures are required for thicker films.

Low pressure "slush" molding may be carried out by pouring plastisols into molds and then fusing by application of heat with relatively low applied pressure on the slush in the mold. There is practically no shrinkage in the mold due to the absence of a chemical reaction or the loss of volatiles. Temperatures of 350° to 390° F. for periods of one to five minutes are required to "cure" or fuse the vinyl compounds. High frequency electronic equipment has recently been developed for fusing thick sections.

Many variations in compounding of plastisols and organosols are called for by the diversified end-uses they meet in practice, and stabilization requirements fluctuate accordingly. Several general principles apply. The dispersion resins are less stable than the calendaring and extrusion types, particularly with regard to light stability. There is usually a higher ratio of plasticizer to the resin than in the conventional vinyl resin stocks, so that plasticizer stability and reactivity are of utmost importance in proper stabilization. The removal of air and moisture in order to prevent gassing in the finished product is essential, and the choice of a stabilizer and other ingredients must exclude any materials which tend to absorb and retain appreciable amounts of moisture.

"DUTCH BOY" F
It is especially useful for
uses, with excellent resis-
tance, and maintains
conditions. In all disper-
sions, NITE A and B, based on
PROVINITE A can be

"DUTCH BOY" F
number of desirable prop-
erties compare very favorably
for the highest degree of in-
crease in plasticizer vis-
cosity on adhesion, and does not
interfere in plastisols because

Where maximum re-
sistance should be used
with the directions given

"DUTCH BOY" C
lens light stabilizing
solution coatings, either as
recommended for applica-

"DUTCH BOY" D
and systems. It imparts an
among all stabilizers in use
that they compare favorably

"DUTCH BOY" T
recommended for use in open
protection during the cure

"DUTCH BOY" D
confers excellent heat sta-
bilizer in the field of "slush"
plus mold release.

"DUTCH BOY" P
and plastisols. It combines
and low reactivity with plastic-
izer PLUMBO-SIL C has a
plasticized compounds, a
stability case should be even
high a viscosity in the final

The control of film
"DUTCH BOY" BENT
advantage in this type of
formed through the high

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Injection Molding Formulation

.....	100
.....	30
.....	15
.....	15
.....	10-20
.....	7
.....	2

ISOLS

chloride type resins of particle size, shape and nature suitable plasticizer-resin paste has led to new product. Mixing the usual extendering resin in the ratio of plasticizer yields a dry dough which cannot be easily sure. The "paste resin," on the other hand, is not res at room temperature. Syrupy pastes are formed mechanical grinding may be helpful. These resin-plasticizers. Use of a volatile non-solvent diluent or of these pastes and promotes greater ease of handling. Diluent-plasticizer-resin systems are referred to as

be formulated in two different ways, namely the wide variety of products of varying hardness in ling, and spread and dip coating. Films may be cast four to twenty mils with plasticizers. Thinner films are granular systems. Coating of fabrics and papers may tins and organometals depending on the thickness and ating. Cast films and coating compounds must be of the plasticizer-resin systems and drive off any 325° to 375° F. for one-half to five minutes are her temperatures are required for thicker films.

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g of plasticizers and organometals are called for by the service, and stabilization requirements fluctuate ter apply. The dispersion resins are less stable than particularly with regard to light stability. There er to the resin than in the conventional vinyl resin and reactivity are of utmost importance in proper moisture in order to prevent gassing in the finished of a stabilizer and other ingredients must exclude and retain appreciable amounts of moisture.

"DUTCH BOY" PROVINITE is highly recommended for clear plasticizers. It is especially useful for its performance under high processing and service temperatures, with excellent retention of clarity. PROVINITE contributes excellent light stability, and maintains the color and clarity of the stock under outdoor weathering conditions. In all dispersion resin applications, the usual level is 1% each of PROVINITE A and B, based on the resin. For special high heat conditions, the amount of PROVINITE A can be increased to meet compounding requirements.

"DUTCH BOY" FLOMAX 25 is a clear liquid stabilizer which combines a number of desirable properties in dispersion resin systems. Its heat and light stabilizers compare very favorably with those of PROVINITE. It is especially recommended for the highest degree of clarity. FLOMAX 25 disperses readily and develops minimum increase in plastic viscosity on aging. It has no lubricating action, no adverse effect on adhesion, and does not plate out on mold surfaces. FLOMAX 25 is particularly useful in plasticizers because its low surface tension promotes rapid and easy deaeration.

Where maximum resistance to sulfide staining is required, "DUTCH BOY" NALZIN should be used with either FLOMAX 25 or PROVINITE in accordance with the directions given on page 19.

