Metallurgical Reports

12

Memorandum
to
Mr. Sawyer A-~~69~~ 88

September 24, 1946

Bismuth

I am studying the metallurgical reports in the endeavor to ascertain the sources and recovery of bismuth. At the outset, I find that the roasters have an apparent 200% recovery. This is due to the fact that about 80% of the tonnage entering the copper plant and 6% in the lead plant show no assay for bismuth. "By difference" some 300,000 lbs. of bismuth in 1945 are missing at the roasters and an unknown -uantity in the converter flux.

Perhaps you will find time to discuss this. The figures are meaningless unless complete.

Lawrence Addicks

LA/vp

1 August 1946

~~Roasters~~ – 115 tons p. day ea. 29.5% S – 16.5% S

Ores – R + R 29212

Santa Ana → Conv. } → ~~1~~2150
1045
32407

Reverb. 597 net chge Total net chge 33848 2 reverb.
858 gross Conv-slag 14720
Gross 58667

~~Coal p~~ Fuel (oil basis) 6.91 p. d.s.t.

	Calc.	Rev. Slag	Matte	Conv-Slag
SiO_2	20.4	33.4	1.2	17.8
Al_2O_3	1.8	3.5	.3	.8
Fe/FeO	34.0	49.0	43.8	53.5
CaO	3.5	5.0	.4	.9
S	16.5	1.5	24.7	2.7
Zn/ZnO	1.8	2.2	1.8	1.9
Pb	2.8	.8	5.2	1.5
Cu	7.15	.35	16.5	2.15
Ag	13.1	.50	32.9	2.64
Bi	0.10	.007	.15	.003
Sb	–	–	.7	–

Cottrell	Conv. Sinter	Reverb.	Pb Blast	Hot Revert.	As Cott Dust	As Elim. Calc.
SiO_2	.5	4.9	~~B.2~~	15.5	3.7	8.1
Al_2O_3	.1	.5	0.4	10.9	1.0	2.2
Fe	1.5	1.5	2.8	7.6	2.6	20.0
↓	↓	↓	↓	↓	↓	↓

	↓	↓	↓	↓	↓	↓
CaO	.4	.2	.6	.8	.4	1.7
S	7.8	3.8	6.9	2.2	5.8	13.3
Zn	3.3	3.7	5.2	3.6	5.1	3.9
Pb	51.4	20.3	32.4	22.5	8.9	31.8
Cu	.45	.50	.70	1.35	2.40	1.22
Ag oz	8.4	3.3	4.4	8.4	7.2	9.6
Au oz	—	—	—	—	—	.034
Bi	2.17	1.26	.62	2.08	.61	1.26
As	6.9	30.6	11.2	9.4	36.4	1.7
Sb	2.9	4.1	1.6	4.4	5.0	1.64
Sn	.66	.45	.31	.74	.14	.385

H_2SO_4 588,194 s.t. 66° Bé total
26.4 t p. day operation
5.4% SO_2 — 0.26 SO_2 Conversion 95.5

	Pb	Ag	Au	As	Sb	Bi	Cu	Sn
Pb —	95.301	79.561	0.184	0.073	3.394	0.883	0.067	0.004

Sinter 54.79% ores tots
0.96 Refy slag
9.08 Conv. slag
~~Roaster Cott Dust~~
24.47 Roaster Cottr. Dust
10.70 Limerock
41 5 dt p machine day

Pb BF Chge -	Sinter	73.49 %
	Ref. Pb Dross	.76
	Copper Dross	22.37
	Reverb. Fine slag	1.24
	Conv. Slag	1.85
	Hard Pyrite Flux	.29
		100.00 %

Coke 13.47 % 269 t.p.d. # Zn dross 9.942

Fl. dust loss 2.286 dst

	Sinter Feed	Product	Slag	Dross	Zn Dross	Hot Matte
SiO_2	6.5	8.0	28.0	~~57.5~~	—	1.3
Al_2O_3	1.0	1.3	5.9	~~21.90~~	—	0.4
Fe/FeO	14.7	18.7	38.2	~~57.80~~	—	38.3
CaO	6.6	8.7	13.9	~~.11~~	—	0.4
S	14.0	1.6	2.2	~~5.7~~	—	17.4
Zn/ZnO	4.4	4.8	9.2	~~4.0~~	—	5.0
Pb	38.0	39.4	1.2	57.5	61.7	7.8
Cu	1.85	2.05	.63	21.90	0.05	18.2
Ag oz	29.0	33.6	.51	57.80	39.6	13.8
Au oz	—	—	—	.11	—	.011
As	0.7	0.6	.10	5.7	0.6	3.7
Sb	1.4	1.6	.12	4.0	7.7	1.0
Bi	.24	0.29	.001	.51	.47	0.008
Zn	.13	0.16	.04	.62	18.5	0.8

As Plant — Prod. for Stock 452,190 As_2O_3 | + 1,555,139 calc.

	As_2O_3	calc.
% As_2O_3/As	91.7	8.6
As_2O_5	.24	—
Sb_2O_3/Sb	1.7	5.2
S	1.2	10.5
Zn	.2	2.0
Pb	1.6	14.0
Cu	.20	4.10
Bi	.10	0.88
Sn	—	0.22
Insol.	1.9	12.5
Fe	.6	24.2
Ag oz	—	13.1
Au oz	—	0.055

Pb Refy. Produced 7,028,328 #

Electrolyte 114 g/l H_2SiF_6

Acid Loss 5.87 # p.s.t.

Glue 1.24 "

Goulac 1.01 "

Curr. dens. 16.73 Eff. 78.1

Part Plant 1.37 volts 8.23 a p.s.f.

HNO_3 — 31.33 # p.s.t.

Tartaric — 20.16

~~Zn~~ Plant 90.7% leach extraction

H_2SO_4 — 533 # p.s.t.

Curr. Eff. 77 Curr. dens. 60

Recovery 68.7% as slab 79.0% incl. $ZnSO_4$

A-264 Oct. 1, 1930

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

Dear Mr. Drew:

LEAD METALLURGY

Noting Mr. Spilsbury's letter of August 27th on lead plant recoveries, what he says is admitted by all. The hypothetical case taken of straight Casapalca does not however meet the question as to what has become of the missing lead in normal charges of which the periods under discussion were made.

There are only two questions. The first is how to improve our present flow sheet and practice. This Mr. Ellis is studying and we can await his report.

The second is to avoid allowing Cerro ores prejudicing ore purchases by false margin sheets. I think lead recoveries shouod be figured on the basis of what they would be in the absence of copper and then the copper present debited with the loss of lead it causes. Mr. Spilsbury covers this very point when he says: "While the lead recovery for Casapalca concentrates might remain low, we should expect a higher recovery for ores containing less or no copper, and in calculating margin sheets it w would seem to be correct to give such ores their corresponding lead recovery."

Mr. Spilsbury is always pretty level-headed. He may naturally think of Oroya as primarily a copper plant. Mr. Ellis will in turn think largely in terms of lead. With both sides ably represented we shall soon get a balanced program.

Very truly yours,

Cw

Lima, September 6, 1930

Cerro de Pasco Copper Corporation,
44 Wall Street,
New York.

Dear Sirs: Lead Plant Recoveries

Acknowledgment is made of your letter of August 6, with enclosure as stated, on above subject.

