14

BNWL-1845-27
UC-23

Pacific Northwest Laboratory Monthly Report to the Nuclear Research and Applications Division for August

September 1976

Prepared for the Energy Research and Development Administration under Contract E(45-1)-1830

Battelle
Pacific Northwest Laboratories

BNWL-1845-27

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
Under Contract E(45-1)-1830

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151
Price: Printed Copy $4.50; Microfiche $2.25

ERDA-RL RICHLAND, WA

BNWL-1845-27
UC-23

PACIFIC NORTHWEST LABORATORY MONTHLY REPORT TO THE NUCLEAR RESEARCH AND APPLICATIONS DIVISION FOR AUGUST 1976

H. T. Fullam

September 1976

BATTELLE
Pacific Northwest Laboratories
Richland, Washington 99352

CONTENTS

PACIFIC NORTHWEST LABORATORY

MONTHLY REPORT TO THE

NUCLEAR RESEARCH AND APPLICATIONS DIVISION

FOR AUGUST 1976

STRONTIUM HEAT SOURCE DEVELOPMENT PROGRAM

At Hanford, strontium is separated from the high-level waste, then converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage take place in the Waste Encapsulation and Storage Facilities (WESF). This encapsulated strontium fluoride represents an economical source of ^{90}Sr if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. The information needed for licensing can be divided into three general areas:

1. *Long-term SrF_2 compatibility data.*
2. *Chemical and physical property data on $^{90}SrF_2$.*
3. *Capsule property data such as external corrosion resistance, crush strength, etc.*

The current program is designed to provide the required information.

LONG-TERM COMPATIBILITY TESTS

All of the compatibility tests are continuing as scheduled. Oak Ridge National Laboratory has completed the metallographic examination of the TZM specimens from the 1000-hr $^{90}SrF_2$ compatibility tests. The estimates of metal attack, based on the photomicrographs, for the TZM specimens are presented in Table 1. The data for the 1000-hr nonradioactive SrF_2 tests are also shown in Table 1 for comparison purposes. Attack of the test specimens consisted entirely of chemical attack, and there was no indication of microstructural changes in any of the specimens.

TABLE 1. Attack of TZM Specimens Exposed to Strontium Fluoride for 1000 hr

Temperature, °C	S/V Ratio,[b] cm^{-1}	Depth of Metal Affected,[a] mils: WESF-Grade SrF_2 Chemical Attack	WESF-Grade SrF_2 Change in Microstructure	WESF $^{90}SrF_2$ Chemical Attack	WESF $^{90}SrF_2$ Change in Microstructure
600	4.5	0	0	1	0
600	4.5	<1	0	2	0
600	2.5	<1	0	3	0
600	0.9	<1	0	-	-
600[c]	4.5	-	-	1	0
800	4.5	<1	0	2	0
800	4.5	<1	0	2	0
800	2.5	<1	0	3	0
800	0.9	1	0	-	-
800[c]	4.5	-	-	1	0
1000	4.5	<1	0	2	0
1000	4.5	<1	0	1	0
1000	2.5	<1	0	2	0
1000	~0.9	<1	0	-	-
1000[c]	4.5	-	-	1	0

(a) Attack estimated from micrographs
(b) S/V - the test couples exposed metal surface to SrF_2 volume ratio
(c) The $^{90}SrF_2$ was spiked with ZrF_4 and Zr metal powder to simulate decay product buildup equivalent to 10 yr decay

The test results show more attack of the TZM occurred in the $^{90}SrF_2$ couples than in the equivalent nonradioactive couples. The data also indicate that decreasing the metal surface to $^{90}SrF_2$ volume ratio (S/V) of the test couples results in increased TZM attack. This is to be expected if impurities in the $^{90}SrF_2$ are a principal cause of metal attack. Metal attack did not appear to increase with exposure temperature; and the addition of ZrF_4 and Zr metal powder to the $^{90}SrF_2$, to simulate decay product buildup, appeared to decrease metal attack to a marked degree.

At 600 and 800°C the chemical attack of the TZM consisted principally of pitting and grain boundary attack (see Figure 1). At 1000°C the attack was more uniform and grain boundary attack was less apparent (Figure 1).

