WHITE PIGMENT CATECHISM

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ARE PIGMENTS?

Pigments are the fine solid particles used in the preparation of paint and are substantially insoluble in the vehicle.

MAY THE DIFFERENT PIGMENTS USED IN PAINT BE CLASSIFIED?

Several methods of classification are used, dependent upon color, opacity, chemical similarity, etc. A satisfactory division is:

OPAQUE WHITE PIGMENTS, such as the white leads, zinc sulphide pigments, zinc oxide, titanium pigments, etc.

REINFORCING PIGMENTS, including the pigments of little or no opacity, as blanc fixe, calcium sulphate and carbonate, silica, etc.

NATURAL EARTH COLORS, as the iron oxides, siennas, umbers, etc.

LAKE COLORS, to include those pigments prepared by precipitation of a dye onto a base (usually one of the inerts or alumina hydrate).

ARE THE PRINCIPAL OPAQUE WHITE PIGMENTS USED IN PAINT?

WHITE LEAD (basic lead carbonate)

WHITE LEAD (Basic lead sulphate)

ZINC OXIDE

ANTIMONY OXIDE

LEADED - ZINC OXIDE

LITHOPONE

ZINC SULPHIDE (and the reinforced Zinc Sulphide Pigments)

TITANIUM DIOXIDE (and the reinforced Titanium Pigments)

...T ARE THE MOST IMPORTANT REINFORCING PIGMENTS?

BARIUM SULPHATE, either as ground barytes or as blanc fixe

CALCIUM SULPHATE, as precipitated, as gypsum, or as calcined

SILICA

WHITING

ASBESTINE

TALCS, MICACEOUS TALCS and MICA

...T AVERAGE BULKING VALUES ARE SHOWN BY THE WHITE PIGMENTS AND INERTS?

	Specific Gravity	One Pound Bulk Gallons	Weight of Pigment in 28.5 Gals.
...ite Lead (Basic lead carbonate)	6.81	.01763	1317 lbs.
...ite Lead (Basic lead sulphate)	6.41	.01873	1522 lbs.
...nc Oxide	5.66	.02121	1343 lbs.
...nc Oxide (Leaded 35%)	5.65	.02052	1389 lbs.
...nd Oxide (Leaded 40%)	5.94	.02021	1410 lbs.
...nc Oxide (Leaded 50%)	6.06	.01974	1444 lbs.
...thopone	4.30	.02792	1021 lbs.
...gh opacity lithopone (titanated)	4.22	.02847	1001 lbs.
...S Pigment (ca) (crypt CB-21)	3.1	.03875	736 lbs.
...S Pigment (magnesium)(crypt MB-170)	3.35	.0361	789 lbs.
...S Pigment (Ba)	4.20	.02853	997 lbs.
...nc Sulphide	4.00	.03001	950 lbs.
...tanium Pigment (Barium)	4.30	.02792	1021 lbs.
...tanium Pigment (Calcium)	3.13	.03836	743 lbs.
...tanium Pigment (magnesium)(Ti-Sil)	3.093	.03878	735 lbs.
...tanium Dioxide	5.88	.0309	922 lbs.
...timony Oxide (Timonox)	5.75	.02090	1364 lbs.

Reference - Bibliography (3)

...T IS THE SIGNIFICANCE OF INDEX OF REFRACTION?

The refractive index of a pigment measures its power to bend light. From a purely optical viewpoint, the reflecting value of a pigment, and consequently its HIDING POWER, depends upon the square of the differences between the index of refraction of the pigment and the index of refraction of the medium surrounding it.

The index of refraction of a dry film is in the vicinity of 1.48 to 1.54 for oil films and up to 1.70 for films of synthetic composition, and the white pigments run above this. Therefore, generally speaking, the higher the index of refraction of the pigment, the better its hiding power.

This is not strictly true, since other properties, such as particle size, have a bearing on hiding power. Thus for every refractive index (single pigment), there is an optimum particle size at which its hiding power is at its best.

The refractive indices of the common white pigments are:

	Against Air	
Lead Carbonate (Basic)	1.94 to 2.09	(4),(7)
Lead Sulphate (Basic)	1.93	(4),(7)
Antimony Oxide	2.09 to 2.35	(3),(8)
Zinc Oxide	2.02	(4),(7)
Lithopone	1.84	(7)
Barium Titanate	2.38	
Zinc Sulphide	2.37	(7)
TiO_2	2.55	(8)

NOTE: (Numbers in parenthesis are to references found in bibliography attached.)

WHAT IS THE DIFFERENCE BETWEEN THE TERMS "COVERING POWER," "HIDING POWER," "OPACITY," AND "TINTING STRENGTH?"

These four terms are used rather loosely. Correctly speaking they are entirely different measures.

The Covering Power of a paint is its ability to spread out over or "cover" a surface with a thin film, and is measured as area or "spread." Covering power bears no relation to the hiding power or opacity of the film.

The Hiding Power of a paint or pigment is defined by the A.S.T.M. as its ability to obscure a surface over which it is spread. The hiding power of a pigment is usually expressed as square feet per pound; of a paint as square feet per gallon. The figures given for Hiding Power indicate the number of square feet of a contrasting black/white surface which will be "completely" obliterated to normal eye by one pound of the pigment (in a vehicle) or by one gallon of paint.

Opacity is a measure of the power of a film to obstruct transmitted light; that is, light passed through the film as against the measure of light reflected from it as is the case with Hiding Power.

Tinting Strength is the ability of a pigment to resist dilution with another pigment, or, the power of a pigment to color a given quantity of paint or other pigment.

WHAT ARE THE USUAL FIGURES FOR HIDING POWER OF WHITE PIGMENTS?

The figures given by different authors in the literature vary considerably according to the method of measure, the particular sample used, etc. Particle size, brightness, the vehicle formulation in which measured, ratio of pigment to vehicle, and a number of other factors may vary the figures obtained. The Hiding Power of a given pigment is therefore not an absolute value; depends upon the condition of its usage; and when figures are given they must be considered as, at best, averages.

The following figures are found in the literature:

	OPACITY AS SQ. FT. PER LB. OVER BLACK	
	Hallet	Hallet Hiding Power
Basic Lead Carbonate	15 - 18	100
Basic Lead Sulphate	15	82
Zinc Oxide	20	103
Leaded-Zinc Oxide		
Lithopone	27	85
50% ZnS Pigment (Barium)	44	
50% ZnS Pigment (Calcium)		
15% Titanated Lithopone	44	
Zinc Sulphide	58	
25% TiO_2 Pigment (Barium)	40	167
30% TiO_2 Pigment (Calcium)	48	
Titanium Dioxide	115	
Antimony Oxide		

HIDING POWER (3) A.S.T.M. PAINTS TINTED BLUE

	Tinting Strength		Hiding Power Sq. Ft./ Lb. Pigment	
	Blue	Black	Tinted	Untinted
Basic Lead Carbonate	100	100	26.9	15.1
Zinc Oxide	287	225	43.0	26.8
Lithopone	251	200	42.1	28.3
25% Titanium Pigment	433	410	60.4	55.3
Zinc Sulphide	470	545	56.3	46.6
Titanium Dioxide	942	1050	80.5	64.3

A.S.T.M. HIDING POWER (3)

Sq. Ft./ Lb. Pigment

	Cryptometer	Linoleum Brush-Outs Operator 1	Operator 2
Basic Lead Carbonate	15.3	14.4	15.8
Zinc Oxide	22.9	25.5	28.0
Lithopone	26.3	27.3	29.2
Titanox (B?)	22.4	34.6	35.9
Zinc Sulphide	41.6	46.2	47.0
Titanium Dioxide	56.3	61.2	67.5

HIDING POWER OF PAINTS OF EQUAL MOBILITY (3)

Sq. Ft./Lb. Pigment

	CRYPTOMETER		LINOLEUM BRUSH-OUTS	
	Fresh Paint	Aged Two Weeks	Fresh Paint	Aged Two Weeks
Titanium Dioxide	62.6	61.2	68.0	58.7
Zinc Sulphide	30.7	28.5	43.0	42.8
Titanox C	25.6	26.1	40.5	37.9
Zinc Oxide	25.0	25.2	39.7	30.2
ZnS Pig. Barium	23.9	23.8	37.2	33.9
Titanox B	22.8	23.1	35.5	31.8
Antimony Oxide	22.2	22.1	29.6	30.9
Lithopone	21.8	24.0	28.7	30.0
35% Leaded Zinc Oxide	17.6	17.8	25.4	23.6
Basic Lead Carbonate	14.7	14.0	17.3	22.9
Basic Lead Sulphate	12.9	12.7	15.5	14.3

A.S.T.M. HIDING POWER AT DIFFERENT CONTRAST RATIO (3)

Pigment	Methods Using Photometric Endpoint				Methods Using Visual Grading For Establishing Complete Hiding				
	Photo-elect. Cryptometer		Mechanical Brush-out		Gard-ner Brush out	Mod. Mech. Brush Out	Abso-lute Crypt-ometer	Cryptometer 60/40 Pigment Vehicle Ratio	
	99%	98%	99%	98%				Original Brushout	90%
Basic Lead Carbonate	14.7	19.9	14.0	18.0	13.6	13.6	15.2	14.6	11.6
Zinc Oxide	25.5	30.2	24.0	52.0	19.9	19.9	22.0	18.6	18.6
Lithopone	24.0	34.1	26.3	34.0	20.2	20.2	23.0	19.8	23.7
Titanox B	25.0	37.3	27.0	45.0	22.0	22.0	23.5	18.0	25.6
Titanated Lithopone	27.5	45.0	35.0	43.0	23.8	23.0	30.7	26.3	28.8
Titanox C	30.7	45.7	35.5	56.0	25.9	25.9	28.9	24.1	31.3
ZnS Pigment Barium	28.0	50.2	35.0	47.0	20.9	25.8	34.0	30.2	36.1
Zinc Sulphide	53.0	76.1	53.0	71.0	43.2	56.6	44.8	41.2	47.7
Titanium Oxide	84.5	132.7	84.0	128.0	54.4	52.0	62.8	43.7	67.9

IS CHEMICAL REACTIVITY IN A PIGMENT?

When the pigment has a "basic" composition such as Zinc Oxide (ZnO) the acidic components of the vehicle may react chemically with it to form a metallic soap (Zinc Linoleate).

Some pigments, such as pure zinc sulphide, do not normally react in this manner. Zinc sulphide pigment, however, is not 100% ZnS, but contains small amounts of other substances of which ZnO (Zinc Oxide) is usually one. This fraction of basic component (ZnO usually less than 1/2%) may react with linseed or other free fatty acids to form the zinc soap.

The relative reactivity then is the degree to which the pigment will combine chemically with acidic substances of the vehicle to form soaps.

Such soaps are of interest to the paint maker in obtaining certain effects in consistency, dispersion, drying, etc., and as a result, some special modifications of pigments (reactive lithopone) are offered. These have been treated with basic materials to produce the reactive effect.

