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Title: **Accelerator Transmutation of Nuclear Waste: Towards the Elimination of Long-Lived Radioactive Waste**

Author(s): H. J. Dewey

Submitted to: For presentation at the Pyrochemical Workshop to be held in Albuquerque, NM on October 21, 1993

Los Alamos
NATIONAL LABORATORY

September 29, 1993
13th Pyrochemical Workshop
October 18-21, 1993
Albuquerque, NM

Accelerator Transmutation of Nuclear Waste: Towards the Elimination of Long-Lived Radioactive Waste

Harry J. Dewey
Chemical Science and Technology Division
Los Alamos National Laboratory

Abstract:

Researchers at Los Alamos have been developing tarnsmutation concepts involving accelerator-driven nuclear systems. A medium energy, high current proton beam strikes a heavy metal target, producing a high flux of spallation neutrons. These neutrons are moderated to near-thermal energies in a blanket surrounding the target. Materials to be transmuted flow through the blanket region where they are fissioned or transmuted to stable nuclides. Stable or short-lived nuclides are separated while the long-lived radioactive species are returned to the blanket. For most applications the fission energy produced is much greater than that required to power the accelerator and can be directed to the commercial power grid.

A number of possible applications are envisioned for accelerator-driven nuclear systems. These include destruction of suplus weapons-grade plutonium, production of tritium, transmutation of commercial spent fuel, and even commercial power generation in next-generation nuclear power plants. Some of these applications will be discussed with particular emphasis on the required chemical separations for such systems.

Accelerator Transmutation of Nuclear Waste: Towards the Elimination of Long-lived Radioactive Waste

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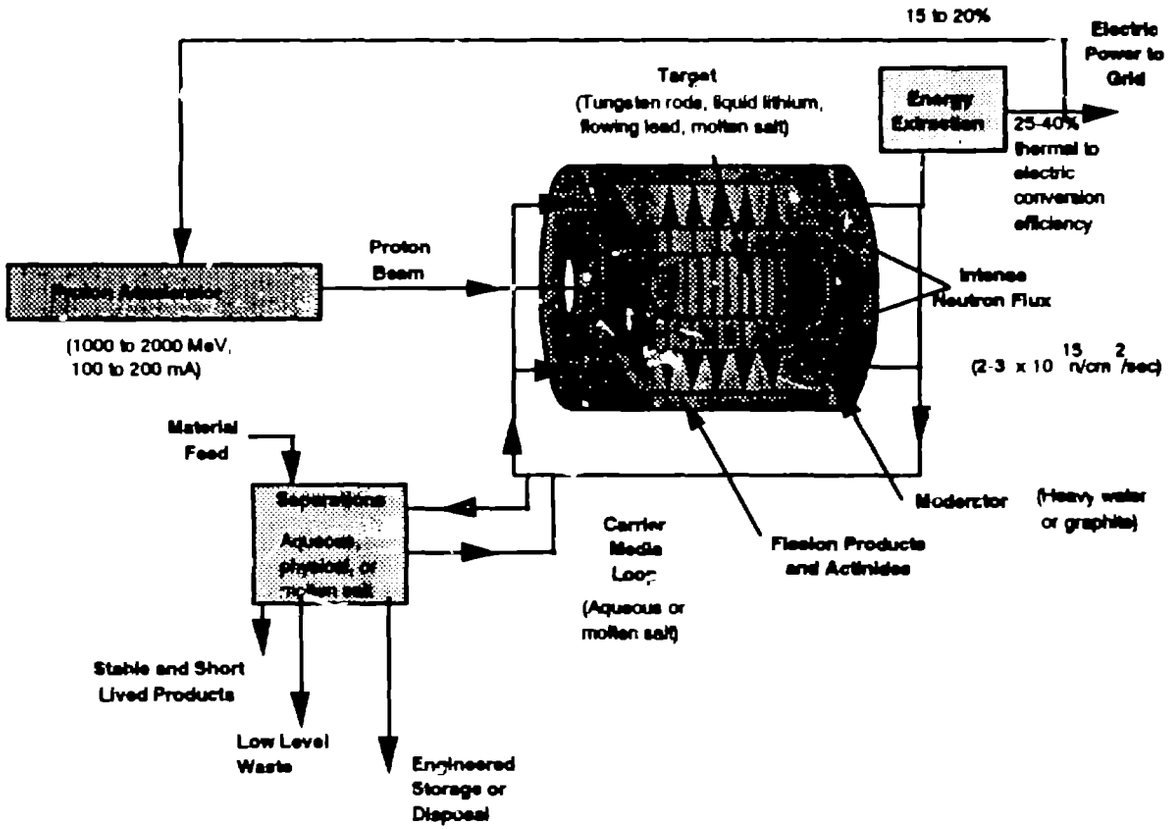
General Features
ATW System

- Driven, sub critical system
- Intense thermal neutron fluxes
- High transmutation cross sections
- Minimal material inventories
- Continuous material feed
- Advanced separations



Nuclide	Half-Life (years)	Isotopic Abundance	ATW Production Rate (g/kg fissioned)	Capture Cross Section (CANDU) (barns)
^{79}Se	6.50×10^{4}	11.24%	0.13	1.188
^{93}Zr	1.50×10^{6}	19.30%	13.75	2.123
^{99}Tc	2.13×10^{5}	100%	19.94	16.620
^{107}Pd	6.50×10^{6}	21.21%	15.02	6.760
^{126}Sn	1.00×10^{5}	40.41%	0.88	0.167
^{129}I	1.57×10^{7}	72.88%	5.27	15.370
^{135}Cs	2.30×10^{6}	7.30%	5.09	5.882

Radiation Dose from Contaminated Water from Proposed U.S. Repository is Dominated by Fission Products

Species	Halflife (yrs)
^{99}Tc	213,000
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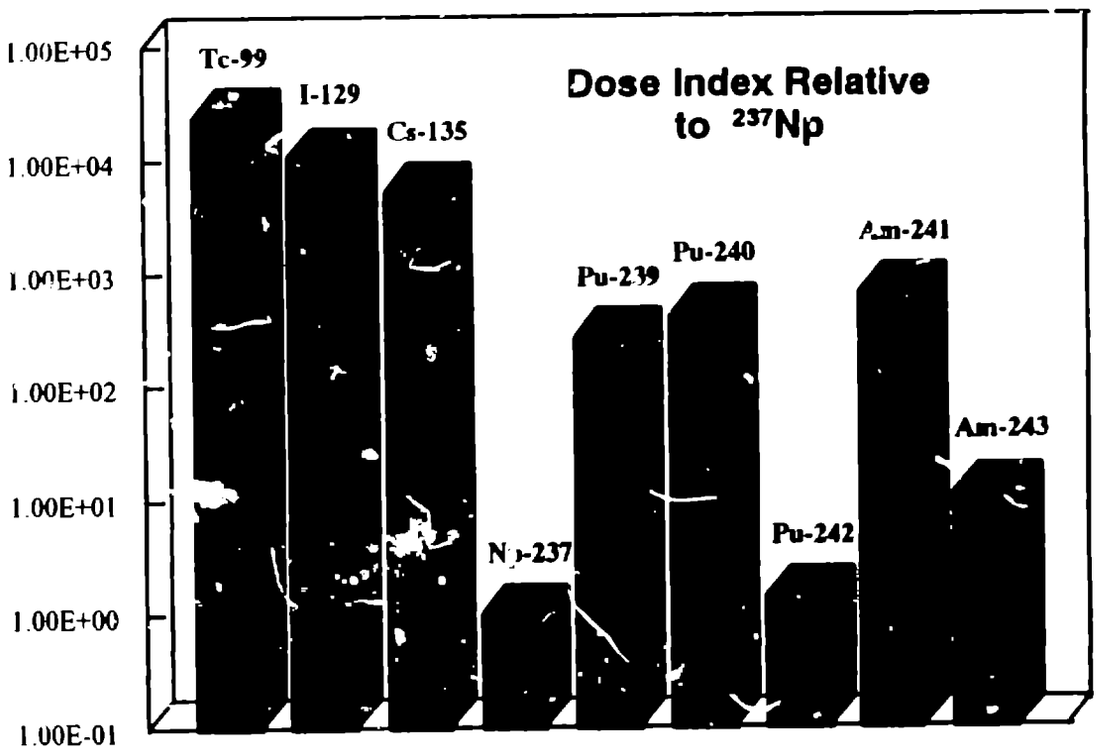

Dose Index = (Repository Inventory)(Fractional Dissolution Rate)(Dose Conversion Factor)

