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COMPARATIVE GOLD PRECIPITATION TESTS ON "DURHAM ULTRAFINE" AND "DURHAM STANDARD" ZINC DUSTS SUBMITTED BY DILLONS CHEMICAL CO. LTD., MONTREAL, P. Q.

by

R. P. BAILEY

MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

"Durham Ultrafine" zinc dust, at 99.6% minus 325 mesh, was slightly finer than the two other commercial dusts used for comparison. The "Ultrafine" dust was equal to or more effective than the others in all small-scale gold precipitation tests on synthetic pregnant solutions.

"Durham Standard" zinc dust, which was much coarser (80.3% minus 325 mesh) than the "Ultrafine"and the two comparison dusts, was not nearly as effective as a gold precipitant.

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* Senior Scientific Officer, Mineral Processing Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

INTRODUCTION

The Dillons Chemical Co. Ltd., 410 St. Nicholas Street, Montreal 1, P.Q., are agents for an associate company, Durham Chemicals Limited, Birtley, England, producers of zinc dust.

Shipment

Two cans of Durham zinc dust were received at the Mines Branch on May 1, 1962. One of these, weighing 18 pounds, was marked "Standard Grade"; the other, 14 pounds gross weight, was labelled "Ultrafine".

Purpose of Investigation

In a letter dated March 16, 1962, Mr. R. A. Langlands of Dillons Chemical Co. Ltd., requested that tests be made on these samples to assess their suitability for precipitating gold from cyanide solution.

General Test Procedure

As there were no particular specifications for zinc dust used in gold cyanidation plants, all tests on the Durham zinc dusts were made on a comparative basis with two other brands which have been widely used in gold mills in Northern Ontario and Quebec. In this report, the "comparison dusts" have been designated "M" and "G".

Miscellaneous tests on all four samples of zinc dust included visual microscopic examination, determination of approximate packing density, screen and infrasizer tests, chemical and semi-quantitative spectrographic analysis.

Precipitation tests were made using each zinc dust in amounts from 0.06 to 2.0 pounds per ton of solution. For most of these tests a "synthetic" pregnant solution was prepared by dissolving gold powder in cyanide-lime solution at concentrations typical of those found in many gold mills. One test series was done on a "natural" gold solution of similar concentration obtained by cyaniding a gold ore.

DETAILS OF INVESTIGATION

Packing Density

As a rough measure of the fineness of the zinc powders, approximate packing density was determined by pouring 200 grams of each zinc dust in turn into a dry 100 ml graduated cylinder and tapping the cylinder lightly on the bench top about 25 times to obtain a fairly constant packed volume, free of noticeable voids. From this volume the packing densities shown in Table 1 were calculated.

Visual Examination

Because of the arbitrary importance of colour and appearance in the appraisal of zinc dusts by some mill operators, the four brands under comparison were examined microscopically at 625X magnification. Table 1 summarizes the writer's visual impression of these characteristics.

TABLE 1

Physical Characteristics of Zinc Dust Samples

Sample	Packing Density lb/cu ft	Colour	Shape
Durham Standard	2.53	light grey	spherical
Durham Ultrafine	1.73	medium "	"
Dust "M"	1.84	dark "	"
Dust "G"	1.72	medium "	"

Size Analysis

Results of screen and infrasizer tests on the four samples of zinc dust are shown in Tables 2 and 3.

TABLE 2

Screen Tests on Zinc Dust Samples

Size	Weight %			
	Durham Standard	Durham Ultrafine	Dust "M"	Dust "G"
+150m	-	-	0.6	-
-150 +200m	3.0	-	1.2	5.8
-200 +250m	0.8	-	0.3	-
-250 +325m	15.9	0.4	1.5	4.4
-325m	80.3	99.6	96.4	89.8
Total	100.0	100.0	100.0	100.0

TABLE 3

Infrasizer Tests on Zinc Dust Samples

Size (microns)	Weight %			
	Durham Standard	Durham Ultrafine	Dust "M"	Dust "G"
+56	11.4	0.4	1.0	4.5
-56 +40	9.7	0.5	0.7	3.0
-40 +28	10.1	0.8	0.6	4.7
-28 +20	11.9	2.3	0.9	5.5
-20 +14	17.9	3.6	2.7	6.0
-14 +10	15.0	3.1	5.5	7.3
-10	24.0	89.3	88.6	69.0
Total	100.0	100.0	100.0	100.0

Spectrographic Analysis

The four samples of zinc dust under comparison were analyzed semi-quantitatively by emission spectrograph with results as listed in Table 4.

