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S.A. DEPARTMENT OF MINES.

PLASTER OF PARIS.

FIRST REPORT.

COLOUR IMPROVEMENT.

BY

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This report describes work undertaken at the request of the South Australian Department of Mines. The experimental work was carried out under the general supervision of D.W. Read, Chief Metallurgist.

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PLASTER OF PARIS PRODUCTS.

COLOUR IMPROVEMENT.

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PLASTER OF PARIS PRODUCTS.

COLOUR IMPROVEMENT.

1. SUMMARY.

The addition of various dyes and a colouring agent to samples of plaster of paris produced from Kangaroo Island gypsum did not improve the colour of the final cast plaster.

Optical whitening agents which absorb ultaviolet light and re-emit it in the visible spectrum range showed some improvement in the amount of light reflected from plaster casts but visual examination could not detect the difference shown by a reflectance spectrophotometer.

2. INTRODUCTION.

The poor color of some of the gypsum and clay products manufactured in Australia has promoted the investigation of methods to improve their colour by the addition of small amounts of colouring material and optical whitening agents.

3. MATERIAL EXAMINED.

Preliminary tests were carried out on plaster of paris produced from Kangaroo Island gypsum.

4. EQUIPMENT USED.

(a) EEL spectro-reflectometer fitted with filters of the following wavelengths:-

(a)	NO. 601	4260A°	-	Violet
(b)	NO. 602	4700	-	Blue
(c)	NO. 603	4900	-	-
(d)	NO. 604	5200	-	Green
(e)	NO. 605	5500	-	-
(f)	NO. 606	5800	-	Yellow
(g)	NO. 607	6000	-	-
(h)	NO. 608	6300	-	-
(i)	NO. 609	6840	-	Red

(b) Twin-shell mixer.

5. RESULTS.

Preliminary testing was carried out with the following dyes, colouring material and optical whitening agents.

(1) Methyl Violet 2B200

(2) Victoria Blue

(3) Ultramarine Blue S3283

(4) Calcofluor White P.M.S. Conc (American Cyanamid CO.)

(5) Photine C (Hickson and Welsh Ltd.)

Materials 1, 2, 4 and 5 were to be used as solutions by adding them to the water before mixing with the plaster of paris. Material 3 was to be mixed with plaster in the dry state prior to casting.

5.1. PREPARATION OF METHYL VIOLET.

Difficulty was experienced in dissolving this material. Water, acetic acid and alcohol were used as solvents with little success. Finally the dye was discarded due to the inability to produce a solution of suitable concentration.

5.2. VICTORIA BLUE.

Victoria Blue dye was dissolved in 0.5 per cent acetic acid solution. The plaster of paris was mixed with water in the ratio of 3 parts of water to 4 parts of plaster. The dye solution was added to the water prior to mixing. The dye proportions used initially are shown in Table 1.

Table 1.

Parts of dye per 10,000 parts of plaster.
0.25
0.5
1.0
2.0
4.0

The plaster casts prepared from these mixtures were dried at a temperature below 120° F. On examination of the dry casts the surface appeared mottled, the size and number of the spots being proportional to the amount of dye present.

These casts were discarded and further casts made using the dye proportions shown in Table 2. Very careful preparation and mixing of the dye solution and the plaster resulted in the production of casts which were relatively uniform in colour.

Table 2.

Test Number.	Parts of dye per 10,000 parts of plaster.
1	-
2	0.05
3	0.1
4	0.2
5	0.5
6	1.0
7	2.0

Table 3 shows the results of reflectance measurements made with the E.E.L. reflectometer.

Table 3.

Sample Number	Visual* Brightness.	Reflectivity +	Reflectivity with filter no.								
			601	602	603	604	605	606	607	608	609
1.	77	72	73	75	76	77	79	79.5	81	82	83
	77		72	73.5	75	76	77.5	78	79.5	81.5	82
2.	75	69	73	75	76	77	77.5	77	78	87	82
	75		71.5	73	74	75	76	75.5	77	79.5	81.5
3.	74	66	74.5	75	76	76	74	75	74	79	82.5
	74		73	74.5	75	76.5	75.5	74	74	79	82
4.	71	64	73	74	75	74	72.5	70	70	76	80.5
	70.5		72	73.5	74	74	72.5	70	70	75.5	80
5.	66	56	73	74	74	72.5	68.5	63.5	63.5	72	79
	66		72	73	73	72	68	64	64	72	78.5
6.	56	43	70	70	69	66	58.5	51	52	63.5	73
	56.5		68	68	67	64.5	57.5	51.5	52	62.5	71.5
7.	52	37.5	68.5	69	66	63.5	54.5	47.5	48	60	70.5
	52.5		68	68.5	66	63.5	55	48.5	49	61	71

*Visual Brightness.