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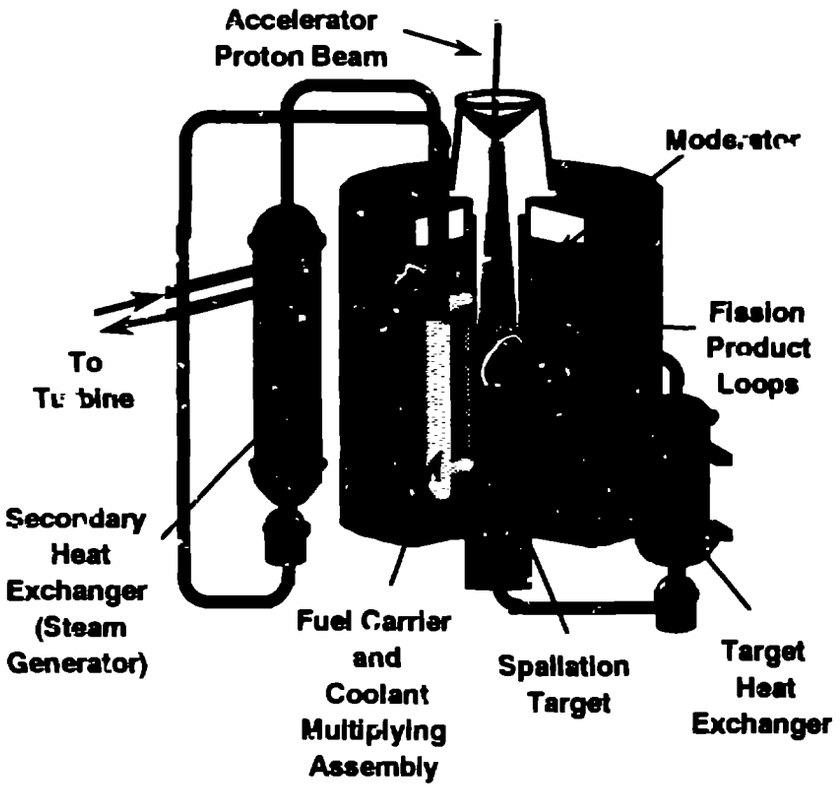
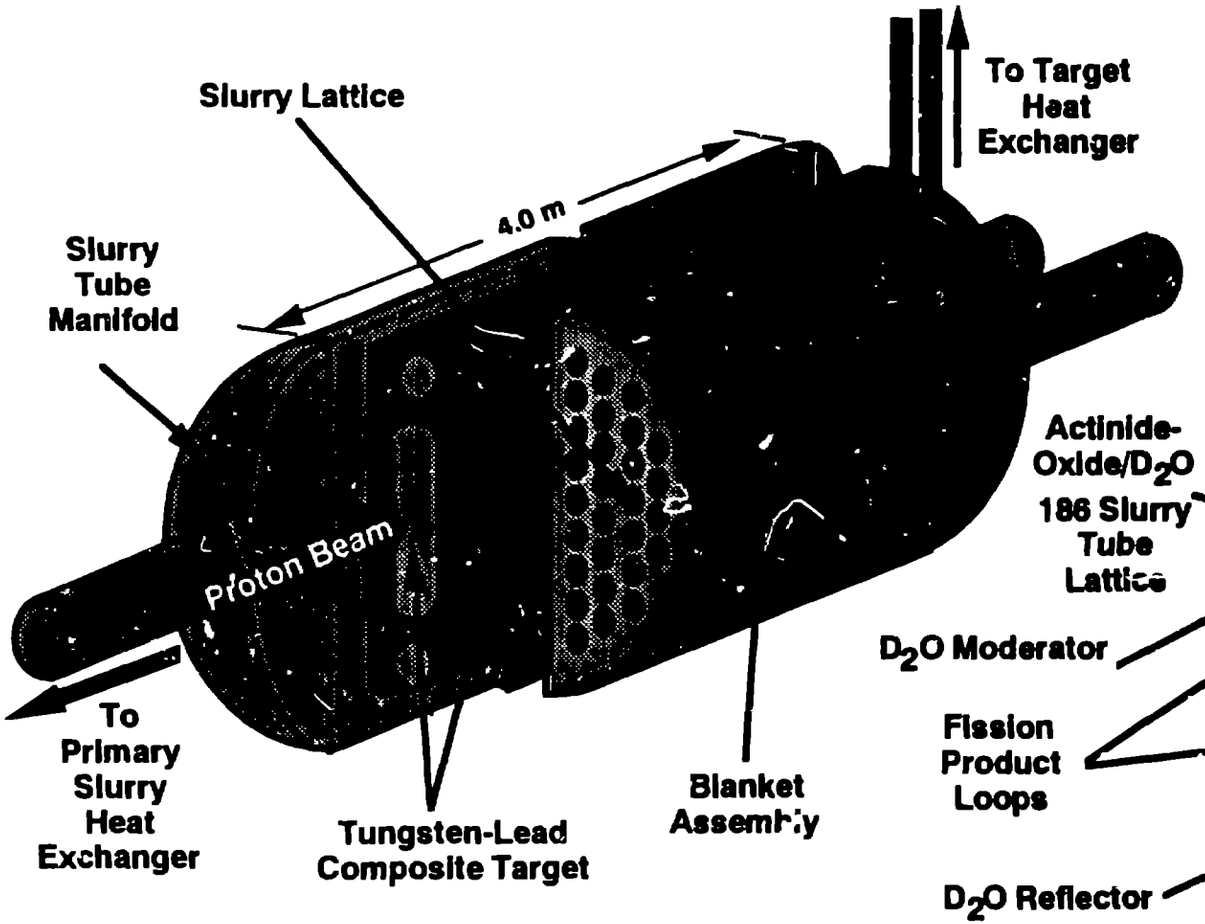
Target and Blanket Approaches



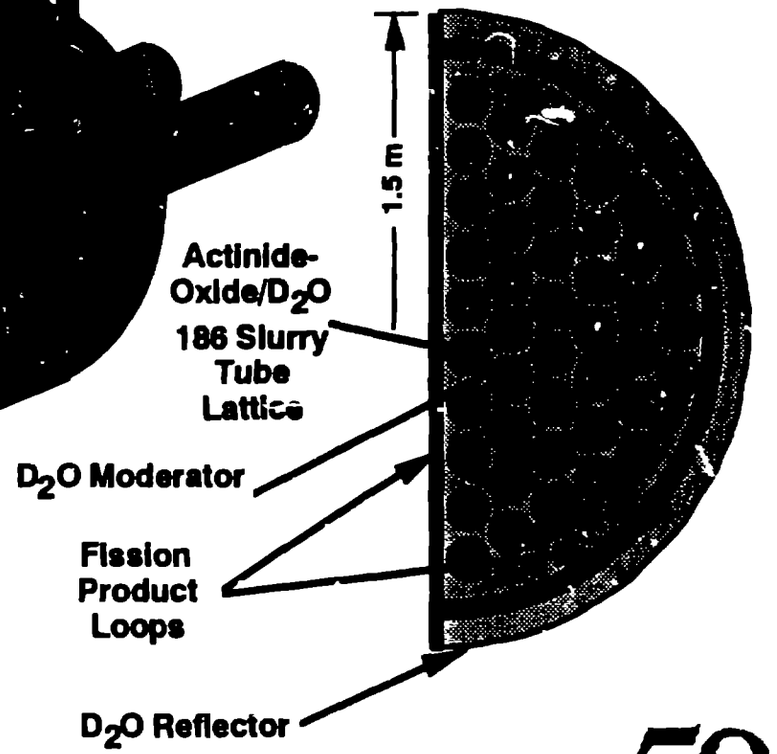
Technical Approach	Aqueous (Reference)	Non Aqueous (Advanced)
Target	Solid Tungsten/ Lead	Flowing Metal
Multiplying Blanket		
Moderator	D_2O	Graphite
Fluid Fuel	Oxide Slurry	Molten Fluoride Salt
Features	Allows concept "existence proof"	Superior neutronics, economics
Separations	Demonstrated	Advanced