TABLE 4

Semi-quantitative Spectrographic Analysis of Zinc Dusts

Element	Analysis % *			
	Durham Standard	Durham Ultrafine	Dust "M"	Dust "G"
Zn	PC	PC	PC	PC
Pb	0.4	1	0.3	0.5
Cd	0.2	0.3	0.3	0.05
Al	0.09	0.009	0.01	0.2
Mg	0.06	0.04	0.03	0.01
W	0.05	ND	0.1	0.07
Fe	0.03	0.01	0.07	0.07
Ca	0.02	ND	0.05	0.03
Cu	0.007	0.004	0.006	0.005
Sn	0.002	0.01	0.002	Tr?
Si	Tr?	Tr?	0.07	0.09
Mn	Tr?	Tr?	0.004	0.01
Ti	ND	ND	Tr	Tr
Cr	-	-	-	Tr
Bi	-	-	-	Tr

* From Internal Reports MS-AC-62-494 and 742, by E. M. Kranck, Mineral Sciences Division, Mines Branch.

PC - Principal constituent; ND - none detected

Tr? - Possible trace

Chemical Analysis

Total zinc, metallic zinc and lead were determined quantitatively by wet chemical methods. Results are shown in Table 5.

TABLE 5

Zinc and Lead Content of Zinc Dusts

Constituent	Analysis % *			
	Durham Standard	Durham Ultrafine	"M"	"G"
Total zinc	98.27	98.27	96.73	97.87
Metallic zinc	95.08	95.08	87.99	92.66
Zinc oxide**	3.98	3.98	10.90	6.49
Lead	0.28	0.23	0.14	0.25

* From Internal Reports MS-AC-62-626 and 658.

** calculated

Gold Precipitation

(a) Mill Practice -

In most Canadian gold mills, current technique for precipitation of gold from cyanide solution follows the Merrill-Crowe system. This is based on the fact that gold is precipitated by zinc more efficiently from a deaerated solution than from one containing atmospheric oxygen. Therefore, the cyanide solution, saturated with air during the extraction process, is maintained under high vacuum during the precipitation cycle. In practice, the solution is first drawn through a clarifier to remove finely divided solids before going to a Crowe tower where it is deaerated under vacuum of 26-29 inches as it cascades down through a series of baffles or grids. After being drawn from the Crowe tower by centrifugal pump, zinc dust is added and the solution is pumped to a precipitation press for collection of the gold precipitate. The amount of zinc dust, which is added slowly to the solution line between the Crowe tower and the pump, varies from mill to mill but is usually in the range of 0.02 to 0.10 pounds per ton of solution. A lead salt, either nitrate or acetate, is usually added to the zinc mixing cone in amount seldom exceeding 0.02 lb per ton of solution. Gold content of the pregnant solution ranges from as low as 0.05 oz/ton in some mills to a maximum of about 0.5 oz/ton in others.

(b) Laboratory Test Procedure -

Equipment used for small-scale gold precipitation tests at the Mines Branch laboratory simulated the physical and chemical reactions which take place in commercial Merrill-Crowe systems. The laboratory apparatus, shown in Figure 1, consisted of three 2000 ml Erlenmeyer flasks, closed tightly by rubber stoppers and inter-connected by glass and heavy wall rubber tubing. The final flask, fitted with a stoppered No. 1 Buchner funnel, was connected to a vacuum pump capable of evacuating to 29 inches of mercury. Effective filtration of precipitated gold was ensured by a coating of asbestos and Filter-cel on a Whatman No. 42 filter paper held down by a lead ring fitting tightly inside the funnel.

For all the precipitation tests in this investigation, the following basic procedure was followed:

(1) 500 ml of pregnant solution containing about 0.25 oz Au/ton was poured into No. 1 flask;

(2) Under 27" - 28" vacuum, the No. 1 flask was agitated vigorously for 30 minutes to deaerate the solution;

(3) Under the same vacuum the deaerated solution was transferred to No. 2 flask containing the required amount of zinc dust;

(4) No. 2 flask, under vacuum, was agitated vigorously for six minutes to contact zinc dust and solution as thoroughly as possible;

(5) Solution-zinc mixture was drawn through the filter into No. 3 flask;

(6) The clear filtrate was assayed for gold.

