COMMENTS

The editorial staff of *Fusion Technology* (*FT*) is very pleased that this special issue on compact toroids (CTs) has developed. The fusion community has had a growing interest in CTs because of their potential for development of unique, attractive reactors. The magnetic configuration, with a large portion of the magnetic field produced by plasma currents, makes possible a high plasma beta, hence a higher power density. This, combined with the fact that CTs do not require a solid center post (as is used for ohmic current drive in a tokamak), allows for "compact" plasma configuration (hence the name "compact torus"). Further, the magnetic field configuration, by virtue of having closed inner-field lines, creates good plasma confinement while the open outer-field lines automatically provide an effective divertor action.

Although the reactor embodiment of the CT appears attractive, the present concern is that the physics data base is not yet sufficient to ensure the scalability of CTs. Still, rapid progress has been made in recent years with aggressive experiments in several laboratories. This is apparent from papers in the present issue.

In their review of the large field-reversed theta pinch experiment at Los Alamos National Laboratory, FRX-C, R. Siemon et al. discuss transport studies that demonstrate an R^2 scaling, suggesting plasma leakage by diffusive processes. Experiments involving translation of toroids are also discussed. This work forms a basis for CT reactor concepts that involve translation through a burn chamber. In his review of spheromak experiments, M. Yamada discusses ongoing research that is directed at the development of improved magnetohydrodynamic (MHD) stability and plasma parameters. He points out that electron temperatures that exceed the low-Z radiation barrier have already been achieved, signaling the start of extensive studies of transport characteristics.

Energy-efficient formation techniques are essential for attractive operation, especially for pulsed operation where repetitive creation of the CT plasmoid is required. A. Hoffman et al. discuss experimental studies of the formation of field-reversed configurations (FRCs) based on a low-voltage technology that is particularly attractive for scale-up to reactor operation. They also review scaling laws for flux trapping and heating effectiveness as a function of the formation time scale and poloidal flux level. A. Janos and M. Yamada discuss possible formation techniques for spheromaks based on the S-1 experiment, which employs a flux core for inductive formation. They also consider possible current drive schemes for sustained operation.

The $n = 2$ rotational instability has long been a problem with theta pinch configurations. S. Shimamura and Y. Nogi review experiments where this rotation has been stabilized using a helical quadrupole field. They describe predictions of the critical field strength required for stabilization but point out that future work is needed to fully understand this phenomenon. Magnetic equilibrium for FRCs is a fundamental issue, both for steady-state operation and for dynamic operation as may occur during compression heating. Two-dimensional MHD equilibrium calculations are discussed by D. Shumaker, who compares his results with data from the FRX-C experiment.

Some schemes for reactor operation with CTs require magnetic compression for auxiliary heating. Along these lines, D. Wells et al. describe experiments where plasma vortex structures have been successfully heated to ion temperatures of ~6 keV with adiabatic compression.

It is hoped that the papers in the special issue will provide the readers with a comprehensive view of the present status and key problems in CT research. In the remaining papers in this issue, recent work on conceptual reactor designs is presented. R. Zubrin points out that a CT could potentially provide an attractive means of burning advanced fuels such as catalyzed-D and D-^{3}He. His optimism is based on the anticipated high beta and long confinement times. In their studies, M. Nishikawa et al. concentrate on the development of a CT reactor that offers rapid replacement of critical parts in the first wall and blanket. A key concept that they propose to allow quick replacement of structural components is the use of shape memory alloy couplings built of a special alloy so that the coupler reversibly expands at low temperature to release flange joints. If feasible, this approach would allow a relatively simple temperature control for connection and disconnection of joints. They also address the problems of heat removal and thermal electromagnetic stress associated with the high heat flux characteristic of high power density CTs.

Two CT reactor designs, one by G. Vlases and D. Rowe, and the second by A. Smith et al., provide specific examples of the translating plasmoid concept. Vlases and Rowe consider high beta, elongated, FRC plasmoids translated through a linear chamber with a helium-cooled, solid breeder blanket. The plasma transport model is based on an appraisal of recent experiments and the design attempts to minimize both the initial plasma energy and the temperature excursion in the blanket per pulse. Their studies include thermal-hydraulic and neutronic analyses for plants with sizes ranging from 300 to 1000 MW(electric) with burn chamber lengths ranging from 35 to 70 m and a circulating power fraction of ~16%. The design described by A. Smith et al. uses a coaxial plasma gun to inject plasma rings that undergo adiabatic compression to ignition while they are translated into the burn chamber. This concept uses three burn chamber stations whereby the plasma rings pause for one-third of the total burn time in each station. Tilt stabilization requires ~20% of the ring current as "fast" axis-encircling particles (injected separately into the ring). The blanket employs silicon carbide and Li_2 to minimize structural radioactivity to allow hands-on maintenance outside of the blanket. A closed-cycle helium gas turbine is used in a relatively small 100-MW(electric) prototype reactor. This prototype is envisioned as a follow-up to an earlier design for an 11-MW(electric) "pilot" unit.

With their high power density, CT reactors are especially vulnerable to problems of neutron damage to the blanket materials. These problems are considered by W. Terry and E. Paperman. They discuss four conceptual design studies for simplified blankets employing liquid-metal concepts to minimize structural damage. Their designs identify critical issues and form an evolutionary sequence of improved designs with increasing complexity.

I would like to deeply thank the authors of this special issue for their hard work that they put into the preparation of these excellent papers. This combination of papers on experimental status and reactor concepts provides a unique and important insight into the status and future directions in CT research.

Also included in this issue is an annual listing of reviewers of papers for *FT*. This listing includes persons who have reviewed articles in the special proceedings issues (Sixth Topical Meeting on the Technology of Fusion Energy and Second National Topical Meeting on Tritium Technology in Fission, Fusion and Isotopic Applications) as well as the standard *FT* volumes. The "behind the scenes" input from reviewers is extremely important to maintain the high standards of the journal. I have been particularly impressed with the constructive insights that a number of reviewers have provided. Indeed, it has not been uncommon for authors to ask me to thank reviewers for their help (since the reviewers for a particular paper remain anonymous, I must serve as a go-between in these instances).

In summary, the review process continues to run smoothly. Admittedly, some difficulties have arisen in specific cases, but these have generally been due to communication problems that could be worked out without hard feelings. The important point, though, is that the community of persons involved, i.e., the authors and the reviewers, has generally adopted a constructive attitude rather than one of adversary. Much credit goes to the reviewers listed in this issue along with the authors of papers over the past year.

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