AQUEOUS-BASED ATW /ABC TARGET-BLANKET CONCEPT

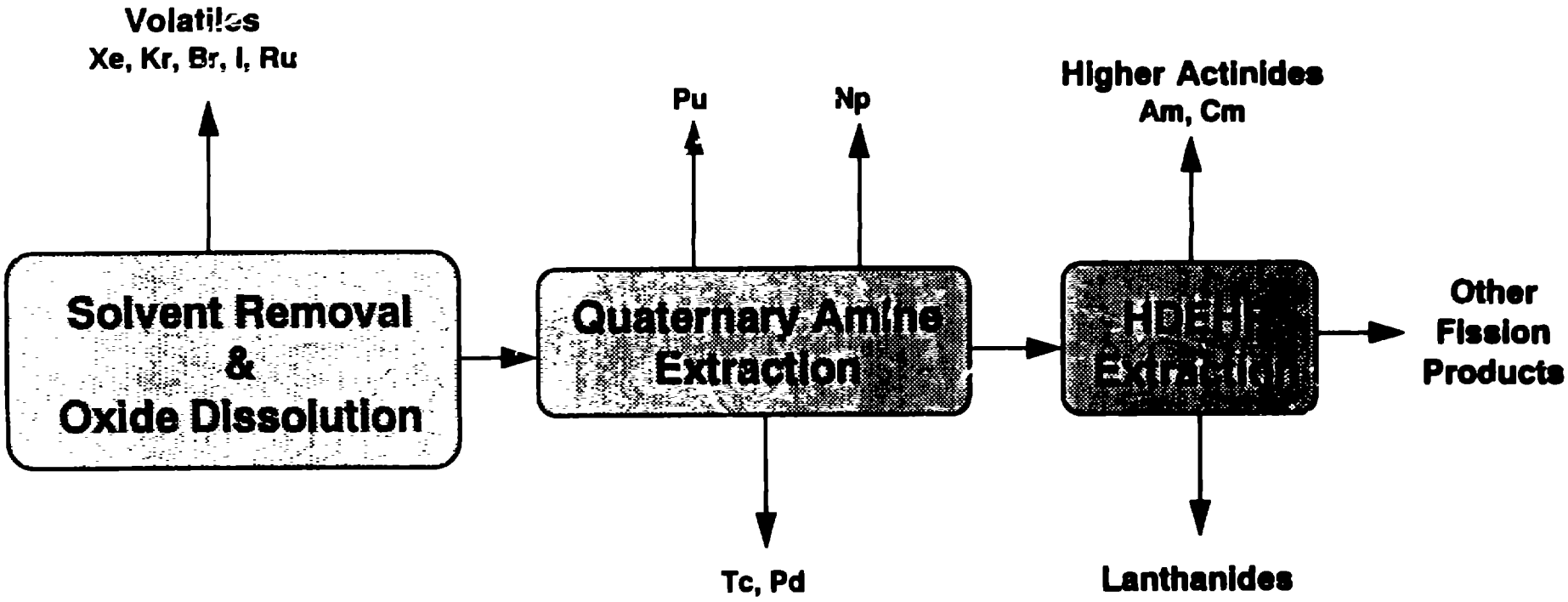
Target-Blanket Configuration



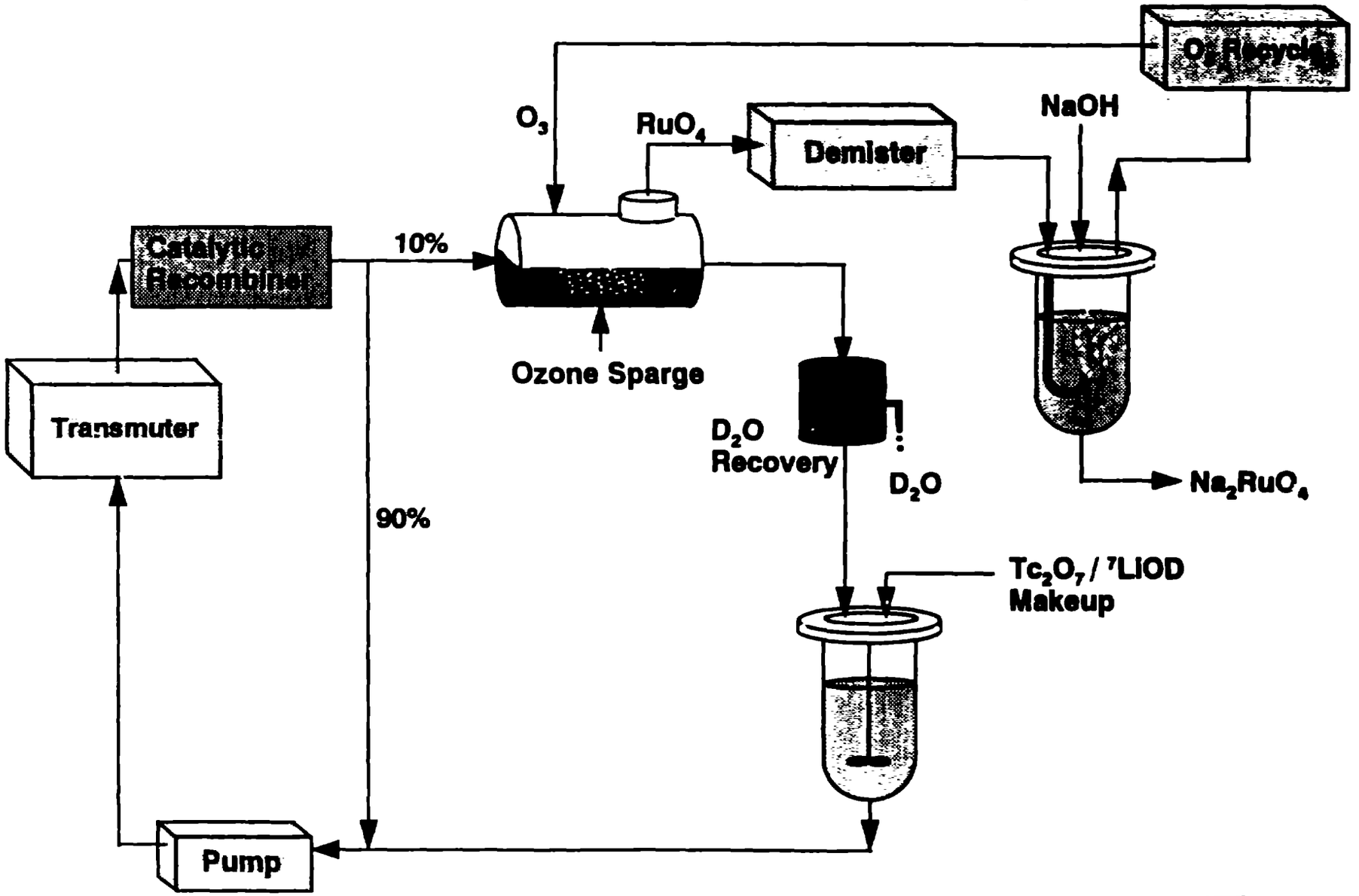
Blanket Actinide Slurry Lattice and FP Loops



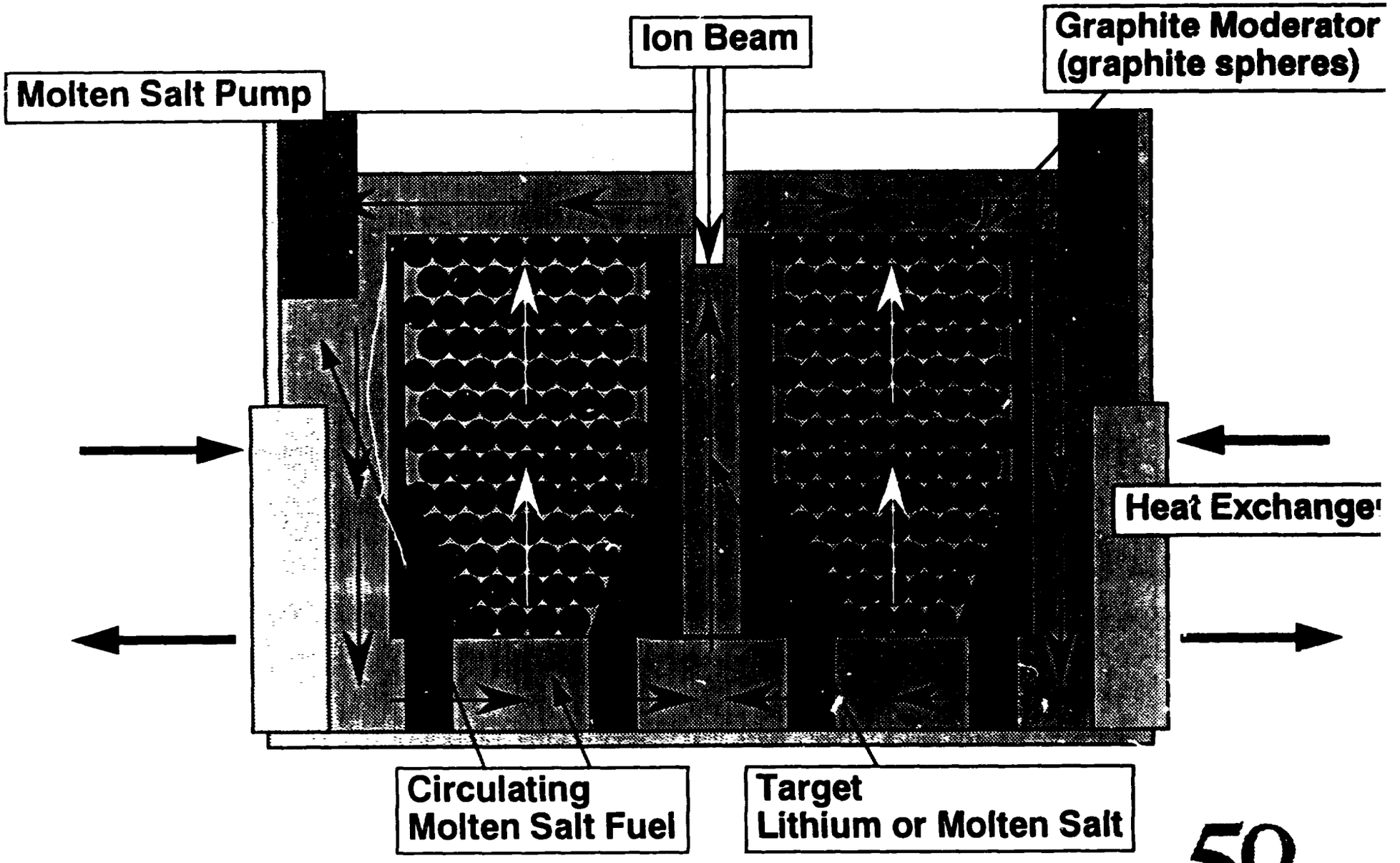
Example of an Aqueous Approach to ATW Separations



