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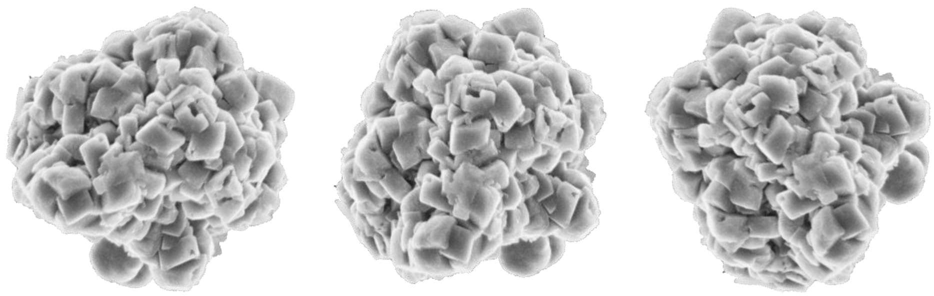

An Evaluation of Leading Distemper Paints and Their Cost Optimisation using Opacity Pigments™ from FP-Pigments

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Distemper paints have long been associated with and play an important part of the Indian paint market. Designed as economical paints that can refreshed frequently to help keep building walls clean and bright, many different brands are available from small local producers to the largest of multinational companies. This evaluation looked at six commercially available Distemper products, five from the leading, multination brands and one from a local (Mumbai) supplier.

The chosen paints were all purchased from locations within Mumbai in September 2018. The paints were tested for their application and optical properties and the results compared to give a ranking of performance. The same paints were then evaluated, by various analytical techniques, to determine their approximate composition including titanium dioxide type and level and extender types and levels. Using the reverse-engineered formulations, the paints were then tested with various levels of FP-Pigments Opacity pigment replacing the titanium dioxide pigment.

Part 1 – Comparison of the Six Commercial Paints

All six commercial paints came with instructions to dilute the as-supplied paints before application. The paints all gave slightly different dilution rates and all started at different solid contents which would lead to different film thicknesses being applied when tested. However, since this was a direct comparison of how the paints compared as used, we decided to allow the volume solids to vary as they would in real use. Further testing was then made using FP-Pigments spreading rate software which gave opacity results at equivalent dry film thicknesses.

Paint No.	Supplied Solids Content (%)	Recommended Let-down	Final Solids Content (%)	Final Volume Solids (%)
1	59.9	600ml/kg	37.8	21.0
2	68.2	500ml/kg	45.4	24.1
3	65.9	650ml/kg	39.9	20.7
4	70.3	650ml/kg	42.8	22.2
5	69.1	600ml/kg	43.3	22.9
6	63.4	500ml/kg	42.6	24.2

Table 1. Suggested let-down levels and Effect on Weight and Volume Solids

The six paints are all supplied at relatively high weight solids content with the explicit intention that they will be diluted before use.

