Cadmium

23

FORM 49a [illegible]-52

CERRO DE PASCO CORPORATION • NEW YORK
INTER-DEPARTMENT MEMORANDUM

Date: January 14, 1953

To: R. P. Koenig, Lima

From: W. C. Smith

Subject: Cadmium Recovery
(Your longhand memo of 1/10/53)

The future recovery of cadmium must come from four sources:

(a) Lead blast furnace cottrell or possibly lead blast furnace baghouse dust and fume.

(b) Purification cake from electrolytic zinc plant.

(c) Roaster fume from electrolytic and electrothermic zinc plant, supplemented by preheater fume from the electrothermic zinc plant.

(d) Cadmium rich material from the zinc redistillation process, if and when installed.

1. We can assume that materials b, c and d are relatively free of arsenic and the cadmium can be extracted from them by acid leaching, followed by sponging out with zinc dust or slab zinc.

The extraction of cadmium from the lead blast furnace fume or dust (a) is more difficult, due to the excess of arsenic and other impurities in the fume.

Most lead smelters employ pyrometallurgical methods for concentration of the cadmium from lead furnace fume. In most cases, as much of the arsenic as possible is removed from the fume by roasting prior to the concentration of the cadmium. In every case we know if the cadmium concentrate contains more arsenic than is desirable.

2. The cadmium concentration developed at Oroya has given the best results of any of the several methods tried to date. We do not know that it is the cheapest method which may be developed, but we believe it should be used until a better process can be found. It would appear that all pyrometallurgical processes will require a furnace and cadmium fume collection equipment. Therefore, why not start with this equipment.

3. The cadmium concentrate from this equipment will have to be leached in acid and sponged out with zinc dust or slab zinc and this sponge then can be combined with the sponge from the other products for final purification.

WCS-RPK, 1/14/53

4. The final cadmium can then be prepared by distillation or electrolytic precipitation whichever proves to give the better product at the lowest cost. We believe the retort equipment for distillation is now available at Oroya.

5. We can estimate the cadmium available in various products as:

(a) In lead blast furnace fume	250-300	lb. per day
(b) From electrolytic zinc plant	250-300	" " "
(c) From each electrothermic zinc unit	200-220	" " "
	700-820	" " "

As of January 1954 we should have available about 900 to 1,040 lbs. of cadmium per day. Assuming an overall recovery of 75% of this and a margin of $1.00 per lb. between the market price and production plus delivery costs, the net outcome should be $675 to $780 per day, or from $240,000 to $280,000 per year. The eventual return with 6 electrothermic units would be of the order of $500,000 per year.

6. I believe the Research Dept. has sufficient information available on which to base a preliminary layout of a cadmium recovery plant to treat all the cadmium-bearing products from lead plant, the electrolytic zinc plant and six electrothermic units and this layout should be made as soon as possible for further study and criticism. Meanwhile experimental operation should be intensively continued.

W C Smith

W. C. Smith

WCS:JC

cc: R.P.Koenig, NY (1)
A.E.Engelhardt (4)
J.D.Smith (2)
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CERRO DE PASCO CORPORATION - OROYA

CORRESPONDENCIA INTERDEPARTAMENTAL

Fecha January 23, 1953

A: A. H. Engelhardt, Manager of Operations

De: A. K. Schellinger, Director of Research

Materia: Cadmium Recovery (Re: Memo of W. C. Smith to R. P. Koenig, January 14, 1953)
(Memo of A. K. Schellinger to A.H. Engelhardt, December 20, 1952.)

The following comments may be pertinent to the W. C. Smith memorandum of January 14, 1953 to R. P. Koenig. Additional data and estimates of the cadmium supply and recovery situation, as seen here in Oroya, are offered in extension to my recent memorandum (AKS to AHE, December 20, 1952) on the status of the cadmium recovery program as of January 1, 1953.

1. Any discussion of sources of cadmium must recognize that:
   (1) We have tentative data on what to expect from blast furnace fume (see attached graph) in the way of grade and total pounds of Cd circulated per month. We have very little data on actual Cd intake and stack loss. This data is being gathered and should be compiled within the next three months.

   (2) We have more exact data on zinc plant purification cake cadmium content and production. We can expect about 1 ton a day of this material containing from 5 to 8 percent cadmium, based on the experience of the past year.

   (3) We have no data on roaster fume from the electrothermic zinc plant, nor have we any data on preheater fume from the same plant. Such data may be in existence from pilot plant operations at Palmerton, but has not been seen by the Oroya Research Department staff. The collected dust from the roaster flue of the electrolytic zinc plant assays about 0.03% Cd, but the fume is not collected and probably runs considerably higher. A recent assay of Paragsha zinc concentrate showed 0.13% Cd.

2. With reference to the difficulty of extraction of Cd from the various materials mentioned above, it should be recognized that arsenic is not the only interfering element in our blast furnace fume. Our fume contains as much as 15% zinc and 13% sulfur normally, the latter probably combined as zinc and cadmium sulfides. Smelting operations on such fume are rendered difficult by the continued volatility of these sulfides, and the formation of high melting zinciferous slags and crusts. In addition to the formation of lower melting point mattes, the soda flux takes much of the indium into solution in a soda slag, from which it can be extracted by leaching.

3. The concentration of cadmium from zinc plant purification cake has been done in the laboratory with marked success by fuming methods. A 57% Cd. concentrate was recently produced by fuming with fuel oil reductant at 800 deg. C, with a recovery of over 90%. On the basis of this it has been decided to proceed with a pilot operation on this principle. The Research Department roaster will be repaired and operated on this work. A high grade fume, if producible on a pilot scale, will be leached along with concentrated blast furnace fume in the present leaching plant, suitably modernized with effective leach equipment. The process, if a success, will do away with bulky leaching equipment and slow leaching purification cake. Oxidized zinc residue will be fast leaching and substantially free of cadmium.

4. Cadmium metal of 99.85 plus grade has been prepared by double sponging, pressing, melting and kettle drossing. The main impurity remaining in the metal is thallium which is present to the extent of 0.10%. This has been removed in the laboratory by zinc chloride drossing and the use of some chlorine. The process is being tried on a larger scale and, if successful will give us a metal of 99.95 plus grade without resorting to retorting or electrolytic refining. Retort equipment for distillation has not yet been received at Oroya.

5. Our estimates, made with data gathered by us at Oroya, indicate the following amounts of cadmium available in various present and future products of the reduction plants:

(a) In lead blast furnace fume: 50 -100 lbs. per day
(based on withdrawing 5 tons per day from the blast furnace circuit for average of 100 days during the year to maintain an average grade of 3% Cd during withdrawal.)
(See attached graph for average statistics during 1952)

(b) In electrolytic zinc plant purification residue: 100 -200 lbs. per day
(based on 1 ton per day of residue containing from 5 to 8% Cd).

(c) In future products from each electrothermic unit: 200 -300 lbs. per day
(based on treating 80 tons of Paragsha concentrate at about 0.15% Cd).

Total available: 350 -600 lbs. per day

It will be noted that the metal estimated to be presently available is from 150 to 300 lbs. per day. Pilot plant facilities, as can be seen on the attached flowsheet, are estimated to allow for a production of 180 lbs. per day <u>provided</u> we construct facilities for pelletizing and roasting blast furnace fume, and for fuming zinc plant purification cake. Improved leaching and filtering equipment must also be installed to insure continued production. These latter items have been provided for in 'Statements of Necessity' and AFE requests during 1953.

6. The attached flowsheet is qualitative and preliminary in nature and is presented for the following purposes:

   a. To give an idea of the general flowsheet, based on pilot plant experimental work, for recovering cadmium from blast furnace fume and zinc plant purification cake.

   b. To form the basis of a quantitative flowsheet when all experimental data is available. We hope this will be possible in 1953.

   c. To show existing pilot plant facilities and those that will be necessary to complete the experimental flowsheet. Those facilities marked inadequate are our present bottlenecks. Plans have been made to eliminate these in order to bring the experimental flowsheet to full estimated production. These plans are now subject to the approval of management.