Ozonolysis Option for Tc/Ru Separation



Schematic layout of the non-aqueous target/blanket assembly



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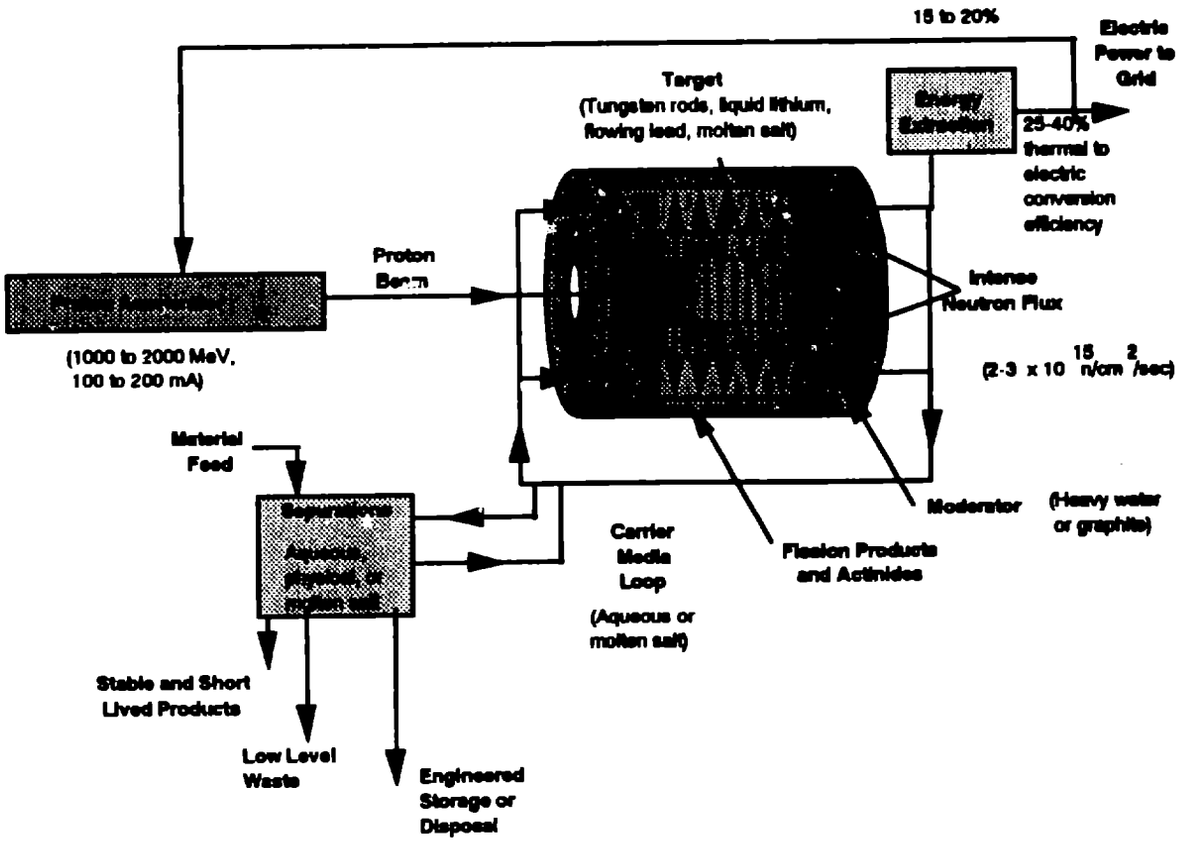

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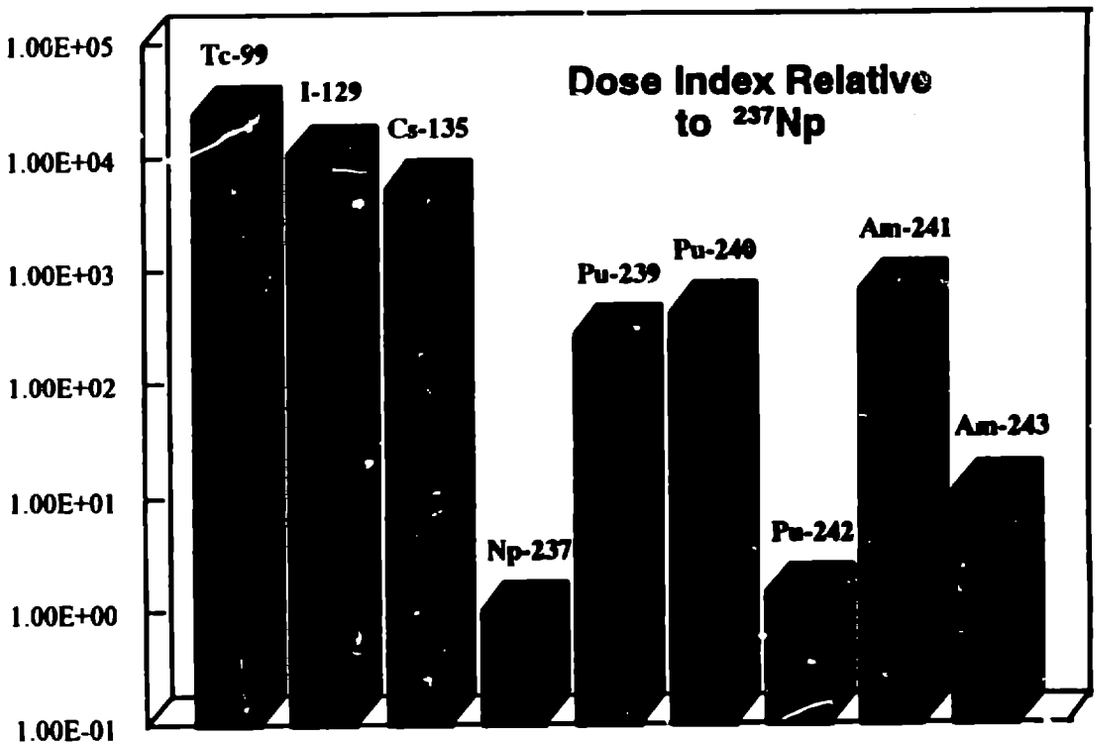

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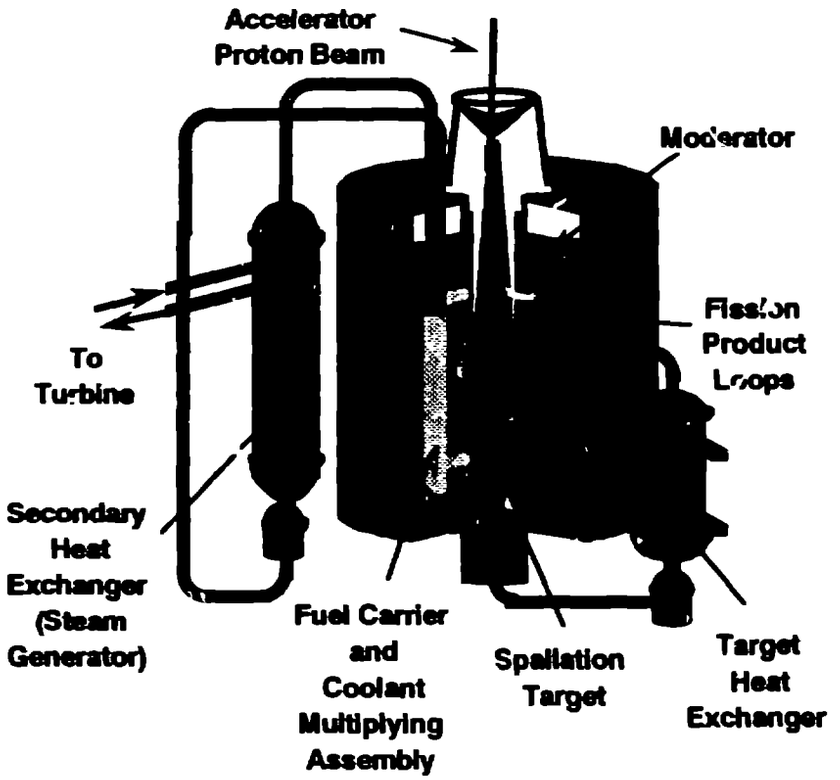