IS THE IMPORTANCE OF "CHEMICAL COMPOSITION" IN EVALUATING WHITE PIGMENTS?

The ideal chemical composition of each kind of white pigment being known, the testing of a sample for composition gives a measure of its purity and indicates the degree of accidental or deliberate adulteration.

A certain proportion of impurities are expected in any commercial process, and the permissible degree has been established by the A.S.T.M.

PIGMENT	THEORY COMPOSITION	A.S.T.M. SPECIFICATION	Max.	Min.
Basic Lead Carbonate	$2\ PbCO_3 \cdot Pb(OH)_2$ (Ratio of the $PbCO_3$ to $Pb(OH)_2$ may vary somewhat in different production processes.)	Lead carbonate ($PbCO_3$), %	75.0	65.0
		Total impurities including moisture	2.0	
		Coarse particles retained on 325 sieve	1.0	
Basic Sulphate White Lead		Coarse particles retained on 325 sieve	1.0	
		Total impurities including moisture	1.0	
	Lead Oxide (PbO)		18.0	11.0
	Zinc Oxide (ZnO)		9.0	
	Lead Sulphate ($PbSO_4$)		Rem.	Rem.
Sublimed Blue Lead	Lead Sulphate ($PbSO_4$), %			45.0
	Lead Oxide (PbO), %			30.0
	Lead sulfide (PbS), %		12.0	
	Lead Sulfite ($PbSO_3$), %		5.0	
	Zinc Oxide (ZnO), %		5.0	
	Carbon and undetermined		5.0	
	coarse particles--total residue on 325 sieve		1.0	

		AMERICAN PROCESS Max.	AMERICAN PROCESS Min.	FRENCH PROCESS Max.	FRENCH PROCESS Min.
Zinc Oxide	Coarse particles retained in 325 sieve	1.0		1.0	
	Zinc oxide (ZnO) %		98		99
	Total sulfur, %	0.2		0.1	
	Total impurities including moisture, %	2.0		1.0	

Leaded Zinc Oxide		High-leaded Max.	High-leaded Min.	Low-leaded Max.	Low-leaded Min.
	Coarse particles retained on 325 sieve	1.0		1.0	
	Zinc oxide (ZnO) %		60		93
	Water soluble salts	1.0		1.0	
	Total impurities including moisture	1.5		1.5	
	Normal or basic lead sulfate	remainder	rem.	rem.	rem.

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Leaded Zinc Oxides (35%)		
	Zinc Oxide (ZnO)	65%
	Basic lead sulfate	35%

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Lithopone		Max.	Min.
	Coarse particles retained on 325 sieve, %	1.0	
	Zinc sulfide (ZnS), %		28.0
	Zinc oxide, (ZnO), %	2.0	
	Material soluble in water, %	0.8	
	Barium sulfate ($BaSO_4$)	98% of the remainder	

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High Opacity Lithopone (Titanated)		
	Zinc Sulfide (ZnS)	25%
	Barium Sulfate ($BaSO_4$)	60%
	Titanium dioxide (TiO_2)	15%

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Zinc Sulfide Pigment (Barium)		Max.	Min.
	Coarse particles retained on 325 sieve, %	1.0	
	Zinc Sulfide (ZnS), %		45.0
	Zinc Oxide (ZnO), %	1.0	
	Moisture, %	0.5	
	Barium sulfate ($BaSO_4$), %	Remainder	Remainder

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Zinc Sulfide Pigment (Calcium)		
	Zinc Sulfide (ZnS)	50%
	Calcium Sulfate ($CaSO_4$)	50%

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Zinc Sulfide Pigment (Magnesium)	Magnesium Silicate	50%
	Zinc Sulfide	50%

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		Max.	Min.
Zinc Sulfide (ZnS)	Coarse particles retained on 325 sieve	1.0	
	Zinc Sulfide (ZnS), %		95.0
	Zinc oxide (ZnO), %	1.0	
	Moisture, %	0.5	

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		REGULAR		"HIGH HIDING"	
		Max.	Min.	Max.	Min.
Titanium Pigment (Barium)	Coarse particles retained on 325 sieve, %	1.0		1.0	
	Titanium Dioxide (TiO_2), %		24.0		29.0
	Total impurities, including moisture, %	1.0		1.0	
	Barium Sulfate ($BaSO_4$), %	Remainder	rem.	rem.	rem.

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		Max.	Min.
Titanium Pigment (Calcium)	Coarse particles retained on 325 sieve	1.0	
	Titanium Dioxide (TiO_2), %		28.0
	Total impurities including moisture, %	1.0	
	Anhydrous calcium sulfate ($CaSO_4$)	Remainder	Remainder

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Titanium Pigment (Magnesium)	Magnesium Silicate	70%
	Titanium Dioxide	30%

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		Max.	Min.
Titanium Dioxide	Coarse particles retained on 325 sieve	1.0	
	Titanium Dioxide (TiO_2), %		97.0
	Moisture, %	0.5	

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Barium Titanate ($BaTiO_3$)	Substantially pure barium titanate.

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Lead Titanate ($PbTiO_3$)	Substantially pure lead titanate.
Zinc Titanate ($ZnTiO_3$)	Substantially pure zinc titanate.
Antimony Oxide	Principally antimony oxide (Sb_2O_3)

IS THE EFFECT OF "ALKALINITY" IN THE WHITE PIGMENTS?

Acidity or alkalinity is usually referred to as "pH" which indicates hydrogen ion concentration. In pH range 7 is considered as practically neutral. As the pH goes below 7, the pigment becomes more acid and similarly, the higher above 7 it is, the more alkaline.

In considering what this means in terms of relative acidity or alkalinity, progression from 7 to 6 or from 7 to 8, for instance, is logarithmic. That is, a pH of 6 indicates that the acidity is 10 times that of pure water, while a figure of 8 pH means that the alkalinity is 10 times that of pure water.

Consequently the alkalinity of a pigment having a pH of 9.0 will be 10 times that of one of a pH = 8; or 100 times that of one having a pH = 7.

The pH of pigments varies considerably and with some types, as lithopones, may run anywhere between 6 and 10 on different brands. The effect of pH, furthermore, is different with different pigments. Generally, increasing pH gives easier wetting and mixing and inclination to reactivity or soap formation with the liquids. The differences found are sight, however, and more emphasis is placed on the surface characteristics of the pigment as a whole of which the pH is only one indication.

The following figures are given as the pH value of pigments in National Paint & Varnish Assoc. Scient. Circ. No. 491:

Aluminum Hydrate	6.1	Litho. (Regular)	7.0
Antimony Oxide	4.2 - 4.25	H. S. Lithopone	8.8
Asbestine	8.4	Titanated Litho.	7.9 - 8.0
Blanc Fixe	8.5	Talc	9.15
Basic Carb. Wh. Lead	5.9	Barium Base)	
Basic Sulph. Blue Lead	6.0	Titanium Pig)	7.6
Basic Sulph. White Lead	6.2 - 6.25	Calcium Base)	
Calcium Sulph. (Gypsum)	6.7 - 6.75	Titanium Pig.)	7.25
Calc. Carb. (Whiting)	8.6	Titan Dioxide	7.4
China Clay	6.8	Zinc Sulphide	6.55

In practice, the general run of pigments of different brands varies quite widely from these figures.

IS MEANT BY THE "WETTING EASE" OF A PIGMENT?

The wetting of a pigment is a combined effect of pigment wetting properties and liquid wetting power.

Generally, the "wetting ease" of the pigment is a relative term used to denote the rapidity with which it will wet down or disappear into a vehicle in the usual paint mixing equipment. More correctly, it refers to the ease or ability of the pigment to make intimate contact with the liquid over the entire surface of every particle.

In its dry state, a pigment exists as air flocculates in which the ultimate particles are more or less strongly attracted and held to each other through electrical forces. The surface of the particles and the flocculates or aggregates is covered by an envelope of air, moisture or other alien chemical. An easy wetting pigment then is one which permits complete displacement of these envelopes by the vehicle without much work being put upon it. A poor wetting pigment is one which resists such displacement.

S MEANT BY THE TERM "OIL ABSORPTION"?

"Oil Absorption" is simply the measure of the quantity of an oil required to produce a paste with a unit quantity of pigment.

The "oil absorption" of any given pigment varies considerably with different oils and with the method by which the pigment and oil are brought together.

It is legitimate, however, to refer generally to pigment of "low" or "high oil absorption in a relative sense, and the term "oil absorption" is still frequently met with in the trade.

The oil absorption gives little true indication as to paint consistency, since low and high oil absorption pigments can be made to give low or high consistency or reverse by manipulation of the liquids.

It is considered preferable to refer to pigments as of "low or high consistency characteristics" rather than "oil absorption."

...PAINT?

Paint is a suspension of a pigment in an organic liquid; such suspension being suitable for application to a surface by means of a brush, spray device or dipping, and capable of solidifying to a dry film on the surface.

...THE CONSISTENCY OF PAINT AN IMPORTANT CONSIDERATION?

The consistency of paint is directly related to many of the important properties or characteristics of the paint. Desirable package condition as prevention or retardation of settling is affected by consistency. The brushing characteristics, ease of application, the flowing and leveling properties of the wet paint, the penetration and sealing of the surface, the gloss and film hardness after drying, and other properties are related to consistency.

The consistency of the paint in the package must be designed to take the proper amount of thinner to render it of correct body for brushing, spraying or dipping according to the purpose for which the paint is intended without injury to its opacity and film forming properties after reduction.

...RE DIFFERENT KINDS OF CONSISTENCY?

Different types of paint consistency are recognized according to their observable characteristics. Each type is important and desirable for certain purposes. The following terms are used in connection with consistency or body.

VISCOSITY

The term is often used incorrectly for "consistency." The latter is a general term to describe the body, structure or rigidity of any pigmented or unpigmented paint material either as to its type or its degree. "Viscosity" should be used only with reference to that type of flow which is proportional to the force or pressure applied. As such only free flowing liquids such as oils should be referred to as viscous.

PLASTIC TYPE

The plastic type of consistency, or flow, is that usually met with in the pigmented liquids, or ordinary paints. The plastic type paints do not flow directly proportionally to the pressure. There is a certain internal resistance due to structure which resists flow, and a certain amount of initial pressure is required in order to start flow.

YIELD VALUE is a term used as the amount of pressure required to start the flow in a plastic type paint.

THIXOTROPY

Some plastic paints which have a heavy structure or consistency will become thinner when stirred or agitated. The term "thixotropy" is used to describe those plastics which become thinner on agitation but tend to regain their initial body on standing again. A paint may be plastic <u>and</u> thixotropic or plastic and non-thixotropic, although it is doubtful whether there are any paints without some small degree of thixotropy.

FALSE BODY

This term is used to describe a heavy non-thixotropic type of consistency, usually obtained through the introduction of water or a soap or both to a paint.

THE PRINCIPAL FACTORS AFFECTING PAINT CONSISTENCY?