Both letter and enclosure were referred to Mr.Spilsbury and attached hereto you will please find copy of his letter of August 27, to me, in which he deals very fully with the lead recovery from the Casapalca concentrates.

As soon as the report on lead smelting by Mr.Ellis has been received,copies will be sent to you.

Yours truly,

HAROLD KINGSMILL

General Manager.

COPY

La Oroya, Peru,
August 27, 1930

Mr. Harold Kingsmill,
General Manager,
Lima.

Dear Sir: LEAD PLANT RECOVERIES

Please refer to your letter of August 22nd enclosing Mr. Drew's letter of August 6 regarding the above subject.

Mr. Drew seems to think that the recovery figure of around 70% lead is much lower than the actual figure. We believe the figure is lower than it should be for all ores, but the recovery for Casapalca concentrates could not be expected to go much above 70% with such high copper and low lead, and with operations as at present, i.e., with no Sintering Plant, Cottrell or baghouse, and with no converter and baghouse for the treating of lead copper matte and the recovery of the lead fume.

Consider Casapalca concentrates to assay 15.0% Cu and 32.0% lead, about the correct figures for current receipts. Consider the ratio of copper to lead in the matte which now goes to the converters to be 2 to 1. This is as good an average ratio as we have been able to make: at times it is higher and, at times, lower. Consider that 90% of t e copper in the concentrates is recovered in the copper lead matte. Concentrates assaying 15.0% copper would contain 300 lbs. of copper per ton and 90% of this amount would be 270 lbs. which would be the amount of copper going to the converters per ton of concentrates treated. With this amount of copper there would be 135 lbs. of lead, using the 2 to 1 ratip for copper to lead in the copper lead matte. Now 135 lbs. of lead per ton of concentrates is equal to 21.1% of the lead contained in the concentrates.

$$\frac{135}{640\ (32.0\%)} = 21.1\%$$

Now take sintering plant stack losses as 4.5%; slag losses as 4.5% and fume and dusting losses as 1.0%, and you have a total of 10.0%. Add this amount to the 21.1% lost to the converter and you have losses amounting to 31.1% of the lead in the concentrates. From this it will be seen that the lead recovery figure of around 70.0% for Casapalca concentrates is not low.

While the lead recovery for Casapalca concentrates might remain low, we should expect a higher lead recovery for ores containing less or no copper, and in calculating margin sheets it would seem to be correct to give such ores their corresponding lead recovery.

The lead recovered in the bullion for July was 72.88% of the lead in the ores and concentrates treated. We hope the figure for August will be somewhat higher because we believe our present practice should give better results than have been obtained heretofore. The ratio of the copper to lead in the charge treated is now much higher than previously and, therefore, the amount to lead going to the converters is greater.

As soon as recovery figures for August are available, we will write you further on this subject. In the meantime, Mr. Ellis is preparing a report on our lead smelting practice.

Yours very truly,

(Sgd) R. Spilsbury.-

Superintendent.-

not clear. How can they expect better results with higher copper to lead ratio? W.S.Smith

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A A-198 December 20, 1944

Mr G. P. Sawyer, Vice Pres.,
Cerro de Pasco Copper Corp.,
40 Wall Street, New York City

Dear Mr Sawyer: LEAD METALLURGY

I have rewritten as per enclosure my A-198 removing the ambiguous "gasping". Please substitute this copy.

Very truly yours,

Gay

A-197 December 18, 1944

Mr G. P. Sawyer, Vice Pres.,
Cerro de Pascp Copper Corp.,
New York City 5

Dear Mr Sawyer: LEAD METALLURGY

Referring to your letter of the 13th, recdived somewhat mangled on Saturday, I think the Smith-Reinberg memorandum is a very good piece of metallurgical detective work. Personally I am convinced that air starvation is the answer to the conundrum but I doubt whether the answer is so simple as the running of a single blower.

I enclose comments for Mr McLaughlin. Will you please send these along with the Smith-Reinberg document.

Very truly yours,

Ady

CERRO DE PASCO COPPER CORPORATION

40 WALL STREET, NEW YORK 5, N. Y.

December 13, 1944

Mr. Lawrence Addicks
Bel Air
Maryland

Dear Mr. Addicks:

There is attached hereto a copy of Mr. Fowler's letter dated November 29th which gives the information which we requested by cable when you were here in New York. Please return this letter for our files. Messrs. Smith and Reinberg have drafted the attached memorandum commenting on the information contained in this letter. The low blast pressure is now explained by the fact that two furnaces were being operated from the same blower.

Yours very truly,
CERRO DE PASCO COPPER CORPORATION

Geo. P. Sawyer

Geo. P. Sawyer

GPS/vp
enc.

A-214

Breakwater Court,
Kennebunkport, Me.
August 10, 1930.

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

Dear Mr. Drew:

LEAD METALLURGY

I note copy of Lima cable #5. As this is in reply to one written by Mr. Hamilton I presume he is suggesting a reply. For my part I would like to see some figures based on running the furnace on a sulphur which will give a good slag and a bullion free from copper and then reroasting and concentrating the matte to a 40% ~~xxxx~~ copper (probably 10% lead) matte to go to the copper plant. This would give a maximum direct lead recovery and keep excessive lead out of the copper bullion.

We have really three programs. The first is the old one of sending excessive quantities of leady matte to the copper plant. The second is the one suggested above. The third is to shut down the lead plant and throw the lead away (for the present) in the converter fluedust. This fluedust will be not over-rich in bismuth and will complicate our bismuth problem later.

We should have margin sheets which charge for impurities in the ore only the recovered amounts in the product sold at the rates imposed by Chrome or Maurer (Perth Amboy) as the case may be.

Finally no stone should be left unturned to find out where the missing lead and silver as shown by difference between amounts paid for and accounted for in bullion, slag and flue products, go. It is disquieting to note that almost parallel conditions as regards losses exist in the leqd blast furnace and in the dust reverberatory. All else aside I understand we are losing custom business because our margin sheets reflect these missing quantities.

Very truly yours,

P. S. 69° here. Think I shall stay until the end of the week here.

Memorandum
to
Mr. Smith

September 24, 1946

Mr. Sawyer said before leaving that he had no special plans for you during his absence so during intervals in your routine duties I want to get you to examine our metallurgical sheets some more with the idea of being able to make suggestions leading to lifting them from the universal criticism they now suffer from and also to aim for real information on recovery efficiencies and excess losses due to circulating so many by-products.

We should some day be able to make an accurate flow-sheet of every ~~soluble~~ saleable constituent of the incoming ores. I have taken a try at bismuth myself and should like to know if you check my figures. I have already asked Mr. Sawyer to investigate the question of not analyzed ores.

Lawrence Addicks

LA/vp

February 20, 1945

Mr. Addicks:

With further reference to my letter of February 15th, there is enclosed herewith a memorandum from Mr. Smith. The matter will be held in abeyance until your next visit to New York.

Geo. P. Sawyer

A-46 February 17, 1945

Mr G. P. Sawyer, Vice Pres.,
Cerro de Pasco Copper Copr.,
40 Wall Street, New York City 5

Dear Mr Sawyer: LEAD METALLURGY

Noting your letter of the 15th with enclosures I should very much like to push the blast question to a conclusion as it was one of the main matters discussed at the conference of last summer when Mr Fowler was here. It is perfectly clear that the data from Oroya is self-contradicting but they must see that without our forcing the point. I am personally convinced that the furnaces are not getting the proper air.