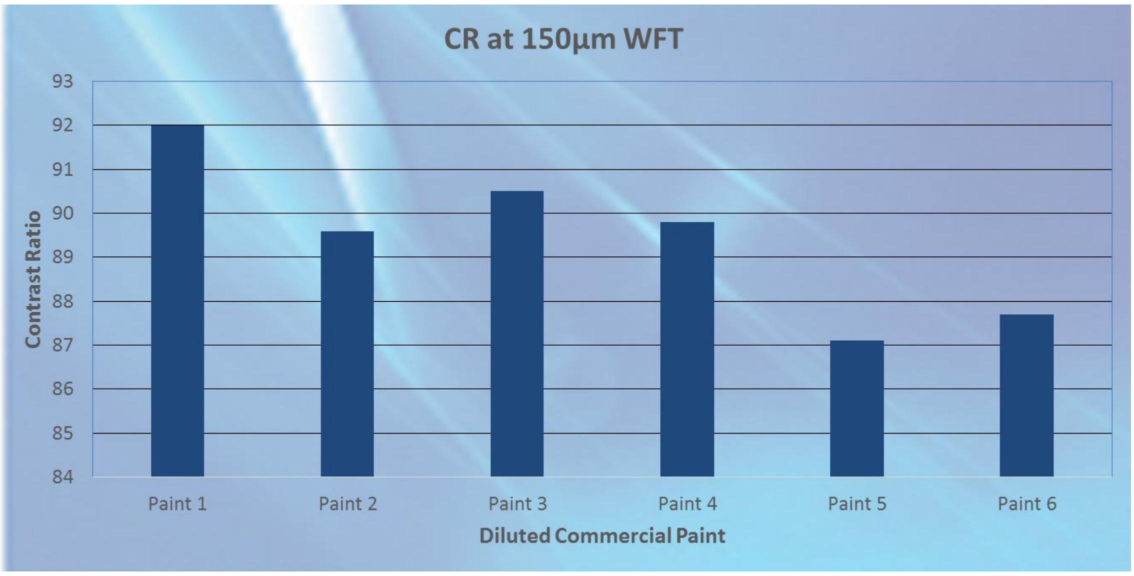


Figure 1: Contrast ratio at 150µm wet film thickness – all paints diluted as recommended

The initial contrast ratio results placed the paints into three approximate groups: Group 1 with a relatively high contrast ratio (1 Paint); Group 2 with a medium contrast ratio (3 paints) and Group 3 with a relatively low contrast ratio (2 paints). As will be seen later, this was not necessarily an effect of TiO_2 content or volume solids differences.

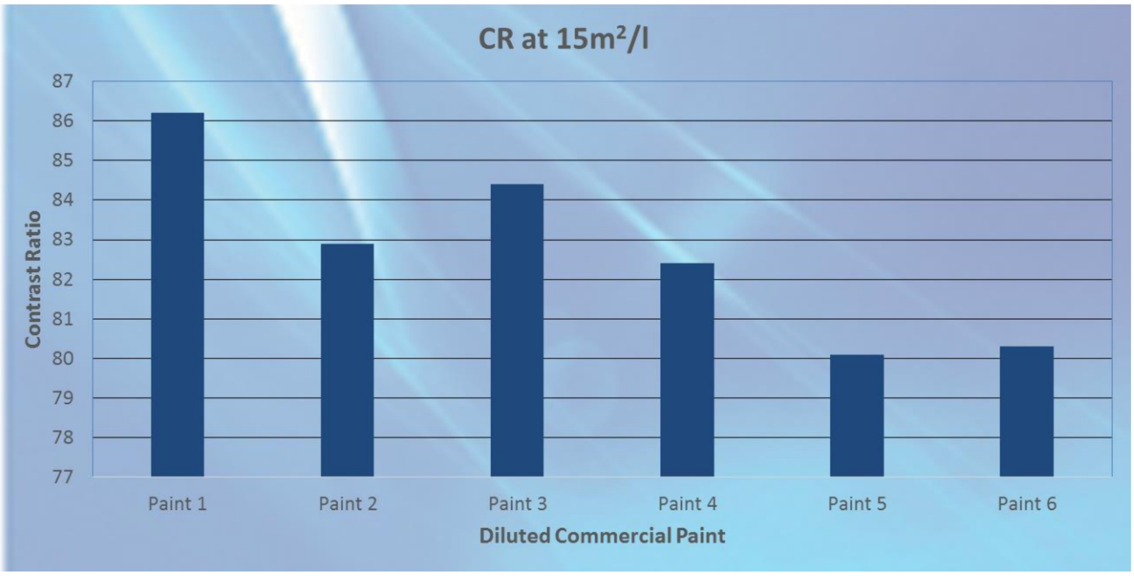


Figure 2: Contrast ratio at a Spreading Rate of $15m^2/l$ – all paints diluted as recommended

A similar partner of performance appeared when the opacity was measured at a constant spreading rate – in this case $15m^2/l$. The more precise measurement still indicated three performance levels but also exaggerated the differences slightly.