1. The viscosity of the vehicle.
2. The type and structure in the vehicle.
3. The wetting power and wetting type of the vehicle.
4. The stability of the vehicle.
5. The concentration of pigment in the vehicle.
6. The chemical reactivity of the pigment.
7. The absorptive capacity of the pigment surface.
8. The state of flocculation or dispersion of the pigment.
9. The presence of soap or other colloidal gel structure in the vehicle.
10. The presence of flocculating agents (as water) or other flocculating or deflocculating agents.

FLOCCULATION" AND "DISPERSION"?

Flocculation is that state or condition wherein the primary pigment particles are attracted to each other and held together by their electrical charges. The flocs are lightly held soft masses. Harder and more compact masses are termed "aggregates."

In the air, flocculation prevents dusting. In vehicles, the attraction of the individual pigment particles for each other sets up a structure in the paint. A high degree of flocculation tends to the production of high consistency.

As a measure of a state or condition of matter "dispersion" is the degree in which the reduction or neutralization of the electrical attractions permits the individual particles to act as separate entities.

As a state of matter "dispersion" is the condition wherein each particle of the pigment has no attraction for any other particle and therefore will not form flocs.

As a process, "dispersion" is the operation of separating the individual particles from each other. With soft flocs, a simple mixing in a liquid of good wetting power will effect dispersion. With the harder aggregates, considerable heavy grinding may be necessary to break down the tightly bound mass of particles. In either case, the process of dispersing effects permanent dispersion as a state only if in addition to the mechanical work of separating the particles, they are at the same time protected against reflocculation by some chemical treatment which will neutralize the electrical charges.

E THE PRINCIPAL CLASSES OR TYPES INCLUDED IN THE TERM "EXTERIOR PAINTS"?

1. Exterior house paints.

   (a) Conventional oil types.
   (b) "Enamelized" house paints.
   (c) Exterior primers.
   (d) Trim colors - may be fast drying.

2. Metal protective paints.

   (a) Special primers - may be rust inhibitive basic lead chromate, zinc chromate, oxide, red lead, graphite, etc.

   (b) Top coats - often black as graphite paints. Also in colors both oil type (as our Metalastic) or synthetic (as our Kemelastic). Also aluminum paints.

3. Petroleum industry finishes.
   - Building paints) must be gas resisting.
   - Tank paints)
   - Maintenance enamels)
   - Metal protective paints)

4. Industrial enamels.

   Agricultural and implement enamels.
   Pump enamels (gas stations).
   Toy enamels - such as coaster wagons, bicycles, etc.

5. Bulletin colors and "tack sign" colors.

   (a) Oil type (paste) bulletin colors.
   (b) Synthetic ready-mixed as Kem Bulletin.
   (c) Synthetic "tack sign" finishes.
   Kem Field Coats
   " Press Sign Colors
   " Silk Screen Stencil Colors

6. Concrete and stucco paints - white and tints.

   Usually similar to our concrete and stucco paints.

7. Porch and deck enamels.

8. Marine finishes.

   Includes bottom paints, boot-topping, hull deck paints, etc.

9. Canvas paints - awnings, etc.

10. Automotive finishes - lacquers and synthetics.

TE PIGMENTS ARE USED IN EXTERIOR PAINTS?

1 - Basic Lead Carbonate

2 - Basic Lead Sulphate

3 - Zinc Oxide

4 - Leaded-Zinc Oxide

5 - Titanium Pigments

6 - Zinc Sulphide Pigments

7 - Antimony Oxide

CONSIDERED DESIRABLE PIGMENTATION FOR FIRST GRADE HOUSE PAINTS?

The quality of house paint depends to a large extent on the pigment combination used and upon the relation of opaque pigments and total pigments to the total non-volatile (oil plus pigment) in the paint.

The pigment combination in a first grade house paint should be such as will give sufficient opacity as a result of its high-hiding pigment content together with a wise selection of inert pigment to give maximum durability.

The pigment volume ratio (total pigment volume divided by total pigment volume plus non-volatile vehicle volume) should be 28 - 30%. In no case is less than 28% recommended. With zinc sulphide type of paints, the New Jersey Zinc Company and Krebs favor 28 - 32%. With high lead type paints The National Lead Company favors 35 - 40%.

Paints of lower quality are usually characterized by lowered total pigment in which the high hiding pigment is decreased and the inert increased, lowered non-volatile vehicle content, increased volatile content.

The question of high vs. low lead, zinc-less, zinc-lead-titanate, Zinc Sulphide paints, etc. is so controversial that typical high grade formulation may here be presented by a tabulation of five different first grade paints.

PAINT	1	2	3	4	5
Percentage by Weight					
Total Pigment	66.0	66.0	66.2	65.0	68.3
Total Liquid	34.0	34.0	33.8	35.0	31.7
	100.	100.	100.	100.	100.
Pigment % By Weight					
Lead Carbonate	34.3	18.0	-	37.9	50.0
Lead Sulphate	16.2	16.0	15.8	12.9	-
Zinc Oxide	29.5	29.5	29.2	24.6	-
Ti.-Ba. Pigment	-	36.5	48.0	-	50.0
Lead Titanate	-	-	7.0	-	-
Ti. Dioxide	10.0	-	-	12.3	-
Calcium Carbonate	-	-	-	3.1	-
Mg. Silicate	10.00	-	-	9.2	-
	100.	100.	100.	100.	100.
Pigmentation (Gals.)					
Opaque Pigment	.296	.251	.297	.296	.276
Total Pigment	.251	.251	.261	.248	.276
Total Non-Volatile	.913	.913	.914	.900	.917
Total Paint	1.	1.	1.	1.	1.

...AT EXTENT MAY OZLO LEADED ZINC OXIDE BE USED IN MEETING THE FORMULATIONS SHOWN IN PREVIOUS QUESTION?

Paint No. 1

34.3	lbs.	Lead Carbonate
16.2	"	Lead Sulphate
29.5	"	Zinc Oxide
80.0	lbs.	

(Volume of Lead and Zinc Pigments - 1.5295 Gals.)

(a) To use Ozlo 412 - (35% Leaded-Zinc Oxide)

$\frac{16.2}{29.5}$ = 35.5/65.5% or approximately 35% Leaded-Zinc Oxide

The formula for this paint would then be:

	34.3	lbs.	White Lead Carbonate
	45.7	"	Ozlo 412 - 35% Leaded
	10.0	"	Titanium Dioxide
	10.0	"	Magnesium Silica
per	100.0	lbs.	Total Pigmentation

(Volume of Lead and Zinc Pigments - 1.5450 Gals.)

(b) To use Ozlo 511 (50% Leaded-Zinc Oxide)

Although the original formula calls for 34.3 lbs. of White Lead Carbonate, there is no basic reason why the lead should not be added as the sulphate as far as the composition of the pigment will permit. Zinc Oxide exceeds Lead Sulphate by 29.5 - 16.2, or 13.3 lbs.

The formula might then be:

	21.0	lbs.	White Lead Carbonate
	59.0	"	Ozlo 511-50% Leaded
	10.0	"	Titanium Dioxide
	10.0	"	Magnesium Silicate
per	100.0	lbs.	Total Pigmentation

(Volume of Lead and Zinc Pigments - 1.5360 Gals.)

Paint No. 2

18.0	lbs.	W. L. Carbonate		4.5	lbs.	W. L. C.
45.5	"	Ozlo 412	or	59.0	"	Ozlo 511
36.5	"	Ti. Ba. Pigment		36.5	"	Ti. Ba.
100.0				100.0		

Paint No. 3

45.0	lbs.	Ozlo 412
48.0	"	Ti. Ba. Pigment
7.0	"	Lead Titanate
100.0		

Paint No. 4

37.9	lbs.	W.L. Carb.)	or	26.2	lbs.	W.L.C.
37.5	"	Ozlo 412)		49.2	"	Ozlo 511
12.3	"	Titanium Dioxide				
3.1	"	Calcium Carbonate				
9.2	"	Mg. Silicate				
100.0						

Paint No. 5

Is of the so-called "Zinc-less" type. No Ozlo can be used.

"REINFORCING PIGMENTS" USED IN EXTERIOR PAINTS?

The term "Reinforcing Pigment" is used to designate those insoluble materials such as asbestine, whiting, silica, etc. which have practically no hiding power or color values but are added to the paints for the purpose of conferring certain other very specific and definite advantages.

It is a common popular error to consider the addition of these materials simply as diluents, added by unscrupulous paint manufacturers for the purpose of reducing costs. Nothing could be further from truth.

With the present knowledge of paint performance on exterior surfaces it may be considered practically impossible to formulate what would pass as a first rate, high grade exterior paint without the inclusion of some proportion of inert ingredient.

Before the advent of the high opacity pigments such as Zinc Sulphide or Titanium considerable emphasis was placed upon "pure" paint. Even if formulated to contain as much pigment as the paint would hold, the opacity was relatively low as compared to modern outside house paints and attempts to reduce cost by replacing pigment with the non-opaque silica, etc., were naturally considered objectionable.

Before long, however, the advantages in durability that might be obtained by the judicious use of a portion of a large particled substance or reinforcing pigment were recognized. With the availability of Zinc Sulphide and Titanium to maintain the opacity, the use of the reinforcing pigment for durability was possible and at the same time became practically a necessity since the use of a pure zinc sulphide — or pure titanium dioxide paint would not only be far too costly but would produce a paint lacking the properties of durability, brushing ease, etc., that addition of the reinforcing pigment can confer.

A wide range of extender pigments is available and each has specific characteristics which influence the choice as to which one or which combination of them should be used to balance the opacity pigments, and the desired performance of the resulting paint.

The principal extender types may be listed as:

TYPES

Asbestine, fibrous type of magnesium silicate (good consistency and brushing).

Mica and Talc, plate types of magnesium silicate (high opaqueness to ultraviolet light).

Whiting, calcium carbonate (easy brushing).

Gypsum, hydrous calcium sulphate.

Calcined $CaSO_4$, anhydrous calcium carbonate sulphate.

Silica, ground quartz or the infusorial type (to prevent crawling and to give "tooth" to the paint - high reflectivity for zone marking paints).

Barytes, ground barium sulphate ore.

Blanc Fixe, precipitated barium sulphate.

They all contribute toward brushing ease, consistency, package condition, including non-settling, and durability when used in the optimum proportions that have been determined by long periods of experimentation and research.

THE PRINCIPAL CLASSES OR TYPES INCLUDED IN THE TERM - "PIGMENTED INTERIOR ES"?

I. Interior Wall Finishes (residential, hotels, office buildings, etc.)

(a) Primers and Sealers

(1) for plaster, concrete and conventional wall boards, as well as repaint surfaces.

(2) for porous insulating boards such as Masonite or Celotex Insulating Boards, etc.