However Mr McLaughlin must have reasons not apparent to us in suddenly changing his attitude and in the present state of affairs we should do nothing which might embarrass him. I think therefore that "radio silence" is indicated until we understand better which won't be long if he is soon to be in New York.

Very truly yours,

Ady

CERRO DE PASCO COPPER CORPORATION

40 WALL STREET, NEW YORK 5, N. Y.

February 15, 1945

Mr. Lawrence Addicks
Bel Air
Maryland

Dear Mr. Addicks:

Attached hereto you will find a copy of Mr. McLaughlin's letter dated February 2nd transmitting Mr. Fowler's letter of January 23rd as well as a copy of Mr. McLaughlin's letter of February 7th transmitting a copy of Mr. Colley's letter of February 5th. You were quite correct with regard to Peru's reply about the quantity of air being supplied the lead furnaces.

Judging by the last paragraph of Mr. McLaughlin's letter of February 7th, it is apparent that he desires to ring down the curtain on this correspondence. It seems to me, however, that there is one question which should be answered and that is what becomes of the 6400 cu. ft. of air per minute which Mr. Fowler says each furnace is receiving. Mr. Smith comments on this in his memorandum dated February 13th but I cannot conceive that channelling or blow holes in the charge would account for the difference. A more plausible explanation would be that air is being wasted through a safety valve before reaching the furnace.

Yours very truly,
CERRO DE PASCO COPPER CORPORATION

Geo. P. Sawyer

Geo. P. Sawyer

GPS/vp
enc.

-15

A-196 December 18, 1944

Mr D. H. McLaughlin, Vive Pres.,
Cerro de Pasco Copper Corp.,
40 Wall Street, New York City 5

Dear Mr McLaughlin: LEAD METALLURGY

Referring to my memorandum to you of November 17th, while you were still in New York, and your request that I continue this correspondence, you will receive by this mail a memorandum dated December 8th covering a study by Messrs Smith and Reinberg of the data included in Mr Fowler's letter of November 29th. The last-named completed the information asked for in our cable of October 5th on lead blast furnace flue gas composition. We are indebted to someone for some painstaking work.

When Mr Fowler was in New York last summer the question was raised as to the seemingly impossibly low blast pressure at the furnaces and I reëmphasized this point in memorandum to you as probably being the key to furnace speed. Smith & Reinberg have correlated the data to show that either the two furnaces are operating on a single blower (which we had not understood) or that about half the airstated does not reach the furnace. Certainly all the pieces of the puzzle fall into place in such a conclusion. They have carefully considered the carbon in CO_2 from carbonates and other possible effects of various constituents of the charge and I can see no flaw in their argument.

The facts that the gas analyses show complete exhaustion of the oxygen and that the low blast pressure indicates that the air is not being fed plus the higher blast pressures in the early days when the furnace was running fast (although on a different charge) make an overwhelming circumstantial case. The crusting difficulties tie in with the argument as the upper part of the furnace must be relatively cold and without roasting effect.

Whether or not this position is right can be quickly investigated on the ground. If the furnaces are not getting the 6000 or 7000 C.F.P.M. each we had heretofore assumed I think we should plan to run a furnace with that air and with not less than 9% fixed carbon on the charge

(Thermodynamically some extra fuel is required by the altitude). With the additional air there will not be excessive reduction.

In view of the importance of maintaining production the use of the third furnace for experimental runs, assuming the men can be found, would probably ease the conscience of everyone. If we have not recently run a speed/pressure curve with closed throttle on the blowers, I suggest it. 95% efficiency seems much too high to me.

Very truly yours,

Alex

P. S. Of course I am assuming that we are in agreement that, other things being equal, we want to get higher furnace tonnages. This is the only reason for the suggestions made above.

A-196 December 18, 1944

Mr D. H. McLaughlin, Vice Pres.,
Cerro de Pasco Copper Corp.,
40 Wall Street, New York City 5

Dear Mr McLaughlin: **LEAD METALLURGY**

Referring to my memorandum to you of November 17th, while you were still in New York, and your request that I continue this correspondence, you will receive by this mail a memorandum dated December 8th covering a study By Messrs Smith and Reinberg of the data included in Mr Fowler's letter of November 29th. The last-named completed the information asked for in our cable of October 5th on lead blast furnace flue gas composition.

When Mr Fowler was in New York last summer the question was raised as to the seemingly impossibly low blast pressure at the furnaces and I reëmphasized this point in my memorandum to you as probably being the key to furnace speed. Smith & Reinberg have correlated the data to show that either the two furnaces are operating on a single blower or that about half of the air ~~fed escapes through relief valves or otherwise before~~ reaching the furnace. Certainly all the pieces of the puzzle fall into place in such a conclusion. They have very carefully considered CO_2 from carbonates and other possible effects of various constituents in the charge and I can see no flaw in their conclusions.

The facts that the gas analyses ~~indicate~~ that ~~the furnace is gasping for~~ oxygen and that the low blast pressure indicates that the air is not being fed plus the higher blast pressures in the early days when the furnace was running fast (although on a different charge) make an overwhelming circumstantial case. The crusting difficulties tie in with the argument as the upper part of the furnace must be ~~very~~ cold.

~~Either~~ this position is right ~~or it isn't. The facts regarding air can~~ quickly be investigated on the ground. If the furnaces are not getting the 6,000 or 7,000 c.f.p.m. we had heretofore assumed I think we should plan to run a furnace with that air and with not less than 9% fixed carbon on the charge. (Thermodynamically some addition of fuel is required by the altitude). With the additional air there will not be excessive reduction.

In view of the importance of maintaining production the *use of* third furnace ~~run experimentally~~ *for experimental runs* would probably ease the conscience of everyone. If we have not recently run a speed/pressure curve with closed throttle on the blowers, I suggest it. 95% efficiency ~~looks pretty high.~~ *seems much too high to me.*

Very truly yours,

Of course I am assuming that we are all in agreement that, other things being equal, we want to get higher furnace tonnages. This is the only reason for the suggestions made above.

February 15, 1945

Mr. Sawyer:

LEAD METALLURGY

The data from Oroya indicate that the blowers at the lead plant are supplying about twice the air to the furnaces needed to burn the carbon actually burned.

We can calculate the volume of top gas from its nitrogen content and the nitrogen content and the volume of air supplied by the blowers. The carbon content of the top gas can be calculated from its volume and the CO_2 and CO assayes. By this method we find that the carbon burned per furnace minute at Oroya was about 48.4 lbs.

Yet the carbon in coke used per furnace minute was only about 21.0 lbs.

By using the data available for Kellogg, Tooele and Trail furnaces, we get the following estimates:

Plant	Carbon per Furnace Minute	
	Carbon in coke charged	Calculated Carbon in top gas
Kellogg	42.6 lb.	43.7 lbs.
Tooele	73.7 "	69.2 "
Trail	47.2 "	39.3 "
Oroya	21.8 "	48.4 "

It is evident that something is unusual at Oroya. Either about half the air supplied by the blowers at Oroya was wasted before it reached the tuyeres of the furnaces, or it must have passed thru the furnace without coming in contact with hot coke and this portion of the top gas was not sampled. The low blast pressure at Oroya by comparison to other plants, tends to point to air wastage before it reaches the furnaces.