The Y filter of the tristimulus wheel has the same spectral distribution as the "average eye". The percentage of light reflected when compared with the standard $MgCO_3$ block is called "Visual Brightness".

+Reflectivity.

This figure is the amount of white light reflected from the sample when compared with that of the standard $MgCO_3$ block.

5.3. ULTRAMARINE BLUE.

This colouring material was mixed with the plaster of paris in a twin shell mixing machine. A primary mixture of 5 grams of ultramarine blue and 500 grams of plaster was prepared. This was then sampled and various amounts added to 500 gram lots of plaster. The mixtures made are shown in Table 4.

Table 4.

Test Number	Parts of colouring Material per 10,000 parts OF Plaster.
8	-
9	2
10	4
11	8
12	16
13	32

Casts made from these mixtures showed increasing amounts of blue colouration. The final cast, containing 32 parts of ultramarine was light blue in colour.

Results of reflectance measurements of these casts are shown in Table 5.

Table 5.

Sample Number	Visual Brightness	Reflec-tivity	Reflectivity with Filter Number								
			601	602	603	604	605	606	607	608	609
8	77.5	72	72	74	75	76	78.5	79	81	81.5	83
	77		72	74	75	76	78	79	80	81	83
9	74.5	68	71	73	74	74.5	75	75	77	79	81
	74		71	73	74	74.5	75	75	77	79	81
10	74	66	72	74	74.5	74.5	74	73.5	75	78	81
	73.5		72	74	74.5	75	74	74	75	78.5	80.5
11	68.5	60	70	72	72	71	70	68	69.5	74	78
	69		70	71	71	71	68.5	66.5	69	74.5	77
12	62.5	51	69	70	69	67.5	63	61	62.5	69.5	74
	63		68	69.5	68.5	67	62	60	62	68,5	73
13	61.5	50	74	74	71.5	67	62	58.5	60	68	73.5
	61		73	73	71	67	61	58.5	60	68	73

5.4. CALCOFLUOR WHITE P.M.S. CONC.

Calcoflour is an optical whitening agent supplied by the American Cyanamid Company. This material was made up as a 0.5 per cent water solution and added to the water prior to mixing with plaster.

Table 6 shows the proportions of whitening agent used and Table 7 shows reflectance results.

Table 6.

Test Number	Parts of Optical Whitening Agent per 10,000 parts of Plaster.
14	-
15	0.05
16	0.1
17	0.2
18	0.5
19	1.0
20	2.0
21	4.0

Table 7.

Sample Number	Visual Brightness.	Reflectivity.	Reflectivity with Filter Number.								
			601	602	603	604	605	606	607	608	609
14	78	73	73.5	75.5	76	77	78.5	79.5	81	82	83
	78		73.5	75	76	77	78	79	81	82.5	83
15	78	73	73	75	76	76.5	78	82	83	85	86
	78		73.5	75	77	78.5	79	79.5	81	82.5	83
16	78	74	73	75	76	77	78	79	80	81	83
	78		75	75.5	76.5	77.5	79	80	81	82.5	83
17	79	74.5	74	76	76	77.5	78.5	79.5	81	82	83
	79		75	76	77	74	79	80.5	81	83	84
18	78	73	73	74	75	76	77.5	79	80	81.5	82.5
	78		73	75	76	77	78	80	81	82	83
19	76.5	70.5	70	73	74	74.5	76	77	78.5	80	81
	77		71.5	73	75	76	77	78	80	81	82
20	76	71.5	70.5	72.5	73.5	75	76	77	78.5	80	81
	76.5		71.5	73.5	74.5	75.5	77	78	79	81	82
21	75	70	70	71.5	73.5	73.5	75	76	78	79	80
	75		70	72	74	75	76	77	79	80	81

5.5. PHOTINE C.

Photine C was the second whitening agent tried. The sample was supplied by Hickson and Welch Limited, London.

Testing of this material was carried out in the same manner as for the Calcofluor in section 5.4. Table 8 shows the proportion of whitening agent used, and Table 9 the reflectance values.

Table 8.

Test Number	Parts of Optical Whitening Agent per 10,000 parts of Plaster.
22	-
23	0.05
24	0.1
25	0.2
26	0.5
27	1.0
28	2.0
29	4.0
30	6.0

5.6. REFLECTOMETER TESTING OF BLANK PLASTER CASTS.

A cast of plaster of paris was made prior to each series to determine standard values. To enable easier examination these results have been collected and set out in Table 10.

