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UNITED STATES ATOMIC ENERGY COMMISSION

CONCENTRATION OF C-2 SLAG

By
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CONCENTRATION OF C-2 SLAG

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17 February 1944

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FEB 26 1944

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TECHNICAL REPORT

CONCENTRATION OF C-2 SLAG

SUMMARY.

The bomb reaction slag produced at the Electro-Metallurgical X metal plant is at present divided into rich C-1 slag and lean C-2 slag by merely screening through a 4 mesh wire screen, the "on 4 mesh" material becomes the C-1 slag and the "thru 4 mesh" becomes the C-2 slag. In the experiments covered by this report it was found that the concentration of the lean C-2 slag could be facilitated by the use of a 20 mesh screen for the slag separation in place of the 4 mesh screen, as the 20 mesh screen removed troublesome, small, hard lumps which passed the 4 mesh screen. Furthermore, it was found that the additional small lumps removed by the 20 mesh screen were just as rich in X metal as the larger lumps which make up the bulk of the C-1 slag. The C-2 slag which had been separated with the 20 mesh screen was readily concentrated from 0.84% Mx content to 5.6% Mx content, with no appreciable loss of Mx, by the use of the waste hydrochloric acid from the Hooker P-45 Plant. The quantity of waste hydrochloric acid available at the P-45 Plant at Hooker is sufficient to concentrate from 65 to 80 tons of the C-2 slag per month.

The installation cost of the building and equipment for the concentration of a maximum of 80 tons of C-2 slag per month at HEC is estimated to be \$12,000-\$15,000. The necessary equipment includes a wooden dissolving tank, a filter press, a slurry pump, an acid pump, and barrel handling equipment. Approximately two months will be required for the completion of the installation.

The operating cost of this installation is estimated to be \$1,200.00 per month based on three men, eight hours per day, six days per week.

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TECHNICAL REPORT

CONCENTRATION OF C-2 SLAG

I. INTRODUCTION.

The reduction of green salt to produce the X metal results in a reaction slag which is arbitrarily divided into two parts, C-1 slag (or on-4 mesh lumps) which contains 5-10% X metal and the C-2 slag (or through-4 mesh fines) which contains 3-3% X metal content. The C-1 slag is suitable to ship to the X metal recovery plant as produced but the C-2 slag is so low in X content that, if it is shipped as produced, it adversely effects the production of the plant which has been set up to recover the X metal from the slag. Hence, the possibilities of concentrating the C-2 slag prior to recovery were investigated with the purpose of preventing adverse effect of the low concentration on the production of the recovery plant.

Since the bulk of the C-2 slag is magnesium oxide and calcium oxide both of which can be dissolved out by hydrochloric acid without dissolving the X metal, and since the Corps of Engineers have a plant at the Hooker Electrochemical Company where waste hydrochloric acid is produced in large quantities and where limestone must be purchased to neutralize the waste acid, a logical approach to the problem of concentration of the C-2 slag seemed to lie in the use of this waste acid. Therefore, a series of concentration experiments were arranged at the Hooker Research Laboratories, and 1375 pounds of C-2 slag were transferred from the nearby Area Plant at Electromet for the work. Concentration experiments were run using the waste acid from the P-45 Plant at Hooker.

II. RESULTS AND CONCLUSIONS.

The first experimental run showed that the small lumps in the C-2 slag which had been screened through 4-mesh screen gave considerable trouble as they would not dissolve completely during the digestion, but settled out plugging up the tank outlet, and later increased the size and weight of the filter cake. To prevent this trouble, the C-2 slag was screened through a 20 mesh screen. The on-20 mesh and through-20 mesh portion were checked for X content, as it was felt that the lumps from the C-2 material should contain considerably more X metal than the fines, just as the lumpy C-1 material contains more X metal than the finer C-2 material. This proved to be the case as the on-20 lumps analysed eight times as high in X content as the through-20 portion. This screening of the C-2 material produces small lumps which contain approximately the same concentration as the C-1 slag. The C-2 slag which was separated using the 20 mesh screen was readily concentrated

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with the available waste acid to a suitable Mx concentration for feed to the recovery plant.