W C Smith

W. C. Smith

MEMORANDUM

December 8, 1944

Mr. Geo. P. Sawyer:

Dear Sir:- SUBJECT: Lead Blast Furnaces

The data contained in Mr. Fowler's letter of November 29th indicates the No. 2 and No. 3 lead furnaces were operating with a total air supply of 6,407 cubic feet per minute measured at Oroya conditions, which is equivalent to 3,959 cubic feet per minute at sea level pressure and 0° C.

The top gas analyses given by Mr. Fowler show that the oxygen in the air supplied to the furnaces was being completely utilized to burn the fixed carbon in the furnaces. The volume of top gas from the furnaces can be calculated from its nitrogen content and the nitrogen assay and volume of air supplied to the furnaces. From the volume of top gas and the gas analyses, the carbon in the top gas can be calculated. On this basis, the carbon in the top gases from the two furnaces was approximately 47 pounds per minute.

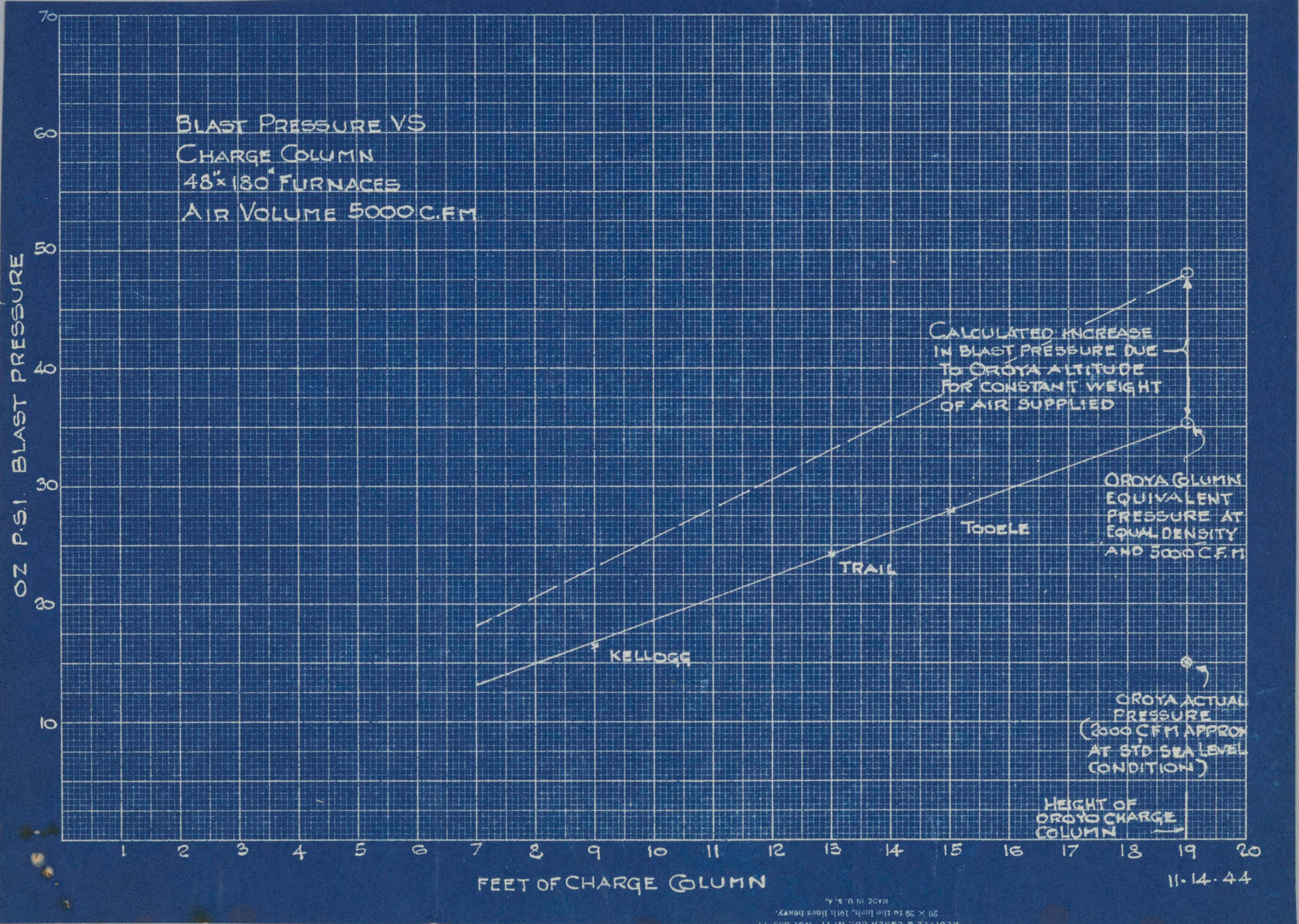
We have no information as to the amount of fixed carbon charged to the furnaces during the test period (October 30 to November 19), but the average for the period January to June, 1944 was about 40 lbs. per minute for two furnaces, which checks reasonably well the 47 lbs. per minute calculated from top gas.

The attached chart shows the effect of height of ore column on the blast pressure needed to force 5,000 cubic feet of air per minute thru each of three furnaces of approximately the same size (Kellogg, Trail & Tooele). The data were taken from Aldright & Miller Page #100, A.I.M.M.E. Transactions Vol. #121. The chart indicates that had Oroya furnaces been the same size as the Kellogg, Trail & Tooele furnaces and at the same altitudes, it would have required about 35 ozs. of blast pressure to force 5,000 cu. ft. of air per minute thru each Oroya furnace and corrected for Oroya altitude, a blast pressure about 48 ozs. would have been required to force the same weight of air thru a 48" X 180" furnace. As the Oroya furnaces are of somewhat greater area, a slightly lower pressure should be required at comparable volume and height of column.

It is now clearly evident that the low blast pressure obtained at Oroya is due to the very low volume of air supplied to these furnaces, which when corrected to sea level condition, is only an average of 2,000 C.F.M. per furnace. This on a weight basis is only about 40% of the oxygen supplied to the furnaces at Kellogg, Trail & Tooele, which is in accord with the comparative smelting rates attained.

W C Smith

Gustave Reinberg



BLAST PRESSURE VS
CHARGE COLUMN
48" x 180" FURNACES
AIR VOLUME 5000 C.F.M.
OZ P.S.I. BLAST PRESSURE
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
KELLOGG
TRAIL
TOOELE
CALCULATED INCREASE
IN BLAST PRESSURE DUE
TO OROYA ALTITUDE
FOR CONSTANT WEIGHT
OF AIR SUPPLIED
OROYA COLUMN
EQUIVALENT
PRESSURE AT
EQUAL DENSITY
AND 5000 C.F.M.
OROYA ACTUAL
PRESSURE
(3000 CFM APPROX
AT STD SEA LEVEL
CONDITION)
HEIGHT OF
OROYA CHARGE
COLUMN
FEET OF CHARGE COLUMN
11-14-44

A-183

New York, November 17, 1944.

