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SUBJECT: Transfer of Carbon Between Dissimilar Metals in Contact with Molten Sodium. Test Conditions: 1000°C - 400 Hours.

TO: W. D. Manly

FROM: R. Carlander and E. E. Hoffman

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Subject: Transfer of Carbon Between
Dissimilar Metals in Contact with
Molten Sodium. Test Conditions:
1000°C - 400 Hours.

SUMMARY

The extent to which AISI-C 1043 steel is decarburized in certain container materials when in contact with molten sodium has been determined at 1000°C for 400 hours. The extent of decarburization of a steel specimen was greater when an Armco iron container was used than when a type 304 elc stainless steel container was used. In addition, sufficient nickel mass transferred to the surface of the AISI-C 1043 steel in the stainless steel test to cause a phase transformation to a depth of 2 - 4 mils. The extent of decarburization of the AISI-C 1043 steel was greater in the 400 hour test than in a previous 100 hour test⁽¹⁾ under similar test conditions. The amount of nickel mass transferred to the surface of the steel specimen was greater in the 400 hour test than in the 100 hour test and furthermore, carburization of the vapor zone of the stainless steel capsule occurred while it did not in the previous 100 hour test. Further tests are to be performed in which the extent of decarburization will be studied when an inert container material (tantalum) and sodium low in oxygen (distilled) will be used.

INTRODUCTION

The extent to which carbon is transferred between dissimilar metals in contact with molten sodium depends not only upon the original carbon contents of the metals, but upon the oxygen content of the sodium⁽²⁾, the solubility of carbon in sodium, the time of the test, and the temperature of the test. The amount of carbon transfer between AISI-C 1043 steel and two container materials (Armco iron and type 304 elc stainless steel) has been previously determined at 1000°C for 100 hours. The purpose of this test was to determine the effect of time on the transfer of carbon in the two systems.

1. E. E. Hoffman et al, ANP Quarterly Progress Report December 10, 1955, ORNL-2012, page 124.
2. L. F. Epstein and C. E. Weber, et al, J. Met. Ceram. January 1951, TID-70, page 74.

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Transfer of Carbon Between Dissimilar Metals in Contact with Molten Sodium. Test Conditions: 1000°C - 400 Hours.

PROCEDURE

Two AISI-C 1043 steel specimens (1/4 inch x 3/4 inch x 1 inch) were polished, measured, and weighed prior to testing. The specimens were then loaded with sodium in the Armco iron and type 304 elc stainless steel containers under an inert atmosphere. Both capsules were evacuated, sealed, enclosed in evacuated protection capsules, and tested for 400 hours at 1000°C. After completion of the test, the capsules were stripped of sodium, the specimens cleaned and weighed, and sections of the capsules and specimens examined metallographically. The turnings that were sent for chemical analysis were made from the entire wall of sections cut from the capsules and the specimens. The conditions and results of the test are given in Table I.

RESULTS

Chemical analysis revealed that the extent of decarburization was greater in the Armco iron capsule than in that of the stainless steel capsule. In addition, the vapor zone section of the stainless steel capsule increased in carbon content while that of the iron capsule did not. Chromium carbide precipitate was found in the grain boundaries of the walls of the stainless steel capsule that was not present before the test, and sufficient nickel mass transferred to the surface of the AISI-C 1043 steel to cause a phase transformation to a depth of 2 - 4 mils. The extent of decarburization in the 400 hour test was greater than in that of the 100 hour test. Photomicrographs of the walls of the container materials before and after testing are shown in Figures 1 and 2. The photomicrographs of the as-received and of the tested steel specimens are shown in Figures 3 and 4.

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Table I

THE TRANSFER OF CARBON FROM AISI-C 1043 STEEL TO ARMCO IRON AND TO TYPE 304 ELC STAINLESS STEEL

Test	Specimen Wt. Change (gm/in ²)	Specimen	Condition	Wt. % Carbon (400 Hrs.)	Wt. % Carbon (100 Hrs.)	Wt. % Nickel (400 Hrs.)
AISI-C 1043 steel specimen in Armco iron capsule	-0.0408	1043 steel	As received	0.43*	0.433*	0.008
		1043 steel	Tested	0.054	0.121	- -
		Armco iron	As received	0.018*	0.018*	- -
		Armco iron	Vapor zone	0.016	0.019	- -
		Armco iron	Bath zone	0.024	0.035	- -
AISI-C 1043 steel specimen in type 304 elc stainless steel capsule	-0.0303	1043 steel	As received	0.43*	0.433*	0.008
		1043 steel	Tested	0.074	0.100	0.090
		304 elc	As received	0.037*	0.037*	11.12
		304 elc	Vapor zone	0.162	0.022	10.32
		304 elc	Bath zone	0.200	0.128	9.98

* Prior to testing.

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Transfer of Carbon Between Dissimilar Metals in Contact with Molten Sodium.
Test Conditions: 1000°C - 400 Hours.

(a) Y-17309

(b) Y-17306

(c) Y-17305

Figure 1. Photomicrographs of (a) as received, (b) bath zone, (c) and vapor zone of Armco iron capsule tested in sodium with an AISI-C 1043 steel specimen at 1000°C for 400 hours.
Etch: 2% Nital

200X

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Transfer of Carbon Between Dissimilar Metals in Contact with Molten Sodium.

Test Conditions: 1000°C - 400 Hours.

(a) Y-17310

(b) Y-17780

(c) Y-17779

Figure 2. Photomicrographs of (a) as received, (b) bath zone, (c) and vapor zone of type 304 elc stainless steel capsule tested in sodium with a AISI-C 1043 steel specimen at 1000°C for 400 hours.

Etch: Aqua Regia

200X

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Transfer of Carbon Between Dissimilar Metals in Contact with Molten Sodium.
Test Conditions: 1000°C - 400 Hours.

(a) Y-17308

(b) Y-17307

Figure 3. Photomicrographs of AISI-C 1043 steel (a) as received, (b) and tested in sodium in an Armco iron capsule at 1000°C for 400 hours.
Etch: 4% Picral 200X

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Transfer of Carbon Between Dissimilar Metals in Contact with Molten Sodium.

Test Conditions: 1000°C - 400 Hours.

(a) Y-17777
50X

(b) Y-17776
200X

(c) Y-17778
1000X

Figure 4. Photomicrographs of AISI-C 1043 steel tested in sodium in a type 304 elc stainless steel capsule at 1000°C for 400 hours.
Etch: 2% Nital