A meeting was held on August 26-27, with members of the Nuclear Research and Applications Division at Germantown to discuss the program and future plans. A formal briefing on program objectives, work currently underway, and work scheduled for FY-77-80 was presented.

ADDITIONAL SHORT-TERM COMPATIBILITY TESTS

The 4400-hr tests have been completed and the couples sectioned. The ductile cast iron and Hafnalloy 2525 specimens had completely reacted with the SrF_2 and could not be recovered. Visual examination of the other test specimens indicated that metal attack was similar to that observed in the 1500-hr tests. The specimens are now at Metallography for examination.

HASTELLOY C-4 CORROSION RESISTANCE

Tests are underway to measure the oxidation resistance and seawater corrosion resistance of Hastelloy C-4. The initial tests are utilizing the alloy in the solution heat treated form while subsequent tests will use specimens which have been thermally aged at temperatures from 600 to 1100°C for various time periods. Similar tests are planned using Hastelloy S.

The seawater corrosion tests are being carried out at 23°C using natural seawater with and without aeration. Unwelded Hastelloy C-4 specimens exposed to seawater suffered very slight but definite weight losses initially; but after about 350 hr of exposure the samples began to increase in weight. After 600 hr of exposure sample weights had returned to approximately the original values. Tests are also underway using TIG-welded Hastelloy C-4 specimens. After 120 hr of exposure to seawater the welded specimens have suffered about the same weight losses as the unwelded specimens after the same exposure time. Overall, the corrosion data indicate that unaged Hastelloy C-4 is very resistant to seawater attack. However, metallographic examination of the specimens will be needed to confirm this conclusion.