LEAD METALLURGY.

Mr. McLaughlin:

Referring to our recent talk about the Oroya metallurgical operations - as I then said, the labor difficulties, the critical shortage of staff and the reorganization problems that are under way make this a doubtful time to make demands on the time of anyone at Oroya either to discuss or investigate anything not immediately necessary to maintain production. The production crisis of last summer indicates we are operating too close to the edge of a metallurgical cliff to justify meddling with existing practice except on a well-considered basis on which anyone involved agrees. As you ask for it, I make the following comments

Personally, I am not at all prepared to say that our present practice does not represent the best that can be done with the very unusual factors of impurities, altitude, cheap but scarce labor, costly and poor fuel and very cheap electric power. I do think that the practice has developed under forced limitations as the plant has grown from a very simple copper operation to one of the most complicated ore supplies existent and that we can well undertake a thorough review. I do not think we should be writing letters back and forth until we have thoroughly digested the 1943 figures and can put forth well grounded reasons for undertaking any variations in present practice.

One misconception should be corrected. There would be a real gain in being able to smelt more tons of marginal material per furnace-day. Apart from the saving in scarce even though cheap labor the intake in lead is going to be greatly increased with the building of the zinc refinery and both investment and crowded land area come into the picture.

One enigma needs solving. The blast pressure is amazingly low at the blast furnaces. The altitude apparently enters only as a square root of the barometer in driving air through an orifice and the air density very slightly. Are the data wrong? Faulty gauges or something? Have we a charge porosity astonishingly different from all the other smelters where the pressure seems to be a direct function of the height of charge and would indicate a pressure at Oroya of 48 ozs. p.s.i. instead of say 16?

One item has been already reviewed with some thoroughness. Our metallurgical accounting for lead losses has been faulty. We have shown 7 or 8% "unaccounted for", which is impossible for a plant equipped as is Oroya. Apparently some of the circulating products are being double charged in the accounts and the corrected figure is more reasonable, as shown in the attached calculations.

Finally, I think thought has to be given to fishing impurities out of the smelting cycle rather than recharging them. The point is that the production of mattes in the presence of high zinc is a severe test of the skill of the smelterman and that is the real argument for not recharging copper dross. I wish Oroya would for the moment arbitrarily assume that an electric furnace could handle the drosses satisfactorily and consider how the zinc and possibly arsenic would behave in the blast furnace in the absence of the matter collector. Merely removing dross from the charge does not serve the purpose unless the sulphur in the sinter is cut down to the point of extinction of the matte. The whole object is to keep sulphur away from zinc and arsenic. So far I have not fully digested the trials made some years ago from a somewhat different angle, which however did show lower copper losses in the slags. Mr. Colley's opinion would be most helpful here.

L. ADDICKS

LEAD PLANT 1943

		Pb. Tons		Ag. Ozs.
In Lead Ores		44,661		4,444,528
In Roasted Cottrell Dust (Est.)		7,260		261,488
Inventory Changes (Note #1)		1,456		30,435
Total to Account for		53,377		4,736,451
Bullion		49,536		4,529,757
Tin Dross		303		22,638
Matte		711		108,018
Speiss		120		29,076
Slag		827		14,721
Stack Loss (Est.)		200		6,000
		51,697		4,710,210
Unaccounted For	-	1,680	-	26,241
Loss		3.15%	Loss	.55%

Note #1

		Pb. Tons	Ag. Ozs.
Refined Pb. Dross		477	29,814
Refinery Slag		981	29,814
Matte & Speiss	-	2	621
		1,456	30,435

COMBINED COPPER AND LEAD PLANTS

YEAR 1943

		Pb. Tons	Ag. Ozs.
In Copper Ores (New Pb.)		8,709	7,782,284
In Lead Ores (New Pb.)		44,661	4,444,528
Inventory Changes (Note #1)		1,049	433,084
Total to Account for		54,419	12,659,896
In Copper Bullion		128	11,242,763
In Refined Lead		47,587	10,000
In Fine Silver			968,303
In Coin Silver			579,609
In Tin Dross		303	22,638
In Lead Chloride		135	
In Arsenical Dust to Stock (Est.)		476	39,600
In Reverb. Slag		2,470	219,183
In Lead B.F. Slag		827	14,721
Stack Loss (1982) (Est.)		601	18,872
		52,527	13,115,689
Total Accounted For		52,527	13,115,689
Unaccounted For	-	1,892	+ 455,793
Loss		3.66%	Gain 3.60%

Note #1

		Pb. Tons	Ag. Ozs.
Silver Products			56,646
Anode from Stock		484	68,446
Refined Lead Dross		477	
Matte & Speiss	-	2	621
Roasted Cottrell Dust		102	6,517
Materials in Process (Ref.)	-	12	300,854
		1,049	433,084

A-157

MEMORANDUM OF CONFERENCE SEPTEMBER 9, 1944
Messrs Sawyer, Fowler, Smith, Reinberg and Addicks

This meeting was called as a result of Mr McLaughlin's cable received August 31st stating:

"PERFORMANCE LEAD BLAST FURNACES SINCE CLEANING OUT EXTREMELY POOR, ATTRIBUTED PRESUMABLY TO PHYSICAL QUALITY BY-PRODUCT COKE AND INCREASED ARSENIC AND ZINC IN DUST AND OTHER PRODUCTS. OUTPUT LEAD, SILVER, BISMUTH SERIOUSLY CURTAILED UNTIL CONDITION REMEDIED. REQUEST FOWLER RETURN PERU IMMEDIATELY AND DISCUSS LEAD SMELTING PROBLEMS FULLY WITH ADDICKS AND SMITH IN NEW YORK"

The immediate problem was how to account for and remedy the the serious fall in production of the last three months and the secondary one a general discussion of the present status of lead smelting at Oroya.

THE PRESENT CRISIS

The operating data at hand in New York have too much time lag to enable much of a diagnosis to be attempted. It is not even clear whether the cable refers to a general barring down of furnaces in operation or the starting up of a rebuilt one. We do know that two sick furnaces were being struggled with a couple of months ago, that the starting up of a new furnace with strange coke might require some time for stabilization, that the last available sinter assays show too much sulphur---a prolific source of trouble---, and that an acute labor problem exists which accentuates ever-present smelting difficulties.

The best guess is that the denser coke to be expected from by-product ovens has refused to burn as rapidly as the old type and that the excessive sulphur in the sinter has contributed additional zinc mush. A temporary return to old-style coke with gradual change over to the new and closer attention to the roaster operation is clearly indicated, but such a course is so obvious it is assumed that steps have already been taken along these lines and as Mr Fowler expects to arrive in Peru in two or three days no cable on the matter seems necessary.

THE GENERAL CONDITION

Our main disappointment is that while American smelters get 500 tons a day through a furnace we get only 175 to 225 from one of equal size. There is nothing about the character of the charge either chemically or physically to account for this. The explanation must therefore lie in either the heat supplied, the type of slag made or the packing of the charge.

This whole question was reviewed in 1936 and an experimental program decided upon, but due to lack of staff and the intervention of other matters no steps have been taken towards its accomplishment. Instead the low smelting rate has been met by building additional furnace capacity and the question arises as to what would now be gained if the entire output would be put through one furnace, measuring operating savings against cost of the necessary innovations.