"DUTCH BOY" CS-137 is useful in plasticizers for fabric coatings where additional light stabilization is desired. It is especially suited for organometals and vinyl solution coatings, either alone or as a supplementary stabilizer. CS-137 is particularly recommended for applications in which freedom from sulfide staining is desirable.

"DUTCH BOY" DYPHOS is an outstanding stabilizer for plastic and organometal systems. It imparts unequalled heat stability for the fusing cycles, and it is unique among all stabilizers in its ability to stabilize dispersion resins against light, to the extent that they compare favorably with the calendering and extrusion resins.

"DUTCH BOY" TRIBASE is an excellent heat stabilizer which is highly recommended for use in opaque slush molding plasticizers. TRIBASE offers maximum protection during the severe heat history encountered in the molding operation.

"DUTCH BOY" DS-307 performs a special task in dispersion resin systems. It confers excellent heat stability, and its lubricating action makes it the most useful stabilizer in the field of "slush" molding, due to its two-fold performance of stabilization plus mold release.

"DUTCH BOY" PLUMBO-SIL C is a very effective stabilizer for organometals and plasticizers. It combines the advantages of low taring strength for translucent stocks and low reactivity with plasticizers and colorants, with good heat stability and economy. PLUMBO-SIL C has a useful ability to absorb migratory components in highly plasticized compounds, resulting in an attractive dry surface. Due to its adsorptive ability care should be exercised when formulating with PLUMBO-SIL C to avoid too high a viscosity in the finished system.

The control of flow properties in plasticizers is readily achieved by the use of "DUTCH BOY" BENTONE 35 as a thickening agent. BENTONE 35 is of special advantage in this type of application, because its control of sag or penetration is maintained through the high temperature fusion cycle.

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FORMULA XXXVI

Clear High Quality Plastic

Resin (dispersion type).....	100
Type I A Plasticizer.....	40
Type I B Plasticizer.....	15
Type III A Plasticizer.....	10
PROVINITE A.....	1
PROVINITE B.....	1

FORMULA XXXVII

Clear Shock Molding Plastic

Resin (dispersion type).....	100
Type I A Plasticizer.....	40
Type I B Plasticizer.....	25
Type III A Plasticizer.....	10
Type VI A Plasticizer.....	10
FLOMAX 25.....	3

FORMULA XXXVIII

High Quality Opacifier Plastic*

Resin (dispersion type).....	100
Type I A Plasticizer.....	30
Type I A Plasticizer (low cost).....	10
Type I B Plasticizer.....	15
Type III A Plasticizer.....	10
DYPHIOS.....	5

FORMULA XXXIX

Opacifier Shock Molding Plastic

Resin.....	100
Type I A Plasticizer.....	35
Type I A Plasticizer (low cost).....	15
Type I B Plasticizer.....	25
Type VI A Plasticizer.....	10
TRIBASE.....	5
DS-307.....	1

*This resin is especially recommended for outdoor weathering applications.

FORMULA XL

Resin (Type I)
Type I
Type II
Type IV
Methyl
Xylene
Naphth
FLOMAX
CS-117
NALZ

FORMULA XLI

Resin (Type I)
Type I
Type II
Type III
Filler
Xylene
Naphth
DYPH

C. MISCELLANEOUS

The vinyl resins that many specialize separately here. In the combinations are in stabilizers follow the previously.

When little or no to be most satisfactory resins. The prime resins, DYTHAL and DYPH, FLOMAX 25 is recommended.

The high heat requirements of both "DUTCH BOY" D systems follows the chloroparaffins, so it systems containing "DUTCH BOY" D systems, but is greatly of them.

We suggest the products containing "DUTCH BOY" D systems, but is greatly of them.

This is especially of other applications and systems, but is greatly of them.

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XXXX

Clear High Quality Plastic

(dispersion type).....	100
I A Plasticizer.....	40
I B Plasticizer.....	15
III A Plasticizer.....	10
INITE A.....	1
INITE B.....	1

XXXX

Clear Starch Molding Plastic

(dispersion type).....	100
I A Plasticizer.....	40
I B Plasticizer.....	25
II A Plasticizer.....	10
VI A Plasticizer.....	10
IAX 25.....	3

XXXX

High Quality Orange Plastic

(dispersion type).....	100
A Plasticizer.....	30
A Plasticizer (low cost).....	10
B Plasticizer.....	15
A Plasticizer.....	10
I.....	5

