

14th EDITION

TITANIUM DIOXIDE: COMPETITIVE QUALITY

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CHALK-RESISTANT GRADES

Table I shows that Ti-Pure®, titanium dioxide, R-960 is outstanding in chalk resistance. Tronox® CR-822 and Zepaq® RCL-6 are comparable.

Among the various chalk resistant competitive grades we see evidence of various package codes similar to our own. Values listed in these tables are average data.

Low Shear Dispersion Ratings (Cowles Type Equipment)

Excellent - can be dispersed under less than optimum conditions
Good - can be dispersed under optimum conditions
Fair - difficult to disperse even at optimum conditions
Poor - not suitable for this type of equipment

Chalk Resistance Ratings are based on the following

<u>Description</u>	<u>Rating*</u>
Excellent	Better than 28
Very Good	20-28
Good	16-19
Fair	10-15
Poor	Less than 10

*Standard chalk fade data (10/20 scale) in air dry alkyl

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TITANIUM DIOXIDE: COMPETITIVE QUALITY

Averaged competitive pigment quality data for domestic and selected foreign titanium dioxides are presented in the following form:

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These tables are guides to normally-expected quality relationships of competitive products to their approximate Ti-Pure® titanium dioxide counterparts. Any particular code has a range of quality that depends on the test system; consequently, results of specific determinations may not always agree with our averaged results.

Miscellaneous information, such as ASTM Specifications and key laboratory contacts, is listed on pages 32 and 33.

TABLE I: CHALK-RESISTANT PAINT GRIDS

Grade	O.A.	301	HP1	Dispersion ²	Chalk ³	Carbon ³	Undercoat	102
Ti-Pure® R-960 (01)	18	59	91	Excellent	Excellent	<0.06	11	89
Ti-Pure® R-960 (08)	17	70	91	Good	Excellent	<0.06	11	89
Ti-Pure® R-960 (09)	17	66	91	Excellent	Excellent	<0.06	11	89
Ti-Pure® R-960 (18)	17	66	91	Excellent	Excellent	0.13	11	89
Ti-Pure® R-960 (28)	18	59	91	Excellent	Excellent	<0.06	11	89
Ti-Pure® R-960 (48)	17	70	91	Excellent	Excellent	0.13	11	89
Ti-Pure® R-902 (01)	17	68	94	Good	Very Good	<0.06	12	90
Ti-Pure® R-902 (08)	17	72	94	Fair	Very Good	0.14	11	90
Ti-Pure® R-902 (18)	17	72	94	Excellent	Very Good	<0.06	11	90
Ti-Pure® R-902 (28)	17	68	94	Good-Excellent	Very Good	<0.06	12	90
Ti-Pure® R-902 (48)	16	75	—	Good	—	0.14	11	90
Titanox® 2061 (RNC)	20	58	85	Good-Excellent	Good	<0.06	9	92
Titanox® 2062 (RNC-1)	18	63	91	Good	Good	<0.06	9	93
Titanox® 2069 (CLNC)	16	72	93	Good-Excellent	Very Good	0.22	13	93
Titanox® 2101	20	70	93	Good-Excellent	Very Good	0.23	12	91
Unitane® R-650	18	74	87	Good	Very Good	0.14	11	94
Unitane® OR-600	16	76	101	Good	Good	0.15	13	95
Zoexque® R-88-S	18	64	88	Good	Very Good	0.24	11	95
Zoexque® RCL-2	18	62	93	Good	Very Good	<0.06	12	92
Zoexque® RCL-6	19	64	93	Good-Excellent	Excellent	<0.06	10	88
Horne® Hende R-760	20	61	91	Good	Good	0.34	9	94
Titane® CR-822	18	70	94	Good-Excellent	Excellent	0.19	15	92
Rumex® RD-676	23	68	92	—	Very Good	<0.06	12	90
Titanox® RCP-6	14	74	96	Good	—	<0.06	13	92
Titanox® RCP-3	16	81	97	Good	Good	0.11	12	92
Titanox® RCP-7	18	57	92	Excellent	Good	0.14	12	—
Titanox® RCP-6	17	—	—	—	—	—	13	—
Titanox® RCP-2	18	72	99	Excellent	Good	0.14	11	93

1. Alkyd (architectural) enamel hiding power at 15% PVC (R-900=100).
 2. See page 2 for description of ratings.
 3. Pigments analyzing 0.06% or less are not normally considered organic treated.

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CHALK-RESISTANT GRADES

IN TRADE SALES EMULSION PAINTS

- Ti-Pure® R-902 and R-960 are comparable in hiding power and tinting strength in emulsion systems.
- For exterior gloss market, R-902 and R-960, package codes 08 and 48, should be promoted versus the high gloss competitors.
- R-942 provides comparable high gloss levels for slurry users.