(b) Wall Paints

(1) Flat brushing paints

(2) Combination flat brush and stipple paints

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(3) Flat stipple paints

(4) Texture and stipple paints

(5) Semi gloss brushing paints

(6) Semi gloss brush and stipple paints

(7) Semi gloss stipple paints

(8) Gloss brushing paints

(9) Glazing liquids

(10) Concrete interior paints

(11) Radiator paints

II. Interior Enamel Undercoaters & Enamels

(a) Undercoaters

(b) Intermediate or "Split Coats"

(c) Enamels

(1) for wood and trim

(2) for floor and dado

(3) for furniture; chairs, tables, breakfast-nooks, etc.

(4) Radiator enamels

III. Interior Maintenance Paints (factories, mills, warehouses, packing houses, etc.)

(a) Undercoaters

(1) for wood, plaster, wallboard, and concrete

(2) for metal - rust inhibiting

(b) Wall Finishes

(1) Conventional or fume-resisting

(2) Brush, spray, or combination

(3) Flat, semi-gloss, or gloss

(4) Mildew resistant

(c) Enamels

(1) for floor and dado

(2) cooler enamels

(3) pipe line identification

(4) tanks - interior & exterior

(5) Heat-resisting enamels

(d) Zone marking paints

IV. Industrial enamels

(a) Metal furniture enamels - also metal partitions

(1) brush, spray or dip

(2) flat, semi gloss or gloss

(3) air-dry or bake

(4) conventional or mar-proof

(b) Toy enamels

(c) Handle finishes - brooms, kitchen utensils, iron, etc.

(d) General industrial enamels - heaters, air-conditioning units, etc.

(e) Novelty finishes - radios, cameras, stokers, hot water heaters, etc.

(f) Roller coating enamels - bottle crowns, screw tops, battery tops, etc.

(g) Tube coating enamels - toothpaste, creams, etc.

(h) Interior sign finishes

(1) Field coats & press sign colors

(2) Stencil process colors - flat & gloss

V. Water Paints

(a) Kalsomines - glue binder

(1) hot water type

(2) cold water type

(b) Dry powder casein paints - hydrated lime to improve washability

(c) Semi-paste casein paints - no hydrated lime; less washable

VI. Pigmented Furniture Stains

VII. Interior Marine Finishes -

Same as I.

WHITE PIGMENTS ARE USED IN INTERIOR PAINTS?

1. Zinc Oxide

2. Titanium Pigments

3. Zinc Sulphide Pigments

4. Antimony Oxide

It will be seen that the list is practically the same as for exterior paints, with the exception that the White Leads are omitted. White Leads have been and to some extent still are used for certain interior enamels, but owing to their toxicity, the resistance against them has resulted in their practical elimination. The use of White Lead in interior paint is forbidden in certain states..

For interior paints certain demands on performance necessitate consideration of the pigments used from a somewhat different angle. Properties either not considered or more accentuated than in exterior formulations are expected of paints for interior use.

Washability

Exterior paints must withstand rain and light effects, with perhaps a very rare washing with a brush. Interior paints, with the exception of a few specialties must be capable of resisting frequent scrubbing with soap and alkaline washing powders.

Yellowing

The bleaching action of sunlight makes yellowing a minor factor in exterior paints. Without this bleaching available, interior paints must be formulated with respects to its possibility on shaded surfaces.

Sheen

A fair degree of gloss or sheen is looked for on newly applied exterior paints. They are expected to retain this for a reasonable time only. Interior paints may be required to show anything between a very high degree of gloss to a dead flat, and to retain approximately the same degree for a considerable period of time.

Penetration

Since redecoration on interiors is more frequent than on exteriors, paints formulated for interior application must be designed for painting over old film with little or no preparation. With certain type of old film this is expecting a little too much, and accordingly wall primers and sealers have been designed either to seal in the older coats

WHAT IS MEANT BY THE TERM "SPECIFICATION PAINTS"?

A number of authoritative organizations have established specifications on paints and on the pigments that may be used in making the paints used in their jurisdiction. Such, for example, are the various federal and state departments: Navy, Bureau of Standards, Bureau of Agriculture, State Roads Department, etc. Paint manufacturers bidding on contracts with these bodies must calculate their formulations and costs to meet the respective specifications.

In the so-called "L abel" states, enactments compel paint manufacturers to show the content of the paint on the package, and formulations must be made with respects any special laws concerning the nature of contents that these legislative bodies have erected.

Of more general interest are the specifications called "A.S.T.M." which have been established by The American Society for Testing of Materials. This is a national organization of men connected with the manufacturing industry. One branch of the society deals with paint, varnish, lacquer and similar surface protecting materials. This is the Committee D - 1.

This company is represented on this committee and the committee establishes with the approval of the whole society, certain specifications on paints, paint materials and methods of test which are generally accepted as standard practice for the industry. The committee publishes a booklet containing the specifications and manufacturers generally agree that materials furnished, as pigments, will meet these specifications.

Individuals concerned with the marketing of pigments should become acquainted with the A.S.T.M. specifications on their materials. The tests upon which the specifications are based will be discussed in a separate section.

IS A BASIC KNOWLEDGE OF FORMULATING PRINCIPLES OF VITAL IMPORTANCE TO THE [illegible]NT SALESMAN?

In the formulation of paints of various types close attention must be given to the conditions under which it is to be used, both as regards application and the service expected from the film. For this reason, each formulation having resulted from costly research and experimentation, paint manufacturers are generally loath to make any changes whatsoever in an established formula.

Changes in pigmentation can effect radical differences in properties and performance, some of them not observable until long after application and therefore a change in brands is bound to meet with resistance.

When, however, the paint manufacturer is experiencing difficulties and complaints of performance, or finding costs too high against competition, the representative of the pigment producer, when thoroughly familiar with the characteristics of these offerings, may be able to show benefits in either or both performance and cost by utilizing the pigments he has to market.

For this reason, pigment manufacturers are ever alert to keep in touch with the trends of the trade, especially the localized demands of master painters and contractors. The pigment salesman should be able to show his prospect how and why his goods may be profitably improved, and to assist him in working out formulations permitting him to acquire and hold specialized outlets for his products.

This subject is too vast to treat here more than casually. The purpose is to show that the experience of each contact should be pyramided and studied with respects the basic principles of formulation and performance.

Regardless of the type of formula, the paint manufacturer is confronted with:

1. The cost, quality and characteristic properties of his raw materials.

2. The cost, manner, and means of putting these materials together into suitable form for marketing.

3. The ability of the goods to retain a condition in the package such that after a time of storage it will still be in proper shape for use.

4. The characteristics in these goods permitting easy and conventional application to the surface.

5. The inherent properties that permit proper drying and hardening on, and protection of, the surface, and to retain that protection for a reasonable period.

To accomplish these ends, the paint manufacturer selects his raw materials relative to cost and with respects their known performance in the five phases of his problem.

The pigment producer is required to show both the cost and performance of his goods. The pigment product must be adaptable to, and compatible with, the other raw materials in the formula, -- the liquids, thinners, and driers, -- and have certain flexibility when these are modified or changed, sometimes to considerable extent. With this objective, pigments are classified with respect not only to chemical content but to characteristics as established by certain well known and recognized tests,

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plus the specific tests set up by the individual consumers and which they feel give them the story of how the pigment will perform with their specific liquids and conditions.

IS WHITE LEAD?

The term "White Lead" was formerly used to indicate the basic carbonate of lead. Today it is equally applicable to the basic sulphate of lead through the sanction of common usage and Federal and other specifications.

IS BASIC CARBONATE OF LEAD? HOW IS IT MADE?

Generally this pigment conforms to a formula $2PbCO_3.Pb(OH)_2$. The proportion $PbCO_3$ (or lead carbonate) to $Pb(OH)_2$ (or lead hydrate) varies slightly according to the process of manufacture. The Federal Government and A.S.T.M. specifications for white lead require a lead carbonate content of 65 to 75% with the remainder lead hydroxide. The greater the percentage of lead hydroxide the more "basic" the pigment. The specific gravity runs 6.7 - 6.8; and the bulking value 1.75 to 1.79.

It is commonly produced by one or the other of the following processes:

<u>Old Dutch Process</u>, wherein metallic lead with a little acetic acid is placed in earthen pots and the pots arranged in a "stack" with alternate layers of pots and tan bark. Under the influence of heat and carbon dioxide generated by oxidation of the tan bark a complex series of reactions takes place between the lead, acetic acid and moisture. The metallic lead is "corroded" to the white pigment. The pigment is separated from the residual lead, washed, dried and pulverized. About 100 - 110 days is required for the process

Quick Process (Carter Process). This process is considerably less time consuming than the Old Dutch. Finely powdered lead is introduced into rotating wooden cylinders and the charge sprinkled at intervals with dilute acetic acid. Warm air mixed with CO_2 is passed over it continuously. The corrosion time is reduced to 12 - 14 days.

Chamber Process white lead is not used in the United States. The process resembles the Old Dutch but the lead is corroded in the form of thick sheets hung in a chamber.

Precipitation Process (Euston Process Lead). A number of precipitation processes have been tried. Generally they agree in that the lead is first dissolved to a basic salt solution as basic acetate of lead, from which white lead is precipitated by means of CO_2 gas or a soluble carbonate.

Electrolytic Process is a variant of the precipitation process, the lead being dissolved under the influence of an electric current and precipitated with CO_2 gas.

...RE THE GENERAL PROPERTIES OF WHITE LEAD CARBONATE?

High Specific Gravity (with correspondingly low bulking value). Specific Gravity is about 6.7. The weight of one solid gallon is about 55 pounds.

Hiding Power - Relatively low as compared to other white pigments. Approximately [illegible] sq.ft. per lb. ([illegible]).

Refractive Index - 1.94 - 2.09. Compare to linseed oil at 1.48.

Oil Requirement - Varies with process. Carter and Old Dutch take 8 - 9% of linseed oil to make a stiff paste. With the precipitation processes, the oil requirements may be as high as 10-11% for the same consistency.

Wettability - Excellent.

Reactive to acids in the usual oil vehicles. The precipitated white leads are somewhat more reactive than other process white lead, due to greater basicity.

Color - The Old Dutch lead is usually somewhat brownish due to stain from the tan bark. The Carter process produces better color. The precipitated and electrolytic processes show the whitest color of all.

Particle Size - Very variable.

ARE THE CHARACTERISTICS OF BASIC LEAD CARBONATE IN PAINTS?

White Lead, as the Basic Carbonate, is probably the most popular exterior paint pigment; either used in the form of the paste known as lead-in-oil or as an ingredient of the lead-zinc paints.

Basic Lead Carbonate is one of the reactive pigments; that is, it readily unites with the fatty acids of the oil vehicles, forming a lead soap. Lead soaps are soft in nature and rather soluble in the usual paint liquids. Most of the advantages, and also the disadvantages of Basic Lead

Carbonate are related to this reactivity and soap formation.

ADVANTAGES

The formation of the lead soap effects a good bonding between pigment and the non-volatiles of the film, and also explains the ease of wetting associated with this pigment. The soft type of the soap induces a corresponding softness of the film with a slow plasticizing (or hardening) effect and a high degree of elasticity. This is decidedly an advantage in climates having high temperature or low humidity, retarding the development of brittleness.