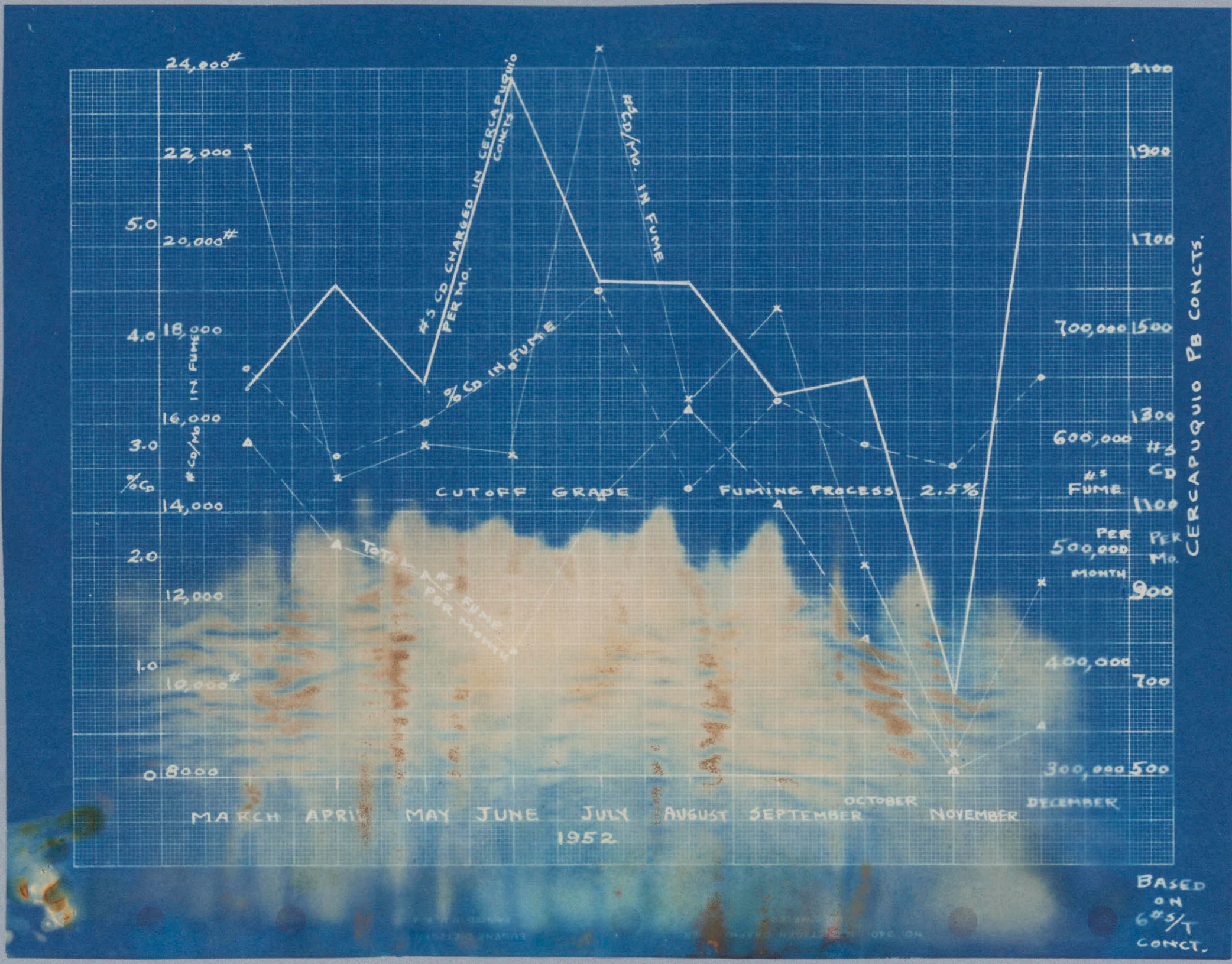
Experimental operation will be pushed as intensively as labor supply and facilities will allow with the object of:

1. Simplifying the existing flowsheet and exceeding the estimated production.

2. Making an exact quantitative flowsheet and obtaining realistic cost figures.

3. Translating experimental cadmium production to a profitable commercial operation in as short a time as possible.

cc: A.H.Engelhardt (7)
I.L.Barker (1)
File (1)


24,000#
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#CD/MO. IN FUME
%CD
#5 CD CHARGED IN CERCAPUQUIO CONCTS PER MO.
#CD/MO. IN FUME
%CD IN FUME
CUTOFF GRADE
FUMING PROCESS 2.5%
TOTAL #5 FUME PER MONTH
2100
1900
1700
1500
1300
1100
900
700
500
700,000
600,000
500,000
400,000
300,000
#5 FUME PER MONTH
#5 CD PER MO.
CERCAPUQUIO PB CONCTS.
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1952
BASED ON 6#S/T CONCT.

Qualitative Flowsheet with

Proposed and Existing Pilot Facilities for Extraction of Cd

from

Blast Furnace Fume - 2.5 - 5.0% Cd

3 - 5 Tons p. day for 100(?) days/year

Dust Pump (non-existent)

Pelletizing Drum (non-existent)

Godfrey Roaster (non-existent)

Storage Bins (non-existent)

2 Tons/day

Cu Cement

Soda Ash Coke

Fuming Smelting Furnace (existent)

Cd Zn Fume

Lead Bullion (To Pb Kettles)

Cu Speiss + Matte (To Cu Converters)

Soda Slag (Leach for In)

Recycle Hi-As Lo-Cd

Cyclones + Baghouse (exist.)

20 Fume 150# day

40% Cd Concl

Storage (non-exist)

from

Zn-Plant Purification Cake

5-7% Cd

60-70% Zn

± 1 Ton/day

20% Fuel Oil

Hearth Roaster (existent)

800°C

H_2SO_4

ZnO-Residue

Leach Tank (exist.)

Fume

Zn-Dust

Solution

Precipit. Tank

Cyclones + Baghouse can be improvised

$ZnSO_4$-Soln to Electrolysis

Cu + In Residue To In Extraction

Fume Concl. 40-60% Cd ± 200# day

Proposed from Lab. Tests

H_2SO_4 15-20%

#1 Leach Tank (existent but inadequate)

Wash-Soln.

To $ZnSO_4$ Plant 100-150 g/L Zn < 0.05 g/L Cd

Residue 10-12% Cd

Pumps

#2 Leach Tank (inadequate)

2 Shriver Filter Presses (very inadequate)

H_2O

Residue 6-8% Cd (?)

Wash Tank (inadequate)

Soln #1

Soln #2

Zn Cathode Sheets

Wash Soln

First Sponging Tank

Soln

1° Sponge

Wash Tank

Residue 3-5% Cd

Present Pilot Plant

Recycle

H_2SO_4

Zn Cathode Sheets

Second Sponging Tank

Soln

2° Sponge

Wash Tank

Bar Cd to N.Y. 99.95% Cd { ± 180# day ± 5.500# month

Slag to In-Extract.

Cl_2

NH_4Cl

NaOH

Press

Cake 20% H_2O

Refining Kettle

Roughing Kettle

Kerosene Carrier

Slag to Tl-extraction

Rough Bar Cd

CERRO DE PASCO CORPORATION - OROYA

CORRESPONDENCIA INTERDEPARTAMENTAL

Fecha October 24, 1952

A: J.W. Hanley, Asst. Manager of Operations No. 520123

De: A.K. Schellinger, Staff Metallurgist (Acting Director of Research)

Materia: Resume of 154-day Cadmium Fuming Campaign in an Experimental Reverberatory Furnace at the Research Department

Between March 28, 1952 and September 28, 1952 a pilot fuming plant for concentrating cadmium in pelletized 5% blast furnace cottrell fume was operated for 154 days at the Research Department. The object of this pilot operation was to concentrate as much of the cadmium and zinc content of the pelletized cottrell fume as possible in a high-grade cadmium-zinc fume for leaching and to eliminate arsenic. Laboratory results prior to pilot plant operations had indicated that smelting the pelletized fume with 10% coke, 10% soda ash, and 15% scrap iron would fix the arsenic content as an irony speiss and allow the production of a 40% Cd fume, ideal for leaching. The pilot fuming plant consisted of a 4' x 9' reverberatory furnace, with a 20" bath, connected to three cyclones in series, followed by a fan and small baghouse. The cyclones increased in diameter from a three-foot diameter cone to a 7-foot diameter cone, with the middle cone water cooled. The gases and uncollected fume that passed the cyclones went through a water cooler and fan into the baghouse on the pressure side of the fan. The first cyclone operated in the temperature range 600 to 800 deg. C, the second between 350 and 450 deg. C, while the third was usually below 200 deg. C. Gases and fume entered the baghouse at less than 100 deg. C.