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Grade	Exterior Gloses T ₁ ¹			Exterior Flat ²	
	H.P.	T.S. ³	Gloss	H.P.	T.S. ³
Ti-Pure® R-902(01)	100	100	49	100	100
Ti-Pure® R-902(08)	97	98	61	100	103
Ti-Pure® R-902(18)	97	99	49	-	-
Ti-Pure® R-902(28)	98	98	49	-	99
Ti-Pure® R-902(48)	100	106	58	-	-
Ti-Pure® R-942 (slurry)	100	100	58	100	100
Ti-Pure® R-960(01)	96	103	41	98	102
Ti-Pure® R-960(08)	98	96	61	98	103
Ti-Pure® R-960(09)	97	96	61	-	-
Ti-Pure® R-960(28)	95	99	46	99	98
Ti-Pure® R-960(48)	99	104	58	-	-
Titanox® 2R60	99	103	68	99	101
Titanox® 2R61	89	98	40	93	93
Titanox® 2R62	96	96	52	98	99
Titanox® 2101	102	100	46	99	99
Dilumox® CR-600	100	100	55	102	102
Dilumox® CR-650	95	93	58	94	98
Dilumox® UDR-606	-	-	-	-	-
Titanox® CR-822	98	96	48	97	99
Titanox® CR-822-S	-	-	-	-	-
Zopaxone® RCL-2	-	-	-	102	101
Zopaxone® RCL-6	-	-	51	102	105
Zopaxone® RCL-2	-	-	45	-	-
Hores Beads® R-760	99	99	39	98	99
TiOxide® RCR-2	-	-	-	98	101
TiOxide® RCR-3	-	-	-	98	99

1. Exterior Acrylic Emulsion Gloses T₁¹, 2 1/8 PVC, 2.75 lbs./T₁O₂/gal., R-902(01) = 100
2. Exterior Acrylic Emulsion Flat, 40% PVC, 2.5/2.0 T₁O₂/Talc (lbs./gal.), R-902(01) = 100
3. Higher Number = Higher T.S.

INDUSTRIAL AND TRADE SALES ENAMEL GRADES

Data in Table II show that:

- Ti-Pure® R-900 is still our best offering for this segment of the market.
- Of the domestic products Tronox® CR-800, Unitane® CR-580, Titanox® 2020 and 2090, and Zepac® RCL-9 compete successfully with R-900.
- Samples of Tioxide® RHD60 we have evaluated indicate it is an R-900(48) counterpart.
- Among the various competitive grades used in enamel systems we see evidence of package codes similar to our own. Values listed in these tables are average data.

TABLE II: INDUSTRIAL AND TRADE SALES BRWELL GRADES										
Grade	O.A.	10T Gloss	10T ¹ HPI	Dispersions ²	Chalk Resistance ²	Carbon % ³	Undertone	TiO ₂ %		
Ti-Pure® R-900 (01)	16	71	100	Good	Fair	<0.06	12	94		
Ti-Pure® R-900 (09)	15	78	100	Good	Fair	<0.06	12	94		
Ti-Pure® R-900 (18)	15	76	100	Excellent	Fair	0.11	12	94		
Ti-Pure® R-900 (19)	15	76	100	Good	Fair	<0.06	12	94		
Ti-Pure® R-900 (28)	16	71	100	Excellent	Fair	0.11	12	94		
Ti-Pure® R-900 (48)	15	78	100	Good	Fair	<0.06	12	94		
Ti-Pure® R-902 (01)**	17	68	94	Good	Very Good	<0.06	12	90		
Titancor® 2020	16	75	98	Good-Excellent	Fair	0.20	13	95		
Titancor® 2090 (R0-30)	15	79	101	Excellent	Fair	0.20	13	93		
Unitem® Op-580	17	79	99	Excellent	Poor	0.13	13	96		
Unitem® Op-600	16	76	101	Good	Good	0.15	13	95		
Tyrox® CR-800	15	75	101	Excellent	Fair	0.19	15	96		
Zopaque® RCL-9	17	69	99	Good-Excellent	Fair	<0.06	13	95		
Force Head® R-745	17	72	96	Good	Fair	0.36	10	95		
Force Head® R-30	16	75	97	Good-Excellent	Fair	0.22	11	94		
Tioxide® R-TC5	13	76	95	—	Good	<0.06	10	95		
Tioxide® R-HD3	17	78	100	Excellent	Poor	0.20	12	96		
Tioxide® R-HD6	18	82	100	Excellent	Fair	0.19	14	94		
Titafence® RL-68	20	74	100	Good-Excellent	—	0.17	13	94		

1. Architectural H.P., 165 PFC, R-900-100
2. See page 2 for description of ratings.
3. Pigments analyzing 0.06% carbon or less are not normally considered organic treated.

** See Table I for properties of other Ti-Pure® R-902 package codes.

1. Architectural H.P., 16% PVC, R-900-100
2. See page 2 for description of ratings.
3. Pigments analyzing 0.06% carbon or less are not normally considered organic treated.

** See Table I for properties of other Ti-Pure® R-902 package codes.

ENAMEL GRADES IN TRADE SALES EMULSION PAINTS

- Unlike the alkyd systems, Ti-Purac R-900, R-902, and R-960 show minimal differences in hiding power and tinting strength in emulsion systems. The optical data in Table IIa and in Table Ia are on the same numerical basis.
- Ti-Purac R-940 and R-942 are comparable in emulsion gloss to the respective 08 and 48 package codes.
- In emulsion systems Tioxide® RND6U has high gloss and low TS compared with R-900 (48).

