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of the chord distribution function $f(l)$, and (b) solving the integral

$$\frac{1}{\Sigma l}\int f(l)[1 - \exp(-\Sigma l)]dl \ .$$

For few simple geometries we know how to find $f(l)$. We do not know how to solve the integral analytically. Approximations are then done using series expansions or treating the integral in different limits.[7,10] Also numerical methods are used to give tabulated solutions for different geometries.[1]

Another method of attacking the problem is to ignore the exact form of $f(l)$ and to find closed form formulas for

$$P(x) = \frac{1}{x} \int dl f(l)[1 - \exp(-\Sigma l)]$$

where $x = \Sigma \bar{l}$. Several methods of attacking the above are known.[2-9,11-13] Recently, Lux[14] again joined the party. Showing that the conditions

$$\lim_{x\to 0} c(x) = c' \quad \text{and} \quad \lim_{x\to\infty} c(x) = c''$$

are too strong, he suggests that $c(x) = \alpha + \beta x$. This choice indeed gives for $\alpha = 0.35$ and $\beta = +\frac{1}{8}$ a very good fit for a cylinder. There is, however, no indication of how this choice is done and to its sensitivity. Indeed $\alpha = 0.6$ and $\beta = 0.007$ gives an error of more than 3.5% for $x < 4$. Thus, the parameter sensitivity of $c(x) = \alpha + \beta x$ seems to be high. The intention in Ref. 13 was to find an approximation that is valid in the whole spectrum and not only in parts of it. It was also indicated there that the sensitivity of the approximating function $A(x)$ to the choice of $c(x)$ is given by

$$\left(\frac{\partial A}{\partial C}\right)_{x,\text{constant}} = \frac{x}{[1 + x + x^2 c(x)]^2}$$

and

$$\delta A = \frac{\partial A}{\partial C}\frac{\partial C}{\partial \alpha;}\delta\alpha;$$

where

$$\frac{\partial C}{\partial \alpha;}\delta\alpha; = \frac{\partial C}{\partial \alpha}\delta\alpha + \frac{\partial C}{\partial \beta}\delta\beta \ .$$

The choice $c(x) = \alpha + \beta x$ leads to

$$\frac{\partial C}{\partial \alpha;}\delta\alpha; = \delta\alpha \to x\delta\beta \ ,$$

a form that is more sensitive to the proper choice of parameters.

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January 26, 1981

Comments on the Tritium Solubility in Lithium Oxide as a Solid Tritium Breeding Material

In a recent paper, Clemmer[1] estimated the tritium solubility in lithium oxide (Li_2O) from the viewpoint of blanket tritium recovery in a deuterium-tritium-fueled fusion reactor. Thermochemical calculations by Clemmer indicated that Li_2O has very high tritium solubility, to the extent that tritium inventories for Li_2O may be unacceptably high. The aim of the present Letter is to show that the model used by Clemmer is not valid for the case of Li_2O.

In our opinion, tritium oxide (T_2O) cannot be dissolved in solid Li_2O in the form of LiOT, because the crystal structure and the lattice constant (that is, lithium density) of Li_2O are quite different from those of LiOH, as shown in Table I. That is, tritium may be dissolved in Li_2O as interstitials, substitutionals, or OT, but not as LiOT. The OT species in Li_2O will be different from that of LiOT. Accordingly, we guess that a reaction

$$2\,\text{LiOT [in } Li_2O(c)] \rightleftarrows Li_2O(c) + T_2O(g) \ ,$$
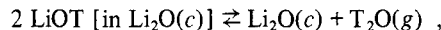
such as assumed by Clemmer, does not take place in the Li_2O lattice.

At the surface of Li_2O, the formation of LiOT(c) is conceivable. However, the equilibrium constant K for the reaction

$$2\,\text{LiOT}(c) \rightleftarrows Li_2O(c) + T_2O(g)$$
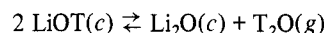
should be expressed as

$$K = \frac{a(Li_2O)\cdot(T_2O)}{[a(\text{LiOT})]^2} = P_{T_2O} \ ,$$

where $a(i)$ is the activity of species i and P_{T_2O} is the equilibrium vapor pressure. The equilibrium water vapor pressure over solid LiOH has already been obtained by Gregory and Mohr.[2] According to their result, the equilibrium water vapor pressure at 300°C is ~1.3 Pa. From this, it is evident that LiOH on the surface of Li_2O decomposes into Li_2O and water above 300°C under the water vapor pressure of 1.3 Pa.