Charge to the furnace was mixed on the floor in batches, usually on the base of 600 kg. of pellets, and charged to the empty furnace after tapping. Average pellet charge to the furnace during the 154-day run was 1340 kgs. per day or 68.0% of the total charge. The total charge during the run averaged 9.9% coke breeze, 7.1% soda ash, and 15.0% Cerro copper precipitates. It was found early in the campaign that coarse scrap iron would not react with arsenic in the charge at the temperatures available in the furnace, but that copper precipitates formed speiss more easily than any other available material. 29.7% of the total arsenic in the fume pellets was removed from the furnace as a speiss product while but 33% of the arsenic found its way into the fume. The remaining arsenic was removed as combination matte-speiss-slag, partially unfused, and in the lead, which carried 2.85% as an average.

Metallurgical results of the fuming campaign follow:

Product	Kgs.	%Wt.	Assays				Distribution			
			% Pb	% As	% Cd	% Zn	% Pb	% As	% Cd	% Zn
Pellets	206,800	68.0	36.12	5.66	5.08	13.26	100.0	100.0	100.0	100.0
Flux	98,072	32.0								
Metal	43,570	14.3	90.8	2.85	-	-	53.0	10.6	-	-
Speiss	17,486	5.7	23.5	19.7	-	-	5.5	29.7	-	-
Matte & Slag	114,557	37.6	11.0	1.9	-	12.9	16.8	18.5	-	53.8
Fumes	49,913	16.4	22.1	7.8	19.5	20.1	14.8	33.2	92.4	36.5
Cyc. 1	13,057	4.3	25.1	4.2	12.5	29.2	4.4	4.7	15.6	13.9
Cyc. 2	7,262	2.4	15.6	7.8	36.3	11.8	1.5	4.8	25.0	3.1
Cyc. 3	1,986	0.6	19.7	10.1	22.5	15.2	0.5	1.7	4.2	1.2
Baghouse	27,608	9.1	22.6	9.4	18.1	18.2	8.4	22.0	47.6	18.3
Unaccounted for loss	27,346	8.9	-	-	-	-	9.9	8.0	7.6	9.7
Volatiles & Gases	52,000	17.1	-	-	-	-	-	-	-	-

In the above table of metallurgical results it is interesting to note that the concentration ratio by weight was about 4 to 1, and that the resulting fume was approximately 20% Pb, 20% Cd, 20% Zn, and 8% As. This fume was ideal for leaching, except for the arsenic content. The latter however would be very difficult to remove 100% in a fuming operation at 1100 deg. C. It is felt that final experimental operations on the pelletized fume with an improved furnace should lower the arsenic content of the enriched fume to approximately the same as the pellets, i.e. 5.7% As. With the fuming operation, then, for every four tons of cottrell fume only one ton would have to be leached, and 66% of the arsenic would be kept out of the leaching circuit. Actually, it may be possible to withdraw fume from, say, cyclone 2 at 36% Cd where the concentration ratio is 30:1, and recirculate the other fumes through the fuming operation. This experiment will be tried with the improved fuming furnace. It should be emphasized that the above campaign was of an experimental nature and it is reasonable to expect improved results in a larger and better furnace.

The cost of the fuming operation, exclusive of furnace construction, is estimated at $0.24 per pound of Cd recovered. This was calculated by allowing a $25/ton credit for the metallic lead recovered and sent to the lead kettles, plus a $100/ton credit for the zinc returned to the zinc sulfate plant as solution. Cerro copper precipitates were charged to the process

with the mining and transportation costs only. This is on the assumption that the speiss formed with the copper would be returned to the copper smelter converters with substantially complete recovery of the copper. During the campaign 85% of the copper charged was found in the speiss and matte and metal where it would find its way into the smelter copper circuit.

At the present time an improved furnace capable of treating about 3 tons per day of pelletized fume is under construction at the Research Department. On completion of this furnace--estimated for the first of January-- the remaining stock of pelletized fume will be treated. A hundred-day campaign should suffice for this treatment. The new furnace is calculated to give better heat transfer to the bath, to provide better insulation, and to allow for more complete separation of lead, speiss, and matte-slag. We hope to produce a higher grade fume with less arsenic in it at a cost not exceeding $0.20/pound of recovered Cd.

No detailed weights or costs were kept on the pelletizing campaign which was done in the zinc pilot plant roaster under adverse conditions. It is felt however by all concerned that the pelletizing step is necessary for successful smelting-fuming and that it could be done for $0.10/pound of Cd, or less. It is recommended that we proceed with a plant to pelletize and roast about 5 tons/day of blast furnace fume prior to storage and/or treatment in a future fuming plant. It may be possible to continue the fuming operations at the Research Department, during construction of an adequate furnace plant. In any case pelletized fume would handle with less losses in the main lead circuit with accompanying savings in Cd, Pb, A , and Au.

No detailed analysis of the leaching and refining steps on the enriched fume is yet available. The inadequate existing leaching facilities are being used for this work, and the refining facilities have just been completed. The present stock of enriched fume will take several months to leach and refine into bar cadmium metal. At the end of that period the final steps in recovering cadmium metal from blast furnace fume will be presented.

A. K. Schellinger

AKS/zc

cc: AHE (7)
JWH (1)
ILB (2)
HWH (1)
File (3)

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1950

Cadmium

BY RICHARD H. MOTE

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UNITED STATES DEPARTMENT OF THE INTERIOR • Oscar L. Chapman, Secretary

BUREAU OF MINES • J. J. Forbes, Director

CADMIUM

By Richard H. Mote

GENERAL SUMMARY

DESPITE record production and large imports, additions to the domestic supply of cadmium during 1950 were insufficient to meet total demand during the year. The all-time high output of primary cadmium—12 percent greater than in 1949—combined with the second highest level of imports in history, failed to meet the expanding requirements of the latter half of the year; and, as a result, stocks were substantially reduced. The quotation for commercial sticks, which remained steady at $2.00 per pound throughout 1949 had, by December 1950, advanced to $2.55 per pound. Shipments of metallic cadmium were 22 percent above the previous year's total and exceeded production by 745,000 pounds. Industry stocks, rebuilt to adequate proportions during 1949, were reduced 16 percent, but purchases for the National Stockpile were continued. Apparent consumption increased 30 percent from 1949.

TABLE 1.—Salient statistics of the cadmium industry in the United States, 1941–45 (average) and 1946–50, in pounds of contained cadmium

	1941–45 (average)	1946	1947	1948	1949	1950
Production (primary)	8,046,990	6,471,187	8,508,146	7,775,657	[2] 8,226,617	9,206,097
Imports (metal)	68,984	17,415	20,292	9,809	157,204	630,109
Exports (metal)	[1] 264,529	140,385	303,401	955,701	566,135	352,927
Consumption, apparent	8,062,760	6,983,610	7,726,753	7,797,105	[2] 7,486,274	9,625,768

[1] 1942–45 average.
[2] Revised figure.

DOMESTIC PRODUCTION

The most important of the cadmium minerals is greenockite (CdS), theoretically containing 77.8 percent cadmium. The mineral occurs in the form of a yellow powder or stain on the mineral sphalerite or zinc blende (ZnS). Greenockite is almost always associated with sphalerite zinc ores and to a smaller extent with the ores of lead and copper containing zinc mineralization. It is never present in adequate quantities, however, to support profitable mining. Some zinc concentrates have been reported to contain as much as 1 percent cadmium; in general, however, the content seldom exceeds 0.5 percent. Zinc concentrates from the Tri-State district average 0.35 percent cadmium, and concentrates from mines in the Rocky Mountain region and far West rarely yield more than 0.2 percent cadmium.

975937—51

TABLE 2.—Cadmium produced and shipped in the United States, 1941–45 (average) and 1946–50, in pounds of contained cadmium

	1941–45 (average)	1946	1947	1948	1949 [1]	1950
Production:						
Primary:						
Metallic cadmium	7,808,724	6,200,398	8,007,287	7,582,961	8,023,616	8,865,393
Cadmium compounds [2]	238,266	270,789	500,859	192,696	203,001	340,704
Total primary production	8,046,990	6,471,187	8,508,146	7,775,657	8,226,617	9,206,097
Secondary (metal and compounds) [3]	207,518	355,104	104,764	121,159	384,398	513,198
Shipments by producers:						
Primary:						
Metallic cadmium	7,818,862	6,180,265	7,852,907	7,639,113	7,867,486	9,610,602
Cadmium compounds [2]	243,593	270,789	500,859	192,696	203,001	340,704
Total primary shipments	8,062,455	6,451,054	8,353,766	7,831,809	8,070,487	9,951,306
Secondary (metal and compounds) [2 3]	208,734	360,924	134,793	121,159	384,398	513,198
Value of primary shipments:						
Metallic cadmium	$6,070,229	$6,094,572	$12,358,526	$12,679,571	$14,813,382	$19,855,049
Cadmium compounds [4]	187,850	267,033	788,352	319,875	381,642	701,850
Total value	6,258,079	6,361,605	13,146,878	12,999,446	15,195,024	20,556,899

[1] Revised figures.
[2] Excludes compounds made from metal.
[3] Bureau of Mines not at liberty to publish figures separately for secondary cadmium compounds.
[4] Value of metal contained in compounds made directly from flue dust or other cadmium raw materials (except metal).