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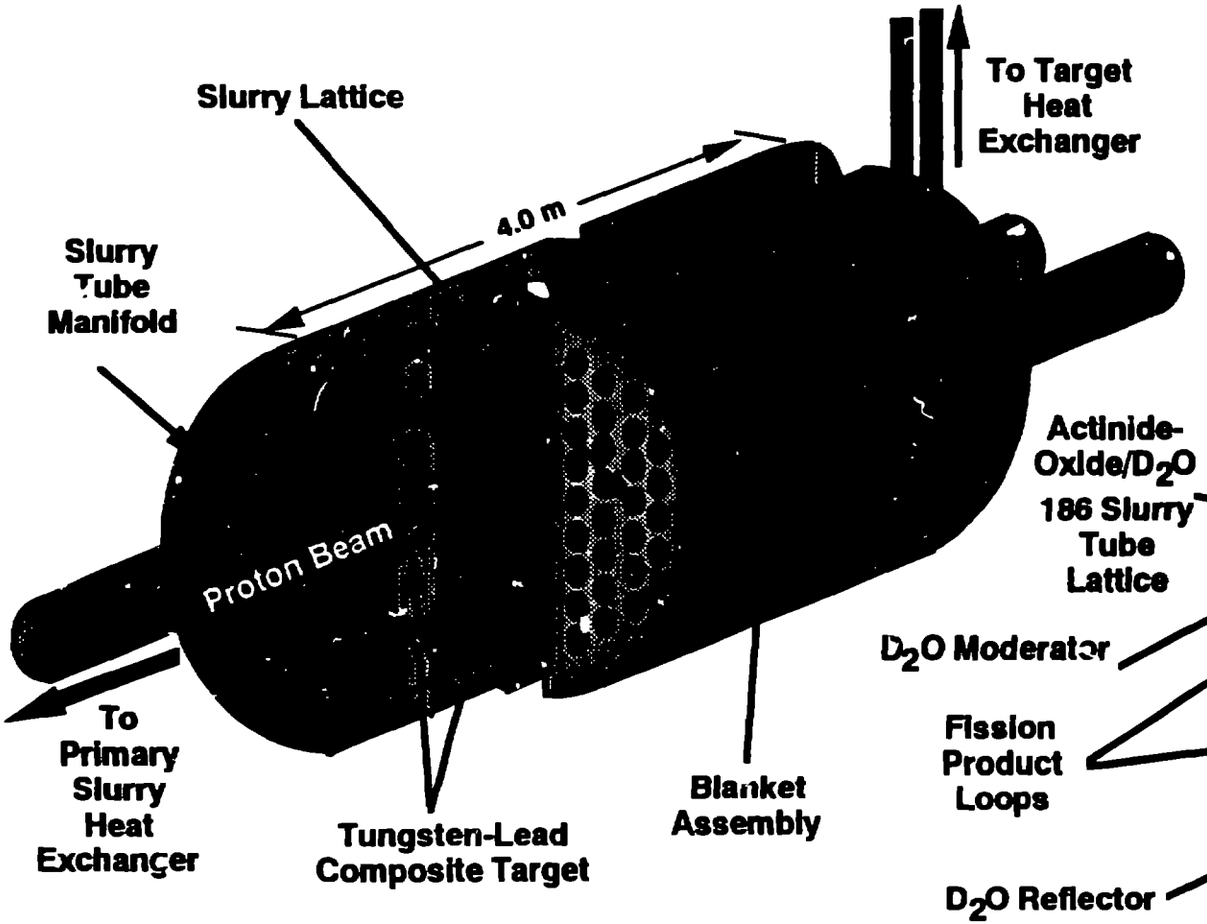

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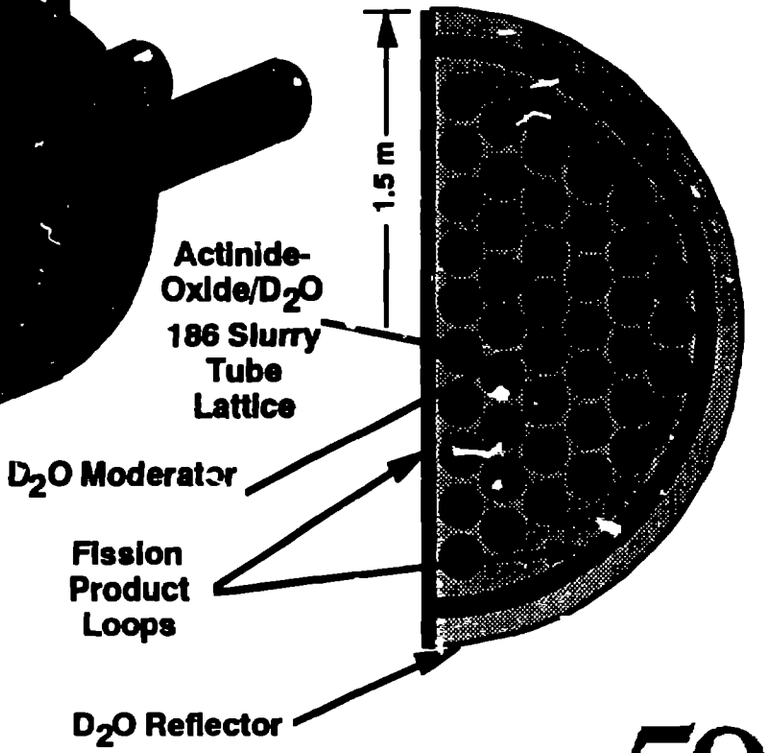

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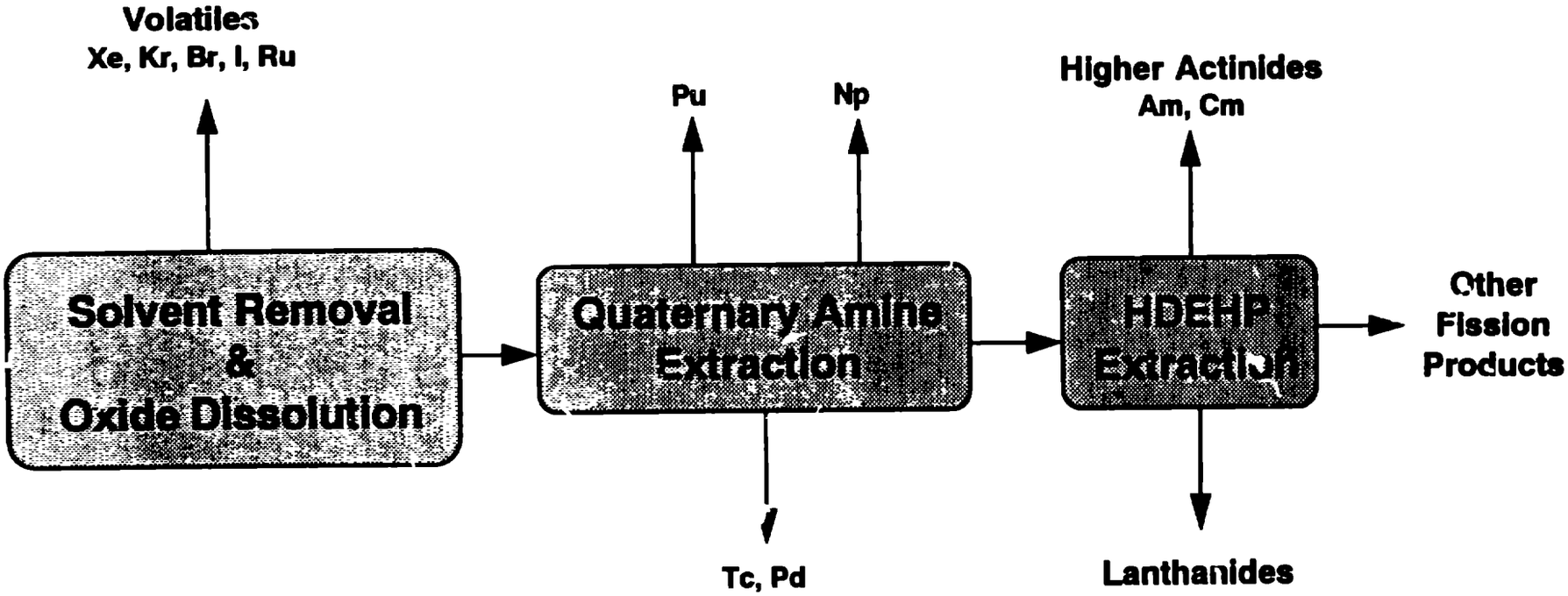

