The role of the University of Washington (UW) component of the FRC Critical Issues study is program is to offer support on the plasma physics modelling aspect of the engineering systems study conducted at the University of Wisconsin under the direction of John Santarius. The Redmond Plasma Physics Laboratory, affiliated with the UW, is the site of the leading FRC experiment and theory programs in the world. The primary areas where plasma modelling has been needed for the critical issues study are (1) quasi-analytic description of FRC equilibria, and (2) properties of rotating magnetic field current drive in FRCS. The following is a brief summary of the various FRC plasma characteristics that were supplied to the engineering team at Wisconsin.

(1) FRC equilibrium description

A quasi-analytical description of 2D \((r,z)\) FRC equilibria was constructed. These are not true equilibria but are accurate enough for the purpose of understanding how the FRC interacts with the reactor engineering aspects. These \textit{quasi-equilibria} are an extension of the familiar “rigid rotor” equilibria (a 1D concept) by: (a) admitting a more flexible radial structure; and (b) introducing a “reasonable” axial structure. Missing from these equilibria is flow, which may be an important feature of relaxed FRCS but should have a modest effect on the bulk equilibrium properties.

The properties of these quasi-equilibria have been characterized in terms of several key parameters: radial size parameter; elongation; separatrix beta; and edge layer relative thickness parameter. Reasonable values and ranges for these parameters based on experience with FRC experiments were identified.

In addition to the equilibrium properties, the confinement scaling properties of FRCS were also characterized. Since the underlying physics of FRC transport is not yet well understood, these properties are based on extrapolations from published empirical confinement times for FRC experiments.

(2) Current drive

Experiments are currently in progress on the STX and TCS facilities at Redmond Plasma Physics Laboratory (University of Washington) to investigate the current drive characteristics of rotating magnetic field (RMF) current drive. Heretofore the understanding of RMF is based on low-temperature experiments in “rotamak” devices. There is also an emerging body of RMF theory, largely through studies by Steinhauer and others at Washington. The main element of RMF current drive needed for the reactor
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engineering study is the power consumed by the current drive system. This was analyzed, accounting both for the power consumption due to the plasma resistivity and by losses in the RMF antennas.

Publications and Presentations from the Critical Issues Study

Publications to date


Presentations


Additional papers in preparation

C.N. Nguyen et al., "Systems Analysis of a D-T Field-Reversed Configuration Power Plant."

E.A. Mogahed et al., "Engineering Design of a D-T Field-Reversed Configuration Fusion Core."

S.V. Ryzhkov et al., "Systems Analysis of a D-^3He Field-Reversed Configuration Power Plant."