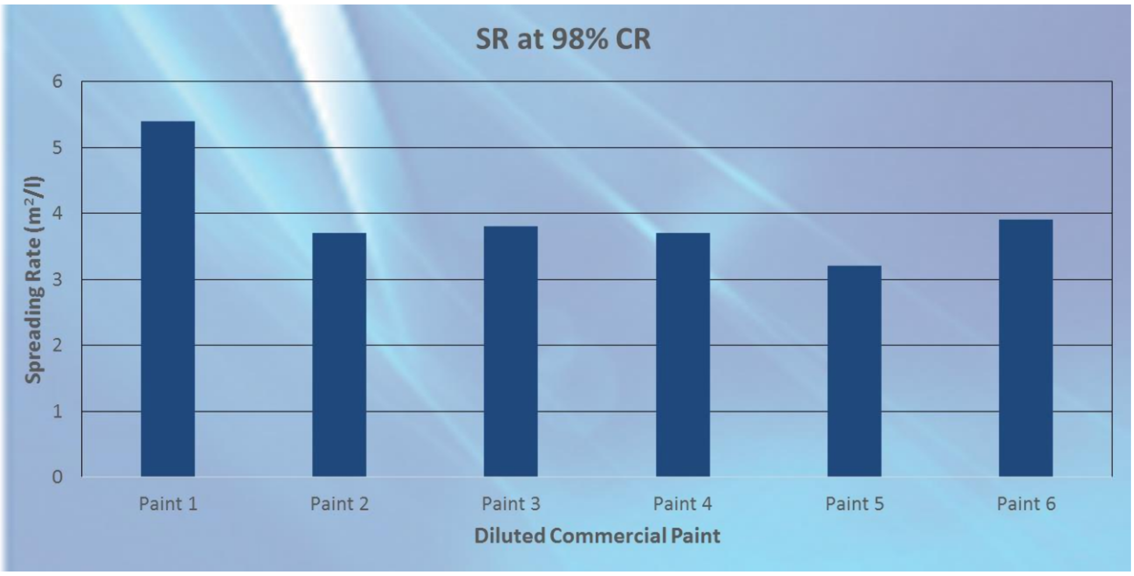
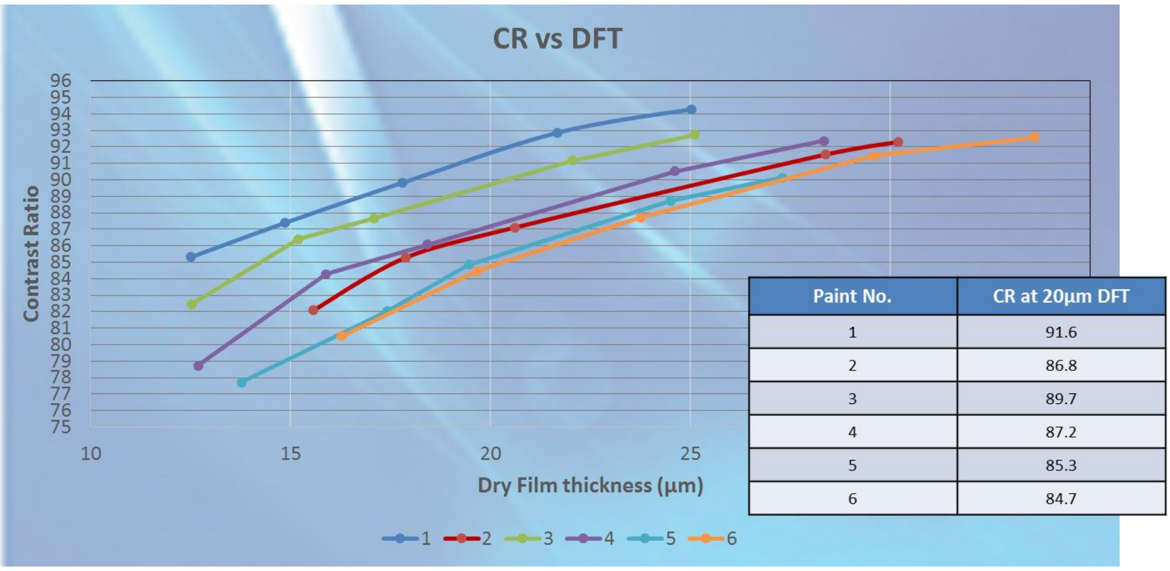


Figure 3: Spreading Rate for a Contrast Ratio of 98% – all paints diluted as recommended

The spreading rate levels for full coverage opacity (98%) showed less discrimination between the paints with only two "classes" now being apparent. All of the paints, as you might expect, gave relatively low spreading rates in order to provide full hiding power.



