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MINES BRANCH INVESTIGATION REPORT IR 64-86

REMOVAL OF ZINC OXIDE FROM SAMPLE OF FLUE DUST SUBMITTED BY DOMINION FOUNDRIES AND STEEL, LIMITED, HAMILTON, ONTARIO

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

It was possible to remove 45 to 50 per cent of the iron, in a product containing from 1 to 2 per cent zinc oxide, by magnetic concentration. The remaining iron was probably associated with the zinc oxide as zinc ferrite $ZnFe_2O_4$.

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INTRODUCTION

Purpose of Investigation

The company recovers dust from oxygen furnace stock gases by gas scrubbers, and would like to agglomerate this material and return it to the blast furnace. However, the dust contains some zinc oxide which is reduced in the blast furnace, vapourized, and then deposited on the walls causing spalling of the refractory. Therefore, the company would like to find a method of separating the zinc oxide from the iron oxide in the flue dust.

It was stated that the zinc oxide content can vary from 0 to 15% but usually is in the range of 5 to 8%. The exact nature of the occurrence of the zinc oxide is not known, but, it is suspected of being present as a spinel $ZnO.Fe_2O_3$.

Shipment

A 5 lb sample was delivered to the Mineral Processing Division on September 18, 1963, by Dr. John Walsh of the Fuels and Mining Practice Division. A 50 lb sample was received later on January 6, 1964. The samples were submitted by Mr. Noel Thomas, Research Metallurgist, Dominion Foundries and Steel, Limited, P.O. Box 460, Hamilton, Ontario.

Analyses

Head samples were cut out of the two samples and a chemical analysis obtained as shown in Table 1.

TABLE 1

Analyses of Oxygen Furnace Flue Dust

Sample 1		Sample 2	
Component	%	Component	%
Fe (total)	60.08	Fe (total)	58.58
Fe^{++}	10.33	ZnO	7.17
CaO	3.42	not analysed	-
MgO	0.87		-
Al_2O_3	0.18		-
MnO	1.55		-
C	0.55		-
SiO_2	1.42		-
ZnO	5.13		-
H_2O (+110°C)	1.28		-

A screen test of the head sample gave a size distribution as shown in Table 2.

TABLE 2

Size Distribution of Flue Dust

Mesh	Weight %
+ 65	6.4
-65 + 100	6.4
-100 + 150	7.0
-150 + 200	9.0
-200 + 325	14.8
-325	56.4

An X-ray diffraction study of the head sample was made by the Physical Chemistry Section, Mineral Sciences Division*. This study confirmed the work reported by Dofasco on the presence of zinc oxide which is considered probably to occur in combination with ferric oxide as a secondary spinel phase, zinc ferrite.

TEST PROCEDURE

A sample of the material was concentrated on the Jeffrey-Steffensen wet drum magnetic separator. The results are given in Table 3.

TABLE 3

Magnetic Separation of Zinc and Iron Minerals

Product	Weight %	Analyses* %		Distribution %	
		Total Fe	ZnO	Total Fe	ZnO
Feed	100.0	59.65**	5.13	100.0	100.0
Mag conc	49.6	63.64	2.45	52.9	23.7
Middling	13.7	60.85	-	14.0	-
Non-mag tailing	36.7	53.82	-	33.1	-

*Internal Report MS-AC-63-1338.

**Calculated.

To see if finer grinding would increase the separation of the zinc and iron minerals and increase the recovery of iron, a sample was ground to 82.2 per cent minus 325 mesh. The results of the test are given in Table 4.

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* "An X-ray Diffraction Examination of Flue Dust Containing Zinc Oxide, Submitted by Dominion Foundries and Steel, Limited, Hamilton, Ontario, in September 1963" by John F. Rowland, Mineral Sciences Division, November 7, 1963.

TABLE 4

Magnetic Separation after Grinding

Product	Weight %	Analyses* %		Distribution %	
		Total Fe	ZnO	Total Fe	ZnO
Feed (calcd)	100.0	59.4	4.91	100.0	100.0
Mag conc	44.2	65.1	2.17	48.4	19.6
Middling	7.1	62.6	3.69	7.5	5.3
Non-mag tailing	48.7	53.8	7.58	44.1	75.1

*Internal Report MS-AC-63-1404.

The remainder of the tests were done on sample 2. A standard magnetic separation test was done to see if the results were the same as with the previous sample. The results of the test are given in Table 5.

TABLE 5

Magnetic Separation of Sample 2

Product	Weight %	Analyses* %		Distribution %	
		Total Fe	ZnO	Total Fe	ZnO
Feed (calcd)	100.0	58.17	7.59	100.0	100.0
Mag conc	40.4	66.00	0.98	45.8	5.2
Non-mag tailing	59.6	52.87	12.07	54.2	94.8

*Internal Report MS-AC-64-466.

To attempt to improve the iron recovery, it was decided to do a reducing roast on the non-magnetic tailing and then separate the iron and zinc minerals by a second magnetic separation step.

A standard magnetic separation was made and after drying the non-magnetic tailing was given a reducing roast at 600°C for 1/2 hour using natural gas as the reducing agent. The reduced material was then passes over a magnetic separator. The results are given in Table 6.

TABLE 6

Magnetic Separation Following a Reduction Roast

Product	Weight %	Analyses* % ZnO	Distribution % ZnO
Feed (calcd)	100.0	6.80	100.0
No. 1 mag conc	45.7	1.36	9.1
No. 2 mag conc	45.5	11.34	75.9
Non-mag tailing	8.8	11.60	15.0

*Internal Report MS-AC-64-482.

As there did not appear to be any additional separation between the zinc and iron minerals in this magnetizing roasting step, a sample of tailing from the first and last tests were submitted for X-ray diffraction studies. The examination* showed that the major constituent of each sample was a spinel which corresponded closely to the compound zinc ferrite $ZnFe_2O_4$.

CONCLUSIONS

Between 45 and 50 per cent of the iron in the flue dust can be removed in a magnetic concentrate having a zinc oxide content between 1 and 2 per cent. The remaining iron is probably associated with the zinc oxide in the form of a spinel which corresponds closely to zinc ferrite with the chemical composition $ZnFe_2O_4$ and cannot be liberated by mechanical methods.

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*Internal Report MS-64-47, "Additional X-ray Diffraction Examinations of Flue Dust Containing Zinc Oxide", by J.F. Rowland, Mineral Sciences Division.