Table 9.

Sample Number	Visual Brightness	Reflectivity.	Reflectivity with Filter Number.								
			601	602	603	604	605	606	607	608	609
22	77	71.5	71	73.5	74.5	76	77	78	80	81	82
	77.5		71	73.5	74	75	76.5	78	79	81	81
23	77	72	72	74	75	76	77.5	78.5	80	81	82
	78		71.5	73	74	75	76.5	77.5	79	80	81
24	76	70	71	73	74	75	76.5	78	79	80.5	81.5
	77		70	72	73	74.5	76	77	78	80	81
25	78.5	73	74	75	76.5	77.5	78.5	80	81	82	83
	78		73.5	75	77	77	78	80	80	82	83
26	77	71	72.5	75	75.5	76	78	78.5	80	81	82
	77		71.5	74	75	76	77	78.5	79	80.5	82
27	77	71.5	72	74	75	76	77.5	78.5	80	81.5	82
	77.5		71.5	73.5	75	76	77	78.5	79.5	81	82
28	77	73	73	74.5	76	76.5	78	79	80	81	82
	78		72.5	74.5	75	76	78	78.5	80	81	82
29	77	72	71.5	73.5	75	76	77.5	79	79.5	81	82
	76		71.5	74	74.5	75.5	77	78	79	81	82
30	77	72	71.5	73	75	76	77.5	78	80	82	82
	76.5		71	73.5	74.5	75.5	77	78.5	79.5	81	82

Table 10.

Sample Number	Visual Brightness	Reflectivity	Reflectivity with Filter Number.								
			601	602	603	604	605	606	607	608	609
1	77	72	73	75	76	77	79	79.5	81	82	83
	77		72	73.5	75	76	77.5	78	79.5	81.5	82
8	77.5	72	72	74	75	76	78.5	79	81	81.5	83
	77		72	74	75	76	78	79	80	81	83
14	78	73	73.5	73.5	76	77	78.5	79.5	81	82	83
	78		73.5	75	76	77	78.5	79	81	82.5	83
22	77	71.5	71	73.5	74.5	76	77	78	80	81	82
	77.5		71	72.5	74	75	76.5	78	79	81	81
Average	77.4	72.1	72.3	74.1	75.1	76.2	77.9	78.8	80.3	81.6	82.5
Limits-	0.4	0.6	1.3	1.6	1.1	1.2	1.4	0.8	1.3	0.6	1.5
+	0.6	0.9	1.2	1.4	0.9	1.8	1.1	0.7	0.7	0.9	0.5

6. CONCLUSIONS AND DISCUSSIONS.

6.1. VICTORIA BLUE.

Mixing of the dye solution with the water prior to the preparation of the plaster slurry would make this method of color correction difficult other than in the plaster board factory. It also has the disadvantage that plaster used on the job would differ in colour from the board produced in the factory.

Measurements made with the reflectometer show a steady decrease in reflectivity as the amount of dye increases. It is assumed that Victoria Blue will not improve the colour of the plaste: of paris treated.

6.2. ULTRAMARINE BLUE. S3283.

The amount of light reflected decreased with increased amounts of colouring material.
It had been hoped that this material would be successful because it can be added to the plaster either during calcination or by dry mixing with the finished plaster.

It is to be noted that mixing of plasters containing Victoria Blue and Ultramarine Blue must be complete to avoid the ap earance of coloured spots on the surface of the casts.

6.3. CALCOFLUOR WHITE P.M.S. CONC.

The addition of small amounts of calcofluor showed an improvement in the readings obtained on the reflectometer. Mainly these fell above the average readings for the blank casts but between the limits on which the average was struck. However 43 per cent of these readings were above the upper limits. It is considered that some test work to check these results is warrented.

As the amount of calcofluor is increased over 0.5

parts per 10,000 parts of plaster the amount of light reflected begins to fall below that of the average blank cast.

6.4. PHOTINE C.

Some improvement was noticed approximately 0.1 to 0.2 parts to 10,000 parts of plaster. The effect was not as noticeable as that found with calcofluor. Above this concentration the amount of light reflected decroased with increased amounts of the optical whitening agent.

6.5. VISUAL EXAMINATION.

Visual comparison of an average blank cast and the whitest casts from the calcofluor and photine C series could not determine any marked difference between the three. Only two of the twelve people asked placed the casts in the same order as the reflectometer.

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