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PACIFIC NORTHWEST LABORATORY
MONTHLY REPORT
TO SPACE NUCLEAR SYSTEMS DIVISION
FOR FEBRUARY 1975

Battelle

Pacific Northwest Laboratories
Richland, Washington 99352

MARCH 1975

Prepared for the U.S. Atomic Energy
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PACIFIC NORTHWEST LABORATORY
MONTHLY REPORT
TO SPACE NUCLEAR SYSTEMS PROGRAM
FOR FEBRUARY 1975

by
H. T. Fullam

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March 1975

On January 19, 1975, research and development programs of the U.S. Atomic Energy Commission (AEC) became part of the newly formed Energy Research and Development Administration (ERDA). In this report, since it refers to work done in 1974, most references are to AEC programs.

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PACIFIC NORTHWEST LABORATORY
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STRONTIUM HEAT SOURCE DEVELOPMENT PROGRAM

At Hanford, strontium will be separated from the high-level waste, then converted to the fluoride, and double encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will 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 $^{90}\text{SrF}_2$ heat sources and specifically the WESF $^{90}\text{SrF}_2$ 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 $^{90}\text{SrF}_2$.*
- 3. Capsule property data such as external corrosion resistance, crush strength, etc.*

The current program is designed to provide the required information.

SHORT-TERM COMPATIBILITY TESTS

Evaluation of the bulk of the short-term $^{90}\text{SrF}_2$ test couples has been completed. The results obtained are shown in Table 1 for couples containing high purity $^{90}\text{SrF}_2$ and in Table 2 for couples containing WESF grade $^{90}\text{SrF}_2$. It is apparent from Table 1 that considerable variation in attack is possible between similar high purity $^{90}\text{SrF}_2$ couples, as in the instances where the 1500-hr couples show more attack than the equivalent 4400-hr couples. This behavior was not observed in the couples containing WESF grade $^{90}\text{SrF}_2$.

Tungsten and TZM show the greatest resistance to attack by the radioactive fluoride of all the materials tested. Haynes 25 shows the greatest

TABLE 1. Metal Attack Observed in Couples
Containing High Purity $^{90}\text{SrF}_2$

Material Tested	Test Temperature, °C	Depth of Metal Affected, mils			
		Chemical Attack		Change in Microstructure	
		1500 hr	4400 hr	1500 hr	4400 hr
Hastelloy C-276	800	4	2	6	6
"	1000	2	2	5	15
"	1100	4	6	12	6
Hastelloy X	800	1	2	5	5
"	1000	2	4	10	15
"	1100	5	4	20	22
Hastelloy N	800	4	5	10	8
"	1000	6	8	16	16
"	1100	2	-	5	-
Haynes 25	800	<1	<1	3	2
"	1000	-	1	3	3
"	1100	1	2	4	3
Haynes 188	800	4	5	10	13
"	1000	6	3	12	5
"	1100	2	2	5	5
Inconel 600	800	1	3	4	8
"	1000	-	-	-	-
"	1100	2	2	4	4
Inconel 625	800	6	3	10	5
"	1000	-	-	-	-
"	1100	5	2	15	15
TZM	800	0	1	0	0
"	1000	0	<1	0	0
"	1100	-	1	-	0
Tungsten	800	0	-	0	-
"	1000	<1	<<1	0	0
"	1100	<1	<1	0	0

TABLE 2. Metal Attack Observed in Couples
Containing WESF Grade $^{90}\text{SrF}_2$

Material Tested	Test Temperature, °C	Depth of Metal Affected, mils			
		Chemical Attack		Change in Microstructure	
		1500 hr	4400 hr	1500 hr	4400 hr
Hastelloy C-276	800	2	2	3	3
"	1000	2	3	5	8
"	1100	3	3	5	6
Hastelloy X	800	1	3	4	4
"	1000	1	1	6	4
"	1100	3	3	6	10
Hastelloy N	800	4	6	7	6
"	1000	7	9	20	12
"	1100	6	-	8	-
Haynes 25	800	1	1	2	2
"	1000	1	1	2	3
"	1100	1	2	2	2
Haynes 188	800	1	2	2	4
"	1000	3	4	7	10
"	1100	1	2	8	5
Inconel 600	800	1	3	4	11
"	1000	1	2	8	14
"	1100	2	2	7	12
Inconel 625	800	1	4	4	8
"	1000	2	5	20	18
"	1100	4	5	18	14
TZM	800	<1	<1	0	0
"	1000	<1	-	1	-
"	1100	<1	<1	0	0
Tungsten	800	0	0	0	0
"	1000	<1	0	0	0
"	1100	1	-	0	-

resistance to attack of all the superalloys tested, followed by Inconel 600. This confirms the results obtained in the short-term tests with nonradioactive fluoride.

The nine containment materials under consideration have been ranked according to their estimated ability to provide long-term containment of $^{90}\text{SrF}_2$ for heat source applications in the temperature range of 800 to 1000°C. The factors considered in making the comparisons include the following:

1. $^{90}\text{SrF}_2$ compatibility - the comparisons were based on all available $^{90}\text{SrF}_2$ compatibility data,
2. Mechanical properties - comparisons were based on published data and estimates of ability to meet IAEA Series 33 test requirements,
3. Resistance to external corrosion (i.e., oxidation, seawater, etc.),
4. Fabricability and weldability - comparisons based on published data,
5. Availability.

In arriving at an overall ranking of the materials, added weight was given to $^{90}\text{SrF}_2$ compatibility.

The relative rankings of the nine materials are shown in Table 3. On an overall basis Haynes 25 is the preferred material for containing $^{90}\text{SrF}_2$ in the temperature range of 800 to 1000°C. TZM would be the second choice with Inconel 600, Hastelloy C-276 and Hastelloy X ranking slightly lower. The other four materials do not appear to be viable choices for $^{90}\text{SrF}_2$ containment. Tungsten is the best material with regard to $^{90}\text{SrF}_2$ compatibility but has too many other limitations to warrant consideration.

$^{90}\text{SrF}_2$ DISSOLUTION RATES

The tests to measure the dissolution rate of WESF grade $^{90}\text{SrF}_2$ in demineralized water and seawater have been completed. Test samples are now being analyzed by beta counting to determine the strontium content. The analyses should be completed in March.

TABLE 3. Ranking of Containment Materials for Use at 800 to 1000°C with $^{90}\text{SrF}_2$

$^{90}\text{SrF}_2$ Compatibility	External Corrosion	Mechanical Properties	Fabricability & Welding	Availability	Weighted Overall
Tungsten	Hastelloy C-276	Haynes 188	Inconel 625	Inconel 600	Haynes 25
TZM	Inconel 625	Hastelloy C-276	Inconel 600	Hastelloy X	TZM
Haynes 25	Haynes 25	Haynes 25	Hastelloy C-276	Haynes 25	Inconel 600
Inconel 600	Hastelloy X	Inconel 625	Hastelloy X	Hastelloy C-276	Hastelloy C-276
Hastelloy X	Inconel 600	Hastelloy N	Hastelloy N	TZM	Hastelloy X
Hastelloy C-276	Haynes 188	Hastelloy X	Haynes 188	Haynes 188	Haynes 188
Haynes 188	Hastelloy N	Inconel 600	Haynes 25	Inconel 625	Inconel 625
Inconel 625	TZM	TZM ^(a)	TZM	Hastelloy N	Tungsten
Hastelloy N	Tungsten	Tungsten ^(a)	Tungsten	Tungsten	Hastelloy N

(a) High ductile-brittle transition temperature is a problem. The material has good mechanical properties at high temperatures.

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