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'COMBINED BREEDING AND THERMOFLUID CYCLE FOR USE WITHIN A FUSION REACTOR CORE'

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SUMMARY

Nuclear fusion energy faces many challenges concerning maximizing the potential output of energy and making it an efficient way of energy transfer into usable in our everyday lives. In a fusion reaction, the mass of products is smaller than the mass of its reactants. This difference is converted into energy, having a tremendous amount of energy, according to Einstein's equation $E=mc^2$. Requirements for fusion here on earth are challenging to obtain because of the energy barrier of electrostatic forces, which must be overcome to accomplish the main objective. Three main conditions are required for a controlled fusion energy reactor: high temperature, high pressure, and controllable magnetic confinement. The temperature must be hot enough (around 100 million Kelvin) for deuterium and tritium ions to overcome the Coulomb barrier by having the necessary kinetic energy and fuse together. In this state, plasma transition occurs which all the electrons are stripped from the hydrogen atoms and move freely around fully ionized. High pressure is the main requirement because for the hydrogen atoms to be fused, they must be at an incredibly small distance together, and pressure alternation makes this possible along with the high temperature. This heating and pressure empowerment in a reactor core need to be controlled as the conditions happening could not be withstander by any means of earth materials. When the gas turns into plasma, magnetic confinement made by superconducting magnets gets pressed, allowing for fusion to occur; therefore, these requirements and conditions for fusion energy to happen to bring many challenges to the structural materials to withstand the terms of such state. Structural elements and functional materials must have the radiation resistance and the required level of integrity, respectively. This case study focuses on a preliminary design for a fusion reactor's helium-cooled, solid breeder coolant. The aim and objectives are given and the project approach to gain a deeper understanding of how everything was monitored. A literature review is given, a brief history of time in nuclear fusion reactors, and examples of existing technology, including tokamaks. Information about tritium and tritium breeding blankets is also included. The design work was mainly focused on neutronic, thermal aspects using a helium coolant.