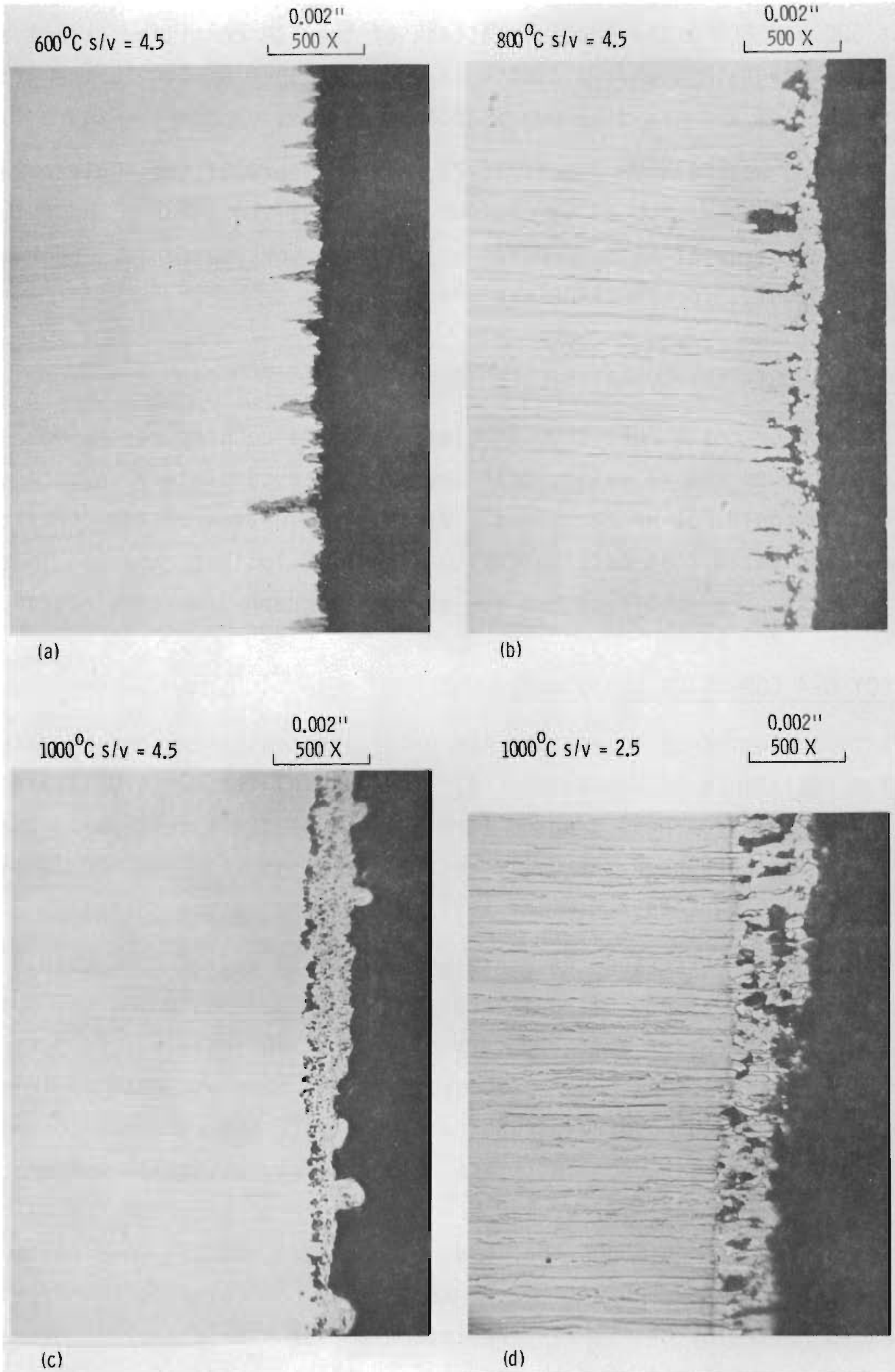

FIGURE 1. TZM Specimens Exposed to $^{90}SrF_2$ for 1000 hr

The oxidation resistance of Hastelloy C-4 is being measured at temperatures from 600 to 1100°C in 100°C increments. Specimens heated in air at 1000°C or less formed an adherent oxide layer with a corresponding weight increase. Figure 2 shows the change in sample weight as a function of time for samples heated at 600 and 1000°C. Similar curves were obtained for specimens heated at 700, 800 and 900°C.

The oxide formed on specimens heated at 1100°C was not adherent and tended to flake off after reaching a certain thickness. Thus the test specimens showed an initial weight gain followed by a weight loss after scaling began. After 14 days exposure the average weight loss per sample was 5.45%. This corresponds to a corrosion rate of approximately 0.2 cm/yr assuming uniform attack of the metal surface.