The entire domestic supply of primary cadmium is recovered concurrently with the treatment of ores of other metals as a byproduct from the flue dusts of zinc-blende roasting furnaces and lead blast furnaces, from zinc dust collected in the early stages of distillation in zinc retorts, and from the high-cadmium precipitate obtained in purifying zinc electrolyte at electrolytic zinc plants. A small quantity of secondary metal is recovered from old bearings and other alloys but constitutes no great portion of the total supply. As most reduction plants participating in the recovery of cadmium treat both domestic and foreign cadmium-bearing materials without determining the cadmium content of either, the geographic origin of the metal produced from domestic plants is a matter of conjecture. Thus the data presented as domestic cadmium production in this chapter are not comparable to those given in other chapters of this volume for metals like copper, lead, and zinc.

The domestic output of primary metallic cadmium and the production of cadmium contained in primary compounds increased 10 percent and 68 percent, respectively, in 1950. Recovery of cadmium in secondary metal and compounds advanced 34 percent.

A list of plants producing cadmium metal in the United States in 1950 follows.

Primary metallic cadmium

Colorado: Denver—American Smelting & Refining Co.
Idaho:
  Bradley—Bunker Hill & Sullivan Mining & Concentrating Co.
  Kellogg—Sullivan Mining Co.
Illinois:
  Depue—New Jersey Zinc Co.
  East St. Louis—American Zinc Co. of Illinois
Montana: Great Falls—Anaconda Copper Mining Co.

Oklahoma:
  Bartlesville—National Zinc Co., Inc.
  Henryetta—Eagle-Picher Mining & Smelting Co.
Pennsylvania:
  Donora—American Steel & Wire Co.
  Josephtown—St. Joseph Lead Co.
  Palmerton—New Jersey Zinc Co.
Texas:
  Corpus Christi—American Smelting & Refining Co.
  Dumas—American Zinc Co. of Illinois

Secondary metallic cadmium

Arkansas: Jonesboro—Arkansas Metals Co.

Output of cadmium oxide (by cadmium content) increased slightly more than 1 percent during the year, while the cadmium content of sulfide produced advanced 57 percent. Data for the production of other cadmium compounds are unavailable for 1950.

TABLE 3.—Cadmium oxide and cadmium sulfide produced in the United States, 1945–50, in pounds

Year	Oxide		Sulfide [1]		Year	Oxide		Sulfide [1]	
	Gross weight	Cd content	Gross weight	Cd content		Gross weight	Cd content	Gross weight	Cd content
1945	439,415	383,553	1,731,510	637,667	1948	334,859	291,847	3,137,035	1,096,770
1946	364,285	317,767	3,637,177	1,225,680	1949	570,993	497,876	2,631,888	999,386
1947	449,847	392,556	3,501,508	1,308,385	1950	579,538	505,336	4,383,943	1,570,522

[1] Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

The apparent consumption of primary cadmium in all forms totaled 9,625,768 pounds in 1950, as computed by adding production and net imports and adjusting for producers', distributors', and compound manufacturers' stock changes. This figure reflected a 29 percent increase over the quantity apparently consumed in 1949. In 1950, as in the previous 2 years, cadmium metal was purchased by the Federal Government for the National Stockpile. About 95 percent of available cadmium is used in electroplating, bearing alloys, and pigments. The remaining 5 percent goes into miscellaneous alloys, laboratory reagents, and photographic chemicals.

Electroplating.—The principal use of cadmium metal is as a protective coating for iron and steel, and, to a much smaller extent, copper alloys. Its chief advantages as an electroplating medium compared to zinc are as follows: (1) Thinner coatings provide equal protection; (2) the rate of deposition for a given quantity of electric current is larger, hence electricity costs are reduced; (3) cadmium retains its metallic luster longer; (4) plated parts are more easily soldered; (5) cadmium has a greater resistance to atmospheric corrosion; (6) it is superior in throwing power, or ability to deposit uniformly in recesses; and (7) corrosion by galvanic action is more effectively minimized. A disadvantage of cadmium plating is its low resistance to acids. Items commonly electroplated with cadmium include

nails, screws, rivets, bolts, nuts, washers, fasteners, and miscellaneous parts for a wide variety of products, including aircraft, ordnance, and automobiles.

Cadmium-Bearing Alloys.—Cadmium-base bearing metals are used successfully in internal-combustion engines that operate at high speeds and temperatures. The bearing alloys are generally of two types—the cadmium-nickel bearing, composed of 98.5 percent or more cadmium and 1.2 percent nickel, and the cadmium-silver bearing, containing 98.3 percent or more cadmium, 0.7 percent silver, and 0.6 percent copper. "Graphalloy," a cadmium-impregnated graphite containing 30 to 35 percent cadmium, is used in oilless bearings, bushing linings, and contacts for controller switches.

Cadmium Solders and Other Cadmium Alloys.—A minor use of cadmium metal is in the manufacture of low-melting-point alloys for soldering and brazing and fusible alloys for sprinkler apparatus, fire-detector systems, and valve seats for high-pressure gas containers.

Cadmium Compounds.—Cadmium sulfide and cadmium sulfoselenide are standard agents for producing yellow and red colors, respectively, in paint, soap, rubber, ceramics, paper, printing ink, and other products. Virtually all the cadmium oxide, hydrate, and chloride produced is used in cadmium plating solutions. Cadmium bromide, chloride, and iodide are used in photographic films, process engraving, and lithographing. A table listing the more important cadmium compounds, their physical properties, and uses can be found in the Cadmium chapter of Minerals Yearbook, 1949, pp. 187–188.

STOCKS

Total domestic stocks of cadmium metal and compounds, excluding consumers' stocks, for which data are not available, decreased 16 percent. Details are given in table 4.

TABLE 4.—Cadmium stocks at end of year, 1949–50, in pounds of contained cadmium [1]

	1949 [2]			1950		
	Metallic cadmium	Cadmium compounds	Total cadmium	Metallic cadmium	Cadmium compounds	Total cadmium
Producers	502,462		502,462	521,811		521,811
Compound manufacturers	9,655	164,189	173,844	15,378	134,713	150,091
Distributors [3]	185,250	40,499	225,749	48,715	38,949	87,664
Total stocks [4]	697,367	204,688	902,055	585,904	173,662	759,566

[1] Excludes cadmium in National Stockpile.
[2] Figures partly revised.
[3] Comprises principally 8 largest dealers.
[4] Excludes consumers' stocks, which were about 1,000,000 pounds at the end of 1944 (latest date for which figures were compiled).

PRICES

The quoted New York price of $2.00 a pound for commercial sticks of cadmium, established November 15, 1948, continued through June 14, 1950. Effective June 15 the quotation advanced to $2.15 a pound. On the same day the price for patented shapes was raised from $2.15 a pound to $2.30. On September 15, the quotation for commercial sticks advanced to $2.40 a pound and for patented shapes to $2.65.

A further rise to $2.55 a pound for commercial sticks occurred December 1.

The London market quoted 14s. 6d ($2.03) per pound from January through June 21, when the price was advanced to 15s. 6d($2.17). On September 18 and November 2 further rises occurred—to 17s. 3d ($2.41) and 18s. ($2.52), respectively. The final increase to 19s ($2.66) took place during the first week of December.

FOREIGN TRADE [1]

Total imports for consumption of metallic cadmium and of cadmium contained in flue dust increased 15 percent in weight and 59 percent in value in 1950. The total value of exports decreased 37 percent.

Imports.—Imports of cadmium-bearing flue dust, all derived from Mexico, were 11 percent below the 1949 level. Imports of metallic cadmium, however, increased four times over the quantity reported for 1949 and were the second highest in history. Of the more than 630,000 pounds imported, Canada supplied 38 percent, 31 percent came from Japan, 23 percent from Belgium-Luxembourg, and 5 percent from the Netherlands. Australia, Italy, Peru, New Zealand, Egypt, and the United Kingdom supplied smaller quantities.

