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LETTER TO DR. CALKINS FROM DAVID HENRY ON LITHIUM HYDRIDE

January 16, 1956

GENERAL ELECTRIC-AIRCRAFT NUCLEAR PROPULSION DEPARTMENT-CINCINNATI 15, OHIO

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ABSTRACT OF REPORT NO. DC 56-1-64

TITLE: Radiation Damage Test of Lithium Hydride Cast Material

AUTHOR & ORIGINATING UNIT: David L. Henry - Materials Development

DATE SUBMITTED: January 16, 1956

A radiation damage study on cast lithium hydride was conducted at Oak Ridge in the LITR. After a dosage of approximately 2 X 10^{18} nvt at 1000°F, there was no perceptible change in physical properties.

SUBJECT: RADIATION DAMAGE TEST OF LITHIUM HYDRIDE CAST MATERIAL

Cincinnati 15, Ohio, January 16, 1956

Dr. V. P. Calkins
Supervisor - Materials Research and Radiation Studies

According to some recent research there is some evidence of radiation damage to pressed lithium hydride powder. These tests were done in the Brookhaven pile at 400-600°F at three dosages, 10^{13}, 10^{15} and 10^{17} nvt. At 10^{13} nvt there was no damage other than blackening of the sample. However, the one at 10^{15} nvt and also 10^{17} nvt showed an approximate 30% increase in volume, thus filling their containers.

A test has been conducted by ANPD to determine what damage would be encountered in the cast material. A five-inch cylindrical container of 304 stainless steel with a .031 inch wall was filled by dipping it into molten lithium hydride. This was done under a hydrogen atmosphere to insure maximum hydrogen content. This resulted in approximately 33 gram cast body of normal lithium hydride essentially shrink-pipe free as shown by Figure 1, an X-ray of the sample prior to irradiation. This capsulated sample was then canned as shown in Figure 2 with expansion gages set to indicate 3% expansion.

The hydrogen pressure over the sample was recorded both during the six hour bench test and during the in-pile test. There was some increase during the cook-out period which would indicate elimination of moisture according to the equation $LiH + H_2O \rightarrow LiOH + H_2\uparrow$. This stablized at approximately 50 mm/Hg. The fluctuation of the in-pile test pressure between 20 and 30 mm/Hg is not correlated with any change in reactor power level. The LITR operating conditions at the level where the sample was located were:

1. Thermal Neutron Flux

   Experimentally determined unperturbed flux in facility - 3×10^{13} n/cm^2-sec.
   Calculated perturbed flux in lithium hydride - 0.38×10^{13} n/cm^2-sec.

2. Fast Flux (estimated) 7.5×10^{12} n/cm^2-sec ($\geq$1 Mev)

   This is approximately equal to the maximum fast flux expected in an AC 110 reactor shield under operating conditions (DC 56-1-3).

3. The total dosage over the 100 hour test period was:

Thermal - 1.37×10^{18} nvt
Fast - (approx.) 2.7×10^{18} nvt

A flow of 5 SCFM of helium was required to maintain the center of the casting at a temperature of 1000°F. The outside wall temperature of the casting was 870°F, thus indicating a maximum ΔT through the lithium hydride of 130°F.

During the in-pile test observation of the hydrogen pressure over the sample, the temperatures at five locations on the sample and of the conductance of three expansion gages connected to the test capsule gave no indication whatsoever of any radiation damage. Futhermore, no change in the helium flow rate was required, thus indicating that the heat transfer properties did not change. Also, the pressure head of the cooling helium did not require any adjustment which would have been necessary had there been undo swelling or rupture of the sample container.

Upon completion of the test, the sample was removed from the reactor and allowed to cool. The sample was then transferred to a hot cell for sectioning and physical examination. After removing the outer shell, the sample container was measured by a micrometer and within experimental error ($\pm$ .25%) there was no expansion discernible. The bottom of the container did not appear to have bulged beyond that shown by the starting X-ray. When the capsule was cut at the point of the highest flux intensity, the crystalline nature was still apparent (see Figures 3 and 4) and it had the characteristic blue appearance of the original material. X-ray diffraction and chemical analysis are being conducted on the irradiated material.

Conclusions and Plans

It has been concluded that lithium hydride in the form of a cast material does not undergo noticeable change in properties when exposed to pile radiation to a dosage of $\sim 2 \times 10^{18}$ nvt and at a temperature of 1000°F.

A similar pile experiment is being conducted on lithium hydride fabricated by powder pressed techniques. This will provide a direct comparison of the extent of radiation damage of lithium hydride prepared by the two methods of fabrication.

