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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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MINES BRANCH INVESTIGATION REPORT IR 62-52

EXAMINATION OF CORROSION PRODUCT ON GALVANIZED STEEL WIRE FROM DOMINION STEEL AND COAL CORPORATION, LIMITED, MONTREAL, P. Q.

by

H. M. WELD & G. J. BIEFER

PHYSICAL METALLURGY DIVISION

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SUMMARY OF RESULTS

X-ray analyses, demonstrating a basic zinc chloride in the corrosion product of a galvanized wire, indicated that an unidentified chloride had been present when the corrosion took place.

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*Senior Scientific Officer and **Head, Corrosion Section, Physical Metallurgy Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

INTRODUCTION

On June 13, 1962, Messrs. J. Picard and F. Ellis of Dominion Steel and Coal Corporation, Limited (DOSCO), Montreal, P. Q., visited the Physical Metallurgy Division to describe a corrosion problem they were encountering with galvanized wire during shipment by lake boat and rail to Western Canada. Meetings were attended by the writers, and Messrs. D. E. Parsons and J. J. Sebisty of the Physical Metallurgy Division, and Dr. R. R. Rogers of the Extraction Metallurgy Division.

As their part of the investigation, the Corrosion Section agreed to examine the corrosion product on some of the galvanized wires, in order to determine whether any contaminant was present.

VISUAL EXAMINATION

In some areas the galvanized wires exhibited a normal metallic lustre, but in other regions a whitish corrosion product was observed. Associated with this was a darker corrosion product. No red rust was observed.

LABORATORY CORROSION TESTS

Two short-term tests were carried out:

(a) A length of as-received corroded wire was immersed in distilled water for twenty-four hours. No dissolution of the corrosion product was observed. An increased amount of white corrosion product was present after the test.

(b) A three inch length of uncorroded wire was cut adjacent to a corroded region. It was thoroughly degreased in acetone, then placed in a test tube and partly immersed in distilled water. The test tube was stoppered, and left standing for a week.

After less than twenty-four hours, white corrosion product was visible on the surface of the wire and at the bottom of the test tube. The amount of corrosion product increased with time.

X-RAY DIFFRACTION

Corrosion product from the as-received wire was examined by the Debye-Scherrer technique. It was identified as a combination of ZnO and $ZnCl_2 \cdot 4Zn(OH)_2$.

Corrosion product on the degreased wire which had been free from corrosion, and had been left standing in distilled water for a week, was identified as principally ZnO, and some $Zn(OH)_2$.

EXAMINATION UNDER ULTRA-VIOLET LIGHT

The as-received wire, in uncorroded regions, appeared deep blue. The corroded regions glowed orange, pale white, and red.

The degreased wire, originally uncorroded, which had been immersed in distilled water, glowed various tints of red.

This indicated that compounds were present in the as-received corrosion product which were absent from the corrosion product formed on the degreased wire.

SPECTROSCOPIC ANALYSIS

Two pieces of as-received wire were submitted, one from a corroded region, the other from an uncorroded region. The results of the semi-quantitative analyses appear in Table 1.

These results are not considered to throw any light upon the nature of any contaminant in the corrosion

product. It should be noted that chlorine is not detected by this type of analysis.

QUALITATIVE ANALYSES OF WATER USED IN THE CORROSION TESTS

Qualitative analyses were carried out to determine whether the chloride ion was present. In the fresh distilled water used in the tests, no chloride was detected.

In the distilled water in which the as-received corroded wire had been immersed for twenty-four hours, chloride was definitely present. In the distilled water in which a degreased, originally uncorroded specimen had been immersed for one week, there was perhaps a trace of chloride.

CONCLUSIONS

The X-ray analyses, showing that a basic zinc chloride ($ZnCl_2.4Zn(OH)_2$) was in the corrosion product on the as-received wires, indicated that a chloride-containing contaminant was present at the time of the corrosion. The qualitative water analyses and the examinations under ultraviolet light provided supporting evidence.

ACKNOWLEDGEMENTS

The X-ray analyses were carried out by G. P. Green of the Metal Physics Section, Physical Metallurgy Division. The semi-quantitative spectrographic analyses were carried out by Miss E. M. Kranck of the Mines Branch Spectrographic Laboratory, Mineral Sciences Division.

TABLE 1

Semi-quantitative Spectrographic Analyses

Element	As-Received Wire	
	Corroded Region	Uncorroded Region
Si	0.2	0.08
Mn	0.008	0.01
Fe	0.3	0.5
Mg	0.04	0.03
Pb	0.05	0.02
Sn	0.05	0.008
Al	0.03	0.02
Ca	0.15	0.07
Cu	0.03	0.01
Ag	Trace	Trace
Ti	0.005	0.003
Ni	Trace	Trace
Mo	0.003	n.d.
Zn	p.c.*	p.c.*

*Principal constituent.