TABLE 5.—Cadmium metal and flue dust imported for consumption in the United States, 1948–50, by countries

[U. S. Department of Commerce]

Country	1948		1949		1950	
	Pounds	Value	Pounds	Value	Pounds	Value
Metallic cadmium						
Australia			7,210	$7,919	7,918	$21,528
Belgium-Luxembourg			48,503	101,560	143,825	518,552
Canada	6,300	$14,491	68,140	139,392	237,494	472,322
Egypt					1,240	2,292
Italy					4,400	10,120
Japan			31,640	50,742	194,745	368,084
Netherlands					34,205	95,031
New Zealand					2,264	6,722
Peru	3,509	7,018	1,711	3,422	3,010	6,624
United Kingdom					1,008	2,621
Total metallic cadmium	9,809	21,509	157,204	303,035	630,109	1,503,896
Flue dust (Cd content)						
Australia	621	303				
Brazil			2,906	2,801		
Mexico	1,827,518	1,437,833	1,786,761	1,593,142	1,601,640	1,519,104
Total flue dust	1,828,139	1,438,136	1,789,667	1,595,943	1,601,640	1,519,104
Grand total	1,837,948	1,459,645	1,946,871	1,898,978	2,231,749	3,023,000

Exports.—Shipments to European Recovery Program "participating countries" accounted for 97 percent of the cadmium metal exported from the United States in 1950. Of the 352,927 pounds shipped—38 percent less than in 1949—Germany received 36 percent, the United Kingdom 27 percent, France 20 percent, Sweden 9 percent,

[1] Figures on imports and exports compiled by M. B. Price and E. D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

and the Netherlands 3 percent. The remaining 5 percent was distributed among 14 other countries. Exports of cadmium alloys tripled, rising from 3,000 pounds in 1949 to more than 9,000 in 1950. Canada received 73 percent of the total and the Union of South Africa the remainder.

TABLE 6.—Cadmium exported from the United States, 1948–50, by kinds, in gross weight

[U. S. Department of Commerce]

Kind	1948		1949		1950	
	Pounds	Value	Pounds	Value	Pounds	Value
Dross, flue dust, residues, and scrap	92,847	$55,247	500	$125		
Metal	955,701	1,872,467	566,135	1,264,307	352,927	$794,540
Alloys	1,506	2,657	3,000	6,150	9,106	11,575
Total		1,930,371		1,270,582		806,115

Tariff.—Action taken at the Geneva Trade Conference of 1947 reduced, as of January 1, 1948, the import duty on cadmium metal from 7½ cents per pound as established in the Canadian Trade Agreement of 1939 to 3¾ cents per pound. Cadmium contained in flue dust remained duty free in 1950.

WORLD PRODUCTION

World production of cadmium in recent years, insofar as data are available, is shown in table 7.

TABLE 7.—World production of cadmium, by countries, 1944–50, in kilograms

[Compiled by Berenice B. Mitchell]

Country	1944	1945	1946	1947	1948	1949	1950
Australia (Tasmania)	271,610	245,955	231,913	209,030	293,352	271,133	287,603
Belgian Congo	21,544	18,213	16,571	26,040	18,056	24,635	[1] 36,000
Belgium	[1] 1,089	[2]	[3] 88,900	[3] 86,300	[3] 157,900	[3] 148,000	[2]
Canada	239,032	293,048	364,073	325,874	347,491	383,983	378,393
France	5,250	7,000	47,000	43,000	50,067	58,123	[2]
Germany	209,105	[2]	[4] 1,000	[4] 1,206	[4] 3,500	[4] 5,000	[3]
Italy	38,855	28,800	40,000	38,400	47,000	73,000	[5] 42,000
Japan	[6] 85,000	[7] 22,000	7,509	8,710	30,000	52,484	90,348
Mexico [8]	682,295	1,052,766	717,000	778,000	905,000	820,000	689,000
Norway	10,600	13,000	28,000	50,000	62,000	71,400	[2]
Peru	2,174	9,320	850	1,407	1,592	800	[2]
Poland	195,044	49,150	115,000	[9] 71,000	[2]	[2]	[2]
South-West Africa [10]					517,000	755,000	787,000
U. S. S. R.	[11] 50,000	[2]	[2]	[2]	[2]	[2]	[2]
United Kingdom	206,541	222,713	121,925	106,440	115,769	102,662	118,878
United States:							
Metallic cadmium	3,834,409	3,598,139	2,812,439	3,632,025	3,439,555	3,639,432	4,021,254
Cadmium compounds (Cd content)	148,045	204,592	122,827	227,185	87,405	92,079	154,540
Total (estimate)	5,318,000	4,764,000	4,048,000	4,927,000	4,844,000	5,113,000	5,619,000

[1] Exports.
[2] Data not available; estimate by author of chapter included in total.
[3] Estimate.
[4] Bizonal area.
[5] January to September, inclusive.
[6] Preliminary data for fiscal year ended Mar. 31 of year following that stated.
[7] April to September, inclusive.
[8] Cadmium content of flue dust exported for treatment elsewhere; represents in part shipments from stocks on hand. To avoid duplication of figures, data are not included in the total.
[9] January to July, inclusive.
[10] Cadmium content of concentrates exported for treatment elsewhere. To avoid duplication of figures, data are not included in the total.
[11] Estimated average for 1936–38.

U. S. GOVERNMENT PRINTING OFFICE: 1951

World production of cadmium, by countries, in 1942-49, in kilograms

/Compiled by Berenice B. Mitchell/

Country	1942	1943	1944	1945	1946	1947	1948	1949
Australia (Tasmania)	166,184	181,689	271,610	245,955	231,913	212,354	293,638	1/157,488
Belgian Congo	27,344	23,094	21,544	18,213	16,571	26,040	18,000	2/ 27,000
Belgium	2/40,188	2/31,797	2/1,089	3/	4/88,900	4/86,300	4/157,900	3/
Canada	521,158	356,804	239,032	293,048	364,073	325,874	347,491	383,185
France	10,000	10,000	5,250	7,000	47,000	43,000	50,067	3/
Germany	243,124	275,783	209,105	3/	5/1,000	5/1,206	5/3,500	5/5,000
Italy	122,785	71,606	38,855	28,800	40,000	38,400	47,000	1/57,000
Japan	6/102,000	6/112,000	6/85,000	7/22,000	7,509	8,710	18,874	3/
Mexico	854,264	801,992	682,295	1,052,766	717,000	778,000	905,000	819,000
Norway	13,482	11,355	10,600	13,000	28,000	50,000	69,000	3/
Peru	2,131	3,653	2,174	9,320	850	1,407	1,592	800
Poland	231,784	219,991	195,044	49,150	115,000	9/71,000	3/	3/
South - West Africa 10/	-	-	-	-	-	-	431,000	757,818
U.S.S.R.	11/50,000	3/	3/	3/	3/	3/	3/	3/
United Kingdom	159,234	189,228	206,541	222,713	121,925	106,440	115,769	102,662
United States:								
Metallic cadmium .	3,321,797	3,808,474	3,834,409	3,598,139	2,812,439	3,632,025	3,439,555	3,639,488
Cadmium compounds. (Cd content)	21,600	32,100	148,045	204,592	122,827	227,185	87,405	159,188
Total	5,033,000	5,378,000	5,318,000	4,764,000	4,048,000	4,930,000	4,840,000	5,080,000

1/ January to September, inclusive.
2/ Exports.
3/ Data not available; estimate by author of chapter included in total.
4/ Incomplete data.
5/ Bizonal area.
6/ Preliminary data for fiscal year ended March 31 of year following that stated.
7/ April to September, inclusive.
8/ Cadmium content of flue dust exported for treatment elsewhere; represents in part shipments from stocks on hand. To avoid duplication of figures, data are not included in the total.
9/ January to July, inclusive.
10/ Cadmium content of concentrates exported for treatment elsewhere. To avoid duplication of figures, data are not included in the total.
11/ Estimated average for 1936-38.

CHROMITE

Guatemala. - Chrome ore is found in small pockets in Guatemala, and after some 35 years of working the larger pockets, only the small ones, which are uneconomical to exploit, are left. No production was reported for 1949. (Economic Attaché Gilbert E. Larsen, Guatemala City.)

