1. INTRODUCTION

2. THEORY

2.1. Fundamentals of Nuclear Fusion

2.2. Neutron Transport and Interactions

2.3. Tritium Breeding and Neutron Multiplication

3. LITERATURE REVIEW

3.1. The D-T Reaction and the Tritium Fuel Imperative

3.2. Breeder Blanket: Concept, Function, and Evolution

3.3. The Role of Neutron Multipliers

3.4. Major Breeder Blanket Architectures (Bullet Point to Subsection Demo)

Blanket designs are broadly divided into two categories—liquid and solid—based on the phase of the lithium-bearing breeder material.

3.4.1. Liquid Breeder Concepts

Liquid breeders (LBs) are attractive because the breeding medium can simultaneously function as the coolant, simplifying the design and allowing for continuous tritium extraction outside the reactor [1].

3.4.1.1. Lithium-Lead (Li–Pb):

This is one of the most mature concepts, typically using the eutectic alloy $Li_{17}Pb_{83}$ [2, 3]. The lead acts as both a neutron multiplier and the primary component of the alloy, while the eutectic composition provides a low melting point, which is crucial for circulation [2]. This concept is the basis for the **Dual-Cooled Lithium-Lead (DCLL)** blanket, a primary candidate for the European DEMO reactor [4, 5]. A key challenge for all liquid metal blankets is magnetohydrodynamics (MHD), where the strong magnetic fields of the tokamak induce currents in the flowing metal, creating a drag force that inhibits circulation [5].

3.4.1.2. Molten Salts:

An alternative LB concept uses molten fluorine or chlorine salts. The most prominent example is **FLiBe** ($\mathbf{2\,LiF \cdot BeF_2}$), which advantageously combines the breeder (LiF) and multiplier (BeF_2) into a single, low-conductivity fluid [1]. This is the reference design for the **Affordable Robust Compact (ARC)** reactor concept from MIT [6, 7, 8]. A wide variety of other salt compositions, including $LiF \cdot PbF_2$ and novel chlorine-based salts, are also under investigation to optimise breeding, temperature, and material compatibility [9, 10].

3.4.2. Solid Breeder Concepts

4. METHODOLOGY

5. RESULTS

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