Paint No.	CR at 20µm DFT
1	91.6
2	86.8
3	89.7
4	87.2
5	85.3
6	84.7

Figure 4. Contrast Ratio vs Dry Film Thickness – all paints diluted as recommended

The more accurate spreading rate method also allows for dry film thicknesses to be calculated and the date to be plotted against contrast ratio. This technique tends to confirm the three performance levels although it could be argued that Paint 3 is between Group 1 and Group 2 in overall performance.

Part 2 – Analysis and Reverse Engineering of the Six Commercial Paints

To better understand the performance of the paints, the six commercial samples were analysed to identify their major components. The majority of the analytical work was undertaken with the help of the Paint Research Association (PRA) with the paints being analysed by X-Ray Fluorescence, Energy Dispersive X-ray analysis, Scanning Electron Microscopy and standard laboratory tests to determine an approximate paint composition.

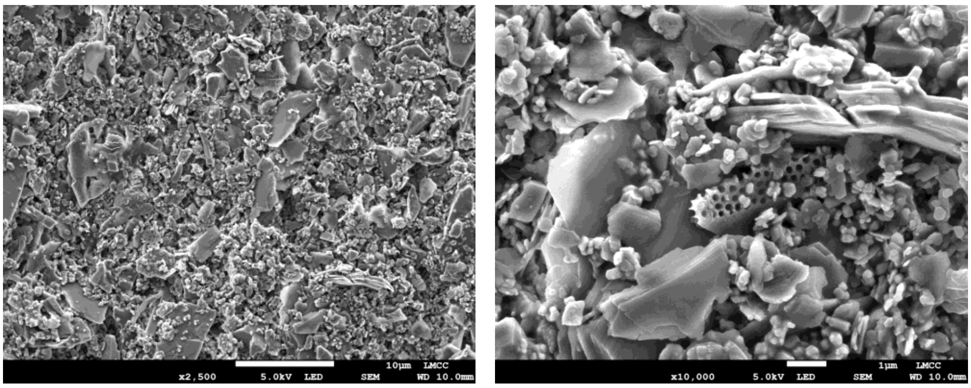
XRF Results

Paint No.	NV (%)	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	CaO (%)	MgO (%)	ZnO (%)	Other (%)
1	59.9	24.92	4.59	10.3	12.62	13.6	0.01	33.94
2	68.2	7.47	0.99	2.6	26.16	17.58	0.07	45.17
3	65.9	23.99	0.73	9.1	16.07	16.23	0	33.87
4	70.3	9.36	1.19	2.9	25.27	17.25	0.02	44.04
5	69.1	11.58	2.25	2.6	29.27	12.34	0	41.94
6	63.4	20.07	1.62	2.9	18.99	15.28	0	41.19
Repeat of No 1	59.9 (=)	24.84 (-0.08)	4.6 (+0.01)	10.3 (=)	12.58 (-0.04)	13.58 (-0.02)	0 (-0.01)	34.07 (+0.13)

Table 2. XRF Data for main elemental composition

The XRF data gave us an understanding of what major raw materials were used in each formulation. The repeated test of Paint 1 gave us confidence in the accuracy of the tests. Using the data obtained from the XRF analysis together with SEM images of the dried paint films (see example in Figure 5 below) were able to estimate the approximate composition of each paint.