David L. Henry

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Materials Research and Radiation Studies

DLH:dmm

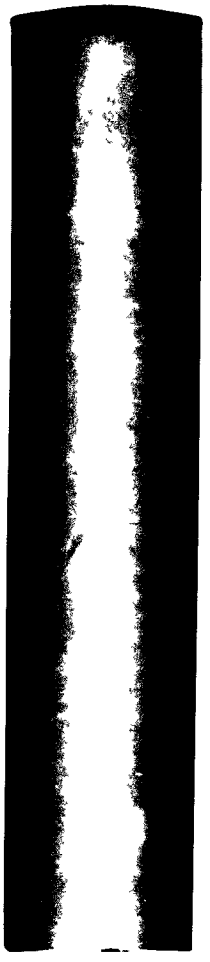

FIGURE 1 X-ray of Lithium Hydride Starting Material as Cast

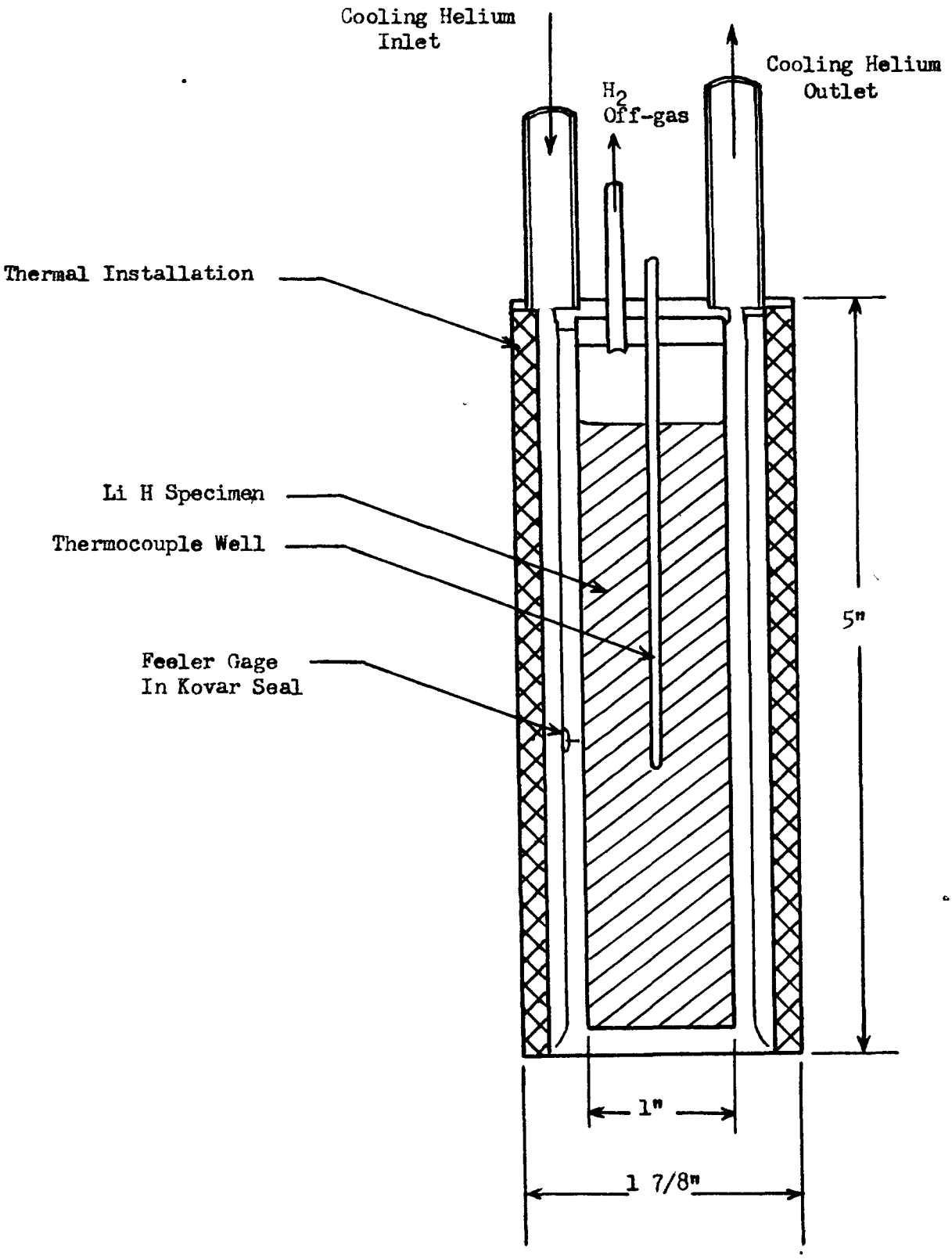

FIGURE 2 Lithium Hydride Contained in Its In-pile Capsule Assembly

FIGURE 3 Crystalline Structure as Seen at the Point of Highest Flux Intensity

FIGURE 4 The Crystalline Lithium Hydride as Seen on the Surface of the Void Area (the darkened portion deep within the capsule)