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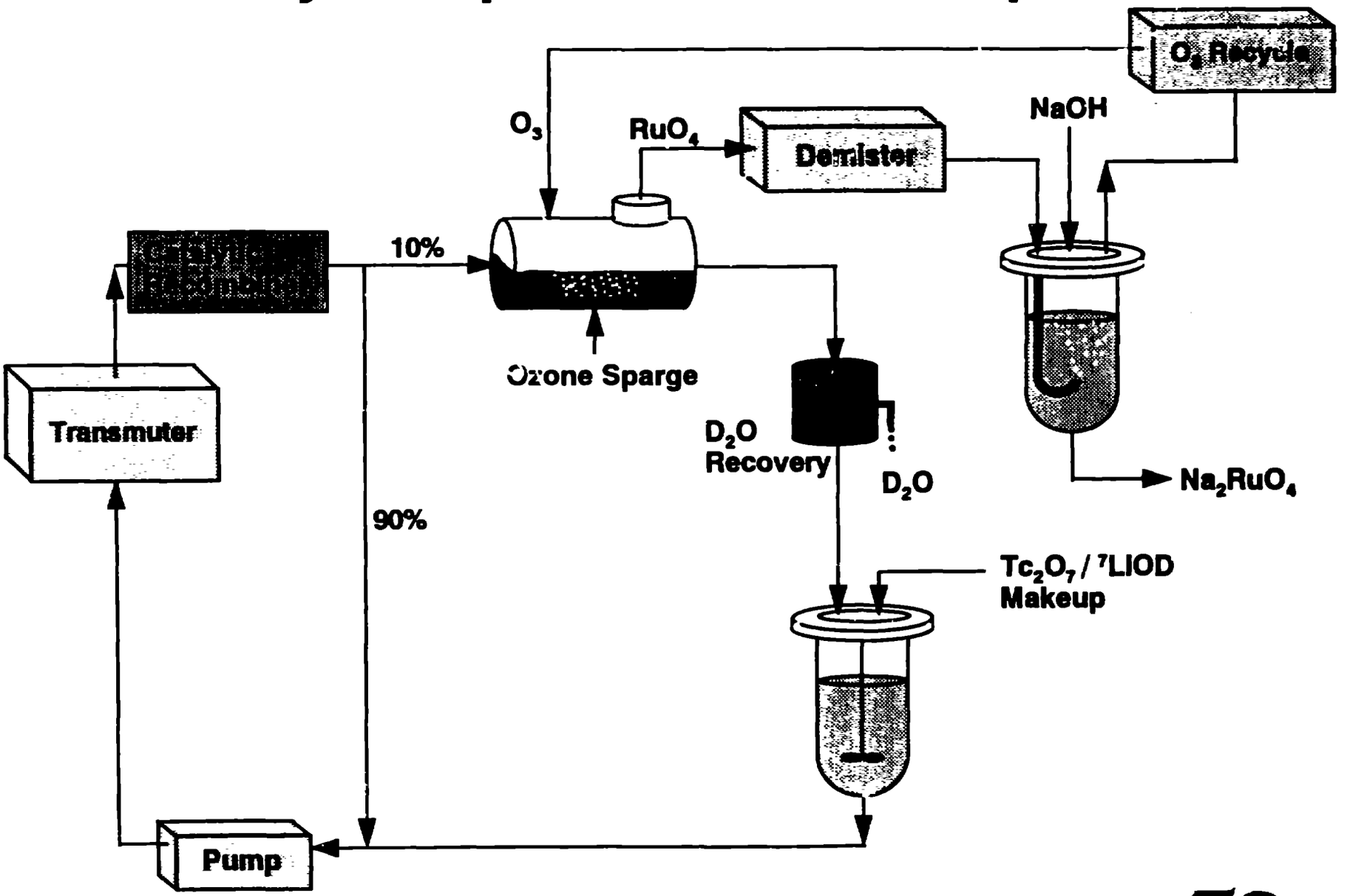

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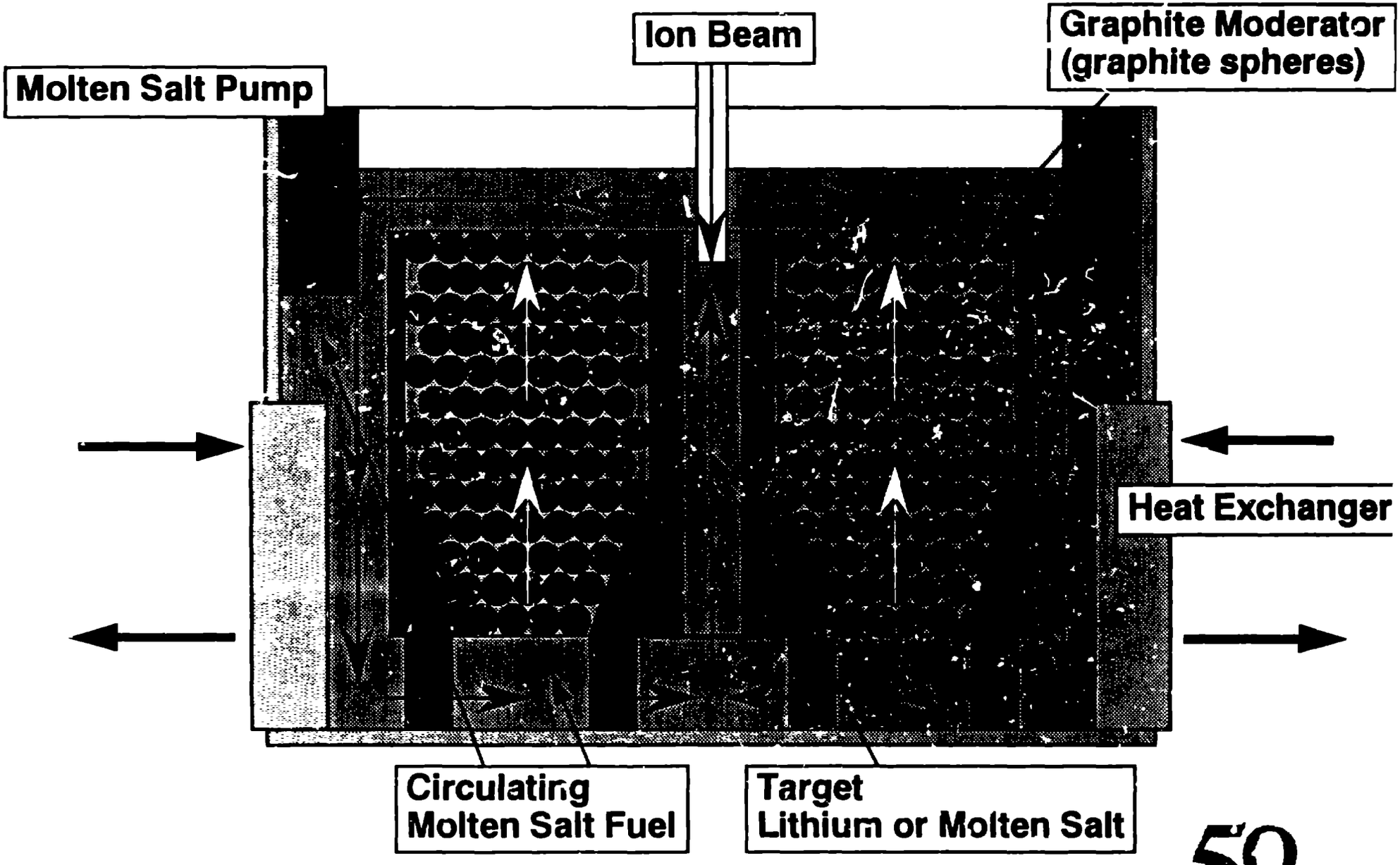

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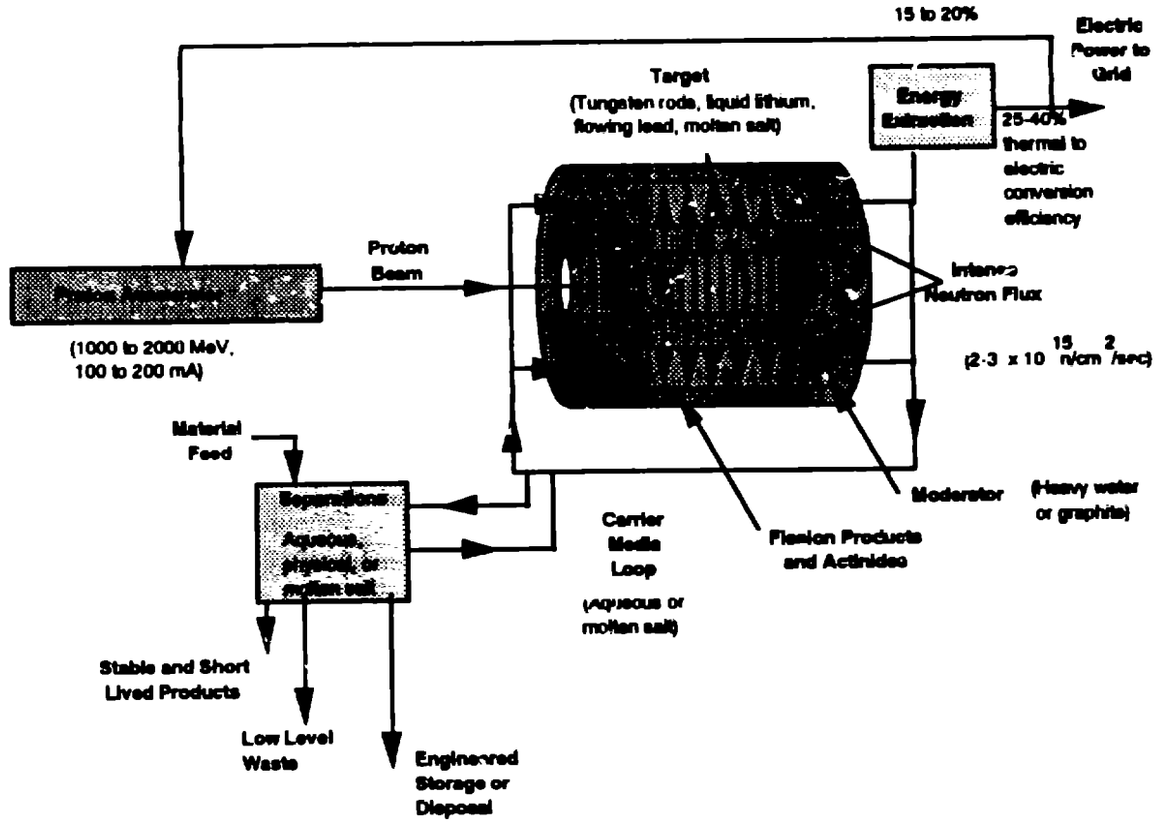

