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INTRODUCTION TO TRITIUM TECHNOLOGY

by

L. H. Meyer

Savannah River Laboratory
E. I. du Pont de Nemours & Co.
Aiken, South Carolina 29801

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> *Tritium was first prepared in the Cavendish Laboratory by Rutherford, Oliphant, and Harteck*[1,2] *in 1934 by the bombardment of deuterophosphoric acid with fast deuterons. The D-D nuclear reaction produced tritium* ($^{2}_{1}D + ^{2}_{1}D \rightarrow ^{3}_{1}T + ^{1}_{1}H$ + *energy), but also produced some* ^{3}He *by a second reaction* ($^{2}_{1}D + ^{2}_{1}D \rightarrow ^{3}_{1}He + ^{1}_{0}n$ + *energy). It was not immediately known which of the two mass-3 isotopes was radioactive. In 1939 Alvarez and Cornog*[3] *at Berkeley established that* ^{3}He *occurred in nature and was stable and later*[4] *proved that tritium was radioactive.*

The paragraph above is a direct quote from the item on tritium which I prepared for publication in the *Encyclopedia of Chemical Technology*[5] in 1965. This article summarized the information on tritium technology that could be cited at that time from references in the unclassified literature.

Because of the initially potential and subsequently proven importance of tritium to the national security of the United States, serious development of tritium technology began

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soon after World War II. Almost all information developed was first published in classified documents. In the thirty years since the beginning of this effort, an impressive reservoir of tritium technology has been developed. This information and the accompanying technological expertise reside at a few government-owned sites that are today part of the Energy Research and Development Administration complex. Large segments of the information on tritium technology are still classified at a time when this information is vitally needed in support of the fusion energy program. Therefore, ways should be found to make the information available to the current fusion program workers.

Recently some progress has been made in this direction. Many of the experts in tritium technology are being involved in the fusion energy program through the efforts of the Division of Controlled Thermonuclear Research of the U. S. Energy Research and Development Administration. Others in the program who are relatively unfamiliar with tritium technology are being made aware that information critical to their needs may already have been developed. Also, some initiative has been taken by personnel at the principal sites of expertise to have germane (by their own assessment) information declassified. Recently, we at Savannah River were able to have declassified much of the fundamental data on the lithium-tritium system that was developed in the 1950's and early 1960's to understand the thermodynamics and kinetics of the tritium extraction process. These data were presented publicly for the first time last month at the International Conference on Radiation Effects and Tritium Technology for the Fusion Reactors at Gatlinburg, Tennessee.[6]

The most expeditious method for existing tritium technology to be declassified is for the interested user to request such action. Every declassification request must state the motivation for the proposed action. Naturally, the request cannot be totally general, but must cite specifically the documents of interest. The most compelling reason that can be provided is the potential user's need for the information in support of his own fusion energy program project. My advice to such project managers and workers is therefore to canvass potential sources of tritium technological information before initiating what he may believe to be original work. These sources -- i.e., those laboratories in the ERDA complex mentioned earlier -- can cite documents (sometimes only by number) that may contain pertinent information, which will give the potential user a basis for filing a declassification request. By this process the worker may be able to advance his project and may spare himself the later embarrassment of learning that he has rediscovered information that was already known.

Tritium is energetically unstable and decays radioactively by the emission of a low-energy β particle. The half-life is relatively short (12.36 yr), and therefore tritium does *not occur naturally, except in equilibrium with amounts produced by cosmic rays or man-made nuclear devices.*

This paragraph also is a direct quote from the tritium article in the *Encyclopedia of Chemical Technology*.[5] Controlled thermonuclear fusion reactors will use and produce tritium in large quantities and will therefore in no way be exempt from the problems of dealing with radioactive substances, despite the absence of fission products. Recognition of and accommodation to this factor is essential to the ultimate public acceptance of the large-scale use of controlled fusion power. The technologists in the field of fusion power are already aware of this factor (though some may not yet fully appreciate its magnitude). An adequate awareness on the part of environmentalists and political planners is equally important, or perhaps even more so.

The concept that fusion reactors are devoid of major problems of radioactivity because they have no criticality potential and produce no fission products is inappropriate. Too much has been said and too much has appeared in the press which implies that unanimous public acceptance and acclaim for nuclear power will accompany the successful advent of the first fusion reactor. The fact of the matter is that the technical and public scrutiny of the fusion reactor will (and should) be equally as intense as that currently being applied to fission converter and breeder reactors. The problems of handling and containing multikilogram tritium reactor inventories, of separating and recycling tritium on the same scale, and of minimizing and dealing with induced radioactivity in materials of construction must be defined now. Moreover, the search for solutions to these problems that will assure the public of adequate safety of operation must be pursued on a schedule that is compatible with the development and demonstration of the fusion reactor itself. The problems to which I refer are all soluble; the points that I emphasize are, first, that the solutions are not trivial and will take time and, second, that the solutions should be available when they are needed -- for the environmental impact statements, for the public hearings, and for the entire licensing process.

A basis for optimism on determining and articulating solutions to these problems exists in the experience accumulated at the ERDA production sites (Savannah River and Hanford), at the weapons design laboratories (Los Alamos and Lawrence Livermore), at the weapons systems support laboratories (Mound and Sandia), and more recently at the National Laboratories (Holifield, Argonne, and Brookhaven). At Savannah River, we have safely processed and handled very large quantities of tritium for many years; and although we have experienced both routine and occasional accidental releases of tritium, the resultant personnel and population exposures have been inconsequential.

Technical sessions, such as the one today, are important vehicles in developing the information that is required. To the extent possible, the work of this session should be to clarify the state of tritium technology that is available in support of the fusion power program, to define additional technology that must be provided, and to recognize the problems (both technical and political) in this area that must be resolved to ensure ultimate program success.

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