Japan. - Japanese output of chromite since 1947 has been as follows:

Chromite output in Japan, 1947-49

	High grade		Low grade	
	Metric tons	Percent Cr_2O_3	Metric tons	Percent Cr_2O_3
1947	1,882	49	525	26
1948	3,802	50	5,539	34
1949	4,805	51	22,198	33

World. - The following table was prepared in the Foreign Minerals Region of the Bureau of Mines for publication in Minerals Yearbook, 1949:

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1949

Cadmium

BY RICHARD H. MOTE

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Cadmium

By Richard H. Mote

GENERAL SUMMARY

CADMIUM experienced an economic position unique among most metals during 1949. Consumer demand remained strong despite the general industrial recession in midyear, and the market price for commercial sticks continued unchanged at $2. A record peacetime output of primary metal, 6 percent greater than in 1948, and a sixteenfold increase in metal imports expanded the total domestic supply sufficiently to meet requirements and yet maintain the proper balance between supply and demand necessary to prevent fluctuations in market quotations. Sales of metallic cadmium advanced 3 percent over 1948 and nearly equaled production. Industry stocks, sharply reduced in 1948, were replenished in 1949, and the Federal Government continued to purchase metal for the National Stockpile. As a result, the apparent industrial consumption declined 14 percent from the 1948 level.

Salient statistics of the cadmium industry in the United States, 1940–44 (average) and 1945–49, in pounds of contained cadmium

	1940–44 (average)	1945	1946	1947	1948	1949
Production (primary)	7,642,978	8,383,629	6,471,187	8,508,146	7,775,657	8,374,561
Imports (metal)	68,737	28,724	17,415	20,292	9,809	157,204
Exports (metal)	[1] 318,639	102,199	140,385	303,401	955,701	566,135
Consumption, apparent	[2] 7,569,800	8,642,799	6,983,610	7,726,753	[3] 7,797,105	7,676,800

[1] 1942–44 average.
[2] Actual consumption.
[3] Revised figure.

DOMESTIC PRODUCTION

As cadmium minerals—the most common of which is greenockite (CdS, 77.8 percent cadmium)—are too rare in occurrence to support profitable mining, no ore is mined or concentrated for the recovery of cadmium alone. The metal is recovered entirely in the mining, milling, and smelting of sulfide ores containing zinc mineralization and is obtained chiefly from the zinc sulfide sphalerite (ZnS), on which greenockite occurs as a yellow stain or coating. Although some zinc concentrates have been reported to contain as much as 1 percent cadmium, the content seldom exceeds 0.5 percent. Zinc concentrates from the tri-State region average 0.35 percent cadmium, and concentrates from mines in the Rocky Mountain region and far West rarely carry more than 0.2 percent cadmium.

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The entire domestic supply of primary cadmium is recovered concurrently with the treatment of ores of other metals as a byproduct from the flue dusts of zinc-blende roasting furnaces and lead blast furnaces, from zinc dust collected in the early stages of distillation in zinc retorts, and from the high-cadmium precipitate obtained in purifying zinc electrolyte at electrolytic zinc plants. A small quantity of secondary metal is recovered from old bearings and other alloys but constitutes no great portion of the total supply. As most reduction plants participating in the recovery of cadmium treat both domestic and foreign cadmium-bearing materials without determining the cadmium content of either, the geographic origin of the metal produced from domestic plants is a matter of conjecture. Thus the data presented as domestic cadmium production in this chapter are not comparable to those given in other chapters of this volume for metals like copper, lead, and zinc.

Cadmium produced and shipped in the United States, 1940–44 (average) and 1945–49, in pounds of contained cadmium

	1940–44 (average)	1945	1946	1947	1948	1949
Production:						
Primary:						
Metallic cadmium	7,453,048	7,932,579	6,200,398	8,007,287	7,582,961	8,023,616
Cadmium compounds [1]	189,936	451,050	270,789	500,859	192,696	350,945
Total primary production	7,642,984	8,383,629	6,471,187	8,508,146	7,775,657	8,374,561
Secondary (metal and compounds) [1 2]	238,604	72,473	355,104	104,764	121,159	173,104
Shipments by producers:						
Primary:						
Metallic cadmium	7,524,582	7,938,658	6,180,265	7,852,907	7,639,113	7,867,486
Cadmium compounds [1]	194,563	451,050	270,789	500,859	192,696	350,945
Total primary shipments	7,719,145	8,389,708	6,451,054	8,353,766	7,831,809	8,218,431
Secondary (metal and compounds) [1 2]	240,671	67,513	360,924	134,793	121,159	173,104
Value of primary shipments:						
Metallic cadmium	$5,754,248	$6,106,992	$6,094,572	$12,358,526	$12,679,571	$14,813,382
Cadmium compounds [3]	147,214	347,308	267,033	788,352	319,875	659,777
Total value	5,901,462	6,454,300	6,361,605	13,146,878	12,999,446	15,473,159

[1] Excludes compounds made from metal.
[2] Bureau of Mines not at liberty to publish figures separately for secondary cadmium compounds.
[3] Value of metal contained in compounds made directly from flue dust or other cadmium raw materials (except metal).

The domestic output of primary metallic cadmium, the production of cadmium contained in primary compounds, and the recovery of cadmium in secondary metal and compounds increased 6, 82, and 43 percent, respectively, in 1949.

A list of plants producing cadmium metal in the United States in 1949 follows.

Primary metallic cadmium

Colorado: Denver—American Smelting & Refining Co.
Idaho:
Bradley—Bunker Hill & Sullivan Mining & Concentrating Co.
Kellogg—Sullivan Mining Co.

Illinois: Fairmont City—American Zinc Co. of Illinois.
Missouri: Herculaneum—St. Joseph Lead Co.
Montana: Great Falls—Anaconda Copper Mining Co.
Oklahoma:
Bartlesville—National Zinc Co., Inc.
Henryetta—Eagle-Picher Mining & Smelting Co.
Pennsylvania:
Donora—American Steel & Wire Co.
Josephtown—St. Joseph Lead Co.
Palmerton—New Jersey Zinc Co.
Texas:
Corpus Christi—American Smelting & Refining Co.
Dumas—American Zinc Co. of Illinois.

Secondary metallic cadmium

Arkansas: Jonesboro—Arkansas Metals Co.
New York: Whitestone—Neo-Smelting & Refining, Inc.
Rhode Island: West Warwick—Rare Metals, Inc.

The cadmium content of the cadmium oxide produced advanced 71 percent but the content of the sulfide output dropped 9 percent. Data for the production of other cadmium compounds are not available for 1949.

Cadmium oxide and cadmium sulfide produced in the United States, 1945–49, in pounds

Year	Oxide		Sulfide [1]		Year	Oxide		Sulfide [1]	
	Gross weight	Cd content	Gross weight	Cd content		Gross weight	Cd content	Gross weight	Cd content
1945	439,415	383,553	1,731,510	637,667	1948	334,859	291,847	3,137,035	1,096,770
1946	364,285	317,767	3,637,177	1,225,680	1949	570,993	497,876	2,631,888	999,386
1947	449,847	392,556	3,501,508	1,308,385					

[1] Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

The apparent consumption of primary cadmium in all forms totaled 7,676,800 pounds in 1949, as computed by adding production and net imports and adjusting for producers', distributors', and compound manufacturers' stock changes. This quantity was 2 percent less than the apparent consumption of 7,797,105 pounds in 1948. In both 1948 and 1949 cadmium metal was purchased by the Federal Government for the National Stockpile. Allowing for these Government withdrawals, the apparent industrial consumption of cadmium in 1949 was 14 percent under 1948 and over 30 percent less than the peak quantity used in 1945.

By far the largest single use of cadmium is for electroplating iron, steel, and, to a much smaller extent, copper alloys. The metal is desired for this use because (1) a thin coating is adequate to provide the necessary protection against corrosion; (2) cadmium has a high

Properties of cadmium compounds

Name and formula of compound	Molecular weight	Appearance	Specific gravity	Melting point, °C.	Boiling point, °C.	Soluble in—	Manufacture	Use
Cadmium acetate ($Cd(C_2H_3O_2)_2 \cdot 3H_2O$).	284.55	Colorless, monoclinic crystals.	2.01	256 (becomes anhydrous at 130).		Water and alcohol	Dissolve cadmium metal, CdO_2, or $Cd(OH)_2$ in acetic acid; evaporate solution to incipient crystallization.	To produce iridescent effects on porcelain and pottery ware; chemical testing for sulfides, selenides, and tellurides.
Cadmium bromide ($CdBr_2$).	272.24	Yellow, crystalline powder.	5.20	567	963	Water, alcohol, and HCl; slightly soluble in acetone and ether.	Dissolve cadmium metal in bromine water acidified with hydrogen bromide to prevent formation of basic salts; or dissolve $CdCO_3$ in aqueous hydrogen bromide and evaporate solution to dryness.	Photography, lithography, and process engraving.
Cadmium carbonate ($CdCO_3$).	172.42	White, crystalline powder.	4.26	Decomposes below 500.		Acids, potassium cyanide, and ammonium salts.	Add an alkali carbonate to a solution of a cadmium salt.	Starting compound for other cadmium salts.
Cadmium chloride ($CdCl_2$).	183.32	Colorless, hexagonal crystals.	4.05	568	960	Water, methanol, and ethyl alcohol.	Dissolve cadmium metal in an aqueous solution of HCl and evaporate in a stream of HCl gas; or dissolve CdO_2 or $CdCO_3$ in HCl.	Reagent in photography; analysis of sulfides; testing for pyridin bases; ingredient in cadmium plating electrolytes; mordant in dyeing and printing calicoes.
Cadmium hydroxide ($Cd(OH)_2$).	146.43	White powder	4.79	Decomposes at 300.		Dilute acids and in ammonia salts. Readily absorbs CO_2 to form $CdCO_3$.	Add ammonium hydroxide to solution of a cadmium salt, producing gelatinous precipitate with the formation of the complex ammonia ion. To obtain purest material, precipitate from a nitrate solution, for it absorbs the nitrate ion less strongly than either the chloride or sulfate ion.	Manufacture of cadmium salts.