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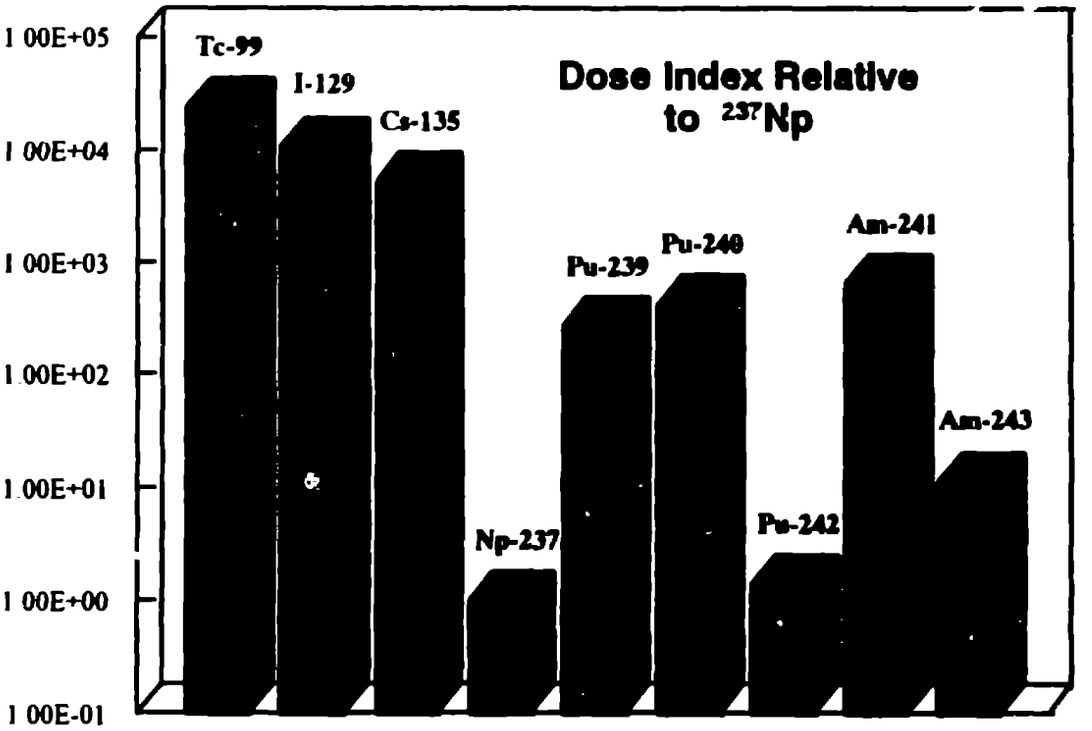

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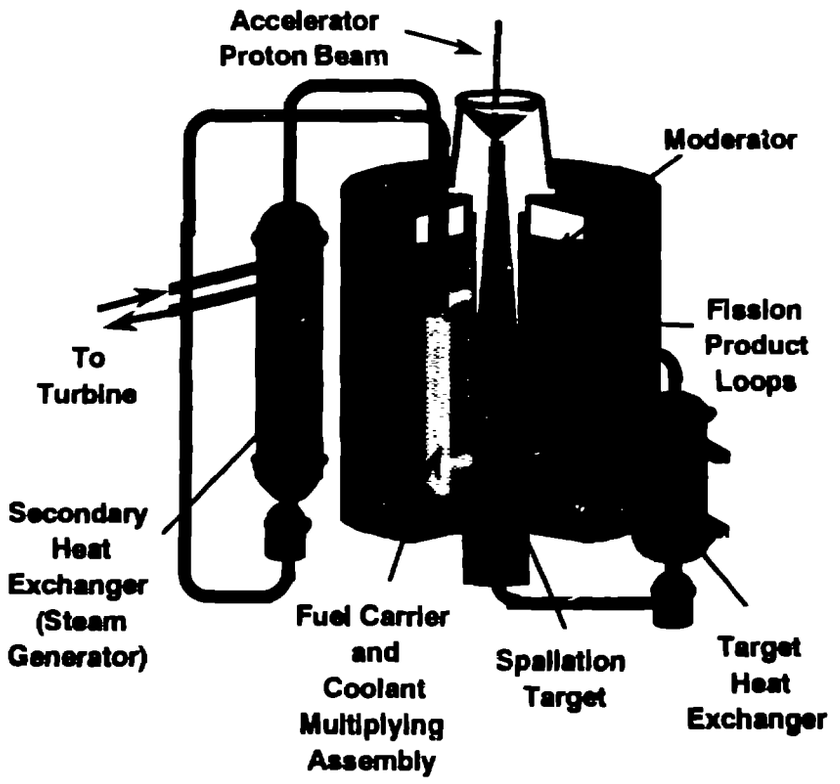

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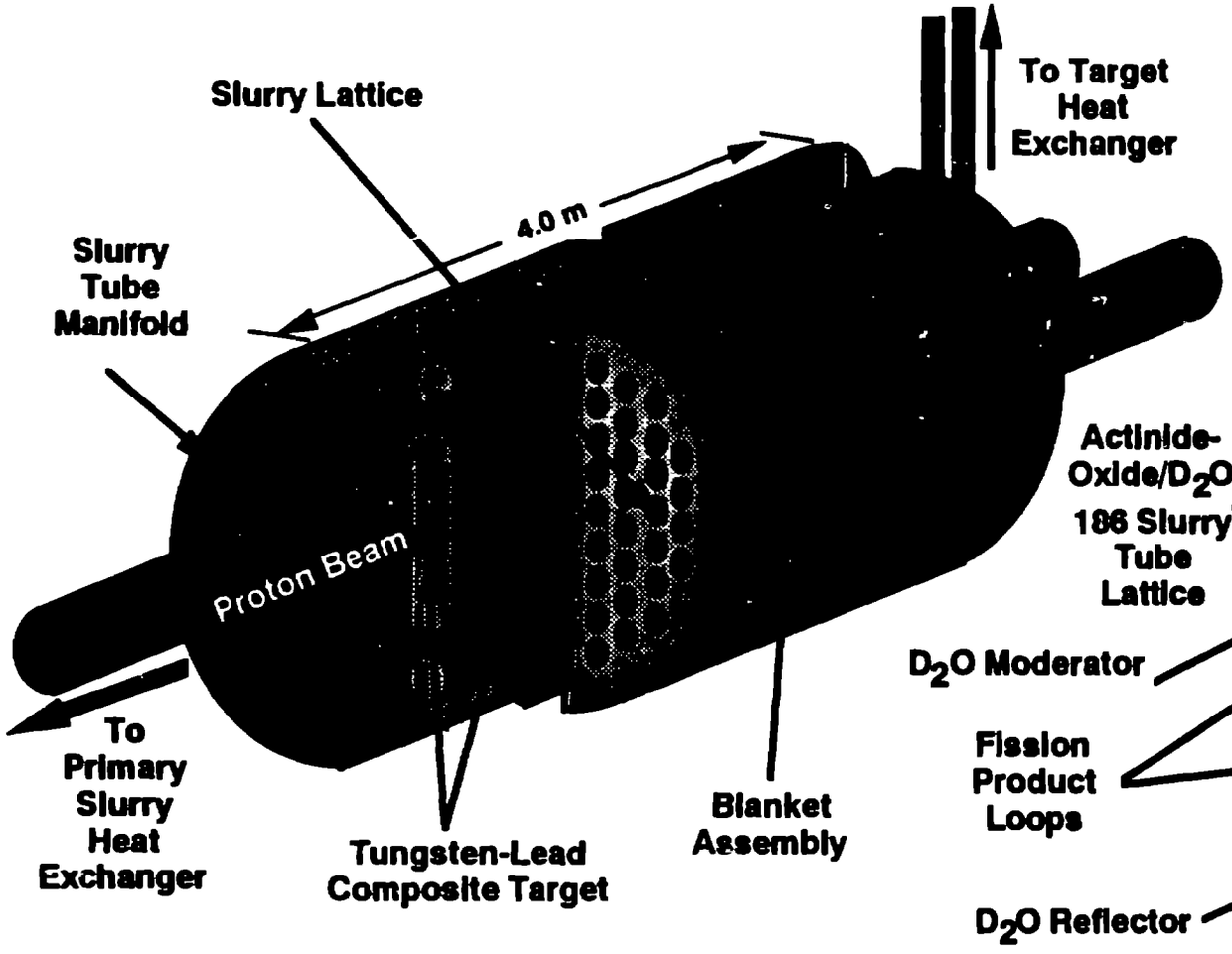