TABLE 11A. PANEL GRADES IN TRIM SALES EMISSION PAINTS

Grade	Interior Gloses Panel 1			Exterior Gloses Trim 2			Exterior Panel 3		
	H.P.	T.S. 4	Gloss 60°	H.P.	T.S. 4	Gloss 60°	H.P.	T.S. 4	
Ti-Pure R-900 (01)	100	100	60	100	100	58	100	100	
Ti-Pure R-900 (08)	96	97	72	100	100	76	97	101	
Ti-Pure R-900 (13)	98	100	60	100	101	60	-	-	
Ti-Pure R-900 (28)	100	100	61	103	101	58	103	100	
Ti-Pure R-900 (48)	100	100	72	100	100	72	-	-	
Ti-Pure R-902 (01)	102	101	55	102	103	45	102	101	
Ti-Pure R-940 (salutry)	101	100	70	100	100	67	100	100	
Ti-Pure R-942 (salutry)	102	101	68	102	103	58	102	101	
Ultimate 2020	97	100	67	100	97	75	100	108	
Ultimate 2090	94	96	66	-	-	-	100	99	
Ultimate OR-580	94	92	66	103	99	67	95	101	
Ultimate OR-600	101	97	60	102	100	58	104	107	
Ultimate DR-606	-	-	-	-	-	-	-	-	
Tromax CR-800	97	92	64	102	99	65	100	101	
Tromax CR-800S	-	-	71	-	-	-	-	-	
Zoque R-9	99	94	57	97	97	65	100	107	
Zoque RCS-3	-	-	56	-	-	-	-	-	
Boice Beade R-745	94	97	65	99	97	62	100	106	
Boice Beade R-30	97	96	60	103	97	67	103	106	
Boice Beade R-40	-	-	69	103	102	44	-	-	
Flouline RMD60	100	93	74	96	97	67	-	-	

1. Interior Acrylic Emulsion Gloses Panel 1, 22.68 PFC, 2.7 lbs. TiO₂/gal., R-900(01) = 100
2. Exterior Acrylic Emulsion Gloses Trim, 23 PFC, 2.75 lbs. TiO₂/gal., R-900(01) = 100
3. Exterior Acrylic Emulsion Flat, 40 PFC, 2.5/2.0 TiO₂/gal. (lbs./gal.), R-900(01) = 100
4. Higher Number = Higher T.S.

WATERBORNE INDUSTRIAL FINISH GRADES

Data in Table Iib show:

- In acrylic solution vehicles, hiding power decreases with amount of surface-oxide treatment on the rutile grade; the reverse is true in polyester solution vehicles.
- Enamel grades (R-900, R-902, and R-960 types) all show similar gloss behavior in a given vehicle system.
- Unitane® CR-600, Zopaques® RCL-9, and Tronox® CR-900 are among the best competitive grades in the R-900/R-902 category.
- Standard quality (01 package code) Ti-Pure® grades perform well.
- Use of Ti-Pure® slurry grades generally provides hiding power equivalent to that obtained from corresponding dry Ti-Pure® grades, but gloss may be different, depending on the vehicle system.

Other important points to keep in mind:

- All waterborne vehicle systems within a given polymer type are not equivalent, so Table Iib should be considered only a guide. Changing vehicles may affect hiding power, gloss, and dispersibility more than changing pigments (among the enamel grades).
- Outdoor exposure information indicates that chalk-resistance of rutile grades in waterborne industrial systems parallels that shown in trade sales or conventional solventborne industrial vehicles.

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1. Reclor® 557, Ashland Chemical Company.
2. Cykloss 1600, American Cyanamid Company.
3. See page 2 for description of ratings (Low Shear Dispersion Ratings (Cowles-Type Equipment)).

HIGH PVC FLAT PAINT GRADES

Data in Table III show:

- Ti-Pure® R-931 is our best offering for this segment of the market. Package Code 26 (102 min. Tinting Strength) should show equal performance to the best dry competitive samples we have evaluated. Package Code 01 (96 min. Tinting Strength) compares favorably with average competitive performance.
- Unitane® CR-573, Tronox® CR-613, Titanox® 2131, and Zepaque® RCL-3 also show excellent properties and average 2-4 points higher CBU than R-931. For customers preferring bluer undertone, Ti-Pures R-933 should be promoted.
- These tables are guides to normally expected quality relationships of competitive products to their approximate Ti-Pures titanium dioxide counterparts. Any particular code has a range of quality that depends on the test system; consequently, results of specific determinations may not always agree with our averaged results.

NOTE: The tendency of these highly treated pigment grades to lose hiding power when dispersed under severe conditions should be taken into consideration when discussing these data. We feel that the results here represent the maximum obtainable values under ideal dispersed conditions. Pigments with similar treatment levels are subject to similar changes in hiding; however, surfactant and fluid demand of the specific pigment involved are the critical parameters.