Name and formula of compound	Molecular weight	Appearance	Specific gravity	Melting point, °C.	Boiling point, °C.	Soluble in—	Manufacture	Use
Cadmium iodide (CdI_2)	366.25	Brownish, lustrous, hexagonal scales.	5.67 (α) 5.30 (β)	388	713	Water, acids, ether, alcohol, ammonium salts.	Heat cadmium metal with iodine, or treat a cadmium compound with a solution of hydrogen iodide.	Photography, lithography, and process engraving.
Cadmium oxide (CdO_2)	128.41	Light-brown to yellowish brown to dark-brown cubic crystals or amorphous powder, depending upon method of preparation.	8.15 (cubic form). 6.95 amorphous).	Above 1,426 Decomposes at 900.	Decomposes at 900–1,000.	Acids and ammonia salts.	(1) Distill pure cadmium metal in graphite retort, and permit vapor to react with air. (2) Heat $CdCO_3$ or $Cd(NO_3)_2 \cdot 4H_2O$ temperature of thermal decomposition to form CdO_2.	Cadmium plating baths; manufacture of paint pigments; coating for luminescent powders, such as cadmium sulfide and zinc sulfide; active ingredient in negative plates of nickel-cadmium batteries.
Cadmium nitrate ($Cd(NO_3)_2 \cdot 4H_2O$).	308.49	White, hygroscopic crystals.	2.46	594	132	Water, alcohol, and liquid ammonia.	Dissolve the metal, CdO_2, or $CdCO_3$ in HNO_3, and evaporating to incipient crystallization.	Imparts a reddish yellow cadmium luster to glass and porcelain ware.
Cadmium sulfate ($3CdSO_4 \cdot 8H_2O$).	769.54	Colorless, monoclinic, efflorescent crystals.	3.09			Water	Dissolve metal in H_2SO_4, CdO_2 or $CdCO_3$.	Reagent to determine H_2S and detect fumaric acid; as an electrolyte in standard cadmium electric cells; in medicine for diseases of the eye, for corneal opacities, conjunctivitis leucoma.
Cadmium sulfide (cadmium yellow) (CdS).	144.47	Amorphous, yellow, orange, or brown powder. Dimorphous crystals in lemon-yellow or vermillion.	3.91–4.15 (α). 4.48–4.51 (β).			Acids	(1) Heat CdO_2 with sulfur. (2) Pass H_2S through acid solution of cadmium salt (better-quality producer). (3) Dissolve CdO_2 in H_2SO_4 CdS precipitated from this solution by H_2S.	Pigment in paints requiring high-quality yellow pigments; coloring vulcanized rubber, artists' colors, soaps, glass, textiles, paper, printing inks, ceramic glazes; ingredient of ultra-marine green and fluorescent pigments.

rate of deposition; (3) the metal has a high throwing power (the property of depositing uniformly on intricately shaped objects); (4) cadmium is capable of imparting an enduring metallic luster to the electroplated item; and (5) cadmium has high resistivity to atmospheric, alkali, and salt-water corrosion. A disadvantage of cadmium plating is its low resistance to acids. Items commonly electroplated with cadmium include nails, screws, rivets, bolts, nuts, washers, fasteners, and miscellaneous parts for a wide variety of products, including aircraft, ordnance, and automobiles.

Another large use of cadmium metal is in the manufacture of bearing metals. Cadmium-base bearing metals containing 98.3 to 98.5 percent cadmium and varying quantities of nickel, silver, or copper, depending upon the type of bearing desired, are used successfully in internal-combustion engines that operate at high speeds and temperatures.

Small quantities of cadmium metal are consumed for the manufacture of solders and other alloys.

Cadmium is consumed in the manufacture of a number of compounds having a wide variety of uses. The accompanying table lists the more important cadmium compounds, their physical properties, and uses.

STOCKS

Total domestic stocks of cadmium metal and compounds increased 51 percent in 1949. Details are given in the following table.

Cadmium stocks at end of year, 1948–49, in pounds of contained cadmium [1]

	1948 [2]			1949		
	Metallic cadmium	Cadmium compounds	Total cadmium	Metallic cadmium	Cadmium compounds	Total cadmium
Producers	351,564		351,564	509,019		509,019
Compound manufacturers	8,230	87,944	96,174	8,360	121,909	130,269
Distributors [3]	83,496	39,409	122,905	184,417	35,768	220,185
Total stocks [4]	443,290	127,353	570,643	701,796	157,677	859,473

[1] Excludes cadmium in National Stockpile.
[2] Figures partly revised.
[3] Comprises principally 8 largest dealers.
[4] Excludes consumers' stocks, which were about 1,000,000 pounds at the end of 1944 (latest date for which figures were compiled).

PRICES

The quoted New York price of $2 a pound for commercial sticks of cadmium, established November 15, 1948, remained unchanged throughout 1949. The price for patented shapes, quoted at $2.10 a pound since November 15, 1948, was adjusted upward to $2.15 a pound on April 1. The average price for domestic metal, as reported to the Bureau of Mines by primary producers, was $1.88 a pound in 1949, compared with $1.66 in 1948, $1.57 in 1947, 99 cents in 1946, 77 cents in 1945, and 75 cents in 1944.

The London market quoted 12s. 6d. ($2.42) per pound in January through mid-September, when quotations were suspended. Due to devaluation of the British pound on September 19, the price as announced the first week in October was 14s. 6d. ($1.97), at which level it remained the balance of the year.

FOREIGN TRADE [1]

In 1949 total imports for consumption of metallic cadmium and of cadmium contained in flue dust increased 6 percent in weight and 30 percent in value. The total value of exports fell off 34 percent owing to sharp declines in the quantity of exported metal and drosses, flue dust, residues, and scrap.

Imports.—Imports of cadmium-bearing flue dust, virtually all from Mexico, dropped slightly more than 2 percent from the 1948 rate. Imports of metallic cadmium, however, were over 16 times greater than the total imported in 1948 and the largest quantity recorded since 1939. Canada supplied over 43 percent of the metal imported in 1949, nearly 31 percent came from Belgium-Luxembourg, 20 percent from Japan, 5 percent from Australia, and 1 percent from Peru.

Cadmium metal and flue dust imported for consumption in the United States, 1947–49, by countries

[U. S. Department of Commerce]

Country	1947		1948		1949	
	Pounds	Value	Pounds	Value	Pounds	Value
Metallic cadmium						
Australia					7,210	$7,919
Belgium-Luxembourg	2,000	$7,073			48,503	101,560
Canada	14,612	20,551	6,300	$14,491	68,140	139,392
Japan					31,640	50,742
Peru	3,658	4,508	3,509	7,018	1,711	3,422
Switzerland	2	150				
United Kingdom	20	63				
Total metallic cadmium	20,292	32,345	9,809	21,509	157,204	303,035
Flue dust (Cd content)						
Australia			621	303		
Brazil					2,906	2,801
Mexico	2,355,588	1,673,153	1,827,518	1,437,833	1,786,761	1,593,142
Total flue dust	2,355,588	1,673,153	1,828,139	1,438,136	1,789,667	1,595,943
Grand total	2,375,880	1,705,498	1,837,948	1,459,645	1,946,871	1,898,978

Exports.—Countries in the Organization for European Economic Cooperation continued to receive substantial quantities of metallic cadmium from the United States in 1949, despite a drop of 41 percent in the exports of this item from the 1948 level. Of the 566,135 pounds of cadmium metal exported, France received 45, Germany 16, United Kingdom 8, Netherlands 7, and Sweden 6 percent; the remaining 18 percent went to 15 other countries.