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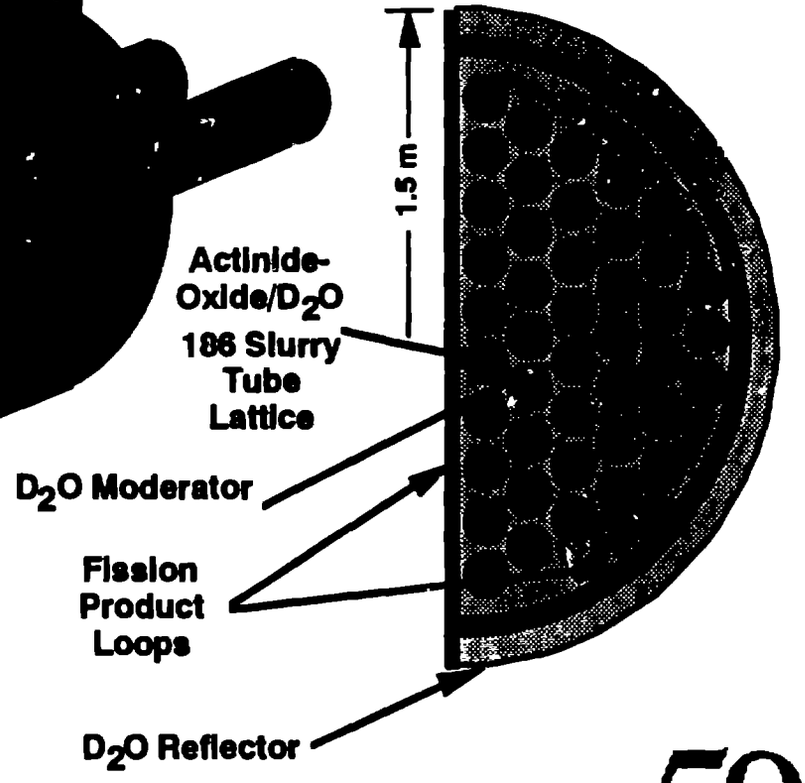

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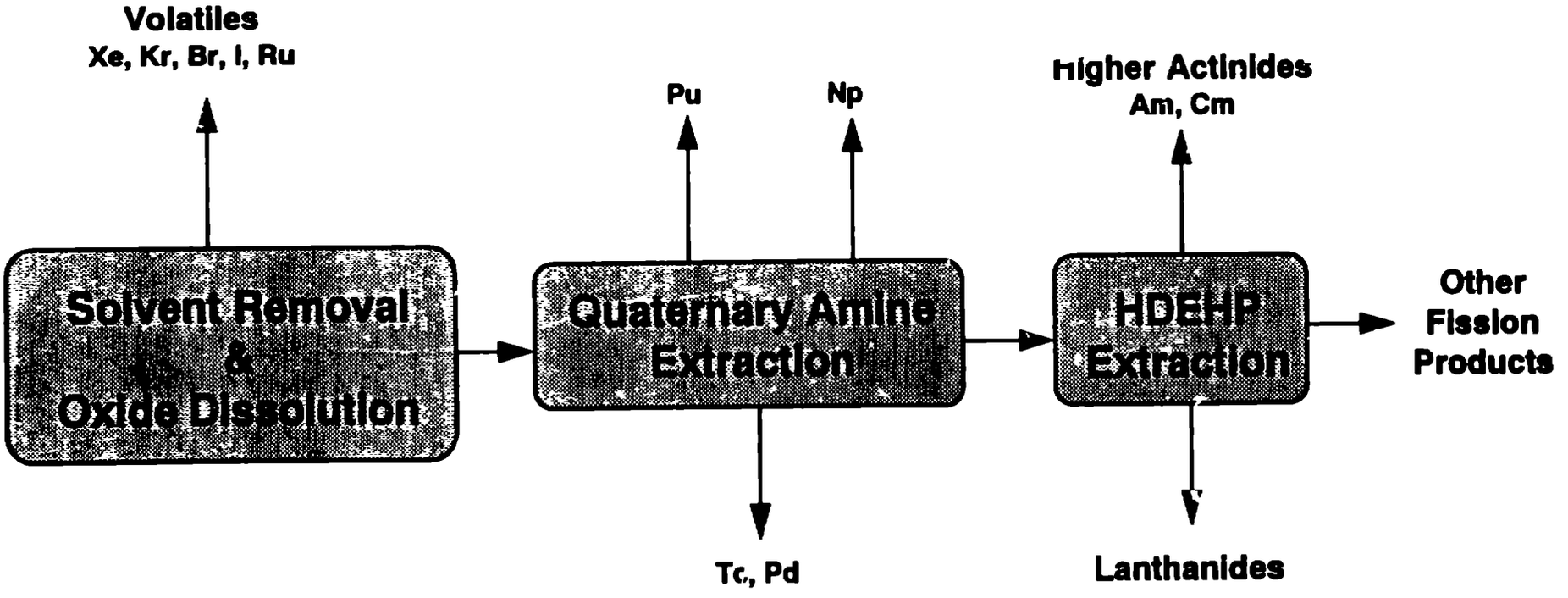

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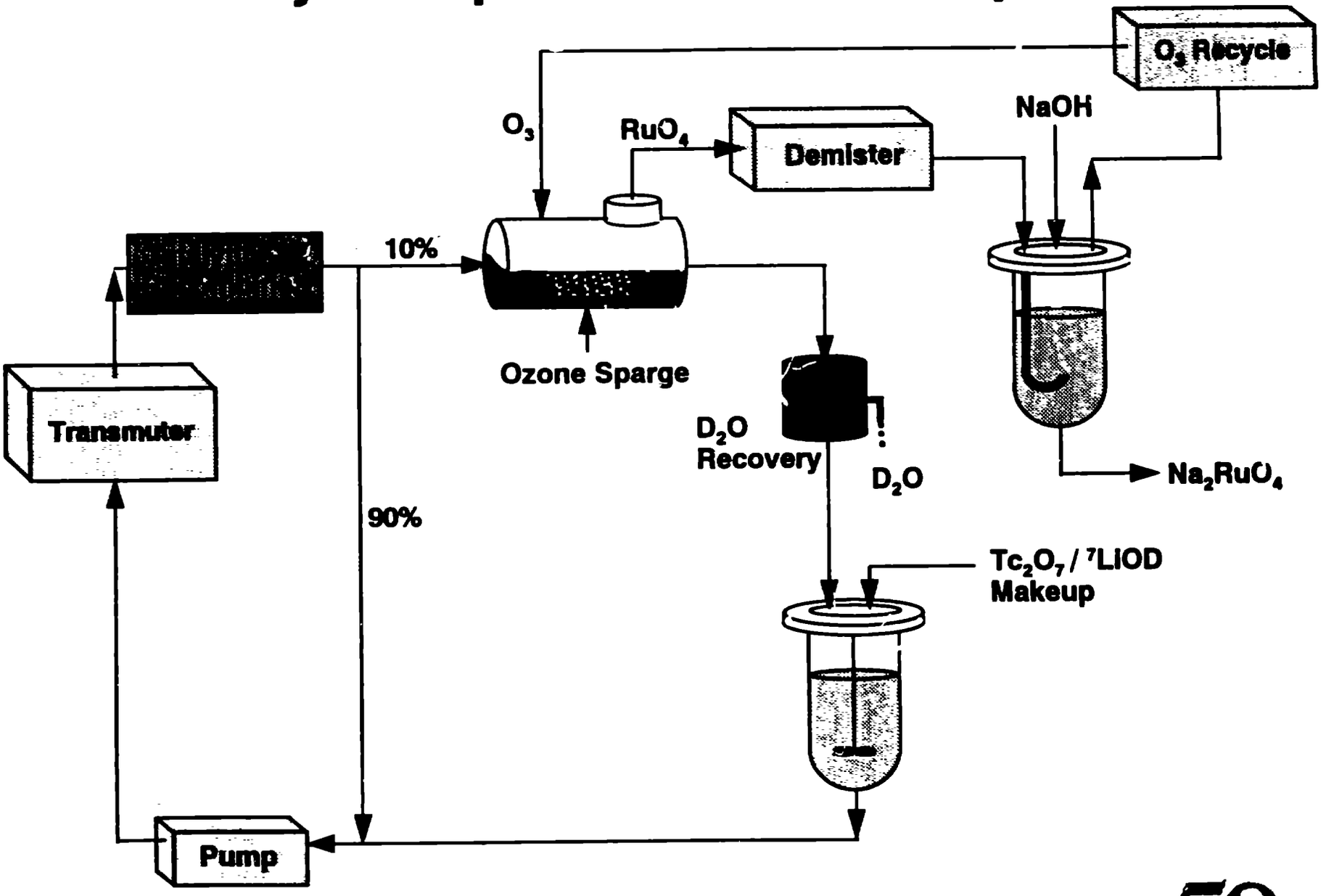

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