ORNL-4189
C-92a – Systems for Nuclear Auxiliary Power (SNAP)-Isotopic SNAP Program
M-3679 (52nd ed.)

AEC RESEARCH AND DEVELOPMENT REPORT

COMPATIBILITY DATA SHEETS FOR CERIUM-144, CESIUM-137, CURIUM, AND STRONTIUM-90

(Title Unclassified)

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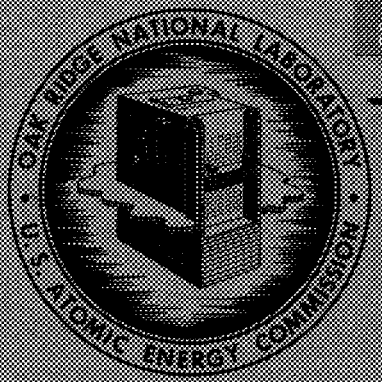

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ISOTOPES DEVELOPMENT CENTER

COMPATIBILITY DATA SHEETS FOR CERIUM-144, CESIUM-137, CURIUM, AND STRONTIUM-90

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NOVEMBER 1967

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COMPATIBILITY DATA SHEETS FOR CERIUM-144, CESIUM-137, CURIUM, AND STRONTIUM-90

CERIUM-144

CERIUM OXYSULFIDE (Ce_2O_2S)

REFERENCE COLUMN

The compatibility of Ce_2O_2S with various containment materials at 1000°C and at 1850°C is summarized as follows. 1

Container material	Maximum penetration observed, mils		
	168 hr	500 hr	1000 hr
1000°C			
Hastelloy X	No attack	Traces	Traces
Tungsten	No attack	No attack	2.0
N-155	2.5	–	–
Nionel	2.0	–	–
1850°C			
Molybdenum	No attack	No attack	Traces
Tantalum	Traces	Traces	Traces
Tungsten	Traces	Traces	Traces

CERIUM SULFIDE (Ce_2S_3)

The compatibility of Ce_2S_3 with various containment materials at 1000°C is summarized as follows. 2, 3

Container material	Maximum penetration observed, mils		
	168 hr	500 hr	1000 hr
Haynes 25	1.5	1.5	2.0
Molybdenum	0.1	0.1	1.0
Tantalum	No attack	Traces	0.5-1.0
Tungsten	No attack	No attack	No attack
TZM	0.1	0.2-1.0	1.0
Hastelloy X	No attack	No attack	Traces
Nionel	No attack	6	6
N-155	Traces	Traces	Traces

CEROUS FLUORIDE (CeF_3)

The compatibility of CeF_3 with various containment materials at 1000°C for 1000 hr is as follows. 4

Container material	Remarks
Hastelloy X	Slight reaction
Haynes 25	Slight reaction
Molybdenum	No visible reaction
Niobium	No visible reaction
Nionel	No visible reaction
N-155	No visible reaction
Tantalum	Slight reaction
Tungsten	Some reaction

CESIUM-137 REFERENCE COLUMN

CESIUM CHLORIDE (CsCl)

A CsCl source which was encapsulated in stainless steel and contained 1540 curies of ^{137}Cs showed no signs of reaction after being opened nine years later. The source operated at slightly above ambient room temperature. 5

CURIUM

CURIUM-244 SESQUIOXIDE (Cm_2O_3)

A molybdenum alloy containing 0.5% titantium and 0.1% zirconium (TZM) was contacted with an oxide mixture containing 29 wt % $^{244}Cm_2O_3$, 57 wt % $^{241}AmO_2$, and 14 wt % $^{239}PuO_2$. Static capsule tests at 1100°C for periods of 250 and 1000 hr and at 2000°C for 25 hr showed no reaction with molybdenum, even though the oxide fuel was molten at 2000°C. 6

System	Temp, °C	Time, hr	Atm	Extent of reaction	
Cm_2O_3 powder in W crucible	1800	8	Vacuum	None detected visually	7
Cm_2O_3 powder on W filament	2150 (melted)	1	4% H_2–96% He	No reaction, wetting, or penetration detected by metallography or by fission fragment autoradiography	7
Cm_2O_3 powder on Ir filament	2150 (melted)	1	He	Curium penetration and surface reaction	7
Cm_2O_3 powder on Pt-50% Rh filament	1700	10	O_2	No curium penetration but possible surface reaction	7
13 vol % B-type Cm_2O_3 in a Ta matrix	1400	12	10^{-6} torr	An unidentified reaction product was observed by metallography and X-ray diffraction	8

CURIUM-242 OXIDE CERMET

Tests at 1100°C for 1000 hr and at 2000°C for 24 hr with an oxide mixture containing 29 wt % Cm_2O_3, 57 wt % AmO_2, and 14 wt % PuO_2 showed that this oxide mixture was compatible with the alloy Mo-0.5% Ti-0.1% Zr (TZM). 6

With the use of iridium in a metal-metal oxide cermet, alloying of iridium with molybdenum was observed at 2000°C. Also the molten oxide mix appeared to react with iridium to form a lower melting alloy. At 1000°C the reaction between iridium and molybdenum was too slow to be observed, at least over a period of time of 1000 hr.

STRONTIUM-90 METAL

After exposure of 2036 hr at 925°C to liquid strontium metal, it was found that molybdenum and stainless steel 321 showed good compatibility with liquid strontium metal; that wrought iron and Haynes 25 were worthy of further study; and that Hastelloy C, Hastelloy N, Hastelloy X, and titanium had dissolved and were incompatible with strontium metal. 9

No attack on molybdenum was observed after 5000-hr contact with liquid strontium metal at 1000°C. 10

STRONTIUM TITANATE ($SrTiO_3$)

The following results were obtained on stable $SrTiO_3$. 2

Container material	Maximum penetration observed, mils		
	168 hr	500 hr	1000 hr
1000°C			
Haynes 25	Traces	0.1	0.2
Molybdenum	No attack	No attack	No attack
Nionel	1.5	1.7	2.0
Tungsten	Traces	0.2	1.5
TZM	No attack	No attack	No attack
1850°C			
Molybdenum	No attack	No attack	No attack
Niobium	No attack	—	No attack
Tantalum	No attack	Traces	3.0
Tungsten	No attack	—	No attack
TZM	No attack	Traces	5.0

STRONTIUM OXIDE (SrO)

The following results were obtained with SrO-7% BeO material at 1000°C. 2

Container material	Maximum penetration observed, mils		
	168 hr	500 hr	1000 hr
Haynes 25	2.0	2.0	4.0
Molybdenum	—	No attack	No attack
Nionel	—	4.0	4.0-8.0
N-155	1.0	1.5	2.0-4.0
Tungsten	No attack	No attack	No attack
TZM	No attack	No attack	No attack

STRONTIUM FLUORIDE (SrF_2) — REFERENCE COLUMN

Metallographic examination of test specimens exposed for 19 months at 925°C gave the following results. — 11

Encapsulating material	Penetration, in. Maximum	Average
Simulated SrF_2 fuel (1 wt % Ca, 0.5 wt % Fe)		
Haynes 25	0.0006	nil
Ta liner in Haynes 25	Complete penetration of Ta liner	
Hastelloy C	0.001	0.0004
Hastelloy N	0.002	0.001
Hastelloy X	0.0075	0.0014
Simulated aged feed material (SrF_2 + 2-1/2 wt % Zr as ZrO_2)		
Haynes 25	0.0015	0.0008
Ta liner in Haynes 25	Complete penetration of Ta liner	
Hastelloy C	0.0007	0.0003
Hastelloy N	0.0028	0.0011
Hastelloy X	0.0055	0.0011

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