High temperature superconductors (HTS) open high field design space - ARC: A compact, high-field, fusion nuclear science facility and demonstration power plant with demountable magnets


Abstract

The Affordable, Robust, Compact (ARC) reactor conceptual design aims to reduce the size, cost, and complexity of a fusion power plant. ARC is a 260 MWe tokamak reactor with a major radius of 3.3 m, a minor radius of 1.1 m, and an initial internal magnetic field of 9.2 T. Rare Earth Barium Copper Oxide (REBCO) superconducting toroidal field coils with joints to allow disassembly, allowing for removal and replacement of the vacuum vessel as a single component. External current limiting and internal launched ICRF power is used to provide a robust, steady state operation. ARC uses an all liquid blanket, consisting of low pressure, slowly flowing Fluorine Uranium Lanthanum (FUEL) salt. The liquid blanket acts as a working fluid, coolant, and tritium breeder, and minimizes the solid material that can become activated. The large temperature range of FUEL allows for fully liquid blanket operation at 800 K with single phase fluid cooling and a high efficiency Brayton cycle.

Plasma Core Scenario

High field allows easy to fully non-inductive and achieve high field configuration suitable for FNSF mission

High magnetic field enabled by high temperature, Rare Earth Barium Copper Oxide (REBCO) superconductors

- Compact design (same fusion power as ITER at 1/7 the volume)
- All-liquid, molten salt (FLiBe) immersion blanket
- Vertical maintenance scheme makes liquid immersion blanket a single, replaceable component
- High field enables efficient RF current drive

References


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