

The Inner, Initial Permeability of Iron and Nickel from 98 to 410 Megacycles

The *inner*, initial permeability of iron is known¹ to decrease from the comparatively constant value at the longer wave-lengths (above approximately 3 m) to unity for heat waves. Our investigations have been continued along two lines. First, as reported here, we have sought to close the gap in these values which exists between the wave-lengths 120 and 390 cm. Second, we have sought to increase the accuracy of the measurements, as will be reported shortly in detail by J. L. Glathart.

For the frequency range from 98 to 410 megacycles per second, we have modified the method used by Hoag and Jones (H-J), by moving the oscillator, as suggested by King,² instead of the double shorting bridge, thus eliminating the need for matching the oscillator impedance with the characteristic line impedance. It was also possible to use type 56 and 955 tubes instead of a magnetron, and a thermocouple galvanometer instead of a crystal detector. The sample of iron used (commercial mild Bessemer) was comparable with that of H-J (S.A.E. No. 1120 screw stock). Data were also obtained for a somewhat impure sample of nickel (0.13 percent C, 0.31 percent Mn, 0.04 percent Cu, 0.13 percent Fe).

λ_1	cm =	305	266	184	128	73
Iron, μ_i	=	65	60	50	41	35
Nickel, μ_i	=	19	14	10	7	

The curve of permeability as a function of wave-length for iron forms a smooth extension of that of H-J, rising to the constant, long wave-length value. This curve is overlapped, at its lower end (below 120 cm) by that of Potapenko and Sanger. The latter is slightly above our curve and also that of H-J, but not more so than expected from the inaccuracy of the work and the difference in the iron samples.

The values of the *inner*, initial permeability of iron and nickel given in the accompanying table are, to our knowledge, the first to be reported in the range from 120 to 305 cm.

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² R. King, Proc. Inst. Rad. Eng. 21, 1142 (1933).

Nuclear Isomerism and Chemical Separation of Isomers in Tellurium

The growth of an electron-emitting 8-day iodine from a radioactive tellurium of 1.2 days half-life (produced by the deuteron bombardment of tellurium) has been reported by Livingood and Seaborg.¹ Their experiments indicated that this iodine activity was formed also by the decay of a tellurium of shorter life. We have made a more careful examination of this shorter lived parent of the 8-day iodine. Tellurium activated with slow neutrons was used in these experiments in order to avoid the formation of any

radioactive iodine by direct transmutation. Successive extractions of iodine from such neutron-activated samples have been made, and it has thus been definitely established that the 8-day iodine is growing from a parent of about 25 minutes half-life as well as from the 1.2-day parent.

This demonstration that the 8-day iodine grows from both periods proves that the 1.2-day tellurium is isomeric with the activity of 25 minutes half-life. Both activities are formed directly by the neutron or deuteron bombardment of tellurium. We have also proved that these isomers are genetically related by separating chemically the 25-minute tellurium from the 1.2-day tellurium long after the directly formed 25-minute activity was dead.

A method of separation of genetically related nuclear isomers depending upon the appearance of the daughter activity in a form chemically separable from the parent isomer has been worked out by Segre, Halford and Seaborg² and applied by them and DeVault and Libby³ to the separation of the bromine isomers. For the separation in the present case telluric acid was synthesized from a sample of tellurium which had been irradiated with deuterons to produce a strong 1.2-day activity. Inactive tellurous acid was added as carrier; a few hours later this tellurous acid was precipitated as tellurium element, thus separating it from the telluric acid. (Sulfur dioxide in 3 N hydrochloric acid quickly reduces to tellurium the tellurous but not the telluric acid.) This precipitate contained the 25-minute activity with no observable 1.2-day period. It was possible to make such extractions at intervals until the 1.2-day activity had completely decayed.

We may conclude that the 1.2-day period corresponds to the upper state of this radioactive tellurium nucleus. The lower state is formed by a transition from this upper state, and decays with a 25-minute half-life by beta-particle emission to radioactive iodine. In turn this iodine decays with a half-life of 8 days to xenon.

By using a very strong sample of the 25-minute tellurium activity *obtained by extraction from its parent isomer* we were able to observe by successive extractions of iodine the growth of the radioactive iodine from the short period obtained in this way. This experiment provides the most direct proof of the above scheme of decay.

A number of other tellurium activities are formed during the deuteron or neutron bombardment of tellurium. A study of these activities has shown that some of them are also due to isomers and a description of these experiments will be published later.

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³ D. C. DeVault and W. F. Libby, Phys. Rev. 55, 322 (1939).