In comparing Oroya practice with that of most of the American smelters the differences appear chiefly in blast furnished, type of slag made, grade of coke used and the altitude under which the operation is carried on.

1. We are using a greater volume of blast per unit of hearth area and much more per ton of charge but this would be indicated by the lower oxygen content of a cubic foot of air. The strange thing is that we have but a quarter to a half the back-pressure on the blower although the ore column is a high one. The explanation of this needs exploration on the ground. It would seem to indicate too loosely packed a charge or else glory-hole smelting although no over-fire is observed. Solving this puzzle might lead to unexpected improvements in smelting rate.

2. Our silica is higher and iron lower than carried in the slags of most plants having high zinc on the charge. This should be thought over.

3. The excessive ash in the coke, while not desirable, probably is not a major source of trouble as changes from dirty to clean coke elsewhere have not made much difference beyond lowering the non-marginal load by the equivalent of the ash minerals. The physical character of the coke is an important matter, however. At the time of the earlier discussion it was decided to import a cargo of good smelting coke in order to evaluate this factor but for some reason it was not carried out and it is probably out of the question at the moment under war conditions.

4. The altitude causes a slower rate of oxidation of the fuel in the furnace and this is doubtless the chief cause of low capacity. In order to get better heating

effect we should (a) run jacket water as hot as possible, (b) consider whether we are making a slag with a low formation temperature, (c) consider possibility of preheating blast, (d) consider enrichment of blast with oxygen (It had been intended to experiment with the discarded oxygen plant now in Peru but it has not yet been done) and (e) get posted on any work done to lower ignition temperature of coke with catalytic agents.

Finally we have never made the proposed electric furnace runs in order to evaluate this line of attack. In an electric furnace non-marginal charge would disappear, the coke requirement would be cut two-thirds and metal recoveries should be very high. Against this would be the power and electrode costs. Preliminary arrangements were made along these lines but had to be side-tracked. This should be given high priority on any experimental list.

CONCLUSIONS

Under war labor conditions not much can be demanded of Oroya. The arguments advanced above can be given more or less of a paper evaluation in New York but it would seem that one competent man might be assigned at the smelter to follow up and analyze these points and then informal reports be exchanged with New York. The first step is to determine the maximum probable savings, assuming the success of the several proposals and then to determine on a firm program.

Clabs

A-101 July 9, 1945

Mr C. P. Sawyer, Vice Pres.,
Cerro de Pasco Copper Corp.,
40 Wall Street, New York City 5

Dear Mr Sawyer: LEAD METALLURGY

I return herewith Mr McLaughlin's letter of June 22nd on lead metallurgy. What I have been after from the beginning in this discussion of now some years' standing is to discover the real capacity of the lead blast furnaces before the company is obliged to undertake building additional capacity. If we all sat around the campfire at Oroya and talked it wouldn't help things a bit and Mr Smith is fully conversant with Oroya conditions.

The point is not theory but facts. Oroya has furnished blast data which are self-contradictory. Once they ascertain what is the matter with the air-carbon balance as stated by them the questions will probably answer themselves about capacity. On the data presented one can only conclude that the low blast pressure indicates worn blowers with enormous slippage or other air escape before the air reaches the furnace.

Very truly yours,

Ce

A-73-A

Memorandum
to
Mr. F. F. Russell

July 30, 1947

Lead-Zinc Slag Furnace

Following our conversation of yesterday I discussed at some length the idea of cooperation between Cerro and the St. Joseph Lead Company with C. Merrill Chapin, Jr., vice president of the latter company.

The general idea proposed was to consider the furnace proper on the basis of full information of their experience in return for equivalent information as to what we learn at Oroya and an understanding that we should not exploit patents or sale in territory outside our own operations. In the matter of the condenser for the zinc vapor, which is the crux of the matter, this is a fully developed apparatus and reasonable compensation should be paid should we use it. This idea was acceptable but they are not in a position to loan personnel or prepare designs for outside applications or to make any guarantee as to results.

To my surprise, they appear to have complete Peruvian patents taken out last year, subject of course to the usual clause for actual operation in Peru renewable yearly up to eight years. I had assumed they had no patents, but it did not seem to affect the discussion. Incidentally, Mr. Wormser, their newly acquired assistant to the president is probably in Oroya today and will be back in New York in a couple of weeks.

They have apparently reconciled the factions in their staff, and all have faith in the success of the furnace. All difficulties have been overcome except that of life of the furnace refractories. Union Miniere is interested and St. Joe actually installing a <u>smelting</u> furnace in Argentina with a local partner with the backing of the Argentine government and using petroleum coke as the reducing agent.

The slag furnace at Herculaneum is warming up today for a trial run on the new carbon block bottom and will be arbitrarily shut down by September first for examination so that it is essential that we pay a visit to Herculaneum during August. If Mr. Reinberg does not return in time, Mr. Smith should go without him.

No commitments have been made by either side, but after this trip something more definite should be done. We should inform ourselves as to the exact patent average in Peru.

Lawrence Addicks

LA/if

Mr. Addicks

ZINC RECOVERY PLANT AT HERCULANEUM, MISSOURI

SUMMARY

The new process for the recovery of zinc in the metallic form from lead blast furnace slags at the Herculaneum, Missouri smelter of the St. Joseph Lead Company, has not been operated for sufficient time to establish data from which operating costs can be estimated safely, but a preliminary survey indicates the new process has more promise at Oroya than the standard slag fuming processes in which the zinc is recovered as zinc oxide which then must be reduced to metallic zinc by thermal, or electrolytic processes.

The cost of installation of either process at Oroya would be about the same, that is, at least $1,500,000. The St. Joseph plant would occupy only a small part of the ground space required by the slag fuming process. It consumes a relatively large amount of electric power and a minimum of fuel, whereas the fuming process requires large amounts of fuel and only a minimum of power.

The operation of the Herculaneum furnace should be checked from time to time and when sufficient data are available a new estimate prepared.

****

I visited the St. Joseph Lead Company's Lead Smelter at Herculaneum, Missouri on August 19th to study the new plant they have erected for the direct recovery of zinc from the lead blast furnace slags. A number of slag treatment plants are in operation elsewhere, but they all produce zinc oxide which must then be reduced by thermal, or electrolytic methods, whereas the St. Joseph plant is designed to yield metallic zinc directly from the blast furnace slags.