TABLE III: HIGH PVC PLAT PAINT GRADES

Grade	O.A.	BD ¹	TS ⁴	Film Properties	Chalk Resistance	Carbon ²	Understone	η_{sp}/C
Ti-Pure® R-901	26	88	88	Spreads	Fair	<0.06	8	85
Ti-Pure® R-911	35	100	100	Minus	Good	<0.06	6	80
Ti-Pure® R-933	36	101	101	Minus	Good	<0.06	9	79
Ti-Pure® R-941 (slurry)	—	100	100	Minus	—	—	6	64(3)
Ti-Pure® R-943 (slurry)	—	101	101	Minus	—	—	9	64(3)
Titanox® 2030 (R-47)	29	88	87	SI -	Fair	0.12	10	83
Titanox® 2131	35	100	99	Minus	Good	0.04	9	81
Unitemp® OR-560	28	86	86	"	Good	0.29	12	89
Unitemp® OR-572	31	94	95	Minus	Good	0.13	9	84
Unitemp® OR-573	29	103	100	Minus	Good	0.19	10	84
Unitemp® OR-576	—	—	—	—	—	—	—	65(3)
Titanox® CR-601	28	87	83	SI -	Good	0.01	13	93
Titanox® CR-612	30	90	89	Cons -	Good	0.01	12	89
Titanox® CR-613	31	103	101	Minus	Good	0.03	10	86
Titanox® CR-623	32	97	94	—	Good	0.02	11	88
Zepanox® RCL-7	27	87	86	"	Good	0.02	10	90
Zepanox® RCL-3	35	101	102	Minus	Good	0.04	8	82
Zepanox® RCL-7	—	104	100	Minus	—	—	10	63(3)
Horse Head® R-31	30	90	89	"	Good	0.05	9	83
Horse Head® R-770	26	87	87	Cons -	Poor	0.27	8	50
Horse Head® R-771	35	97	97	Minus	Good	0.26	7	84
Horse Head® R-871	—	—	—	—	—	—	—	64(3)
Titanox® R-ED-4	29	98	96	Cons -	Fair	<0.06	7	88
Titanox® R-XL	36	108	108	Minus	Fair	0.02	7	80
Titanox® R-75	37	—	103	Minus	—	0.03	8	83

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1. BD, TS, and film properties determined in a 50% PVC, 2.5 lbs. TiO₂/gal. Interior Flat testing formula. (R-931, L-6784 = 100)
2. Pigments analyzing 0.06% carbon or less are not normally considered organic treated.
3. Percent consistency in slurry.
4. Higher number - Higher T.S.

PLASTIC GRADES

We have a broader, more versatile product line than any other producer by supplying the Plastics Industry. We can take maximum advantage of this by remembering the following:

1. In Vinyl Systems

- a) Ti-Pure® R-900 offers the best combination of strength, flocculation resistance, and plasticizer or soft stock dispersibility in flexible vinyls. Ti-Pure® R-900 is neutral in undertone. We currently do not have a blue undertone grade for flexible vinyls except Ti-Pure® R-101. It is less dispersible than R-900 in these minimum shear systems.
- b) Ti-Pure® R-101 and Ti-Pure® R-100 are generally preferred in rigid systems, where a combination of high strength, good dry-blend dispersibility and known weathering resistance are needed.
- c) Ti-Pure® R-902 offers improved durability at little sacrifice in strength, and Ti-Pure® R-960 offers still better durability at lower strength. Both of these have good soft stock and plasticizer dispersibility.

2. In Polystyrene, ABS, Polyolefin and Other Molding Systems

- a) Ti-Pure® R-101 and Ti-Pure® R-100 are ideally suited for general use because of their high strength and excellent dry-blend dispersibility.
- b) Ti-Pure® R-211 was designed for use in ABS and other rubber modified thermoplastics. It provides higher brightness than is obtainable with R-101, CR-834 and CR-450. This brightness difference is translatable into very significant cost savings in whites.
- c) Ti-Pure® R-902 and Ti-Pure® R-960 offer excellent durability and yellowing resistance, but with some sacrifice in strength and dry-blend dispersibility. They may also cause lacing in thin film extrusions.
- d) Ti-Pure® R-994 offers outstanding color stability in melamine moldings and laminates.

Promotion to Plastics accounts is admittedly difficult because the definition of the "best" pigment depends largely on the customer's systems, uses, and requirements. Our best strategy is to learn his needs and to promote the product with the best combination of properties to fill them.

TABLE IV: CHALLENGED VINYL

Ti-Pure [®]	US (1)	UK (2)	Dispersion	
			Sox. Viny I (0-10 Scale)	CONV. 18 Hegman Fineness (1/1000) (4)
R-100	98	.95	3-7	6.0
R-101	103	1.00	3-7	4.5
R-211	100	1.02	1-3	4.0
R-900	96	.97	5-7.5	6.0
R-902	96	.96	4-7	6.5
R-960	91	.96	7-8	-
R-994	97	1.01	5-6	-
<u>American Cyanamid (Inthane[®])</u>				
OR-342	95	.97	7.0	-
OR-450	103-108	.99-1.02	4-5.5	-
OR-460	104-111	1.01-1.03	4-6	-
OR-580	98	.98	6.5	-
OR-600	93-98	.97	7.5-8.5	-
<u>New Jersey Zinc (Horse Head[®]) including Cabot</u>				
R-772	94-98	.99-1.02	4-7	-
R-743	97	.97	-	-
RP-1	103	1.01	1.0	-
RP-2	103	1.02	2-8	-
RP-3	105-107	.99-1.02	5-7	-
RP-10	100	.95-.98	4.5	-

TABLE IV. CUMBERED VINYL (cont'd)

Children (Zeprene [®])	TS (1)	UT (2)	Dispersion	
			2-Roll Mill (3) Soft Vinyl (0-10 Scale)	Cooling Bremen Phenomenon (Plasticizer) (4)
P-445	96-101	1.01-1.02	4-5.5	-
P-69	95-101	.97-1.02	3-8	-
RCI-4	106-109	.96-1.01	5-7	-
RCI-3	102-105	.96-1.01	5	-
R-885	87	.93	5.5	3.0
NL Industries (Milanox [®])				
2071 (R-41)	95-107	.99-1.03	4-9	-
Rect. Mc Gee (Ticonox [®])				
CR-800 and CR-800 RC	104-108	.96-1.02	2-6	-
CR-833	101	.96	3	-
CR-834	102-108	1.01	1-5	-
Vortivenda Oy (Plintitan [®])				
R ₂	91-97	.98-1.01	1-6	4.0
R ₂ -2	100	1.01	5-7	-
RD-2	98	.99	8	-
Bayer (Trell [®])				
PTC	97	1.02	1	3.0
RT	88-98	.96-1.04	1	-

* The blue undertone type CR-800 is usually designated RC (plintitan grade).