[1] Figures on imports and exports compiled by M. B. Price and E. D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Cadmium exported from the United States, 1947–49, gross weight, by kinds

[U. S. Department of Commerce]

Kind	1947		1948		1949	
	Pounds	Value	Pounds	Value	Pounds	Value
Dross, flue dust, residues, and scrap	18,251	$21,838	92,847	$55,247	500	$125
Metal	303,401	746,804	955,701	1,872,467	566,135	1,264,307
Alloys			1,506	2,657	3,000	6,150
Total		768,642		1,930,371		1,270,582

Tariff.—Action taken at the Geneva Trade Conference of 1947 reduced, as of January 1, 1948, the import duty on cadmium metal from 7½ cents per pound as established in the Canadian Trade Agreement of 1939 to 3¾ cents per pound. Cadmium contained in flue dust remained duty free in 1949.

WORLD PRODUCTION

World production of cadmium in recent years, insofar as data are available, is shown in the accompanying table.

World production of cadmium, by countries, 1942–49, in kilograms

[Compiled by Berenice B. Mitchell]

Country	1942	1943	1944	1945	1946	1947	1948	1949
Australia (Tasmania)	166,184	181,689	271,610	245,955	231,913	212,354	293,638	[1] 157,488
Belgian Congo	27,344	23,094	21,544	18,213	16,571	26,040	18,000	[2] 27,000
Belgium	[2] 40,188	[2] 31,797	[2] 1,089	[3]	[4] 88,900	[4] 86,300	[4] 157,900	[3]
Canada	521,158	356,804	239,032	293,048	364,073	325,874	347,491	383,185
France	10,000	10,000	5,250	7,000	47,000	43,000	50,067	[3]
Germany	243,124	275,783	209,105	[3]	[5] 1,000	[5] 1,206	[5] 3,500	[5] 5,000
Italy	122,785	71,606	38,855	28,800	40,000	38,400	47,000	[1] 57,000
Japan	[6] 102,000	[6] 112,000	[6] 85,000	[7] 22,000	7,509	8,710	18,874	[3]
Mexico [8]	854,264	801,992	682,295	1,052,766	717,000	778,000	905,000	819,000
Norway	13,482	11,355	10,600	13,000	28,000	50,000	69,000	[3]
Peru	2,131	3,653	2,174	9,320	850	1,407	1,592	800
Poland	231,784	219,991	195,044	49,150	115,000	[9] 71,000	[3]	[3]
South-West Africa [10]							431,000	757,818
U. S. S. R.	[11] 50,000	[3]	[3]	[3]	[3]	[3]	[3]	[3]
United Kingdom	159,234	189,228	206,541	222,713	121,925	106,440	115,769	102,662
United States:								
Metallic cadmium	3,321,797	3,808,474	3,834,409	3,598,139	2,812,439	3,632,025	3,439,555	3,639,432
Cadmium compounds (Cd content)	21,600	32,100	148,045	204,592	122,827	227,185	87,405	159,185
Total	5,033,000	5,378,000	5,318,000	4,764,000	4,048,000	4,930,000	4,840,000	5,080,000

[1] January to September, inclusive.
[2] Exports.
[3] Data not available; estimate by author of chapter included in total.
[4] Incomplete data.
[5] Bizonal area.
[6] Preliminary data for fiscal year ended Mar. 31 of year following that stated.
[7] April to September, inclusive.
[8] Cadmium content of flue dust exported for treatment elsewhere; represents in part shipments from stocks on hand. To avoid duplication of figures, data are not included in the total.
[9] January to July, inclusive.
[10] Cadmium content of concentrates exported for treatment elsewhere. To avoid duplication of figures, data are not included in the total.
[11] Estimated average for 1936–38.

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A-7

January 15, 1941

Mr Harold Kingsmill, Vice Pres.,
Cerro de Pasco Copper Corp.,
40 Wall Street, New York City

Dear Mr Kingsmill: CADMIUM

Your letter of December 29th with enclosures relating to lead blast furnace flue dust is of great interest because I expect we shall find other by-products than cadmium when we get adequate samples.

The practice of the USSR&MCo at Midvale where they have a baghouse on the lead furnaces is to circulate the dust until the cadmium content reaches 20% when they leach it out.

Very truly yours,

Clay

CERRO DE PASCO COPPER CORPORATION

40 WALL STREET, NEW YORK

December 29, 1941.

Lead Blast Furnace Dust.

Mr.L.Addicks,
Bel Air,
Md.

Dear Mr.Addicks:

Attached hereto please find for your information copy of letters from Messrs. Spilsbury and Harper in regard to the cadmium in the lead blast furnace dust and possible methods for recovering this metal.

Yours truly,

Harold Campbell S.

22 December 1941.

Lead Blast Furnace Dust.

Cerro de Pasco Copper Corporation,
40 Wall Street,
New York City.

Dear Sirs:

Herewith please find copy of Mr.Harper's letter of December 18 in regard to the cadmium content of lead blast furnace dust.

It is estimated that the tonnage of lead blast furnace dust that can be collected is approximately two tons per day. This is a rough estimate. More definite data will be available shortly.

In accordance with Mr.Harper's suggestion will you kindly obtain a preliminary estimate on the cost of an automatic bag house, with a capacity of 100,000 cu. ft. of gas per minute at 12,200 ft. altitude at a temperature of 300 C.

At the present moment it is impossible to state the best method of recovering dust from the lead blast furnace smoke. The first tests made on the Cottrell plant gave a very low recovery of the dust. However, the smoke was not conditioned. It is not thought that it will be possible to condition the smoke with acid at such a low temperature without injuring the Cottrell plant by corrosion. However, it might be possible to condition the smoke with hot reverberatory smoke taken from the reverberatory ahead of the hot Cottrell or behind the hot Cottrell. Estimates will be made of the volume of gas necessary in either case, and of the analysis of the dust which would result from mixing the two smokes. At the present time the lead blast furnace smoke is being mixed with the cold reverberatory smoke ahead of the Central Cottrell plant. This practice will be continued until a new bypass flue from the reverberatories to the reverberatory stack is completed, after which it will be possible that the lead blast furnace smoke can be treated separately, and experiments made on dust recovery.

Yours truly,

R.Spilsbury
General Manager.

La Oroya, Peru, 18 December 1941

Mr. V.L.McCutchan,
Assistant General Manager,
La Oroya.

Dear Sir: Lead Blast Furnace Dust

Lead blast furnace dust assays 4.5% Cd. Gross value of this constituent is $90. a ton. If cadmium is to be recovered this dust will have to be collected separately. Since the recovery in the Cottrell was low, a bag house is indicated.

It is recommended that a proposal for an automatic bag house for this service be obtained, say to handle 100,000 cu. ft. of gas/min. at 12,200 ft. altitude and 30° C.

Yours truly,

T.E.Harper

4000 x 0.045 = 180 #s a day x 30 = 5400 # a mo.

~~4000 x 30 = 120,000~~

A-113 July 24, 1941

Mr Harold Kingsmill, Vice Pres.,
Cerro de Pasco Copper Corp.,
40 Wall Street, New York City

Dear Mr Kingsmill: CADMIUM

Mr Miller, of the Bureau of Mines, told me in Washington yesterday that a squeeze in cadmium was anticipated until the effect was felt of the reduced automobile output which would release about 1,000,000 lb a year from bearings. They are considering requiring producers to reserve 15% of their present shipments to customers to go into a kitty to be distributed where Washington may direct.

Our ~~bismuth~~ cadmium imported from Peru for our own use would not be included as they do not wish to discourage imports of scarce materials.

Very truly yours,

Cds

A-182 May 28, 1935

Mr. C. V. Drew, Vice-Pres.,
Cerro de Pasco Copper Corp.,
44 WallStreet, New York City.

Dear Mr. Drew: CADMIUM

I think Peru should be posted as to the following abstract of an informal conversation I had with Mr. Matthews in case cadmium should again turn up in Cerro ores.

The present consumption of cadmiumis about 1,500,000 lbs a year in the United States and about 1,000,000 lbs abroad. It is wholly obtained as a byproduct from lead and zinc. For a long while consumption lagged behind production and the price knocked weakly aroung 40 cents a pound. Now automobile bearings with cadmium-nickel and cadmium-copper-silver alloys are largely replacing babbitt and if universally adopted will call for a million or two pounds a year. The price has stiffened and is now about 67-1/2 cents abroad and I gathered a little less here. If the demand continues to grow there will be a shortage.

Very truly yours,

Rolfe