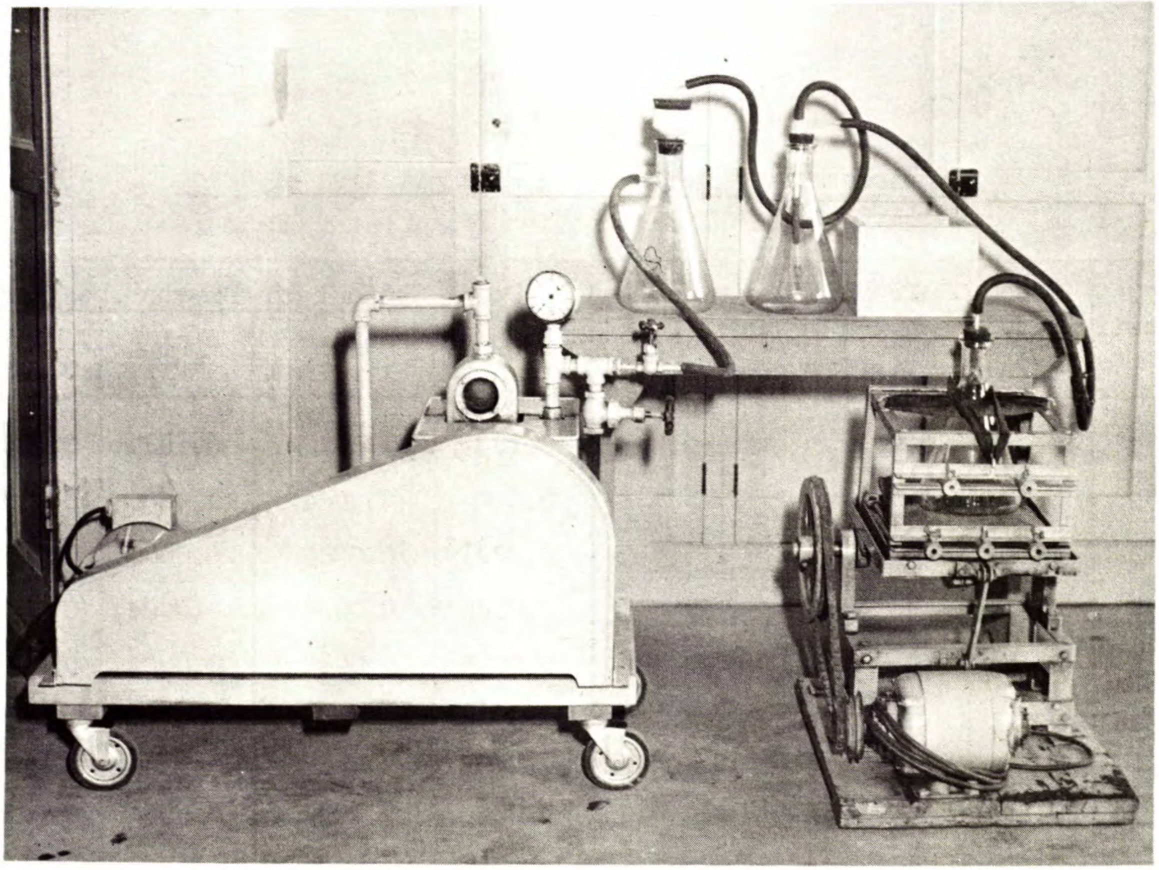

Figure 1 - Laboratory Apparatus for Gold Precipitation Tests

In Tests 1 to 5 inclusive, using a "synthetic" gold solution prepared by dissolving gold powder in cyanide-lime solution, lead nitrate equivalent to 0.02 lb/ton was added to the solution before deaeration. Results of these tests, summarized in Table 6, are shown graphically in Figure 1.

The procedure was varied in Test 6 by adding the lead nitrate (0.02 lb/ton) to the zinc dust-water mixture in No. 2 flask instead of to the pregnant solution. In Test 7, both lead nitrate and a dispersant (Aerosol 18 at 0.02 lb/ton of solution) were added to the zinc. Test results are shown in Table 6.

For Tests 8, 9 and 10, a "natural" gold solution of about the same concentration as the "synthetics" in Tests 1-7 was obtained by cyaniding a gold ore. Lead nitrate (0.02 lb/ton of solution) was added to the zinc dust in Test 8. This procedure, with addition of Aerosol 18 (0.02 lb/ton) was repeated in Test 9 on the "Durham Ultrafine" dust only. Conditions for Test 10 were the same as in Test 4. Results are summarized in Table 6.