Since the lead soaps set up a sort of continuous interlacing structure, pigment/soap/non-volatile, and since the resistance to the disintegrating effect of ultraviolet light rays upon the film is relatively low, a White Lead film fails gradually by a chalking effect. The entire film surface slowly crumbles and wears evenly away as a white powdery material. This moderate chalking is advantageous in rendering the film self-cleaning once chalking has set in, and, after the film has worn down to what is termed "ultimate failure," where there is insufficient remaining film to serve as protection to the wood, the surface is still even and serves as an excellent base for repainting without much preparation.

Excellent brushing qualities.

DISADVANTAGES

Excessive dirt retention in young coatings before the chalking is established, and due to the softness of the film.

Susceptibility to mildew which finds easy lodgement in the soft film, or in the roughened film after chalking.

Poor tint retention, since the chalking accentuates the white and gives the appearance of fading.

High specific gravity with result that only a small amount of oil can be used with it, thus reducing the spreading area per pound.

Susceptibility to industrial fumes (darkening).

Poor gloss retention.

Reactivity, necessitating the use only of vehicles of low and controlled acid value.

Inferior resistance to ultraviolet light.

Excessive washing away of the film in periods of heavy rain or prolonged excessive humidity.

Relatively poor color.

Relatively low opacity.

Low bulking value.

The good points of Basic Lead Carbonate may be utilized, and the undesirable ones modified, by judicious blending with other pigments, notably Zinc Oxide.

White Lead Carbonate finds its chief utility as an ingredient of house paints. It has been used to some extent in high gloss enamels for interior painting, but this is now outlawed in many states due to the toxic properties of this pigment.

IS BASIC LEAD SULPHATE?

Basic lead sulphate (basic sulphate white lead) is a white pigment produced by a sublimation process from lead. Formerly lead ore (Galena), was taken as the base raw material, but today most of the pigment is made from metallic lead rather than the ore. It is frequently called "Sublimed Lead."

The composition is rather variable, the following representing an average:

Lead Sulphate	- 77%
Lead Oxide	- 15%
Zinc Oxide	- 8%

This pigment is finer in particle than the basic carbonate of lead, more resistant to sulphur fume, and less poisonous.

Two grades are ordinarily recognized, the "sublimed" and the "supersublimed." The latter is a selected grade deposited in certain portions of the collecting system during manufacture. It differs from the straight "sublimed" in having a finer average particle size and somewhat better color.

Index of Refraction - 1.93

Hiding Power - Slightly less than the carbonate of lead.

Reactivity - Slightly less than the carbonate of lead.

Specific Gravity - 6.4 - 6.50,

Bulking Value - 1.83 - 1.88

ARE THE CHARACTERISTICS OF BASIC SULPHATE OF LEAD IN EXTERIOR PAINTS?

This pigment does not differ greatly from the Basic Carbonate in general performance, but it does give somewhat higher consistency and bulking value; and somewhat lower opacity. Although greatly improved recently, there is a considerable variation in the basic content (PbO) as between different production lots, resulting in some lack of uniformity in reactivity and other characteristics.

The basic sulphate of lead, or "sublimed" lead, is occasionally used in exterior paint formulation as the means for introducing the lead. Generally, however, this pigment has been replaced by the more durable and more universally applicable leaded-zinc oxide. This replacement is reflected in the tonnage production of this pigment which has dropped considerably over the past ten or fifteen years.

Formerly sublimed white lead had gained a rather wide acceptance among paint manufacturers, not so much because of any particular quality characteristic, but because of lower initial pigment cost and its higher bulk value as compared to the carbonate. Today, however, very few of the brands of house paint are formulated with sublimed lead.

IS BLUE LEAD?

Blue lead is a sublimation product similar to sublimed basic lead sulphate, but it has a gray color due to the presence of carbon from the fuel used in its sublimation and of sulphide of lead.

It contains lead sulphate (about 53%); lead oxide, about 38%; with zinc oxide, carbon and lead sulphide.

USE IS MADE OF BLUE LEAD IN PAINTS?

The gray color limits the use of blue lead in paints. It is rated high as a rust-inhibitor. Compared to the white leads, it is practically non-reactive with linseed oil and resists fumes.

NC OXIDE MADE?

Zinc Oxide is produced by a fuming or sublimation of zinc materials.

French Process - Zinc Oxide is made by burning the fumes of metallic zinc in a current of air.

American Process Zinc Oxide - A mixture of zinc ore and coal is chargedinto a furnace and the resulting zinc fumes are oxidized by air and collected as oxide in large fabric bags.

HE CHARACTERISTICS OF ZINC OXIDE IN PAINTS?

Zinc oxide, like the white leads, is a reactive pigment, combining with the fatty acids of the paint vehicle to form zinc soaps. Zinc soaps are much more insoluble and of a harder type than lead soaps. Consequently the addition of Zinc Oxide to White Lead paints offsets and modifies those characteristics due to the soft lead soaps.

In carefully regulated proportion to the lead, the addition of Zinc Oxide hardens the film, promotes earlier plasticizing, and offsets the early chalking, thus improving gloss and tint retention. Zinc Oxide is highly resistant to ultraviolet light and so serves to retard the influence of that agent upon film disintegration.

The addition of Zinc Oxide, however, tends to an ultimate failure of the film by cracking and pooling, and if used in excessive amount may lead to the necessity for complete removal of the remaining film either by burning or scraping before the surface can be repainted

Advantages	Disadvantages
Resistance to ultraviolet.	Hard, brittle films - lacking elasticity

Advantages (Cont'd)	Disadvantages (Cont'd)
Resistance to mildew.	Failure by cracking and peeling.
Improved gloss retention.	Reactivity with paint liquids.
Improved tint retention.	Formation of insoluble soaps in the package.*
Good color.	

TYPES

Classification of the numerous types of Zinc Oxide is difficult. In general we may distinguish:

American Process: Large acicular or large rounds to small particles.

French Process: Generally smaller particles and more reactive. Usually better color. Used mostly in enamels and specialties.

Kadox: Very fine particle. Very reactive. Used mostly in rubber goods.

Careful exposure study has shown that as between different brands of Zinc Oxide the large particle sized types show better durability in exterior paints than do the finer particles. A range of particle size from large to medium appears most advantageous.

Consequently certain grades or types of Zinc Oxide are recommended for exterior paint usage in combination with lead. None of these have shown any superiority over OZLO and for maximum all around utility OZLO is definitely superior in formulation to blends of zinc oxide and lead.

THE PLACE OF ZINC OXIDE IN INTERIOR PAINTS?

Zinc Oxide contributes gloss, film-hardness, washability, non-yellowing and consistency. It finds its principal use in enamels, but small amounts may be cautiously introduced into almost any type of

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interior formulations since by its reactivity it produces body in the paint, and a certain type of brushing.

Reactivity causes soap formation with acidic vehicles thus increasing consistency and limiting the amount of this pigment that may be employed in such formulation.

ANTIMONY OXIDE?

Antimony oxide, Sb_2O_3, is a white pigment produced by sublimation of antimony ores.

THE USE OF ANTIMONY OXIDE IN PAINTS?

Chemically, antimony oxide is similar to zinc oxide in its paint behavior. Its use is greatly limited on account of its price. It is a good pigment for blanketing or reducing chalking of titanium, and rates high in non-yellowing characteristics.

DED-ZINC OXIDE MADE?

Leaded-zinc oxide is a white pigment produced by fuming processes similar to those employed for the manufacture of straight (lead-free) zinc oxides.

Either the French Process or the American Process types of production are employed, the raw material differing in that whereas for the production of Zinc Oxide a lead-free zinc material is used, in the production of the leaded-zinc oxides a mixture in the proper proportions of lead or lead ores and zinc or zinc ores is taken as the charging material.

The American Process is most frequently employed. Lead Sulphide ore, Zinc Oxide or carbonate ore, Silica "Caatt" and coal are mixed and the charge introduced into a furnace where reduction takes place. The fume is then oxidized with air and the product collected in fabric bags. The Lead Sulphide is changed in the process to basic lead sulphate and this is intimately mixed with the Zinc Oxide.

Grades are recognized according to the percentage of lead, calculated to lead sulphate and run from 2-3% "leaded" up to as high as 60% leaded. The 60% leaded is not usually sold as such, but is reduced with straight zinc oxide to either a 50% or 35% leaded product.

THE CHARACTERISTICS OF THE LEADED-ZINC OXIDES IN PAINTS?

The leaded-zinc oxides are used chiefly in exterior (house) paints.

By combining basic lead sulphate and zinc oxide in a simple fuming process (co-fumed pigment) a useful modification of lead and zinc is obtained which possesses considerable advantage over either straight lead or zinc or a mere mechanical mixture of the two.

The advantage seems to be due to a mixed type of soap. Reactivity is reduced and the chalking tendencies of the lead subdued without as high a degree of tendency toward cracking as when straight Zinc Oxide is blended with Lead.

TYPES

High to low leaded.
100% co-fumed.
Blended co-fumed and straight Zinc Oxide.

No apparent advantage occurs as between a given amount of co-fumed plus straight zinc oxide as blended by the pigment maker or as blended in a paint mixer. The latter procedure permits the paint manufacturer to use different types of zinc oxide as desired, and in many formulations, when the ratio of lead to zinc is calculated as a base, the paint maker may by using a mixture of a co-fumed and zinc oxide obtain equal color, equal or high consistency, and sometimes better costs by taking his lead entirely as leaded-zinc oxide and making up the ratio by a selected type of zinc oxide.

In general, however, any combination of lead to zinc as 100% co-fumed leaded zinc will outwear an equivalent blend of lead carbonate or sulphate with zinc oxide, with better gloss and tint retention better surface cleaning, less reactivity to liquids, and less disturbance of package condition through precipitation of soaps.

Leaded zinc oxide stands supreme as the one opacity pigment that may be used as companion to any other white pigment in formulation. It may be used to introduce lead into formulations containing the Zinc Sulphide pigments whereas the White Leads are not compatible; it introduces ZnO with a modification of the hard inelastic film and insoluble soaps of the straight zinc oxide; it is entirely compatible with either the White Leads, Zinc Oxide, Titanium Pigment or the Zinc Sulphide Pigment.

IS "OZLO" LEADED ZINC OXIDE THE BEST LEADED ZINC OXIDE AVAILABLE?

(a) Because it is 100% co-fumed. With all the lead content and all the zinc content combined into particles of identical composition the soaps produced when the pigment is mixed with linseed oil are modified and balanced. The result is that there is neither a free lead soap nor a free zinc soap present, and the properties of the blended soaps partake of the nature of both without the accentuated disadvantages of either. The reactivity is reduced and the elasticity of the film is retained for a longer period.

(b) Because it confers a durability to films made from it that is equal or superior to any competitive pigment. Numerous and repeated exposure trials by many experimenters have shown OZLO to equal or usually better the performance under the same conditions of any competitive leaded-zinc oxide.

