LETTERS TO THE EDITOR

The Dancoff Effect in H_2O-D_2O Moderated Lattices

As first pointed out by Wigner the surface component of the resonance absorption in closely spaced lattices is reduced by the mutual shadowing of the lattice elements in the resonance lines. The theoretical treatment of this effect given originally by Dancoff and Ginsburg (*1*) provides an approximate expression for the depletion of the resonance flux incident on a given pin due to the presence of a single neighboring pin. The application of this theory to practical reactor lattices in which some of the pins partially obscure others is quite tedious and a more convenient formulation is desirable. An alternative formulation which applies to an effectively infinite lattice has been proposed by Bell (*2*) as a generalization of the Wigner canonical approximation to the escape probability for a single lump.

In this paper we experimentally investigate the validity of Bell's Dancoff-factor defined by

$$\gamma = \left[1 + \frac{S}{4\Sigma_m V_m}\right]^{-1} \qquad (1)$$

where S and $\Sigma_m V_m$ are the pin surface and the moderator scattering cross section, respectively, for a unit cell.

For a given lattice geometry Eq. (1) gives a linear relation between the reciprocal of the infinite lattice Dancoff factor and the moderator mean free path. This prediction was tested on 9 pin and 5 pin square lattices constructed inside a cadmium thimble at the center of the Lynchburg Pool Reactor.[1] The pins consisted of 0.266-in. diameter pellets of 9.2 g/cm³ thorium dioxide clad in 0.014-in. aluminum and were spaced at 0.344 and 0.486-in. in the 9 pin and 5 pin cases, respectively. Mixtures of light and heavy water of six different concentrations were used to obtain the desired variation of the moderator mean free path. Experimentally the fractional reduction in the resonance absorption of the center ThO_2 lattice pin resulting from shadowing by its neighbors was determined for each case by measuring the epicadmium reactivity worth of the center pin both with its ThO_2 neighbors present and with its neighbors replaced by their scattering equivalent in Pb. The infinite lattice shielding factors were deduced from these measurements after correcting for the small reactivity contribution due to scattering in the test pin. These results for both lattice configurations are shown in Fig. 1 together with the corresponding theoretical curves

[1] Experimental details are given in BAW-117 (unpublished).

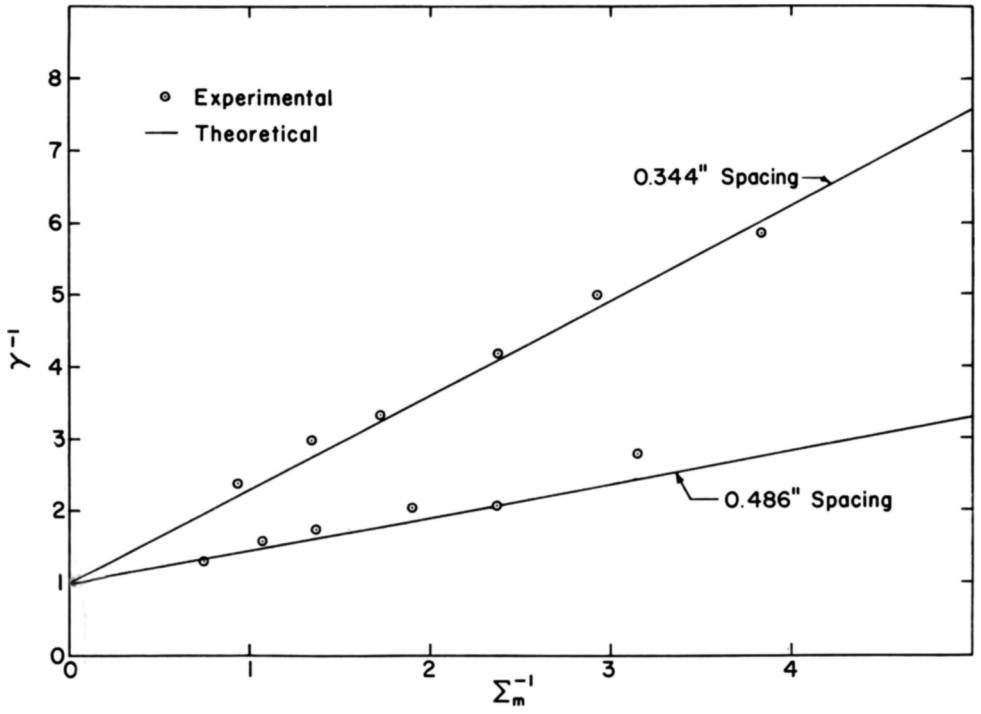

FIG. 1. Inverse Dancoff factor vs moderator mean free path

calculated from Eq. (1). The expected linear dependence is indeed observed in both cases and the agreement is considered close enough to constitute a satisfactory confirmation of the practical utility of Bell's approximation.

