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TITLE

DEVELOPMENT TEST IP-556-D, SUPPLEMENT A, IRRADIATION SERVICE REQUEST HAP0-278 OUTGASSING RATE OF TRITIUM AT HIGH TEMPERATURE

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DEVELOPMENT TEST IP-556-D, SUPPLEMENT A
IRRADIATION SERVICE REQUEST HAP0-278
OUTGASSING RATE OF TRITIUM AT HIGH TEMPERATURES

A. E. DeMers

July 5, 1963

HANFORD ATOMIC PRODUCTS OPERATION RICHLAND, WASHINGTON

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DEVELOPMENT TEST IP-556-D, SUPPLEMENT A
IRRADIATION SERVICE REQUEST HAPO-278
OUTGASSING RATE OF TRITIUM AT HIGH TEMPERATURES

Changes desired from the original Development Test-HW-75942, same title, 12-21-62

The nuclear heat generation rate in the first capsule irradiated was higher by a factor of two than was calculated. The original capsule was irradiated in a dry bore with cooling water in the annulus only. The new capsule will be irradiated in a water-cooled bore facility with additional cooling coils around the lithium containing tube. This will keep the inner capsule temperature below 150 C during the initial tritium buildup period prior to outgassing.

This Supplement authorizes the irradiation of an additional capsule and the removal of the present facility and installation of a single tube general purpose facility. All remaining provisions of the original development test are in force except for minor exceptions due to the water flow in the bore which have been changed in the following writeup.

Objective

The test objective is to determine the effect of radiation and temperature on the outgassing rate of tritium generated in a lithium-aluminum alloy by neutron irradiation.

Basis and Justification

A study has been initiated to evaluate the feasibility of tritium production in N Reactor by the reaction:

using lithium-aluminum alloy target materials. The projected operating temperature of N Reactor (280 C) imposes possible problems of swelling and tritium escape not encountered in previous experience with tritium production in the older reactors at lower temperatures. To determine the combined effects of temperature and radiation on tritium escape, an in-reactor capsule experiment will be run in which the outgassing rate from an irradiated lithium-aluminum alloy is measured at controlled temperatures in an in-reactor test facility. The terminal in-reactor outgassing rate will be compared to the outgassing rate from a similar sample in a laboratory apparatus to evaluate possible effects of radiation.

Capsule Description

The capsule will consist of two concentric aluminum tubes. The outer tube will function to isolate the heater windings and inner capsule from the outer atmosphere. Dimensions of the outer tube are 2-7/8" OD, 0.06 inch wall, 11" long. The inner tube functions as a container for the lithium-aluminum alloy targets. The inner tube dimensions are 1.4" ID, 1/8" wall, 8.12" long. An aluminum alloy containing enriched lithium (40 % Li^6) will be used as the target material. The target will consist of 16 Li-Al alloy discs, 1.39" in diameter by 1/4" thick, with a 3/16" diameter hole in the center. A 3/16" diameter aluminum rod mounted at the center

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of the inner tube will serve as a suspension for the discs and also as a thermo-couple well (1/16" bore). The discs will be spaced 1/4" apart with aluminum spacers.

The inner tube will be heated with Nichrome-V windings. Two thermocouples will be placed in the inner capsule, one at the center of the tube and one near the outer edge.

The capsule is designed to operate at approximately 150 C, unheated. The estimated total nuclear heat generation in the capsule is 1600 watts, assuming 1 watt/gm for aluminum. It will be operated at this temperature until the desired tritium concentration has been generated in the lithium-aluminum alloy discs, approximately one month. The temperature will then be raised and the gas evolution rate will be measured with a vacuum system located on the X-1 level. The temperature will be raised by supplying 0-600 watts to the heater winding as required. The vacuum system will be connected to the inner capsule through a 1/4" aluminum tube welded to the inner aluminum tube. The upper capsule temperature will be 500 C or below and will be adjusted depending on the observed outgassing rate as the temperature is raised. The thermocouple leads, heater leads, and vacuum system lead will all be contained in a 1/2" diameter aluminum tube welded to the outer capsule. The 1/2" tube will be sealed to the nozzle cap.