TABLE 6

Comparison of Zinc Dusts in Precipitation of Gold

Test	Zinc added lb/ton	Pregnant Solution			Gold* Content of "Barren", oz/ton			
		NaCN lb/ton	CaO lb/ton	Gold* oz/ton	Durham Standard	Durham Ultrafine	Dust "M"	Dust "G"
1	0.06	0.96	0.80	0.244	0.130	0.133	0.193	0.129
2	0.24	"	"	"	0.080	0.0044	0.088	0.017
3	0.50	"	"	"	0.027	0.0006	0.0009	0.0023
4	1.00	"	"	"	0.0046	0.00044	0.00044	0.0014
5	2.00	"	"	"	0.0026	0.0003	0.00044	0.0003
6	0.24	0.96	0.84	0.248	0.069	0.0040	0.010	0.0058
7[W]	0.24	"	"	"	0.086	0.0026	0.005	0.013
8	0.24	0.88	0.36	0.248	0.1245	0.0641	0.0536	0.086
9[W]	0.24	"	"	"	-	0.0131	-	-
10	1.00	"	"	"	-	0.0003	0.0003	0.0003

* Analyses from Internal Reports MS-AC-62-702, 869 and 971.

[W] Dispersant added to zinc dust.

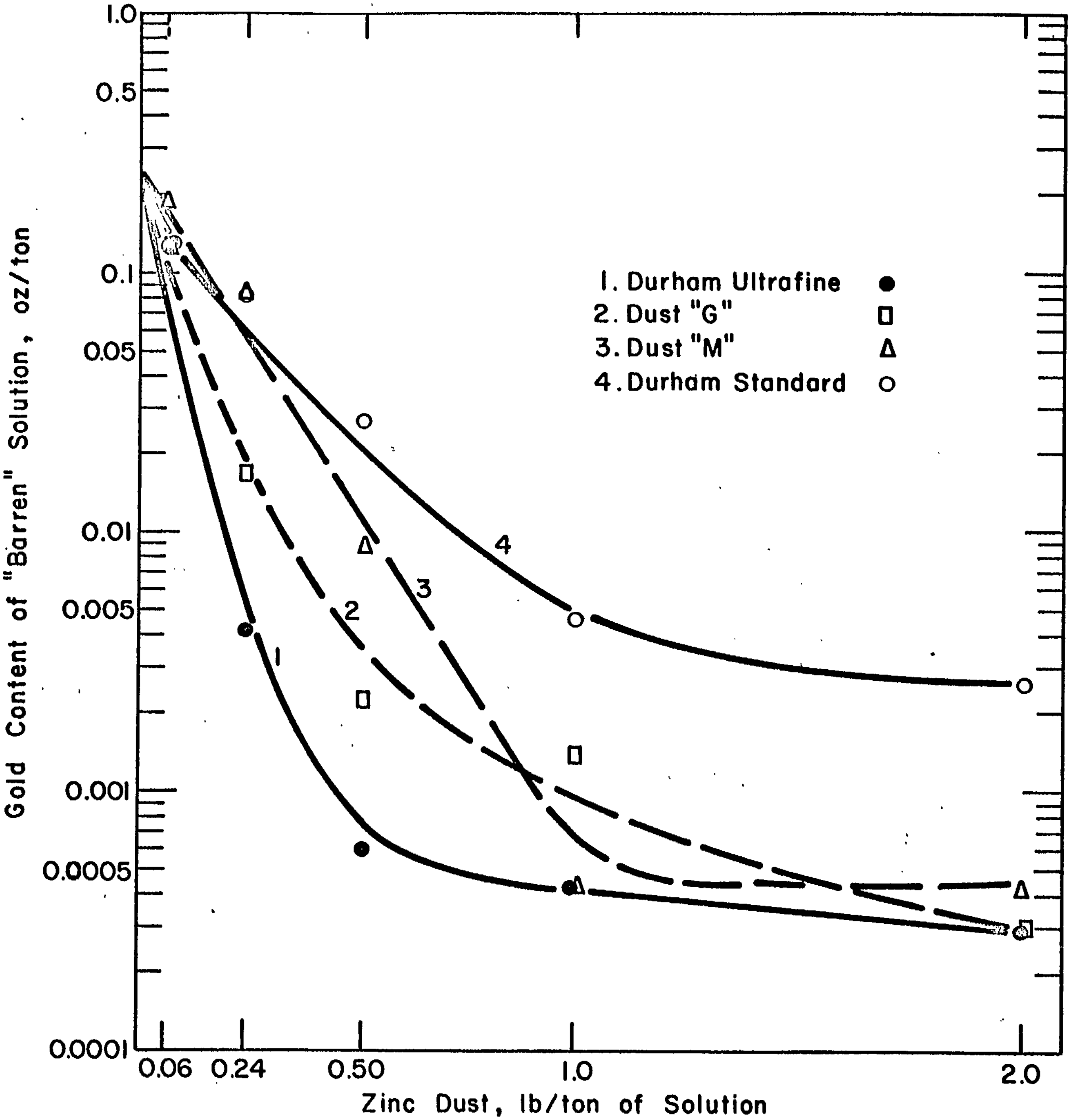

Figure 2; Comparison of Zinc Dusts in Precipitation of Gold From Cyanide Solution.