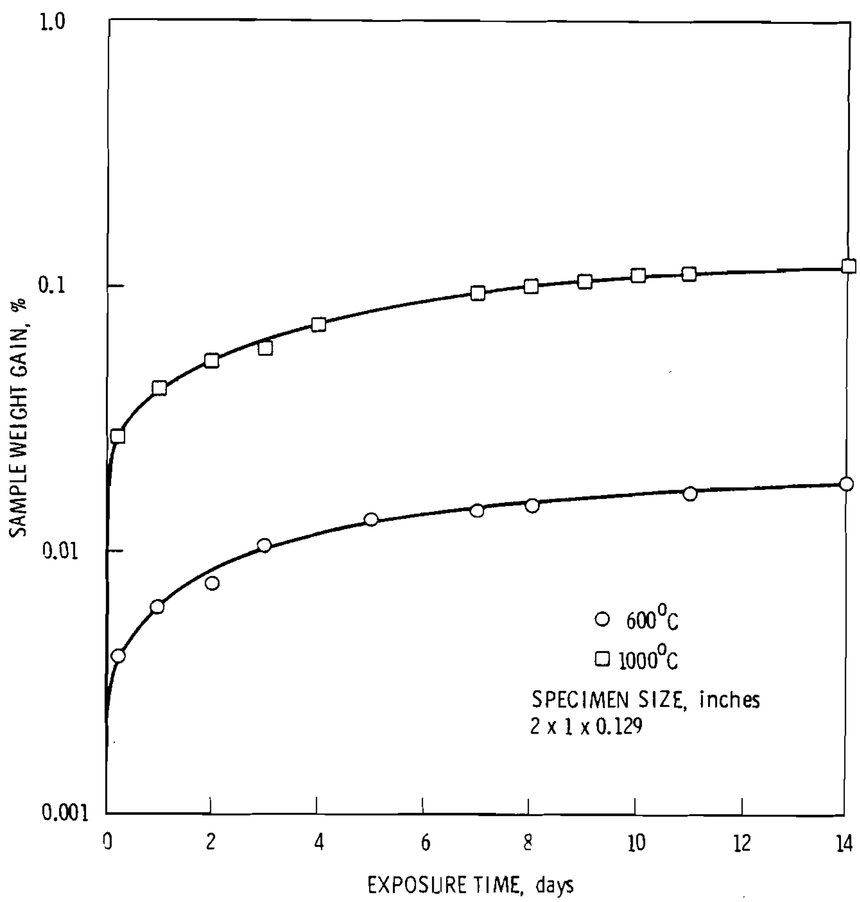

FIGURE 2. The Oxidation of Hastelloy C-4 in Air

DISTRIBUTION

NO. OF
COPIES

OFFSITE

1 ERDA Chicago Patent Attorney
9800 S. Cass Avenue
Argonne, IL 60439

A. A. Churm

1 ERDA Division of Biomedical and Environmental Research
Washington, DC 20545

J. N. Maddox

2 ERDA Division of Production and Materials Management
Washington, DC 20545

F. P. Baranowski
R. W. Ramsey, Jr.

11 ERDA Nuclear Research and Applications Division
Washington, DC 20545

R. T. Carpenter
G. P. Dix
T. J. Dobry, Jr.
N. Goldenberg
A. P. Litman (3)
J. J. Lombardo
W. C. Remini
B. J. Rock
E. J. Wahlquist

1 ERDA Oak Ridge Operations Office
P. O. Box E
Oak Ridge, TN 37830

D. C. Davis, Jr.

3 ERDA Savannah River Operations Office
P. O. Box A
Aiken, SC 29801

R. H. Bass
T. B. Hindman
R. K. Huntoon

NO. OF COPIES	
27	ERDA Technical Information Center
1	Department of the Army Headquarters, U.S. Army Facilities Engineering Support Agency Fort Belvoir, VA 22060 H. Musselman, Technical Director
1	Electronics and Applied Physics Division Building 347.3, AERE Harwell Oxfordshire OX11 ORA Great Britain E. H. Cooke-Yarborough
1	General Atomic Company P. O. Box 81601 San Diego, CA 92138 H. C. Carney
1	General Electric Company MSVD P. O. Box 8555 Philadelphia, PA 19101 P. E. Brown
1	General Electric Company, Vallecitos Laboratory P. O. Box 846 Pleasanton, CA 94566 G. E. Robinson
3	Los Alamos Scientific Laboratory P. O. Box 1663 Los Alamos, NM 87544 S. E. Bronisz R. A. Kent R. N. Mulford
2	Monsanto Research Corporation Mound Laboratory (ERDA) Nuclear Operations P. O. Box 32 Miamisburg, OH 45342 W. T. Cave R. Dewitt

NO. OF
COPIES

1 Naval Nuclear Power Unit
P. O. Box 96
Fort Belvoir, VA 22060

F. E. Rosell

1 Naval Facilities Engineering Command
Nuclear Power Division (FAC04N)
200 Stovall Street
Alexandria, VA 22332

G. E. Krauter

1 Navy Office of the Chief of Naval Operations
Washington, DC 20390

Head, Reactor Branch

4 Holifield National Laboratory
Oak Ridge, TN 37830

R. S. Crouse
J. R. DiStefano
E. Lamb
A. C. Schaffhauser

3 Teledyne Energy Systems
110 W. Timonium Road
Timonium, MD 21093

P. Dick
R. Hannah
P. Vogelberger

1 Westinghouse Astronuclear Laboratory
P. O. Box 10864
Pittsburgh, PA 15236

C. C. Silverstein

ONSITE

3 ERDA Richland Operations

W. A. Burns
W. C. Johnson
P. G. Holsted

NO. OF COPIES	
7	Atlantic Richfield Hanford Company
	L. I. Brecke H. H. Hopkins R. E. Isaacson L. M. Knights C. W. Malody J. D. Moore H. P. Shaw
29	Battelle-Northwest
	J. W. Bartlett D. B. Cash T. D. Chikalla M. O. Cloninger C. W. Dawson T. F. Demmitt R. L. Dillon H. T. Fullam (3) K. M. Harmon A. J. Haverfield J. H. Jarrett R. S. Kemper R. P. Marshall R. W. McKee J. M. Nielsen R. E. Nightingale D. E. Olesen L. D. Perrigo A. M. Platt W. E. Sande J. L. Simmons H. H. Van Tuyl R. E. Westerman Technical Information Files (3) Technical Publications