TABLE IV. CALIBRATED VINYL (cont'd)

British Nylon Products Fluoride of Canada (Fluorides)	TS (1)	WT (2)	Dispersion	
			2-Soft Vinyl (3) Soft Vinyl (0-10 Scale)	Cowles Heggen Fineness Plasticizer (4)
ROC	86-99	1.01-1.02	2	-
ROC-3	98-100	1.01-1.02	2-7	-
ROC-5	102-111	1.01-1.04	6-8	-
ROC-2	98	1.02	1	-
ROC-3	98	1.04	1	3.0
ROC-7	86	.99	1	-
ROC-3	94	.99-1.00	5-6	-
ROC-6	98	.99	9	-
ROC-2	97-99	.97-1.00	7-9	-
Tham & Malhouse (Fluorides)				
RC-11B	93	1.00	0.5	-
RC-11D	84	.94	3	-
RC-14A	92	1.01	1	-
RC-7	90	.96	7.5	-

- (1) Tinting strength measured in medium hard vinyl; all are compared to a testing control @ 100 T.S.
 (2) The higher the number, the bluer the undertone. A difference of 0.01 can be seen, but is within normal product and test variation.
 (3) Dispersion measured in soft vinyl; 10 = no visible specking or streaking; 0 = extremely bad specking or streaking.
 (4) Cowles Dispersion Test in DOP plasticizer, higher numbers indicate better dispersion.

	High Density (HD) Polyethylene		Dry Blend Dispersion	LDPE Lacking (2)	Yellowing Resistance	
	TS	UT			Phenolic Stabilized Polyethylene Brightness (3)	Yellowing Index (4)
Tri-Pure® R-100	98	1.03	Excellent	No	92	9
R-101	100	1.06	Excellent	No	92-94	8
R-211	100	1.06	Excellent	Yes	93	3
R-400	92	1.02	Fair	Yes	87	18
R-402	83	1.02	Poor	Yes	91	4
R-960	96	1.04	Good	Yes	93	4
Unilene® CR-450	-	-	-	No	93	5
CR-460	-	-	-	No	91	4-5
Zogepac® R-69	-	-	-	No	91	11-14
RCL-9	-	-	-	No	91	5-6
RCL-4	-	-	-	No	91	3-5
Titanone® 2071 (R-41)	98	1.05	Good	Yes	-	9-11
Titanone® CR-800 (4 CR-800 FG)	-	-	-	Yes	89	10
CR-835	-	-	-	No	90	4-6
CR-834	-	-	-	No	93	4-6
Borco Hec® R-722	-	-	-	-	94	5
RF-2	-	-	-	Yes	-	-
RF-3	-	-	-	Yes	-	3-4
Thionide® RRC-3	94	1.04	Excellent	-	-	-
RRC-5	-	-	-	-	-	3-4
RRC-2	-	-	-	-	92	4-5
Phanilan® R-2	97	1.06	Fair	Yes	-	3

(1) Dry blend and injection mold with no other dispersive action.

(2) Extruded thin film, 15 pin T102, 600°C.

(3) Brightness are brightest.

(4) Lower numbers are less yellow; 6 pin T102, 0.1% phenolic antioxidant.

TABLE VI. POLYESTER (GENERAL PURPOSE)

	TS	UF	Dry Blend Dispersion (1)	Resistance to Yellowing (2)
TI-Pure® R-100	98-99	1.99	Excellent	Fair
R-101	100	1.00-1.02	Excellent	Fair
R-102	99	1.00-1.01	Excellent	Excellent
R-103	98	1.00-1.01	Fair	Excellent
R-104	90	1.01	Poor	Excellent
R-105	77	1.01	Poor	Excellent
Stamco® 2071 (R-41)	93-98	1.04-1.06	Fair-Good	Good
Dalman® CR-410	100	1.05	Fair-Good	Good
CR-460	103	1.04	Fair	-
Zeque® R-59	93-98	1.02	Good	-
KEL-4	98-107	1.04	Good	-
Tecoco® CR-800 (also CR-800 ES)	96-98	1.01-1.05	Good	-
CR-834	100-103	1.04	Good-Good	-
Horoban® R-2	98	1.05	Fair	-
RE-3	97	1.04	Good	-
Tionla® REC-3	91	1.07	Fair	Fair
REC-5	99	1.07	Fair-Poor	-
Plumtamp® R	96	1.06	Poor	-

(1) Dry blend and injection mold with no other dispersive action; strength development is measure of ease of dispersion.
 (2) Yellowness developed under accelerated weathering (correlates with heat stability during processing).