Distemper SEMs – Paint 1



Paint No.	TiO2	Calcium Carbonate	Kaolin (hydrous/Calcined)	Talc	Dolomite	Zinc Oxide	Other	Binder
1	Rutile	✓	✓✓✓	✓✓	✓✓✓	×	Small amount of Diatomaceous Earth?	Styrene Acrylic

Figure 5. SEM and Approximated Composition of Paint 1

Paint No.	TiO2	Calcium Carbonate	Kaolin (hydrous/Calcined)	Talc	Dolomite	Zinc Oxide	Other	Binder
1	Rutile	✓	✓✓✓	✓✓	✓✓✓	×	Small amount of Diatomaceous Earth?	Styrene Acrylic
2	Anatase	✓✓	✓	✓	✓✓✓✓	✓	×	Unknown
3	Rutile	✓	✓✓✓	✓✓✓	✓✓✓	×	×	Styrene Acrylic?
4	Rutile	✓✓	✓	✓	✓✓✓✓	×	×	PVA
5	Anatase	✓✓✓	✓	✓	✓✓	×	×	Styrene Acrylic?
6	Rutile	✓✓	✓	✓	✓✓✓✓	×	×	Styrene Acrylic?

Table 3: Pigment and Extender Type in Each Paint

Using the date and images we were able to determine the type of extenders present in each paint and whether they were present in large or small quantities. From this, with the use of FTIR, Elemental X-ray analysis and statistical manipulation, we were able to estimate the quantities of pigment and each extender.

Paint No.	TiO_2	Calcium Carbonate	Kaolin (hydrous/Calcined)	Talc	Dolomite	Zinc Oxide	Other	Binder (Dry)
1	2.9	1.1	15.6	10.1	22.8	0	DE – 1.3	4.8
2	0.7	5.6	4.4	4.8	48.3	0.05	0	1.5
3	0.5	3.1	15.2	13.8	29.2	0	0	2.0
4	0.9	6.6	5.1	6.6	46.3	0	0	2.9
5	1.7	22.1	4.6	9.3	25.8	0	0	3.8
6	1.1	10.5	4.6	16.7	20.3	1	0	4.3

Table 4: Approximate Pigment and Extender Content

Part 3 – Cost Efficient Distemper Formulation with FP-Pigments Opacity Pigment

Having analysed and evaluated the commercial formulations the next process was to use the formulations to develop more cost effective paints by substituting as much TiO_2 with FP-Pigments Opacity Pigment (FP-460) as possible. Following our standard reformulation guidance we were able to replace between 25 and 100% of the existing TiO_2 within the reverse engineered formulations while maintaining the original paint properties.

From the results obtained we were able to produce a graph indicating the potential TiO_2 replacement levels given the initial TiO_2 loading (Figure 6 below).

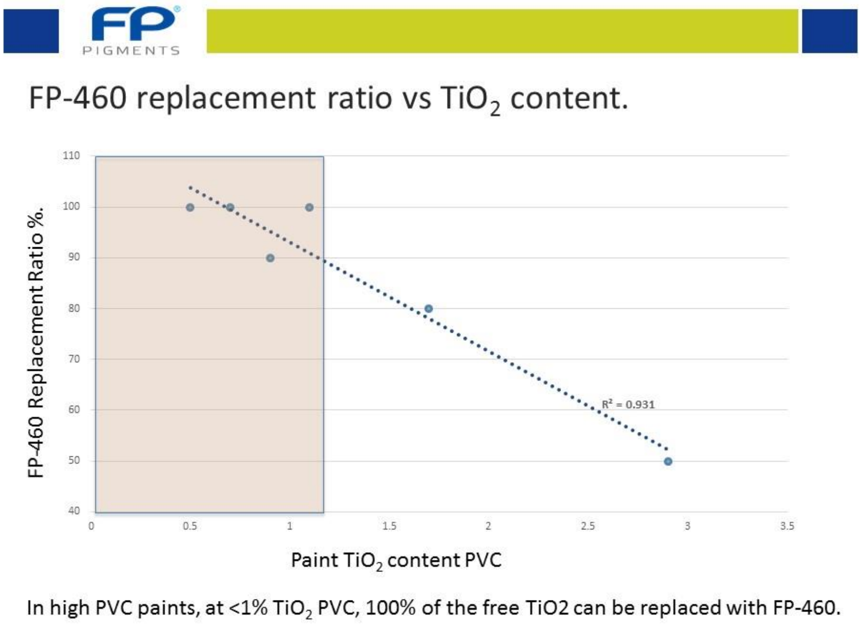


Figure 6. Chart of Replacement Ratio vs Initial TiO_2 loading

From this chart we can see that Distemper formulations which contain 1% or less TiO_2 can have all of that TiO_2 replaced with the more cost-effective Opacity Pigment, FP-460. Those formulations where the TiO_2 level is between 1 and 2% can reduce TiO_2 consumption by 75% and those between 2 and 3% can replace half of the existing TiO_2 with the Opacity Pigment.

