Neutron irradiation heavy water production process

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Introduction

Heavy water, although a toxic product, is widely used in nuclear reactor management. Small amounts of heavy water exist in nature, but it can also be synthesized by exposing ordinary water to a neutron source.

However, the resulting product will contain deuterium, tritium and the oxygen isotope 17.

To obtain heavy water for practical purposes oxygen 17 is not useful.

It will be explained how and in what proportions these elements are obtained.

By-products of neutron exposure

If a neutron source (such as uranium 235 or any arrangement that converts alpha radiation into neutrons) is available, ordinary water will absorb the neutrons and the following reactions will occur:

$H_1^1 + n_0^1 \rightarrow H_1^2 (deuterio)$

$H_1^2 + n_0^1 \rightarrow H_1^3 (tritio)$

$O_8^{16} + n_0^1 \rightarrow O_8^{17}$

It must be remembered that neutrons have no electric charge so they are not repelled by the charges in the atomic nuclei, but they would be attracted by the masses of the nuclei in direct proportion to the nuclear mass.
Taking into account the entire molecular mass of water (18), the reaction giving rise to oxygen 17 would occur 16 out of 18 times. Any reaction involving ordinary hydrogen would occur 2 out of 18 times, and the reaction resulting in tritium would occur only 1 out of 3 times that any hydrogen isotope originates.
Then the probabilities would be:

Isotope	Generation probability
Oxygen 17	88.89%
Deuterium	7.41%
Tritium	3.7%

Obviously, the problem would be to separate the heavy hydrogen from oxygen 17, which is the isotope that would be produced the most.

Hydrogen separation
Taking into account that heavy water without oxygen 17 is desired, the water obtained after irradiation can be electrolyzed, and since chemically hydrogen reacts the same as any of its isotopes, what is obtained at the positive electrode may well be a mixture of ordinary hydrogen and any of its isotopes. If this hydrogen is recombined but with oxygen 16 from the air, a mixture of heavy water and ordinary