PAPER SYSTEM GRADES

Ti-Pure® RPS - Rutile Paper Slurry

- Specifically designed for use in all paper systems; wet end, paper and board coatings. No domestic or foreign counterparts available.
- Optically superior and greater value in use than anatase grades in most applications.
- Potential value in use advantage versus conventional surface treated, micronized rutile grades.

Anatase Grades - Ti-Pure® LN and LMS

- Equal or superior to domestic and foreign counterpart in opacity, brightness, and retention; excellent coating smoothness.
- Excellent dispersion and rheological properties; low +325 mesh residue.
- Equal or better than competitive anatase coating grades; sometimes better value in use than conventional rutiles at low TiO_2 /clay ratios.

Other Rutile Grades (dry/slurry) Ti-Pure® R-900/R-940, R-902, R-931/R-941, R-933/R-943

- In the wet end rutile is recommended for waxed and glassine systems; R-900/R-940 preferred.
- For coatings, grade selection is influenced by the particular system. R-900/R-940 are preferred where properties like high ink holdout, high gloss are desired.

Paper Lamine Grade (Rutile) - Ti-Pure® R-994

- Superior brightness and equal lightfastness to competitors.

TABLE VII: T10 GRADES FOR NET END AND COATINGS

Paints Grades		In 100 ml water 1330 Solids		Dispersant (2) in 100 ml water	
Dispersant (1)	Dispersant	Newtonian	Low	Good	Set up
TI-Puree M (all purpose grade)	Zero	Newtonian	Med	Good	Set up
Tilenace 1000 (PMO)	Zero	Newtonian	Med	Good	Set up
Tilenace 1010 (PMO)	Zero	Newtonian	High	Good	Set up
Diltane B-110	Zero	Newtonian	Med	Good	Set up
Diltane B-110 Special	Zero	Newtonian	Med	Good	Set up
Zopaque RS	Zero	Newtonian	Low-Med	Good	Set up
Zopaque KAC	Zero	Newtonian	Low	Good	Set up
Roco Hade A-410	Zero	Newtonian	Low	Good	Set up
Paints Grades					
TI-Puree R-900	0.3	Newtonian	Med	Good	Set up
TI-Puree R-911	0.4	Newtonian	Med	Good	Set up
TI-Puree R-931	0.5	Newtonian	Med	Good	Set up
TI-Puree R-933	0.6	Newtonian	Med	Good	Set up
Diltane BR-450	0.2	Newtonian	Med	Good	Set up
Zopaque KZ-3	--	Newtonian	Med	Good	Set up
Paints Grades (3)					
Dispersant	Suspension	Newtonian	Good	Good-Poor	Good
TI-Puree LMS	Standard	Newtonian	Good	Good-Poor <td>Good</td>	Good
Tilenace 1050 (PMO)	Slightly +	Newtonian	Good-Poor <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
Diltane (DDA)	Equal	Newtonian	Good-Poor <td>Good<td>Good-Poor</td></td>	Good <td>Good-Poor</td>	Good-Poor
Zopaque HSS	Slightly +	Newtonian	Good-Poor <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
Roco Hade A-500	Equal	Newtonian	Good-Poor <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
Paints Grades					
Dispersant	Suspension	Newtonian	Good	Good-Poor	Good
TI-Puree RPS	Slightly -	Newtonian	Excellent <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
TI-Puree R-410	Considerably +	Newtonian (4)	Excellent <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
TI-Puree R-411	Considerably +	Newtonian (4)	Excellent <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
TI-Puree R-442	Considerably +	Newtonian (4)	Excellent <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
TI-Puree R-943	Considerably +	Newtonian (4)	Excellent <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
Roco Hade 2877	Considerably +	Newtonian (4)	Excellent <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
Zopaque RCS 3	--	Newtonian (4)	Good <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
Diltane DDC57	--	Newtonian (4)	Good <td>Good<td>Good</td></td>	Good <td>Good</td>	Good
(1) Percent TSP see VTR-140-18					
(2) 70% solids in 500 ppm calcium carbonate hardness water					
(3) Generally about 7% solids					
(4) Within usual commercial pumping range					

TABLE VIII: TiO_2 GRADES FOR PAPER LAMINATES

	<u>Lightfastness</u>	<u>Opacity</u>	<u>Brightness</u>
Ti-Pure® R-994	Standard	Standard	Standard
Titanox® 2080	Equal	Equal	Minus
Unitane® CR-690	Equal	Equal	Minus

INK SYSTEM GRADES

Quality data on competitive pigments encountered at ink makers are summarized according to ink types, namely:

- Oleoresinous Inks
(Lithographic and Letterpress)
- Rotogravure (Packaging and Publication)
- Flexographic (Nonaqueous and Aqueous Types
for Packaging)

The data presented, although typical, may not represent pigment performance in some of the specialized ink formulas. With the multiplicity of ink formulas, it would not be feasible to list pigment performance in each vehicle system. Therefore, the data given should be used merely as a guide for the selection of a Ti-Pure® titanium dioxide for promotion against a specific competitive.

TABLE 16: OCEANSPRINTS INC

	Relative Gloss(1)	Relative Clarity(1)	Relative Brightness(1)	Tinting Strength(2)
Ti-Pure® R-900	9	9	10	115
Ti-Pure® R-902	8	10	8	100
Dulcane® CR-342	10	7	5	123
Tecnon® CR-800	9	9	10	113

- (1) Rated on a scale 0-10, 10 is highest; 0 is lowest.
 (2) The higher the number, the weaker in tinting strength.