In addition to optimising existing formulations we were also able to make a generic starting point formulation based solely on FP-460 as the opacifier. The initial formulation (Table 5) was based on 0.7% wt/wt of FP-460 and a high pvc of 95%. If necessary the paint chemist can adjust the binder content to reduce the PVC to obtain the required film properties while maintaining a good optical performance due to the unique, efficient encapsulated composition of FP-Pigments FP-460.

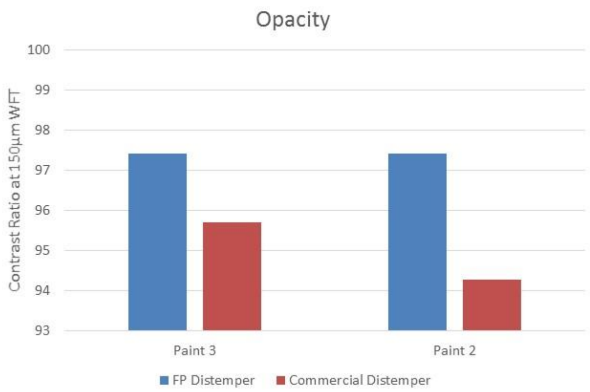
Reduced Cost Distemper based on FP-460 Opacity Pigment

Raw Material	Example material	Weight (g)	Supplier
Water	Water	26.00	
Cellulose Thickener	Cellosize™ QP 15000H	0.35	DOW
Base	Ammonia 25%	0.20	Local Supply
Polyacid Dispersant	Indofil 850	0.25	Indofil Industries
Coalescent	Texanol	0.70	Eastman
Antifoam	Sapco NDW	0.10	Auchtel Products
Biocide	Acticide® MV 14 (1:10 water)	0.10	Thor Biocides
Water	Water	3.50	
FP-460	FP-460	0.70	FP-Pigments, OY
Chalk Calcium Carbonate	Chalk D[50] 3.5µm	5.50	Local Supply
Hydrous Kaolin Clay	BCK china clay	4.50	EICL
Dolomite	Dolomite D[50] 5 µm	48.00	Local Supply
Talc	Talc D[50] 3 µm	4.50	Local Supply
Antifoam	Sapco NDW	0.10	Auchtel Products
Styrene Acrylic Binder	Primal™ AS 450	3.00	Dow
Water	Water	2.50	
	Total	100.00	

Table: 5 Generic Starting Point Formulation

The optical performance of the generic starting point formulation was evaluated against the commercial samples 2 and 3 after dilution of each to ~40% volume solids.

FP Paint performance vs Commercial paints 2 and 3.



Compared against the best of the "standard quality" distempers, the FP Pigments formulation performs excellently for opacity at equivalent solids.

It can be clearly seen that the improved TiO_2 efficiency brought about by FP-Pigments Patented spacing technology provides a boost in opacity compared to the commercial samples and it is this, additional opacity, that allows the formulation to be tailored to local market requirements providing a cost-effective alternative to TiO_2 containing Distempers.

Conclusion

The unique structure and Opacifying ability of FP-460 has been shown to have considerable potential in reducing TiO_2 consumption (and cost) in high PVC, low TiO_2 distemper style paint formulations. In a highly cost competitive market segment, the use of FP-460 to reduce or replace all TiO_2 in existing and new Distemper formulations can help producers provide cost effective products to their customer while maintaining their existing performance criteria or matching current commercial products.

For further information on FP-Pigment Opacity Pigment (FP-460) and how we can help to optimise your formulations for cost effective, equivalent performance please visit our website at www.fp-pigments.com or contact Smita Shelar by email at smita.shelar@fp-pigments.com