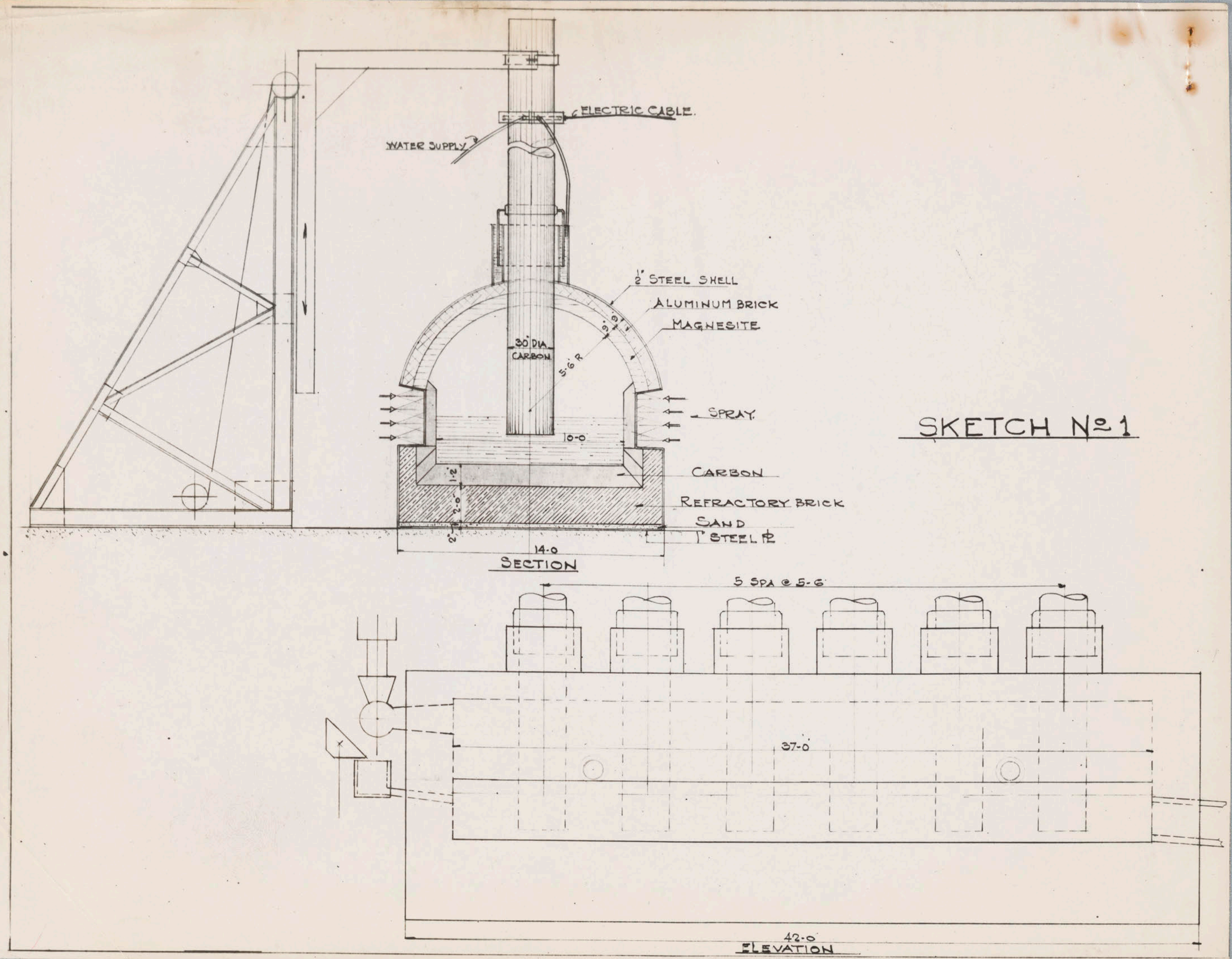
The zinc recovery plant at Herculaneum is located just South of the lead blast furnace building and at the same level. It consists of:

(a) Coke braize drier
(b) A large electrically heated, gas tight dezincing furnace.
(c) Two Weaton-Zajarian zinc condensers.
(d) Gas cooling and cleaning equipment.
(e) Two duplex 14" x 26" vacuum pumps.
(f) One gas compressor.
(g) Two 5000 KVA transformers.
(h) Control room containing the electrical meters, vacuum guages and control apparatus.
(i) Zinc settling furnace.

Coke braize is screened to remove fines (-4 mesh), dried until free of moisture in a small gas fired rotary drier. The dried coke is delivered to either of two small storage bins above the electric furnace by means of belt conveyors.

The electric furnace is about 14' wide, 42' long and 15' high and is built in a gas tight heavy steel shell. The inside dimensions of the furnace are 10' x 37'. A cross section of the furnace is indicated by attached sketch #1. The bottom of the furnace is made of a 2" layer of sand, then 24" of fire brick on which are placed large carbon slabs keyed in place with inclined carbon blocks on which rest carbon blocks which form the side walls of the furnace. The furnace roof is composed of 9" "Fosterite" (basic) lining inside of 9" of the high alumina brick. Both the coarses of roof brick are sprung from special water cooled skewbacks formed as part of the furnace shell. The sections of the steel shell against which the carbon side walls rest are recessed and water cooled by a number of water sprays.

Six 30" diameter x 27' long carbon electrodes enter furnace on the longitudinal center line and are spaced 5' 6" center to center. An insulated annular tank welded to the steel shell surrounds each electrode to form the stationary part of the water seal for each electrode. Clamped to each electrode and sealed by means of an asbestos gasket is an inverted drum which centers in the annular tank and completes the water seal. The seals are about 4' high. Above the seal on each electrode are separate clamps for cable connections and for the electrode hoist and regulation apparatus.


ELECTRIC CABLE.
WATER SUPPLY
1" 2 STEEL SHELL
ALUMINUM BRICK
MAGNESITE
30" DIA CARBON
5'-6" R
SPRAY.
10-0
CARBON
REFRACTORY BRICK
SAND
1" STEEL PL
1-2
2-0
14-0
SECTION
SKETCH No 1
5 SPA @ 5-6
37-0
42-0
ELEVATION

On the North end of the furnace are the coke spreader and the slag receiving port. The coke braize enters a feed pipe from the storage bin through a bell valve. At the lower end of the feed pipe is a second bell valve. The coke spreader is so designed as to receive coke and throw it the entire length of the furnace, without allowing air to enter the furnace or gas to escape. A second coke feeder of different design is located on the condenser side of the furnace and feeds coke between #4 and #5 electrode as desired.

A very heavy electrode suspension frame with individual hoists for each electrode is located at the East side of the furnace.

At the South end of the furnace are the slag tap and the matte tap holes. The slag is tapped to a settler every 20 minutes. It is collected in 3 ton slag pots and transferred to the slag dump. Matte is tapped from the furnace and settler as required. The matte is low grade and often mixed with some high silicon, low carbon pig iron. The amount of iron produced depends on the amount of coke used. The matte and iron are returned to the lead blast furnaces.

The two Weaton-Najarian condensers are on the West side of the furnace, one points North and one South. The gas and vapor offtakes which connect the furnace and condensers are near the #2 and #5 electrodes. One condenser is used at a time, the second being held as a spare. The condensers are of type #5 as developed at the Josephtown, Pennsylvania, Zinc plant. A later design #6 is considered to be better than the #5. The #5 condenser in operation allows considerable surging of the molten zinc in the condenser and these surges permit the pressure in the furnace to swing from about -8" to + 8" of water at such close intervals of time as to make the manual operation of the vacuum control valve difficult. To date no automatic control has been developed. The #6 design is said to greatly reduce these surges. Mr. Deley of the Josephtown plant claims that some surging in the condenser is necessary, as it tends to decrease the amount of blue powder and increase the yield of metallic zinc. The condenser recovers 97% of the zinc vaporized in the furnace as metallic zinc. The CO gas and dust (blue powder) leaving the condenser pass through a water cooling and scrubbing system where the blue powder is removed. The cleared gas then passes through the vacuum control valve and goes to either of the two vacuum pumps, and to the gas compressor. The CO gas is at present ignited and burned in a waste gas burner on top of the building. It is planned to use the CO gas in the smelter when the furnace operations become standardized.