TABLE XI. PHOTOGRAPHIC INK

<u>Nitrocellulose</u>	<u>Relative Density(1)</u>	<u>Relative Density(1)</u>	<u>Relative Absorption(2) Copper Block</u>	<u>gms</u>
Ti-Pure® R-900 (48)	7	10	100	100
Ti-Pure® R-915 (R01) (*)	10	7	56	79
Dulcam® OR-580	9	8	56	68
Tilman® 2090	9	8	49	74
Tromax® CR-800	5	7	44	67
Zepaque® RCL-9	6.5	8	88	92
Borchem® R-745	8.5	10	49	71
Florida® R-H06-U	9	8	31	72
Kronos® RI-63	5.5	7	47	66
Flintem® RD-1	10	8	44	75

(1) Rated on scale 0-10. 10 is highest; 0 is lowest.

(2) The higher the number, the greater the absorbance. The tests are + 10% in reproducibility.

(*) R-915 (R01) grade is obsolete. Data is included for reference only.

TABLE XI: FLEXOGRAPHIC INK

<u>Polyamide</u>	<u>Relative Gloss(1)</u>	<u>Relative Opacity(1)</u>
Ti-Pure® R-900 (01)	7.5	9.5
Ti-Pure® R-900 (08)	8.5	9
Ti-Pure® R-900 (48)	9	9
Ti-Pure® R-902 (08)	8	10
Ti-Pure® R-915 (E-01) (*)	10	8.5
Unitane® CR-580	9.5	8.5
Titanox® 2090	10	8.5
Tronox® CR-800	8.5	8.5
Zopeque® RCL-9	9.5	8.5
Horsehead® R-745	9.5	9
Tioxide® R-HD6-U	10	8
Kronos® BN-63	10	7.5
Pimtitane® RD-1	10	8
<u>Aqueous</u>		
Ti-Pure® R-901	5	6
Ti-Pure® R-915 (E-01) (*)	10	2
Ti-Pure® R-931	5	9
Unitane® CR-580	9.5	2
Unitane® CR-572	5	7
Unitane® CR-573	5	10
Tronox® CR-801	5	6
Tronox® CR-813	5	8

(1) Rated on scale 0-10, 10 = highest; 0 = lowest.

(*) R-915 (E-01) grade is obsolete. Data included for reference only.

TABLE XII: DOMESTIC GROUPS - FEMALE

PIGMENTS GROUPS INDICATED APPARENTLY COMPETITIVE RELATIONSHIP
 -NOT EQUALITY IN COMPOSITION OR PERFORMANCE

Cl. Name DL FOLK	Reference No. Industries	Balance Pa. Cl.	Signature Gibson	Horse Heads N.J. Blue	Yarnage Net. K-Box
R-960	2101	CR-550	RCL-6		CR-922
R-902	2062 (PB-AC) (1) 2061 (PB-AC) 2070	CR-600	RCL-2 R-888	R-760	
R-902	2090 (PB-30)	CR-600	RCL-9 R-55	R-745 R-755 R-30	CR-900
R-931	2131	CR-572	RCL-3	R-771	CR-913
R-933	2131	CR-573	RCL-7	R-33	CR-913
R-901	2030 (PB-47)	CR-560	RCL-10	R-31	CR-912 CR-901 CR-992 CR-993
R-944	2080 (PB)	CR-630		R-49	
R-101	2071 (PB-41)	CR-490		R-722	CR-934
R-211		CR-490	R-445		CR-900-R6
R-100	2010 (PB)	CR-342			CR-333
R-940 (Slurty)		CR-606	RCS-9	R-845	CR-900-R
R-941 (Slurty)		CR-576	RCS-3	R-671	CR-913-R
R-942 (Slurty)			RCS-2	R-41	CR-923-R
R-943 (Slurty)					CR-922-R

TABLE XIII: DOMESTIC GRADES - ANATASE

<u>Ti-Pure</u> <u>Da Pont®</u> <u>LM</u>	<u>Titanium</u> <u>Co. Industries</u> <u>1000 (A-40)</u> <u>1010 (A-40B)</u> <u>1050</u> <u>1070 (A-40)</u>	<u>Unitane</u> <u>Am. Cy.</u> <u>0-110</u> <u>0-110-S</u> <u>UDA</u> <u>0-520</u> <u>0-220</u> <u>0-310</u>	<u>Zenopac</u> <u>Glidden</u> <u>RG</u> <u>R2MC</u> <u>HSS</u> <u>LAC</u> <u>SD</u> <u>LM</u>	<u>Horse Head</u> <u>N.J. Zinc</u> <u>A-410</u> <u>A-500</u> <u>A-440</u> <u>A-420</u> <u>A-430</u>
LM-8 (Slurry)				
(RC)**				
(FR)**				
(LO-CP)**				
**Obsolete				

AA (1075) has no direct Ti-Pure® counterpart.