XX

Orange Starch Molding Plastic

(dispersion type).....	100
Plasticizer.....	35
A Plasticizer (low cost).....	15
B Plasticizer.....	25
I A Plasticizer.....	10
IE.....	5
.....	1

add no further stabilizing applications

FORMULA XL

High Quality Clear Non-Staining Organosol

Resin (dispersion type).....	100
Type I A Plasticizer.....	20
Type III A Plasticizer.....	10
Type IV Plasticizer.....	5
Methyl Isobutyl Ketone.....	33*
Xylene.....	43*
Naphthene Thinner.....	89*
FLOMAX 25.....	2
CS-137.....	1
NALZIN.....	0.3

FORMULA XL

Low Cost Organosol

Resin (dispersion type).....	100
Type I A Plasticizer.....	25
Type I A Plasticizer (low cost).....	10
Type III A Plasticizer.....	5
Filler.....	15**
Xylene.....	96***
Naphthene Thinner.....	42***
DYPHOS.....	5

C. MISCELLANEOUS COMPOUNDS

The vinyl resins are so versatile in their properties and compounding possibilities that many specialized applications are being developed which cannot be treated separately here. In the coating field particularly, many special compositions and resin combinations are in everyday use. For these applications, the "DUTCH BOY" vinyl stabilizers follow the general rules of application demonstrated in the fields discussed previously.

When little or no Type II A plasticizer is used, DYTAL and DYPHOS appear to be most satisfactory for printing inks containing the usual low molecular weight vinyl resins. The prime requisites of these inks are good light stability and adhesion. Both DYTAL and DYPHOS contribute outstanding light resistance to vinyl printing inks. FLOMAX 25 is recommended for vinyl printing inks which must be resistant to sulfide staining.

The high heat resistance, retention of flexibility and gloss, and light stability requirements of baked vinyl resins can satisfactorily be obtained by use of "DUTCH BOY" DYTAL or "DUTCH BOY" DYPHOS. Formulation of these systems follows the suggestions made in the sections on organosols.

The successful use of "DUTCH BOY" DYPHOS in vinyl stocks containing chloroparaffins, to which we have previously referred,*** has been extended to paint systems containing chloroparaffins and chlorinated rubber. Recent work has shown that "DUTCH BOY" DYPHOS not only improves color retention and service life of such systems, but it greatly decreases the yellowing tendencies which have been characteristic of them.

We suggest the investigation of "DUTCH BOY" stabilizers for any organic products containing halogens which may be exposed to heat, light or weathering.

*This is approximately 40% solids content. Solid content down to 20 to 30% for use in very thin coatings and other similar applications may be tested or available through the use of "DUTCH BOY" stabilizers which contain 100% solids.

**This is approximately 10% solids content. Solid content down to 5 to 10% for use in very thin coatings and other similar applications may be tested or available through the use of "DUTCH BOY" stabilizers which contain 100% solids.

***See Page 24.

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VII. CONCLUSION

The foregoing pages have indicated the general usefulness of the various "DUTCH BOY" Stabilizers. The wide variety of applications and specific problems, however, which the vinyl compounder encounters are beyond the scope of any manual. The National Lead Company Research Laboratories and Technical Service Department are steadily working to increase the over-all knowledge of the chlorinated resin fields. As additional information becomes available and new products are developed, factual data will be promptly issued to the industry.

Representatives of the Technical Service Department are available at all times to discuss individual problems in confidence and indicate the best methods for using "DUTCH BOY" chemicals based upon research laboratory data.

The reader is cordially invited to write or call the nearest Branch Office of the National Lead Company and will receive prompt attention in getting all the information and technical assistance available.

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CLEVELAND 11, OHIO
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DALLAS 2, TEXAS
929 Terminal Street

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CANADIAN TITANIUM PRODUCTS LIMITED
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2240 24th Street

SEATTLE 4, WASHINGTON
1128 West Spokane Street

CANADIAN TITANIUM PRODUCTS LIMITED
Terminal Warehouse
Foot of York Street
Toronto, Ontario, Canada

The occurrence of others, and of however, and the and upon reading of such products possible use of the in infringement

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VII. CONCLUSION

have indicated the general usefulness of the various "DUTCH" side variety of applications and specific problems, however, user encounters are beyond the scope of any manual. The Research Laboratories and Technical Service Department increase the over-all knowledge of the chlorinated resin fields, becomes available and new products are developed, factored to the industry.

Technical Service Department are available at all times to us in confidence and indicate the best methods for using its based upon research laboratory data. It is invited to write or call the nearest Branch Office of the and will receive prompt attention in getting all the information available.

Note

The recommendations made in this booklet are based on our research and the research of others, and are believed to be accurate. No guarantee of their accuracy is made, however, and the products described are sold without warranty, express or implied, and upon condition that purchasers shall make their own tests to determine the suitability of such products for their particular purposes. Likewise, comments concerning the possible use of these products are not intended as recommendations to use these products in infringement of any patent.

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