Power is purchased from the local Power Company at an undisclosed rate, but from general remarks, I gathered the rate to be about 6¢ per KWH.

Two 5000 KVA three phase G.E. multiple tap transformers are used to supply the current to the six electrodes. The normal operating voltage has been 70 - 75 volts, but it can be varied from 60 volts to 175 as desired. Each phase is designed to carry up to 22,000 amperes. To date a maximum of 4600 KVA has been drawn from the two transformers when treating 154 tons of slag per day.

The 10,000 KVA of transformer capacity was installed with the idea that the furnace would eventually be able to treat all the slag from the smelter operations plus additional slag recovered from the old slag dump. It is planned to use one of the lead furnaces as a slag melting furnace.

The normal temperature of slag entering the furnace is about 1100°C and it leaves at 1200 - 1300°C.

The furnace and condenser operations are controlled from a central control room, here are located the meters and controls for the transformers and electrodes, pressure and vacuum guages and controls, etc.

Just West of the South condenser is the zinc settling furnace where the zinc tapped from the condenser is maintained in the molten state to allow excess lead and iron to settle. Clean Prime Western grade spelter (zinc) is ladled from this furnace. An impure lead bullion (about 90% lead) is tapped from the bottom of this furnace from time to time. This bullion goes to the drossing kettles at the smelter. From time to time a heavy iron-zinc-lead dross is removed from the settling furnace and returned to the blast furnaces. The blue powder from the coolers and gas scrubbers is collected in a small settling pond and returned to the lead blast furnaces.

The electric furnace is started by drying out with coke fires for several days. About 7 tons of coke are spread over the bottom of the furnace, the electrodes are lowered until they touch the coke and 1000 KVA is used to warm the furnace. The power is gradually increased over a period of 48 hours until the furnace reaches operating temperature. During the warming up period any CO gas produced is burned at the vapor offtake to the condenser. The furnace is filled with molten blast furnace slag (145 tons). The condenser is primed with 22 tons of molten zinc and sealed. The vacuum pump is started and all air carefully exhausted from the system. Molten slag and coke braize are fed to the furnace and the dezinced slag tapped on schedule.

The temperature of the molten zinc in the condenser is maintained between 525 and 575°C by water sprays on the condenser shell. As the zinc vapor is condensed, the pressure drop through the condenser increases and zinc is tapped from time to time in order to keep the pressure drop within the desired limits. Slag is tapped from the furnace just before a new pot of blast furnace slag is charged.

COST OF INSTALLATION

The zinc recovery plant at Herculaneum was completed in 1945 and cost about $1,000,000. Since then changes and additions costing about $300,000 have been made. At present costs to duplicate the plant will cost at least $1,500,000.

The zinc plant was operated for 28 days in 1945 when the carbon side walls were eaten away and since the roof brick were supported on the side walls, the roof fell into the furnace. The furnace shell was redesigned and rebuilt to allow water cooling to the side walls and skewbacks as shown in sketch #1. Restarting of the furnace was delayed by power shortages, labor troubles, etc., until August, 1947.

Messrs. W.T. Isbell, Manager, Deley and Clyde Smith were extremely helpful in supplying information and other data.

TYPICAL DATA

A typical day's operation gave the following data:

			Costs per Day
Slag treated	154 tons		
Zinc assay of slag charged	11.5%		
Zinc assay of slag produced	3.0%		
Zinc volatilized	8.5%		
Power consumed averaged	4600 KVA	@ 14.4¢ -	$662.40
Coke braize charged	8 Tons	@ $4.00 -	32.00
Electrode consumption (est.)	500 lbs.	@ 6.5¢ -	32.50
Aux. Power estimated average	350 KVA	@ 14.4¢ -	50.40
Fuel, air, water (est.)			30.00
Misc. supplies			20.00
Labor 10 men for shift @ $10.00			300.00
Total cost per day			$1127.30
Zinc produced	13 Tons		
Value of 13 tons zinc		@ 10.5¢ lb.	2730.00
* Margin per day exclusive of repairs and capital charges			1602.70

If the price of zinc were 5.25¢ the margin per day would be about - 232.70

* The plant has not been operated for sufficient time to establish data for estimating repair costs.

Applying Oroya factors to the above data we can estimate the margin to be expected at Oroya.

			Cost per Day
Slag to be treated	160 tons per day		
Zinc assay of slag	10%		
Zinc assay of treated slag	3%		
Zinc volatilized	7%		
Zinc recovery	10.7 tons " "		
Power 4600 KVA	2.4¢		$ 110.40
Coke braize	7 tons	@ $12.00	84.00
Electrode consumption	500 lbs.	@ 12¢	60.00
Aux. Power	350 KVA	@ 2.4¢	8.40
Fuel, air, water (est.)			30.00
Misc. supplies			25.00
Labor - 12 men per shift	-	@ $3.00	108.00
Total cost per day			425.80
Value of 10.7 tons zinc		@ 8.82¢ (Oroya)	1887.48
Margin ex - repairs and capital charges			1461.60
If the value of zinc at Oroya is 5.25-1.00 the margin per day would be about -			483.70

A zinc fuming plant at Oroya, similar to the one at Kellogg, Idaho in which the zinc is recovered as zinc oxide would cost at least $1,500,000.

The fuel required to treat 160 tons of blast furnace slag per day would be at least 32 tons of low ash coal or about 49 tons of washed Goyllarisquisga coal. Some coke braize and either coal or fuel oil are required in the deleading operation of the raw zinc fume.

The cost of operation of a zinc fuming plant at Oroya would be about as follows:

Zinc in delead fume per day		10.7 tons	
Coal for fuming furnace	49 tons @	$10.00	$490.00
Coke braize	.45 tons @	12.00	5.40
Fuel oil or coal (kiln)	1.5 tons @	14.00	21.50
Labor - 16 men per shift	@	2.00	96.00
Power,air, water, etc. (est.)			40.00
Misc. supplies			30.00
Cost per day, exclusive of repairs & capital charges			$682.90

The deleaded zinc oxide (18 tons per day at 70% zinc) can be considered as a high grade zinc concentrate and on that basis at today's zinc price would be worth about $56.50 per ton at Callao, but when the cost of sacking, freight Oroya to Callao, Callao charges, duties, and taxes are deduced, its value at Oroya would be about $44.50 per ton and the value per day would be $801.00 or a margin exclusive of repairs and capital charges of $118.10 per day.

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WC Smith
8/10/47

Memorandum
to
Mr. Sawyer

A-~~86~~ 88

September 24, 1946

Bismuth

I am studying the metallurgical reports in the endeavor to ascertain the sources and recovery of bismuth. At the outset, I find that the roasters have an apparent 200% recovery. This is due to the fact that about 80% of the tonnage entering the copper plant and 6% in the lead plant show no assay for bismuth. "By difference" some 300,000 lbs. of bismuth in 1945 are missing at the roasters and an unknown quantity in the converter flux.

Perhaps you will find time to discuss this. The figures are meaningless unless complete.

Lawrence Addicks

LA/vp