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CONTRACTION RATES OF H AND K REACTORS

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CONTRACTION RATES OF H AND K REACTORS

INTRODUCTION

Initially the graphite stacks in the BDF reactors were observed to expand, grow, with neutron irradiation. It was discovered that if the operating temperature of the graphite increased this growth would anneal out. Late in 1952 the graphite in the top central section of H pile had subsided to an elevation below that of the original layout. Since this first observed net contraction, the pile has continued to contract until now the top central section is 1.5 inches below the original layout. The K reactors, after initially experiencing a growth, have subsided in the top central section by 0.9 inches at KE and 1.1 inches at KW. It has been found that the base of KW has settled 0.1 inches, therefore, the net contraction is 1.0 inches.

It is the purpose of this investigation to determine the contraction rates of H and the two K reactors in terms of the neutron irradiation. Utilizing these results, the projected front-to-rear profiles for KE and H piles were determined. It was assumed in the projected profile curves that the reactors would continue to operate at their present levels. - - Of course, an increase in the power levels would result in an increase in the total contraction.

The contraction rates obtained for KW, KE and H reactors are given in Table I. The projected front-to-rear profiles for KE and H piles are given in Figures 4 and 5.

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TABLE I: CONTRACTION RATES

<u>Reactor</u>	<u>Exposure Interval</u>	<u>Contraction Rate</u>
KE	11-1-56 to 11-1-58	0.040%/10 ³ MWD/AT
KW	11-1-56 to 11-1-58	0.041%/10 ³ MWD/AT
H	1-1-53 to 1-6-54	0.025%/10 ³ MWD/AT
H	1-5-54 to 1-6-57	0.033%/10 ³ MWD/AT
H	1-6-57 to 8-13-58	0.048%/10 ³ MWD/AT
H	1-1-53 to 8-13-58	0.040%/10 ³ MWD/AT

GRAPHITE CONTRACTION (GENERAL)

To study the physical effect of neutron irradiation on graphite, HLO has previously irradiated samples, at a controlled temperature of 400° - 500° C, in the Hanford reactors. It was found that initially the graphite samples would grow, then start contracting; this contraction becoming linear for exposures above 3000 MWD/A TON. The irradiated samples were of the following types of graphite KC, CS, GBF and CSF; see Figure 4 and 5 in HW-58026-RD(1).

It was found from these irradiations that the physical changes of the samples could be described by a growth component and a contraction component. It was also found that the contraction was a linear function of exposure and growth was a function of both exposure and temperature which saturated at high exposures, say 3000 MWD/A TON. Preliminary indications are that the contraction becomes a function of both temperature and exposures at temperatures above 850° C(2). The contraction rate for each type of graphite was obtained from the linear contraction curves above 3000 MWD/A TON (See Figures 4 and 5 in HW-58026-RD). These contraction rates are given in Table II.

TABLE II: CONTRACTION RATES FOR VARIOUS GRAPHITE SAMPLES

<u>Graphite Sample</u>	<u>Contraction Rate</u>
KC	0.006%/10 ³ MWD/A TON
CSGBF	0.02%/10 ³ MWD/A TON
CSGBF	0.02%/10 ³ MWD/A TON
CSF	0.02%/10 ³ MWD/A TON

*could that graphite is still growing
at 600 MWD/t*

GRAPHITE CONTRACTION (GENERAL)

Subtracting out the contraction component of the various irradiated samples and plotting the results vs. the exposure gives a plot of the growth, see Figure 1. This saturation of the growth is due to the fact that after some high exposure the number of growth disturbances per unit time will be counteracted by an equal number of disturbances annealed out per unit time. If the temperature of the graphite is increased the growth will saturate at some lower value.

DETERMINATION OF THE CONTRACTION RATE FOR KW, KE, AND H PILES

The contraction rate for a particular reactor can be determined from the actual total contraction experienced by the reactor and the amount of neutron irradiation received by the reactor structure, i.e.,

$$(1) \text{ Contraction Rate} \equiv \alpha = \Delta L_T / \sum_i L_i E_i F_i$$

where ΔL_T denotes the total contraction at some position on top surface of the reactor, L_i is the height of the i^{th} lattice cell, E_i is the power output of the i^{th} fuel channel in MWD/TON, and F_i is the front-to-rear flux weighting factor in the i^{th} channel. If the chosen position is midway between the front and rear reactor faces,

$$(2) F_i = \frac{\text{Flux at } \mathcal{C} \text{ of } i^{\text{th}} \text{ channel}}{\text{Average flux in } i^{\text{th}} \text{ channel}}$$

Now if all the lattice cells are equal in size, and if the flux distribution is similar for all fuel elements, Eq.(1) may be written

$$(3) \alpha = \Delta L_T / l \cdot F \cdot N \sum_i E_i$$

where N denotes the number of channels in the reactor column.

The lattice spacing for the H and K reactors are $8 \frac{3}{8}$ inches and $7 \frac{1}{2}$ inches, respectively. The number of channels in a column at H and K reactors is 46 and 58, respectively.

The flux weighting factors were obtained by Parkos and Goins⁽²⁾ from flux distribution studies. These weighting factors are given in Table III. The power output of each tube in column 73 at H Pile and column 79 at the K-Piles was tabulated for the desired time intervals by Data Processing, IPD. The resulting contraction rates obtained for the three reactors are given in Table I.

Utilizing the above contraction rates and the total tube exposures in the central columns for the K reactors, assuming a cosine flux distribution front-to-rear, the profile of the residual growth was obtained, see Figures 2 and 3. The residual growth is fairly constant in the front-to-rear direction with a slight dip in the central section.

This dip signifies that the graphite temperature in the central section is slightly higher than the graphite temperature near front and rear reactor surfaces.

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DETERMINATION OF THE CONTRACTION RATE FOR KW, KE, AND H PILES (CONT'D)TABLE III: FLUX WEIGHTING FACTORS

<u>Reactor</u>	<u>Time Interval</u>	<u>F</u>	<u>% of Total Production</u>
KE	1-55 to 11-56	1.266	31.5
KE	11-56 to 11-58	1.449	68.5
KW	1-55 to 11-56	1.266	30.4
KW	11-56 to 11-58	1.449	69.6
H	11-49 to 6-50	1.429	3.6
H	6-50 to 6-51	1.305	5.2
H	6-51 to 1-53	1.429	12.8
H	1-53 to 2-58	1.266	63.2
H	2-58 to 11-58	1.449	15.1

Assuming the contraction rates in Table I, the projected front-to-rear profiles for KE and H piles were calculated, assuming a cosine flux distribution. These profiles are given in Figures 4 and 5.

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3. Goins, D. E. and Parkos, G. R., Axial Flux Distribution History of the H and K Reactors, HW-58551, November 11, 1958.

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FIGURE -1
GRAPHITE VS. EXPOSURE
TEMPERATURE: 400 - 500 °C

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FIGURE -3
GROWTH AND CONTRACTION OF KW - PILE

FIGURE -4
FUTURE PROFILE KE REACTOR

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FIGURE-5
FUTURE PROFILE H REACTOR