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LETTERS TO THE EDITOR

The Doppler Coefficient of U^{235} Fuel Elements[1]

Experiments have been performed in the Hanford Test Pile to measure the Doppler coefficient of reactor loadings containing low density concentrations of U^{235}. The experiments utilized current techniques (*1*) that consist of placing heated fuel elements in an insulated cartridge that is positioned at the center of the HTP. During the cooling period simultaneous measurements are made of the fuel element temperature and of the reactivity change of the HTP. These results are interpreted to yield a reactivity coefficient for the test assembly.

The reactivity coefficient is adjusted by applying the statistical weighting of the reactor, thereby yielding the temperature coefficient of the multiplication factor. This quantity is then corrected for systematic errors that include the thermal expansion of the fuel and concomitant effects and the change in parasitic capture near the test assembly. The corrected value is assumed to be that corresponding to the temperature coefficient of the resonance escape probability. Here, it has been assumed that there is no change in the capture to fission ratio in the resonance structure, therefore any change in the neutrons formed per capture in the U^{235} is treated as a change in the resonance escape probability.

TABLE I

Matrix	U^{235} Density (gm/cm^3)	$\partial k/k\,\partial T$ ($\times 10^5$)	$\partial p/p\partial T$ ($\times 10^5$)
$U^{238} + U^{235}$	0.135	-1.74 ± 0.02	-2.14 ± 0.16
$U^{238} + U^{235}$	0.332	-1.34 ± 0.09	-2.08 ± 0.34
$Al + U^{235}$	0.115	0.43 ± 0.02	0.05 ± 0.16
$Al + U^{235}$	0.200	0.97 ± 0.01	-0.03 ± 0.40

The test elements consisted of four different loadings containing U^{235} suspended in a different material. Two of the elements used U^{235} in U^{238}, the other two utilized aluminum and U^{235} to form the matrix. The data and the results are presented in Table I.

The last column in the Table I is the Doppler coefficient of the resonance escape probability for the different fuel assemblies. The large uncertainty associated with the Doppler coefficient is the result of the corrections for systematic errors and the addition of terms that sum approximately to zero.

The conclusion drawn from the above is that the Doppler coefficient of U^{235} at these densities is too small to be measured with the Hanford Test Pile.

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[1] Work performed at the Hanford Operation of the General Electric Company under the auspices of the U. S. Atomic Energy Commission.

REFERENCE

1. M. V. Davis, *J. Appl. Phys.* **2**, 250 (1957).

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The Magneto-Ionic Expander Isotope Separator Applied to Uranium

A short arc in a high vacuum and in a large parallel magnetic field serves as an intense source of ions to a negatively charged surrounding cylinder (*1*, *2*). Ion currents as high as 10 amperes were obtained with an arc current of 100 amperes using a uranium anode. Unfortunately electrons are carried out with the ions, even against the opposing electric field in this so-called "ionic centrifuge." The oscillations induced among the ions cause variations of the isotopic constitution to be vanishingly small in the deposits on the cylinder and on the end plates above and below the arc. These oscillations are normal in discharges of this type. [See (*2*), note 6.] As shown by Chew, Goldberger, and Low (*3*), the relative mean motions of electrons and ions in an electric and magnetic field and in the *absence* of particle collisons, as in the ionic centrifuge, may still produce substantial oscillations of various sorts and these will prevent appreciable isotope separation.

The short electric arc may still serve as an intense source of ions (and electrons) to be deposited, not upon a continuous cylinder, but upon a series of separate insulated strips each bearing a different voltage. The side walls which remain nearly bare of deposit during operation, embrace at their short end the arc, aperture L_0 ($\sim$1 in.), and at their long end the insulated slats, making up the aperture L ($\gtrsim$2 ft), and which become well covered with deposit. See Fig. 1. The space is closed above and below the arc in the magnetic field at a suitably great distance by plates which are insulated or are made up of insulated segments.

Between the two guiding side walls a constant electrical potential difference is impressed which is only large enough. The total current drawn through the ionized gas will react with the magnetic field, and if the sign of the potential difference between the guiding side walls is proper, the ionized gas will be driven up the expander tube. Little current is received by the guiding side walls, however. At the negative side wall electrons are repelled into the gas and positive ions are drawn toward the wall. Thus a space charge of positive ions forms next to the wall, taking up a large part of the voltage because of their charge and reducing the electric field behind them to little more than $\mathbf{E} = (1/c)[\mathbf{H} \times \mathbf{v}]$. But being positive ions alone, in the crossed electrostatic and magnetic fields they will not be accelerated into the side wall, but will be driven nearly perpendicularly to both the electrostatic and the magnetic fields and parallel to the side wall surface. They will thus be the total current *up* the tube.

At the positive side wall, positive ions are repelled into the gas, and the electrons make up a negative space charge at the wall. This space charge in the crossed electric and magnetic fields also is driven up the tube. It constitutes a total current of electricity *down* the tube.

The actual total current in the gas must close itself by flowing back through the gas.