UDA - Unitane® Dispersion Anatase

TABLE XIV - FOREIGN TiO₂ GRADES

Producer	Trade Name	Ti-%				
		R-101	R-300	R-301	R-302	R-311 R-314
England British Titan Products (Titanide International, Ltd.)	Titanides	*R-FC2	R-10	R-104	R-CR	R-VL
		*R-FC3	R-102		R-CR2	A-1R
		R-40	R-106		R-CR3	A-1R2
		R-402			R-CR6	
		R-403			*R-TC4	
		*R-TC2 (1)			R-TC6 (2)	
		R-2	R-42		R-10	R-125**
		R-2	*R-472	R-10	R-10	
			R-11		R-10	
			R-11		R-10	
Laporte Industries	Rumex		R-42		R-10	
			*R-472		R-10	
			R-11		R-10	
			R-11		R-10	
Germany Farbwerke Bayer AG	Bayeritane	R-U-2	*R-2-10	R-10	R-10	R-12-1 A
		R-U-2	R-2-20		R-10	A-2
		R-K-0	R-10-1		R-10-1	
			R-10-3		*R-10-2-5	
Germany Klingsmann AG	Kronos	R	R-10 (1)	R-10	R-10	R-10
		R-10	R-10 (1)		R-10	
		*R-10	R-10		R-10	
		*R-10	R-10		R-10	
		*R-10	R-10		R-10	
		*R-10	R-10		R-10	
		*R-10	R-10		R-10	
		*R-10	R-10		R-10	
		*R-10	R-10		R-10	
		*R-10	R-10		R-10	

*Chloride
*Sample identification as received(1) Plastic grade
(2) Being produced as R-300 type

TABLE XIV - FOREIGN TIOZ GRADES (cont.)

Producer	Trade Name	TIOZ-Price					
		R-101	R-200	R-301	R-202	R-301	R-304
Germany (cont.) Pilsener Beer	Hombler®	R301	R101 (1)	R505	R610 (1)	R506	R610C LM
		R320	R110	R511			
France Thang & Malhouse	Tilfrance®	R1	R110	R510			
		R111	R110	R510			
Italy Montecarlo-Edison	---	R111A (1)	R114 (1)	R116	R15	R175	R118
			R117	R117	R17		R118
Finland Vestermäsa Oy	Flinttaro®		R121 (1)	R165	R167		R16
			R121 (1)	R168			
Holland Rijndorpsefabriek	Tiofine®		R122 (1)	R165	R167		
			R133 (1)	R168	R167		
Spain Dor-Argemasa	Dnltoso			R165	R167		
				R165	R167		
Yugoslavia Cimarna Celje	---			R165	R167		
				R165	R167		

TABLE XIV - FOREIGN TiO₂ GRADES (cont.)

Producer	Trade Name	Ti-Pure®				
		R-101	R-900	R-901	R-902	R-931 R-934 LN
Japan Fuji Titanium	---		TR700	TR840		TA100
Sakai Chemicals	Titonase®		SR-1	RSN		R-3L A-110
Ishihara Sangyo Kaisa	TiPaque®	R-615 R-680	R-550 R-615 R-630 CR-50	R-780 R-820 R-830 CR-80 CR-90	R-780-2	R-650 W-10
Tochigi Chemicals	---			KR-360		
Titanium Industry	---			RS-840		110
Teikoku Chemicals	Sumotox®		JR600	JR-WC	JR801	
India Titanacore Titanium Products, Ltd.	Ajuntose®					AJ
Canada Canadian Titanium Pigment	---					

Same as Titanium Pigments ISA - except RA-38, RA-39,
RA-67 & RA-70 not offered in USA

Most codes are the same as ETP

Tioxide of Canada, Ltd.

TABLE XVI. ASTM SPECIFICATION FOR TITANIUM DIOXIDE PIGMENTS (D-176-70)

Typical Paint applications	Type			
	Type I	Type II	Type III	Type IV
	Anatase(a) Free Chalking	Rutile-Medium Chalk Resistant	Rutile-Highly Chalk Resistant	Rutile-Highly Chalk Resistant
	White exterior house paint	Low-medium PVC enamels and lacquer	Medium-high PVC enamels alloy and emulsion flat wall paints	Exterior coatings requiring excellent durability and gloss retention
	Interior uses			
Titanium dioxide (TiO ₂) min. percent	94	92	80	80
Matter soluble in water specific resistance, min., ohm-cm	5000(c)	5000	3000	3000
Moisture and other volatile matter (loss at 105° to 110°C), max. percent (b)	0.7	0.7	1.5	1.5
Specific gravity	3.8 to 4.0	4.0 to 4.3	3.6 to 4.3	3.6 to 4.3
Coarse particles max. percent	0.2	0.2	0.2	0.2

(a) Identification of anatase or rutile thereof is made by X-ray analysis.

(b) Preconditioned overnight at 50% relative humidity at 25°C (for reference purposes only).

(c) 1000 permissible for water dispersible type only.

Key Contact: J. A. Stigile, Extension 2701

* DN - Chloride Process Product may contain up to 3% Rutile.

**Preferred Ti-Pure® grades for high PVC flat finishes.

TABLE XVI: KEY CONTACTS AT CHESTNUT RUN

	<u>Name and Extension Number</u>	
	<u>Key Person</u>	<u>Alternate</u>
TiO ₂ - Trade Sales & Industrials	J. G. Dickinson (2379)	J. A. Lamiet (4421)
TiO ₂ - Paper	J. T. Bilak (2166)	J. A. Lamiet (4421)
TiO ₂ - Plastics, Ink, Textile Fibers, Elastomers & Others	P. R. Hilfiker (2014)	H. W. Ling (2005)
TiO ₂ - Automotives	P. A. Wriede (2408)	H. W. Ling (2005)