(c) Because the particle size represents a balance of small to large particles without the presence of any undue amount of either extreme fines or extreme coarse. This balanced gradation permits the formation of a film with high strength to resist mechanical abrasions and conform to alternate shrinkage and expansion of the surface on which it is spread, and at the same time carry focal relief points to relieve internal film stresses developed during the drying and hardening processes.

(d) Because it gives optimum consistency in high grade paint. Practically all paint technicians agree their high grade paint must contain a volume proportion of pigment to non-volatile oil plus pigment of 28% minimum. That is, for each 28 gallons of pigment in a formula there must be not more than 72 gallons of drying oil. For high lead paints the figure is well above 28%.

The consistency value of OZLO is such that this ratio can be maintained, using, as desired, pigment mixtures of OZLO - W. L. Carbonate - Titanium - Inert; and with the correct amount of oil have a product of good brushing consistency, covering power and hiding power.

Of late, brands of leaded-zinc oxide made by blending a high-leaded zinc oxide with straight zinc oxide have appeared on the market. These brands give considerably higher consistency than the 100% co-fumed pigment and for this reason have received favorable report from some paint makers.

This conception is based on the idea that the paint maker can by use of this high consistency leaded-zinc oxide, produce a paint to which the painter may add reducers, thus reducing his cost. There are two fundamental fallacies in this idea from the standpoint of a high grade paint job:

reducing the paint thus made, the drop in hiding power is very rapid, and long before the point of good brushing consistency is reached the hiding power is far below normal.

It is impossible to get into the paint formula enough oil and pigment of this high consistency character to maintain the ratio of 28% minimum pigment volume ratio. The paint maker either has to sacrifice the wieght of the paint, the pigment concentration, the balance of his pigments, or his 28% pigment volume ratio. Whichever he does, he must take a penalty in the rating or grade of his paint, and a drop in some desirable feature.

Because the color is the best obtainable from a 100% co-fumed pigment. Color of the blended competitives is whiter than OZLO when compared directly to it, but the other advantages of OZLO far outweigh this consideration, since:

In tints and color paints the color of the leaded-zinc oxide used is not a factor.

Practically all first-grade paints now include a percentage of titanium dioxide introduced for the purpose of increasing opacity. In the presence of this titanium and due to its whitening power, the differences in color due to the leaded-zinc oxide are extremely slight.

All criticisms for color are based on color in the can. On the job the co-fumed pigments are indistinguishable for color differences from the mechanical mixes.

(7) Because it gives satisfactory performance and compatibility with all other white pigments. OZLO may be used, and is being used, in combination

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with the white leads, with titanium pigments and with zinc sulphide pigments. It is the one universal companion opacity pigment for universal formulation. OZLO does the job better.

Lead as white lead may not be used with zinc sulphide pigment. As OZLO the desirable properties of the lead may be introduced into zinc sulphide formulation with entire satisfaction.

There has been considerable propaganda concerning the selection of certain special forms of zinc oxide for exterior paints. In spite of this, no such form has been found to adequately replace the performance of the co-fumed leaded-zinc oxide. Zinc oxide does not meet the requirements as a companion pigment for titanium and zinc sulphide. Leaded-zinc oxide does, and in addition forms compatible mixtures with the white leads.

LITHOPONE? HOW IS IT MADE?

Lithopone is a co-precipitated white pigment. That is, the two ingredients, barium sulphate and zinc sulphide, are precipitated simultaneously by the reaction which takes place on mixing a solution of zinc sulphate with a solution of barium sulphide.

The whole manufacturing process involves a number of steps as follows:

1. Reduction of Barytes ore to Barium Sulphide. This is accomplished by roasting the ore in the presence of carbon in the form of coke. The product is called "Black Ash" and consists principally of Barium Sulphide with some coke and ash.

2. Leaching of the Black Ash. The Black Ash is put into water which dissolves out the Barium Sulphide. The slurry is then filtered. All the coke and other impurities remain in the filter and a pure solution of Barium Sulphide is obtained.

3. Preparation of Zinc Sulphate Solution. Zinc metal or roasted zinc ores are treated with sulphuric acid to give an impure zinc sulphate solution. This solution is purified by oxidizing chemicals and filtered. The product is a pure solution of zinc sulphate.

4. Precipitation of Lithopone. When the pure zinc sulphate solution is mixed with the pure barium sulphide solution, a white precipitate called "crude" lithopone is obtained. It contains about 71% of Barium Sulphate and 29% of Zinc Sulphide. Crude lithopone has no value as a

pigment. It is of low opacity and hiding power and extremely high oil absorption. Calcination or heat treatment is necessary to convert it into the opaque pigment of fine color and paint making quality known as "Lithopone."

5. Calcination of the "Crude." The crude lithopone is separated from the water by filtration and drying. The dry lumps are then passed through a rotary calciner at about 800° C. in a neutral (air-free) atmosphere, and suddenly quenched in cold water.

6. Finishing. The wet slurry, lithopone suspended in water, is ground wet in pebble mills, filtered, dried, and finally pulverized in a roller mill and the final product air-floated. The dust is collected in fabric bags and packaged.

THE MOST IMPORTANT GENERAL TYPES OF LITHOPONE USED FOR PAINT?

1. General purpose or "normal" grades.
2. Special enamel grades.
3. Reactive grades.
4. Suspension grades.
5. Water sensitive grades (thixotropic type).
6. High opacity grades (Titanated Lithopone).
7. Water dispersion grades.

THE CHARACTERISTICS OF THE GENERAL PURPOSE TYPE OF LITHOPONE.

General purpose or "normal" lithopones cover a range of low to high consistency characteristics tending to follow their oil absorption figures. They are all relatively low in chemical reactivity, have excellent mixing and grinding properties and are not particularly sensitive to water or to delicately balanced vehicles.

Raw material stocks may be simplified by using the general purpose type of lithopone and obtaining special effects by formulating with special vehicles and by special processing in the paint factory. Some of the unusual paint effects, however, are either not obtainable by liquid manipulation from the general purpose lithopones, or only with difficulty or excessive costs.

This type of lithopone is advantageously used in the general run of flat paints, gloss paints and enamels.

THE SPECIAL CHARACTERISTICS OF THE ENAMEL GRADE LITHOPONES?

For use in enamels; texture, freedom from hard aggregates, and fineness of particle are of especial importance. In the production of special enamel grades, particular attention is given to fineness, soft texture, mixing and grinding ease, and ability to produce paints having good flow, leveling and suspension characteristics in enamel formulations.

A number of special enamel grades are offered to render possible high flow, to retard flow (or non-sagging), full body to thin body, high to intermediate gloss, etc.

In all of these specialties the vehicular part of formulation is important as the special effects due to pigment modification may be at a maximum or entirely neutralized by choice of liquids.

THE CHARACTERISTICS OF LITHOPONES OF THE "REACTIVE" TYPE?

Reactive types of lithopone are used principally for control of consistency and to obtain certain brushing effects. Reactivity is effected by a pigment manufacturing technique in which a small but carefully regulated percentage of a reactive, basic material is left on the surface of the pigment particles.

This reactive component of the pigment combines with the acidic component of the vehicle with soap formation. The soap affects consistency according to type. The liquids used exert a profound effect upon the results obtained since not only do they govern the type of soap produced, but also determine whether it will remain closely adherent to the pigment surface, form structural polymolecular layers around the pigment, or dissolve out and disperse into the vehicle generally.

THE "SUSPENSION" GRADES OF LITHOPONE?

Lithopones treated with certain soaps, and usually referred to as "Treated" lithopones not only improve wetting ease but actually promote a certain degree of flocculent structure. This structure prevents or retards settling tendencies of the pigment and thus aids in maintaining a good package condition.

These specials are also usually somewhat resistant to flow on account of their flocculent nature and may thus be used in combination with other types to prevent sagging, especially in low pigment-concentration enamels.

They are good mixing and easy grinding lithopones and may be used in many types of formulations in flat wall finishes, stipples, gloss paints and enamels.

ARE THE CHARACTERISTICS OF THE WATER-SENSITIVE LITHOPONES?

Water-sensitive lithopones, frequently termed "thixotropic," are characterized by an unusual degree of sensitivity to the presense of water. Lithopones of this type, in oil formulations, permit a certain degree of replacement of the oil contacting the particle by water.

The result is a flocculated structure of a high thixotropic nature. That is, such paints will on standing set up to a rather rigid nature, and yet, under mechanical stress by stirring or brushing will become quite thin and fluid. When the stress is removed, they return to the rigid structure more or less rapidly.

This type structure permits a good package condition and non-settling and yet breaks down under the brush to a good fluid consistency for easy brushing. Used alone, these pigments give paint structures which usually set up too rapidly back of the brush, thus leaving brush marks, but this feature, as well as general consistency of a paint may be controlled by mixing a portion of thixotropic type with normal type lithopone.

The use of a small percentage of water, or of a neutral (as Ivory) soap solution to the formulation is necessary in promoting the full thixotropic effect.

RE THE CHARACTERISTICS OF THE WATER DISPERSION LITHOPONES?

Just as lithopones may be made more receptive or attractive to oil liquids by certain treatment of the surface, they may be prepared for special water-attractive properties. Such pigments find particular utility in the production of casein-cold-water paints either straight or oil-bound type.

These lithopones readily mix with cold water to form a smooth, limpid paste without lumping. They show considerable resistance against settling in water even in low concentrations.

RE COMPETITIVE ZINC SULPHIDE PIGMENTS CLASSIFIED?

Note: In the following general classification, several brands have been classified according to the manufacturer's information, and have not been tested in this Laboratory. Consequently, the list as given is to be considered as tentative and subject to revision.