We are now performing experiments on the effect of water vapor pressure on the tritium release from Li_2O pellets in order to check whether Clemmer's estimation will be reasonable or not. The preliminary experiments showed that Li_2O with an initial tritium content of 2.5 wppm retained only 0.4 wppm of tritium after heat treatment at 650°C, where the Li_2O was surrounded by tritiated water vapor at 48.5 Pa. According to Clemmer's solid solution model, most of the tritium would have been held in Li_2O. Moreover, it can be concluded that

TABLE I

Crystal Structures and Lithium Densities of Li_2O and LiOH

	Crystal Structure	Lithium Density (kg/m³)
Li_2O	Antifluorite	9.3×10^2
LiOH	Tetragonal PbO	4.1×10^2

[1]R. G. CLEMMER, "The Development of Tritium Breeding Blankets for D-T Burning Fusion Reactors," *Proc. Fourth ANS Topl. Mtg. Technology of Controlled Nuclear Fusion*, King of Prussia, Pennsylvania, October 14-17, 1980, U.S. National Technical Information Service (1981, to be published).

[2]N. W. GREGORY and R. H. MOHR, *J. Am. Chem. Soc.*, **77**, 2142 (1955).

thermodynamic tritium inventories of Li_2O are sufficiently small under an ambient tritium vapor pressure.

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December 22, 1980

Response to "Comments on the Tritium Solubility in Lithium Oxide as a Solid Tritium Breeding Material"

In the context of the STARFIRE study,[1,2] I developed models to estimate tritium inventories in solid blankets. A major uncertainty was the relationship between tritium concentration in the solid and the gas phase, analogous to the Sieverts' constants for hydrogen-metal systems. In the absence of definitive experimental data, it was assumed that bred tritons are dispersed in the oxide lattice, along with the lithium ions. The tritium was then treated as a solution of LiOT in Li_2O. Recent comments by Nasu et al.[3] express doubt that LiOT is soluble in Li_2O, owing to quite different crystal structures.

The question is whether neutron irradiation of Li_2O produces a separate phase of LiOT (having unit activity) or whether the tritium atoms are more uniformly dispersed in the oxide lattice, substituting for lithium atoms. Specifically, does the bred tritium in Li_2O have unit activity in the solid?

This question can only be answered by experimentation. Nasu et al.[3] indicate some preliminary data with 0.4 wppm tritium in equilibrium with an unspecified T_2O (or HTO) pressure. The H_2O pressure (48.5 Pa) could be in equilibrium with LiOH in the solid. However, the data are not complete enough to demonstrate that LiOT is a separate phase.

I would suggest that a simple test could answer the critical question. If the LiOT is in solution in Li_2O, then one would expect the addition of LiOH to the solid (or H_2O to the gas in equilibrium with the solid) would *increase* the tritium overpressure because $p(\text{HTO}) \approx Kp \cdot a(\text{LiOH}) \cdot a(\text{LiOT})$. If, however, the total hydroxide phase has unit activity, then the total water pressure (H_2O + HTO + T_2O) would be independent of the amount of hydroxide (LiOH + LiOT) if the LiOH and LiOT are mutually soluble. Thus, addition of H_2O or LiOH would be expected to *decrease* the amount of tritium in the gas phase.

It is quite possible that the true situation may be intermediate between the two idealized cases. The tritium may show some solubility in the solid. The final answer awaits definitive experimental results.

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January 26, 1981

[1]C. C. BAKER et al., "STARFIRE—A Commercial Tokamak Fusion Power Plant Design," ANL/FPP-80-1, Argonne National Laboratory (1980).

[2]R. G. CLEMMER, "The Development of Tritium Breeding Blankets for D-T Burning Fusion Reactors," *Proc. Fourth ANS Topl. Mtg. Technology of Controlled Nuclear Fusion*, King of Prussia, Pennsylvania, October 14-17, 1980, U.S. National Technical Information Service (1981, to be published).

[3]S. NASU, T. TANIFUJI, and H. TAKESHITA, *Nucl. Sci. Eng.*, **78**, 193 (1981).