CONCLUSIONS AND DISCUSSION

In appearance the "Durham Ultrafine" zinc dust was very similar to the two commercial dusts used for comparison. Size analysis showed it to be appreciably finer than the other dusts, both in the minus 10 micron as well as the minus 325 mesh fraction. The finer the zinc dust (with consequent greater surface area per unit weight), the more effective it is in gold precipitation.

In total zinc and in metallic zinc content, both Durham brands were superior to the other zinc dusts tested. Zinc oxide, which is largely inert in the gold precipitation reaction, was considerably lower in the Durham samples. Lead content was of the same low order in all four samples tested. Semi-quantitative spectrographic examination showed no known impurities in detrimental quantities in the Durham zinc dusts or in the two comparison dusts.

The results of gold precipitation tests on a 500 ml scale in the laboratory, although useful for comparison purposes, are not representative of the "barrens" which would be obtained on a plant scale using zinc dust in practical concentrations (i.e. less than 0.10 lb/ton of solution treated). In gold mill practice, initial "priming" of the precipitation press with a relatively large amount of zinc dust coats the filter medium to the extent of 10-20 grams per square foot of filter area. This coating, in addition to the zinc discharged continually from the feeder, ensures gold precipitation down to "trace" amounts (less than 0.0005 oz Au/ton). In the laboratory apparatus, this effect is not duplicated until zinc is used in the amount of at least 1.2 lb/ton of solution. Therefore, only the "barrens" obtained by addition of zinc dust at ratios between 1.0 and 2.0 lb/ton of solution are likely to be representative of those which would be obtained on a plant scale using the zinc dust in the small amounts common to gold mill practice.

Within these qualifications, the results of Tests 1-5, plotted in Figure 2, show the "Durham Ultrafine" zinc dust to be a very effective precipitant for gold and slightly superior to the two other commercial zinc dusts used for comparison. With the "Ultrafine" dust, even at a zinc-solution ratio of 0.5 lb/ton, the gold content of the "barren" was reduced to 0.0006 oz Au/ton; and, in the significant range of 1.2 to 2.0 lb/ton, "trace" barrens were indicated by the laboratory tests.

As might be expected from its relatively coarse nature (about 80% minus 325 mesh), the "Durham Standard" zinc dust was much less effective as a gold precipitant than the "Durham Ultrafine" powder and the two commercial zinc dusts. Even when added at a concentration of 2.0 lb/ton of solution, the "Durham Standard" dust never produced a "barren" below 0.0026 oz Au/ton (equivalent to a value of about 9¢/ton with gold at $35/oz).

In Test 6 the lead nitrate was added with the zinc dust as in plant practice instead of to the gold solution as in previous laboratory tests. With all four zinc dusts, this variation gave "barrens" appreciably lower in gold than those obtained by the basic procedure of Test 2 and confirmed both the slight superiority of the "Durham Ultrafine" dust and the much lower efficiency of the "Durham Standard" powder.

Because of the tendency of the zinc dusts to collect in clusters or lumps and so to cause poor and erratic precipitation, the effect of adding a dispersant (as well as lead nitrate) was investigated in Test 7. With the two very fine zinc dusts, "Ultrafine" and "M", the expected lower "barrens" were produced; but, with the coarser powders, "G" and "Durham Standard", instead of the same or slightly lower "barrens" expected, much higher results were obtained. This apparently anomalous behavior cannot be explained by the limited data of this test.

The difficulty of preparing a stock quantity of "natural" gold solution by cyanidation of ore limited the tests to two concentrations of zinc dust (0.24 and 1.0 lb/ton). Results of Test 8, although considerably higher than corresponding values obtained with the "synthetic" solution, place the four zinc dusts in about the same order of efficiency. The beneficial effect of a dispersant with fine zinc dust is again indicated by the result obtained with the "Ultrafine" dust in Test 9. Identical "trace" barrens were obtained when the "Durham Ultrafine" and the two comparison dusts were used at a zinc/solution ratio of 1.0 lb/ton in Test 10.

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