Capsule temperatures will be controlled with a current adjusting type Minneapolis-Honeywell magnetic amplifier. Power supplied to the heater will be 0-600 watts at 110 volts AC. Over-temperature protection is provided by a Minneapolis-Honeywell Protect-O-Vane and a fused Variac at the power output.

Outgassing Procedure

The inner capsule will be evacuated at the beginning of the irradiation. During the low temperature irradiation, when the generated tritium level and rate of evolution are low, the capsule pressure will be monitored weekly. When the temperature is intentionally raised, the pressure will be monitored daily. The projected total exposure is one month. This will produce a tritium level in the aluminum lattice of approximately 10 cc (STP) per cc of aluminum. It is expected that the accumulation of tritium in the vacuum system will be less than one cc (STP) during a single daily run. After each run, the accumulated tritium will be vented to the stack through the forepump. The accumulated tritium released to the stack each day will be a maximum of one cc, and will be bled off to the stack over a two-hour period. The calculated curie value of one cc of tritium is 2.6 curies. The maximum permissible inhalation concentration of tritium for continuous working conditions is 5×10^{-6} microcuries/cc. KE Reactor stack exhaust flow is 2.2×10^{11} cc/hr. This will give an H^3 concentration at the top of the stack of 5.9×10^{-6} microcuries/cc which is slightly above the MPC but still an insignificant concentration of tritium.

To measure the outgassing rate, the measuring system is first evacuated to the aluminum valve (normally closed) with the second diffusion pump and forepump. With the mercury cut-off valve closed, the aluminum valve is opened to bleed the accumulated gas into the measuring system. A manometer is included in the system to measure possible gas accumulation beyond the range of the McLeod gauge. Next, the first diffusion pump is started to concentrate the gas into the McLeod gauge

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section. The outgassing rate will be measured by observing the change in pressure with time. Gas will be removed from the McLeod gauge as required by opening the mercury cut-off valve and pumping the gas with the second diffusion pump. The gas will be pumped either to the stack through the forepump or into a gas container for mass spectrometer analysis.

The outgassing system will be enclosed in an aluminum and plastic box. The top of the box will be connected to the building vacuum system to prevent the escape of any tritium gas onto the X-levels.

Reactor and Facility

The capsule will be charged into the flat flux region of the 2A single tube General Purpose facility at KE Reactor.

The 2A test facility will be operated in accordance with KE Processing D.O.P. 3.3.5, which provides for a reactor shutdown upon receipt of temperature and pressure alarms from the facility. An analysis* of the capsule and facility indicates that a complete loss of water to the facility would result in melting of the capsule and facility in approximately five minutes. If water flow to the facility is lost, the reactor will be scrammed within five minutes.

Heat Generation - 1600 watts

CMK Absorbed - Seven nominal

Shutdown Time Required - None

Discharge Procedure

The capsule will be removed by employing the Snout facility cask train and Snout removal procedure. This is accomplished by pulling the capsule and capsule leads into the cask train, removing the capsule from the leads with the guillotine, and pushing the capsule into the shipping cask. The capsule leads will be disposed of by the long rope method and buried. Both of the above removal procedures have been demonstrated many times in the past removing Snout assemblies and various test capsules.

Hazards

The reactor hazards will not be increased significantly due to the presence of this capsule in the facility.

There is an H^3 inhalation hazard associated with this test when sampling and exhausting the accumulated tritium prior to sampling.

The entire gas sampling and exhaust system will be static helium leak tested before and after charging the capsule. The glass sampling system will be enclosed and will

* HW-70129, Loss of Water to KE or KW Side Test Facilities, RE Baars, 6-26-61

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be under a vacuum at all times to prevent escape of tritium gas to working areas. The exhausting of accumulated gases to the stack will be done over a two-hour period to dilute the tritium below the maximum permissible limit prior to exhausting to the atmosphere.

Responsibility

Irradiation Processing Department

Irradiation Testing will be responsible for charge-discharge of capsule and operation of the facility, gas sampling and sample exhausting and routine data collection.

KE Processing will be responsible for compliance with D.O.P. 3.3.5.

A. E. DeMers
Irradiation Testing

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