REFERENCES

1. S. M. Dancoff and M. Ginsburg, CP-2157 (1944).
2. G. I. Bell, *Nuclear Sci. and Eng.* **5**, 138 (1959).

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The Surface Tensions of Liquid Metals at Their Melting Points*

Various attempts have been made to correlate surface tensions of liquid metals with other physical properties of the elements (*1*). Taylor used a number of such correlations as a basis for estimating values of unknown surface tensions of twenty-seven metals at their melting points (*1*). Taylor did not, however, correlate these estimated values with common parameters of the metals. Hildebrand and Scott (*2*) had found that for organic liquids, a linear relation existed between log $(\gamma/V^{1/3})$ and log S, where γ is the surface tension, V the molar volume, and S the energy of vaporization per unit volume. Hildebrand and Scott (*2*) and Bondi (*3*) attempted to apply this surface tension equation to liquid metals, and Bondi had some apparent success. However, these investigators used arbitrary temperatures and relatively small sample sizes in their attempted correlations. Since it was felt that a more significant test should be made, the present investigation was carried out to determine whether or not the Hildebrand and Scott equation or a modification of it could be applied to a large number of liquid metals at their melting points. This study was made difficult in that (*a*) the accuracy of some of the

* This work is part of the liquid metal studies supported by the Bureau of Naval Weapons, Code RRMA-2.

TABLE I

Sources of Surface Tension Data

Element	Method of measurement	References	Element	Method of measurement	References	Element	Method of measurement	References
Ag*	*a, b*	*8, 14*	Ga*	*d*	*4*	Pb	*a, b*	*10, 14*
Al*	*b*	*4*	Ge	*e*	*13*	Pd	*c*	*1*
Au*	*b*	*14*	Hf	*f*	*7*	Rb	*c*	*1*
Ba	*c*	*1*	Hg*	*b*	*4*	Re	*c*	*1*
Be	*c*	*1, 12*	In	*g*	*10*	Sn	*a,b,g*	*9, 10, 14*
Bi	*b*	*5, 14*	Ir	*c*	*1*	Sr	*c*	*1*
Ca	*c*	*1*	K	*b*	*4*	Ta	*c*	*1*
Cb	*c*	*1*	Li	*c*	*1*	Ti	*a*	*11*
Cd*	*b*	*4, 14*	Mg	*b*	*4*	Tl*	*a*	*14*
Co*	*a*	*9*	Mn	*c*	*1*	U	*c*	*1*
Cr	*c*	*1*	Mo	*c*	*1*	V	*a*	*11*
Cs	*c*	*1*	Na	*b*	*6*	W	*c*	*1*
Cu*	*a*	*9*	Ni*	*a*	*9*	Zn	*b*	*4*
Fe*	*a*	*9*	Os	*c*	*1*	Zr	*f*	*7*

* Surface tension extrapolated to the melting point.
[a] Sessile drop
[b] Maximum bubble pressure
[c] Estimated values
[d] Pendant drop
[e] Analysis of solid state curvature
[f] Drop-weight
[g] Capillary

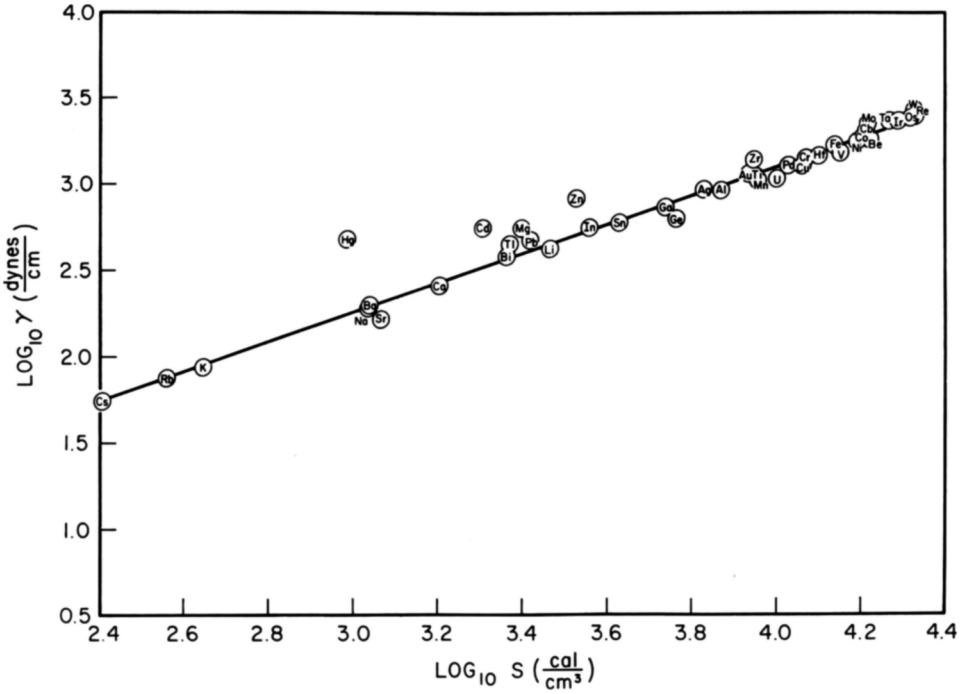

Fig. 1. Log surface tension—log energy of vaporization per unit volume plot for liquid metals at their melting points