Three runs were made to determine the degree of concentration possible with the available waste acid on the C-2 slag which had been separated with the 20 mesh screen. As the table below shows, an increase in concentration of approximately seven times was obtained using a method applicable to plant operations. (Run #4) This produced a wet filter cake containing 5-6% X and about 40% moisture from C-2 slag fines of .84% X content. It is the understanding of the writer that this is a suitable feed for the recovery plant. Analyses of the filtrate from two of these runs showed that no X metal was lost in the filtrate. In view of the success encountered in dividing the reaction slag into C-1 and C-2 portions using a 20 mesh screen, it was decided to determine the results obtainable using even finer screens. Separations were made using 40-mesh and 60-mesh screens. However, neither gave much improvement over the separation obtained using the 20-mesh screen and the screening through the finer screens proved to be considerably more difficult than through the 20-mesh.

III. RECOMMENDATIONS.

It is recommended that:

- a. The necessary installation be made immediately at the Hooker P-45 Plant for the concentration of C-2 slag and that the C-2 slag from all metal reduction plants be shipped to Hooker Electrochemical Company for concentration before going to the slag recovery plant provided the installation and operating costs are justified by the savings at the slag recovery plant.
- b. That the slag at all reduction plants be screened through a 20-mesh screen instead of the present 4-mesh screen in separating it into C-1 and C-2 slags, whether it is to be concentrated at Hooker or not.

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IV. DESIGN CALCULATIONS.

C-2 SLAG CONCENTRATION - EQUIPMENT DESIGN

Basis: 80 tons of C-2 slag per month. (Maximum)

(Slag to be screened through 20-mesh screen before shipping to Hooker Electrochemical Company).

From Run No. 4 of Results: -

80 tons = 80 x 2000 = 160,000 lbs. per month.

$\frac{160,000}{26} = 6,150 \text{ lbs./day}$ or 6,000 lbs. feed per day.

Waste acid required: -

$$\frac{6,000}{191} \times 86\% = 27,100 \text{ lbs.}$$

$$\frac{27,100}{833 \times 1.14} = 2,850 \text{ gals. of waste acid.}$$

*2870 lbs. waste acid
24 slugs / gal acid*

Water req'd to slurry slag:-

$$\frac{6,000}{191} \times 50 = 1,570 \text{ gals.}$$

4,430 gals. of total liquid

$$\text{Sludge wt. and volume} = \frac{6,000}{191} \times 29 = 910 \text{ lbs.}$$

$$\text{Sludge Volume} = \frac{910}{82} \times 7.5 = 83 \text{ gals.}$$

Total Volume per day = 4,513 gallons

Product - 910 lbs. of 5.6% cake containing 41% moisture.

Filter - 36" press 27 leaves.

Tank - 10' diameter, 9' deep.

Pump - 4,513 gals. per hour or 75 gpm at 100' head.

(Rough cost estimate on installation was prepared by HEC.)

V. OPERATING COSTS.

CYCLE OF OPERATIONS

2 Men.

2 hours	Dump 20 bbls. at 275 lbs. each of screened slag into tank and add 1600 gals. of water and start agitator.
Overnight	Run in 2900 gals. of waste acid.
30 minutes	Agitate until all dissolves.
30 minutes	Add 150-200 lbs. slag to adjust pH to 7.0 (test with paper).
3 hours	Filter, wash, and airblow the cake.
2 hours	Dump cake and bbl. (850 lbs.) (3 bbls. of 300# each).
8 hours/day	Plus one man to load and unload barrels.

OPERATION COST ESTIMATE

3 men, 48 hours per week, \$1.20 per hour average.