GENERAL PURPOSE LITHOPONES

High Consistency	Medium Consistency	Low Consistency
Permolith 461-HX	Permolith 461-R	Permolith 461-LL
" 461-H	" 461-S	" 461-L
" 461-HH	Albalith Black Label #11	" 461-M
Albalith Blue Label #10	Ponolith LR (Semi-High)	Albalith Gr. Label #13
" #107	" LR (Regular)	Ponolith LR-LO
Ponolith FT	" NR-Grade 9	" NR-Grade 8
" MO	Beckton White M-Grade 45	" AXL (leady texture for exterior)
Beckton White M-Grade 50	" " " " 49	Beckton White M-Grade 47
" " " " 51	Unilith 44	" " " " 48
Unilith 88	" 60 (High)	Unilith 22
Sunolith #80	" 60-W	" 22-C (coarse tex.)
Eagle (High)	Eagle (Medium)	" 22-W
Astrolith 9		

		Low Consistency
		Eagle (Low)
		Sunolith 47
		" 97
		" 107
		Astrolith-L

SPECIAL ENAMEL GRADES

High Consistency	Medium Consistency	Low Consistency
*Albalith 362	Albalith Maroon Label #24	*Permolith B-44
Eagle Picher 5A	Enamel Beckton #42	Alb. Red Label #14
Unilith 86 NL	Sunolith #90	* " Maroon Label #55
		Ponolith EL
		" EMG
		" EL-117
		" FLO
		" 212
		" 318
		Enamel Beckton Grade 44
		Unilith 22-N
		Sunolith 95
		" 96
		" 96-AA
		Astrolith SEG
		" SF

REACTIVE LITHOPONES

*Albalith 362
" Maroon Label #94
" " " #85
Unilith 88-R
Sunolith 85

SUSPENSION GRADE LITHOPONES

High Consistency	Medium Consistency	Low Consistency
Permolith A-12	Permolith A-24	Permolith W-33
" A-22	Albalith Maroon Label #73	Albalith 98
Albalith 95	" " " #102	" 105
" 106	Ponolith LR-J	Beckton White J-Grade 7
Ponolith HO-J-Grade 149	Beckton White J-Grade 30	" " " " 28
" HO-J " 131	" " " " 31	" " " " 29

SUSPENSION GRADE LITHOPONES (Cont'd)

High Consistency	Medium Consistency	Low Consistency
Beckton White J-Grade 32 & 33	Unilith 44-S	Unilith 22-S
" " JG- " 34	Sunolith 109	
" " JG- " 35		
Astrolith DG		

WATER SENSITIVE (THIXOTROPIC) LITHOPONE

Albalith 404

WATER DISPERSION LITHOPONES

* Albalith 35
" 135
Ponolith LP-W
Astrolith 65

* Pigments which show characteristics of two classes may appear twice.

THE CHARACTERISTICS OF LITHOPONE IN PAINTS?

Lithopone finds its principal use in the interior paints. This pigment, by slight differences in the way it is processed, may be obtained in a wide range of properties from non-reactive to highly reactive, low to high consistency, high sheen to dead flat. Special modifications are made possessing high dispersion properties in oils or in water, extra ease of mixing with the liquids, to give paints having extra non-settling properties, for accelerated or retarded flow, or for special types of brushing or of structure (as thixotropy).

Either as the normal lithopone or in these various modifications lithopone finds extensive usage in flats, undercoaters, semi-gloss paints, enamels and in many special types of formulation. With the wide range of types available, the formulator is able to select a brand which will give him almost any type of paint desired when mixed into properly selected liquids.

Lithopone has a good color and opacity. It has easy brushing and good film forming characteristics. Paints made from it are relatively stable and resist undesirable change in the package. For these reasons lithopone remains one of the most popular pigments for inside paints.

Lithopone is also used for exterior paints.

The earlier lithopones were photogenic, that is, they possessed the undesirable characteristics of darkening in sunlight and bleaching again in the dark. This objection has been overcome by improvements in the process of manufacture, and all high grade lithopones today are light fast.

The use of lithopone in exterior paints has come about because of the lower cost of pigmentation thus obtained. Its lack of durability in exterior paints, failure by early and heavy chalking is more pronounced in the whites in which it is now seldom used. The presence of even relatively small amounts of tinting colors apparently greatly retards this chalking and paints of reasonable durability may be formulated in tints with lithopone. Lithopone paints are classed as second grade compared to the lead-zinc paints.

FORMULATION MAY BE USED FOR HOUSE PAINTS WITH LITHOPONE?

The following is a typical lithopone house paint formula:

Total Pigment % By Weight	67.0
" Liquid % " "	33.0
	100.0

Gallons in One Gallon of Paint

Opacity Pigment	.27
Total Pigment	.29
Total Non-Volatile	.877

Pigment volume ratio is 33%.

Pigmentation (% by weight)

12.5	Lead Sulphate)	As Czlc-412
22.7	Zinc Oxide)	
3.0	Titanium Dioxide	
52.0	Lithopone	
10.0	Magnesium Silicate	
100.0		

Except for the questionable utility of lithopone in an exterior paint at all, the formulation is representative of the best use of that pigment. The replacement of the 52# lithopone by 30# Zinc Sulphide Extended Pigment, micaceous type, and 22# Magnesium Silicate would improve durability.

ATTITUDE SHOULD BE TAKEN IN "MATCHING" A COMPETITIVE LITHOPONE?

The lithopone industry has graduated from the idea that all desired paint types and characteristics could be produced from a general line of pigment, such as the ordinary lithopone solely by manipulation of liquids and incorporating procedure.

The older lithopones were produced with the idea principally of uniformity of the general characteristics, such as color, opacity, reactivity, light-fastness, etc. and graded "oil absorptions" or consistency properties.

With the advent of new types of paint liquids, and the demand for special paint performance, the pigment manufacturer found that by specific modification of certain of the chemical and physico-chemical properties of his pigment, he could materially assist the paint maker in obtaining certain desired results either in quality or costs.

As a result, a number of very specialized types of lithopone have been developed. The actual chemical or physical tests in the laboratory show only extremely small differences as between these different types of pigment, but the performance of paints made from them may vary widely in both type and degree. As between competitive brands of lithopone of the same special type, the differences found by analysis may be so small as to escape detection by the usual laboratory means, and yet these pigments develop paint differences of considerable magnitude.

For this reason, the actual "matching" of a lithopone may prove an impossible task.

In producing specialty paints from the specialty lithopones, the paint manufacturer is not at all freed from responsibility as to results in his product by simply changing his pigmentation. Each of the lithopones is adapted to performance with specific types of liquids for the development of the special properties.

As a result of this close relation between pigment and liquid, in any proposals for change in pigmentation it is far less important to know what pigment is in current use than to know: (1) the exact performance requirement which the paint maker expects or desires in his product, and (2) the exact character and proportions of the liquids used.

If a paint manufacturer is using a certain brand of pigment and certain liquids in obtaining certain product performance, the simple substitution of another brand of lithopone, no matter how similar it appears under the usual chemical and physical tests, may give radically different performance. But, if the data on liquids and desired performance is available, the pigment manufacturer may be able to suggest pigment substitution possibly accompanied by certain liquid modifications to equal or even better performance and cost.

...NC SULPHIDE? HOW IS IT MADE?

Zinc sulphide is an intensely white, highly opaque white pigment produced by a process quite similar to that for making lithopone, except that the precipitation reaction is between zinc sulphate and hydrogen sulphide gas. The product contains zinc and sulphur only, as represented by the chemical equation ZnS.

...THE HIGH OPACITY GRADES OF LITHOPONE?

In regular or normal lithopone the opacity is subject to slight modifications according to degree of dispersion, particle size, etc. For use in certain types of liquids a small amount of deeply adsorbed surface moisture affects opacity and hiding power through interfacial relations in the film.

Generally, however, any definite increase in hiding power over the normal must be obtained by addition of a second pigment, either zinc sulphide or titanium.

In view of the A.S.T.M. rulings, the word "Lithopone" is usable only for the regular, co-precipitative, 28 - 29% ZnS, pigment. Those zinc sulphide pigments containing a greater percentage of ZnS, whether by blending of lithopone with ZnS or by co-precipitation, must be called "Zinc Sulphide Extended Pigments" and not "Lithopone."

A border line case is that mixture of 85% lithopone with 15% TiO_2, which by current acceptance may be called Titanated Lithopone.

As the Zinc Sulphide Reinforced Pigments, then, we have:

ZINC SULPHIDE PIGMENT, BARIUM (not Double Strength Lithopone or High Strength Lithopone) containing 50 - 55% ZnS with barium as blanc fixe ($BaSO_4$)

ZINC SULPHIDE PIGMENT, CALCIUM (not Calcium Lithopone) containing 50 - 55% ZnS with calcium sulphate ($CaSO_4$)

ZINC SULPHIDE PIGMENT, MAGNESIUM - containing 55% ZnS with a magnesium silicate.

E COMPETITIVE ZINC SULPHIDE EXTENDED PIGMENTS CLASSIFIED?

ZINC SULPHIDE - BARIUM

Cryptone BA-19	
" BA-40	(enamel type)
" BA-47	(suspension type)
" BA-455	(thixotropic type)
" BA-140	(water dispersion type)
Krebolith	
Superlith SL	
" 2L	
" LX	

ZINC SULPHIDE - CALCIUM

Cryptone CB-125	(high consistency)
" CB-51	(medium consistency)
" CB-455	(thixotropic type)

TITANATED LITHOPONE

Permolith T-300	(medium consistency)
Cryptone BT-118	(high ")
" BT-115	(medium ")
" BT-120	(enamel grade)
" BT-445	(thixotropic grade)
" BT-164	(water dispersion grade)
Ti-Tone	(medium consistency)
Ti-Tone-L	(low consistency)
" J	(suspension grade)
" P	(paper grade)
Duolith HO	(high consistency)
" NR	(medium ")
" LO	(low ")
Tidolith 88	(high ")
" 66	(medium-high consistency)
" 44	(" ")

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TITANATED LITHOPONE (Cont'd)

Tidolith 66-W	
Titanolith MO	(high consistency)
" LO	(low ")
Tidolith 44-N	(enamel grade)
" 44-S	(suspension grade)
Titanolith 45	(enamel grade)

ZINC SULPHIDE - MAGNESIUM

Cryptone MS-130

ARE THE CHARACTERISTICS OF THE ZINC SULPHIDE PIGMENTS IN EXTERIOR PAINTS?

A discussion of the Zinc Sulphide Pigments is necessarily tied up with that of extender pigments. A few years ago it was the general opinion that Zinc Sulphide Pigments were unsatisfactory for use in exterior paints, and could be used only in the low priced, lower grades of paint. Lithopone did achieve a considerable usage but always in second grade paints with expectation of a comparatively short life on the surface.

The principal reason for the use of Lithopone in exterior paints was, of course, low cost. In the whites the early and excessive chalking was troublesome, but it was found that the addition of even a relatively small amount of colored pigment, as in the tints, materially retarded the failure since the colored pigment helped in resisting the action of ultraviolet light on the film. As a result, fair durability in tints and colors as compared to other second grade paint expectations resulted in a certain degree of popularity for this type of pigmentation in the low priced paint field.

It was suspected and later proven that the early failure of exterior paints made with Lithopone was not due to the Zinc Sulphide content but to the blanc fixe (precipitated barium sulphate) with which it was combined.

Recent studies have shown that Zinc Sulphide can be used in exterior formulations and will give very satisfactory durability performance ranking comparable to the first grade paints providing certain rules of formulation are carefully followed. Paints formulated with straight Zinc Sulphide plus a coarser particled extender, as spar Calcium Sulphate, certain types of Silica or Silicates, especially magnesium silicates of the micaceous type, gave markedly improved resistance to weathering.

And it is now known that if basic lead carbonate or basic lead sulphate are excluded from the formula, if a certain percentage of a flaking typed pigment as mica or micaceous talc is included, and the percentage of zinc sulphide - leaded-zinc oxide and proper type of extender are kept within certain controlled limits, a very satisfactory durability performance may be expected.

