OVERVIEW AND PROSPECTS FOR FUSION FISSION HYBRID SYSTEM DEVELOPMENT IN CHINA

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Nuclear energy is an economic and clean source of base load energy, which provides about 10% of the world's electricity today. Nuclear capacity will keep increasing to meet energy demand and climate change challenge as a competitive large-scale alternative to fossil fuels. However, there are challenges to make nuclear energy as a sustainable technology, such as low efficiency utilization of uranium sources, growing inventory of nuclear waste, nuclear safety issues and so on. Generation IV reactors have more advances in sustainability, economics, reliability and proliferation-resistance than conventional reactors. And fusion energy may also provide a potential solution to meet increasing global energy demand, but still needs further work before commercial applications.

Fusion-fission hybrid system is a highly promising approach as a bridge between fission and fusion energy development, by combining a fusion-powered core with a fission blanket shown in Fig.1. Meanwhile, hybrid system shares lots of vital technologies with fission and fusion reactors. For example, lead-based reactor technologies could be employed in both Generation IV fast reactor system and liquid PbLi blanket.

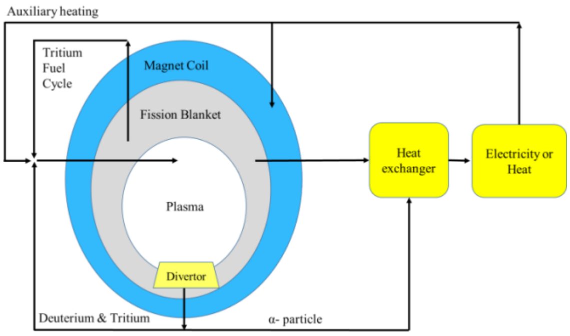

Fig.1. Schematic of fusion fission hybrid system

Hybrid system has many features, which can reduce the requirements of fusion facilities and achieve the early application of fusion energy. It also could solve the problems of fission energy by using the excess neutrons to transmute long-lived radionuclides and breed fissile fuels. Compared with fusion reactor, hybrid system is based on easy-achieved plasma parameters and can achieve higher tritium breeding ratio. Compared with current fission reactor, hybrid system has better sustainable features, more flexible fuel loading and can achieve deep burnup.

China has performed research on hybrid reactor for more than 30 years since the national Hi'Tech program ("863" program) started. The related research units include Chinese Academy of Sciences (CAS), China Academy of Engineering Physics (CAEP), Southwestern Institute of Physics (SWIP), and some colleges, etc. Multi-functional hybrid reactor concepts FDS-SFB and FDS-MFX were proposed as intermediate steps toward the final application of fusion energy. Except for conceptual designs, a series of R&D studies in blanket engineering and analysis software were performed, which included development of the China Low Activation Martensitic (CLAM) steel, the series liquid PbLi experimental loops (DRAGON), the High Intensity D-T Fusion Neutron Generator (HINEG), the Super Multi-functional Calculation Program for Nuclear Design and Safety Evaluation (SuperMC), etc. In this contribution, the progress of fusion fission hybrid reactor research has been summarized, and some suggestions for future development have been given.

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