Direct Labor $3 \times 1.20 \times 8 \times 26 = \748 per month.

Overhead (40% of direct labor) = \$300 " "

Maintenance \$100 " "

Steam, power and water \$52 " "

TOTAL \$1,200 " "

VI. Mx MATERIAL BALANCES.

RUN NO. 4

Wt. of Feed = 191 lbs.

Mx Conc. = 0.84%

Mx Content = $191 \times .0084 = 1.60$ lbs. of Mx

Wt. of tails = 29 lbs. (wet)

= $29 \times .586 = 17$ lbs. (dry)

Mx Conc. = 9.87%

Mx Content = $17 \times .0987 = 1.68$ lbs. of Mx

% Recovery of Mx = $\frac{1.68}{1.60} (100) = 105\%$

RUN NO. 5

Feed = 173 lbs. with 0.84% Mx

$173 \times .0084 = 1.45$ lbs.

Tails = $51 \times .51 = 26$ lbs. (dry) with 6.63% Mx

$26 \times .0663 = 1.72$ Mx

$\frac{1.72}{1.45} \times 100 = 119\%$ recovery.

(Probably off due to difficulties of sampling of the non-homogeneous heads and tails.)

Samples of the filtrates from both runs on analyses showed no Mx content.

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DATA AND RESULTS CONCENTRATION OF C-2 SLAG WITH WASTE ACID

RUN NO.	1	2	3	4	5
Wt. of Feed	264 lbs.	214 lbs.	232 lbs.	191 lbs.	173 lbs.
Screen size of feed	Thru $\frac{1}{4}$ " mesh	Thru 20 mesh	Thru 20 mesh	Thru 20 mesh	Thru $\frac{1}{4}$ " mesh
Wt. of Waste acid (20-30% Hcl)	780 lbs.	862 lbs.	980 lbs.	864 lbs.	791 lbs.
Order of addition	Acid to slag	Acid to slag	Slag to acid	Acid to slag	Acid to slag
pH at filtration	7.5 - 8.0	7.5-8.0	7-8	7.5	7.5-8.0
Wt of wet filter cake	58 lbs.	36 lbs.	40 lbs.	29 lbs.	51
Moisture in cake	43%	57.6%	28%	41.4%	49%
Conc. of X in feed (dry)	-----	-----	-----	0.84%	0.84%
Conc. of X in filter cake (dry)	-----	-----	-----	9.87%	6.63%
Ratio of $\frac{\text{Feed wt.}}{\text{Filter cake Wt. (wet)}}$	4.5	6	6	7	3.4
X in filtrate	-----	-----	-----	nil	nil
REMARKS	Lumps gave trouble	Filter time 4 hrs. Acid added rapidly	Filter time 2 $\frac{1}{2}$ hrs. Air blown 1 hr.	Filtered in 1 hr. Air blown 1 hr.	Trouble removing from reactor Filtered - 2 hrs.

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PRECONCENTRATION OF C-2 SLAG BY SCREENING

(Results of further screening of C-2 slag which was originally separated from the C-1 slag with a $\frac{1}{4}$ " mesh screen)

With 20 mesh screen

On 20 mesh	21.2%	by wt.
Thru 20 mesh	78.8%	" "
	<u>100 %</u>	

X concentration

"On 20"	8.74%	" "
"Thru 20"	1.19%	" "
Unscreened	2.79%	" "

$$\text{Ratio } \frac{\text{conc X in "On 20"}}{\text{Conc X in Unscreened}} = 3.14$$

With 40 and 60 mesh screens

On 40 mesh	15.4%
Thru 40 on 60	1.4%
thru 60	<u>23.2%</u>
	100 %

X concentration

"on 40"	4.04%
"On 60"	2.04%
"Thru 60"	0.23%
Original	0.84%

$$\text{Ratio } \frac{\text{X in "On 40"}}{\text{conc X in unscreened}} = 4.8$$

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