COMPACT TOKAMAKS AS CONVENIENT NEUTRON SOURCES FOR HYBRID REACTORS

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The future possible expansion of nuclear power would involve a solution to burn the long half-life transuranics (TRU) in the spent nuclear fuel discharged from LWRs. D-T fusion neutron sources sufficient to drive sub-critical advanced reactors can be an answer to this need.

A tokamak neutron source could be designed and built soon, extrapolating present designs of fusion tokamaks, paying attention to some additional R&D, such as emphasize quasi-steady state operation, disruption avoidance, component reliability, materials, etc. as well as selected tokamak physics and technology advances.

A sub-critical advanced burner reactor with a fusion neutron source (a "fusion-fission hybrid") will be more complex and expensive than a critical version of the same reactor. A principal advantage of a sub-critical reactor with a variable strength neutron source is that it can achieve deeper TRU fuel burnup (fuel residence time limited by materials damage rather than criticality) and thus require significantly fewer complex and expensive fuel eprocessing/refabrication steps. A second advantage of sub-critical operation is that it substantially increases the margin of safety (to prompt critical) for accidental reactivity insertions.

Most of the neutrons in a subcritical transmutation reactor would be created by the fission process in the reactor, and the role of the fusion neutron source would be to provide a modest number of neutrons to maintain the neutron fission chain reaction; therefore the requirements on fusion power level, power density, and neutron and thermal wall loads is less demanding than for a pure fusion electric power reactor.

Compact high-field tokamaks can be a candidate for being the neutron source in a fission-fusion hybrid, essentialy due to their design characteristcs, such as compact dimensions, high magnetic field, flexibility of operation, etc.

This study address the development of a tokamak neutron source for a hybrid reactor using Ignitor-based technologies. Ignitor is a proposed compact high magnetic field tokamak, aimed at reaching ignition in DT plasmas and at studying them for periods of a few seconds. Revision of its operating parameters in order to act a as a suitable neutron source in a hybrid reactor are discussed and a new operating scenario is proposed.

The Ignitor-based tokamak source has a longer plasma discharge length, operates at lower magnetic field values, and does not reach ignition: however, its neutron production is estimated to be fully sufficient for an experimental hybrid reactor.

Features of the tokamak neutron source are illustrated and preliminary results are discussed.