Advantages	Disadvantages
Moderate chalking	Prejudices based on experience with lithopone paints
Good repainting surface	Graying with ultraviolet light under certain unusual conditions
Medium plasticizing rate	Incompatibility with Lead Carbonate
	Necessity for using a definite type of inert.

TYPES

Lithopone, approximately 28 - 30% ZnS, co-precipitated with blanc fixe.

Titanated Lithopone - 15% TiO_2.

Zinc Sulphide-Barium Pigment, 50 - 55% ZnS with 45 - 50% of blanc fixe.

Zinc Sulphide-Calcium Pigment, 50 - 55% Zns with 45 - 50% of precipitated Calcium Sulphate.

Zinc Sulphide-Magnesium Pigment, 50 - 55% Zns extended with special types of magnesium silicate and micaceous talcs.

A good deal of discussion could center around the different types. Briefly, since it is the precipitated $BaSO_4$ or Blanc Fixe that is responsible for the poorer durability of Lithopone, the improvement with the Zinc Sulphide Extended Pigment, Barium, (or Calcium), is proportional only to the reduction of the ratio of the precipitated portion. The use of spar type, calcined calcium sulphate gives at once a marked improvement.

The principal interest, however, has centered around the use of Zinc Sulphide extended with magnesium silicate. This in long series of exposure tests rates high in durability.

The inability of the small paint user to secure the proper type of extender pigment, and an apparent ability to incorporate more of the micaceous types without introducing "rough" paints indicates a distinct advantage gained in actually pre-mixing the Zinc Sulphide with the micaceous extender, before incorporating into the paint. The adoption of this type as the principal means of introducing Zinc Sulphide into exterior paints seems the logical trend at present.

FORMULATION MAY BE RECOMMENDED FOR A ZINC SULPHIDE HOUSE PAINT?

The following is typical of a formulation that has shown satisfactory durability performance on exposure:

For 100 gallons paint

102 lbs.	(2.16 gals.)	Ozlo 412
420 "	(15.15 ")	Zinc Sulphide Pigment-Silica Type (55% ZnS)
157 "	(6.75 ")	Asbestine
1 "	(0.11 ")	Aluminum Stearate
5 "	(0.06 ")	Paint Grinders' Litharge

The inclusion of above 8 gallons of a bodied linseed oil in the 100 gal. formula is recommended.

The pigmentation then is (by weight):

15%	Ozlo 65/35
61.9%	Zns (55%) Extended Pigment
23.1%	Asbestine
100%	

or

9.75%	Zinc Oxide
5.25%	W. Lead Sulphate
34.00%	Zinc Sulphide
51. %	Extenders
100%	

[illegible] THE COST RELATIONS BETWEEN THE ZINC SULPHIDE PIGMENTS?

100 lbs. (55% ZnS) Zinc Sulphide Barium Pigment costs $5.875

100 lbs. blend (55% ZnS)

63 lbs.	Lithopone @ 4-3/8¢)		costs $6.086
37 "	Zinc Sulphide @ 9¢)		

100 lbs. blend (55% ZnS)

55 lbs.	Zinc Sulphide	@ 9¢)	
35 "	Talc	@ 2¢)	costs $6.05
10 "	Mica	@ 4¢)	

100 lbs. blend (55% ZnS)

55 lbs.	Zinc Sulphide	@ 9¢)	costs $5.85
45 "	Blanc Fixe	@ 2¢)	

TITANIUM DIOXIDE? HOW IS IT MADE?

Titanium dioxide (or titanium oxide), TiO_2, is the whitest and the most opaque of the white pigments today available.

It is produced from titanium ores containing TiO_2, iron oxide, Silica, and some other impurities.

The ore is first "sulphated" whereby the different ingredients, except Silica, are converted to sulphates by a treatment with sulphuric acid. The solution is filtered off from the insoluble silicates and purified to remove the iron and other incidental sulphates.

The pure solution of titanium sulphate is then "hydrolyzed" by pressure and dilution to throw out an amorphous form of titanium, titanium hydrate.

The hydrate upon calcination is converted to titanium dioxide.

Titanium dioxide, like zinc sulphide, is marketed to a considerable extent as an "Extended" pigment. At present there is available

Titanium Pigment, Barium - two forms, one containing 25% TiO_2 and the other 30% TiO_2. The extender is blanc fixe (precipitated $BaSO_4$).

Titanium Pigment, Calcium - 30% TiO_2 with 70% precipitated (and calcined) calcium sulphate ($CaSO_4$).

Titanium Pigment, Magnesium - 30% TiO_2 with 70% silicate of magnesium.

ARE THE CHARACTERISTICS OF THE TITANIUM PIGMENTS IN EXTERIOR PAINTS?

Prior to the advent of the titanium pigments, white lead in oil and the lead-zinc mixed paints were lacking in opacity to the extent that a practical two coat job was impossible over unpainted or badly discolored surfaces. These paints also discolored badly, particularly in the areas of high population where the most paint is applied.

The introduction of the titanium pigments permitted the paint manufacturer to overcome both of these defects, at least in a large measure, but has not resulted in any material increase in durability.

The titanium pigments are practically inert or non-reactive with paint vehicles and form no soaps with them to effect a bonding of the pigment, as is the case with zinc and lead. As a result of this lack of bond, the titanium pigments show considerable chalking in the films on exposure. The chalking of titanium differs in type from that of lead. The particles of the latter having surrounded themselves with an intimate bonding with the film show a weathering effect wherein small flakes of film slowly detach themselves from the surface. With titanium the individual particles simply pop out of the film, leaving minute holes which act as focal points at which weather effects and light effects are concentrated.

Titanium may be added to formulations either as the oxide, TiO_2 or as reductions of the pure oxide with extender pigments (as blanc fixe, calcium sulphate, magnesium silicate, etc.). It is generally admitted that little, if any, actual advantage to the paint is gained by the use of a TiO_2 pre-blended with an extender by the pigment manufacturer as against blends in the paint mixer. Possibly certain paint manufacturers do find it more economical to purchase the blends rather than carry separate stocks of TiO_2 and extender.

Advantages	Disadvantages
High whiteness in color	Inertness
High opacity	Poor bonding with the film
	Rather difficult wetting
	Excessive chalking
	Whitening or fading of tints
	Poor gloss retention
	Absorption of drier in the package with resulting poor drying when applied to surface
	Rather poor wetting and grinding characteristics
	High absorption of ultraviolet light

Lead titanate deserves special mention. It is not used in formulation in the same way as the other titanium pigments and differs materially from them. Firstly, it is of a cream yellow color, and secondly, it is, unlike the other titanium pigments, highly resistant to chalking, so much so that the addition of 20% or more of it to a formulation: where color is unimportant, will offset the chalking due to other pigment ingredients, such as lead. The failure of the film with lead titanate present, becomes of the cracking-flaking type. It is used principally in the manufacture of tinted house paints to improve tint retention, but as yet has received very limited acceptance. In white paints, due to its color, it is impossible to add enough to be of definite value.

<u>Titanium Pigment, Barium</u> was the earliest extended titanium pigment to be generally introduced into house paint for the purpose of increasing opacity. Practical exposures showed too marked a chalking

tendency, and its use has now been largely discontinued.

Titanium Pigment, Calcium is not largely used in exterior paints, although its increased bulking value would appear to make its use economical.

Titanium Pigment, Magnesium Type like the Titanium Barium is no more than a mechanical mix which the paint mixer may duplicate for himself from straight TiO_2 and silicates. Indeed no advantage has been definitely shown to exist between any of the extended titanium pigments, and the same proportions of titanium with the same extender when blended by the paint maker. The magnesium type, however, is much more desirable as an extender than Blanc Fixe and this type can be expected to eventually replace the Titanium-Barium and the Titanium-Calcium for exterior usage.

The general usage of titanium in the best exterior formulations today limits the amount to 10% of the total pigmentation to avoid excessive chalking. It is usually introduced as the straight titanium oxide, since the paint maker is thus enabled to include the extender pigments of small or large grain type which his experience has shown him to possess the best durability performance compatible with the other pigments used.

ARE THE CHARACTERISTICS OF THE TITANIUM PIGMENTS IN INTERIOR PAINTS?

Titanium dioxide, either straight or in the form of one of its "extended" modifications is included in interior formulations solely for the whiteness of color and the increased opacity which it adds.

Titanium dioxide is usually added straight as TiO_2, since it then is necessary to replace only a minimum amount of the other pigments.

The use of the calcium extended Titanium, however, is of considerable interest. Calcium sulphate as an extender has a high bulking value, and consequently gives higher consistency, pound per pound, as compared to other inerts. By use of calcium extended titanium oxide, reducing the other inerts in the formula in proportion, an economic advantage is obtained, i.e. - maintenance of consistency with a lower poundage of pigment. The use of Calcium Titanox is increasing and offers serious competition to lithopone.

Titanium dioxide and the titanium-calcium pigments brush well when properly formulated although there is usually a preference toward the zinc sulphide pigments in this respect.

The chief objections to titanium are serious enough to have resulted in a strict limitation of its usage. They are

(1) Poor wettability

(2) Absorption of driers in the package.

Wettability has been somewhat improved by the manufacturer, but the absorption of driers remains objectionable. Blanketing with relatively large amounts of a second pigment, usually a zinc sulphide pigment is found necessary in producing satisfactory paints of certain types.

Pure titanium oxide finds extensive use in enamels especially those of the baking type, refrigerator enamels, etc. In this type of formulation Zinc Oxide or Antimony Oxide is used to buffer the chalking tendency of the titanium.

BIBLIOGRAPHY

(1) Joachim, "Paint and Varnish Formulation" - (1931) Am. Paint J. Co.

(2) L. A. Melsheimer, "Paint Consistency With Particular Reference to Formulation With Lithopone." Am. Paint Journal, Vol. 21, No. 33, May 24, 1937.

(3) H. A. Gardner, "Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors," 7th Ed., (1935).

(4) "Paint and Varnish Lecture Course" of the New England Paint and Varnish Production Club.

(5) "Paint Section of the New Paint, Varnish and Lacquer Catechism," by Geo. B. Heckel, Drugs, Oils and Paints, November, 1934.

(6) "A.S.T.M. Standards on Preservative Coatings for Structural Materials," September, 1935.

(7) Merwin. Proc. A.S.T.M. 17, Part II, 496, (1917).

(8) Lange's Handbook of Chemistry.

(9) Paint Mfg. Ass'n Circulars No. 70.

(10) Paint and Varnish Sc. Sect. Bull. No. 6.

(11) Paint, Oil and Chem. Rev., July 5, 1928, p. 18B, Recent Improvements in Am. Lithopones by J. E. Booge.

(12) Paint and Varnish Sect. Circular No. 502, p. 49.

(13) Paint, Varnish and Lacquer Assoc. Sc. Circl. No. 491.

(14) "The Relative Methods For Determining Particle Size of Pigments," by Stutz and Pfund, Journ. Id, and Eng. Chem. Vol. 19, 51 (1927).

(15) Handbook of Chemical Microscopy by Chamot and Mason, p. 413.