Toroidal Reactor Designs as a Function of Aspect Ratio* **FT**

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This paper projects the technical and economic performance for superconducting (SC) and normal conducting (NC) coil toroidal designs as a function of aspect ratio (A). Based on the results from plasma equilibrium calculations, the key physics design parameters of β_N, β_p, β_T, and κ were fitted to parametric equations covering A in the range of 1.2 to 6. The parameters investigated include the physics parameters represented by ARIES-RS (A=4), ARIES-ST (A=1.6) designs and DIII–D D-T equivalent high Q discharges (A=2.74). By using ARIES-RS and ARIES-ST as the reference points, a fusion reactor system code in spreadsheet format was used to project SC and NC coil reactor designs over the same range of A. A bootstrap current fraction of 90% was assumed in the evaluation. The principal differences between the SC and the NC designs are in the inboard standoff distance between the coil and the inboard first wall, and in the maximum current density used for respective coil types. For protection from radiation damage, the selected inboard standoff distances for the SC and NC designs are 1.3 m and 0.25 m, respectively. Current densities of 15 MA/m^2 and 31 MA/m^2 were used for NC and SC designs, which are respectively similar to the ARIES-ST and ARIES-RS designs. Designs were evaluated for a range of average neutron wall loading (Γ_n) between 4 to 16 MW/m^2 and electrical power output in the range of 1 to 4 GWe. Results (Figs. 1 and 2) show that for Γ_n in the range of 4 to 8 MW/m^2 and an electrical power output of 2 GWe, the calculated cost of electricity (COE) is 68 to 62 mill/kWh. For SC designs, at constant power output, higher Γ_n and higher aspect ratio lead to lower COE. Aspect ratio of ≥ 3 is a reasonable choice for the 2 GWe design. For the NC design, the optimum aspect ratio is A=1.6, but A in the range of 1.4 to 2 would be acceptable, and re-circulating power rises significantly for A>2. These results comprise a technical and economic road map for SC and NC toroidal reactor designs. Furthermore, the methodology can also be applied to material testing and application devices, such as the burning of fission reactor actinide waste. Preliminary results on these applications will be presented.

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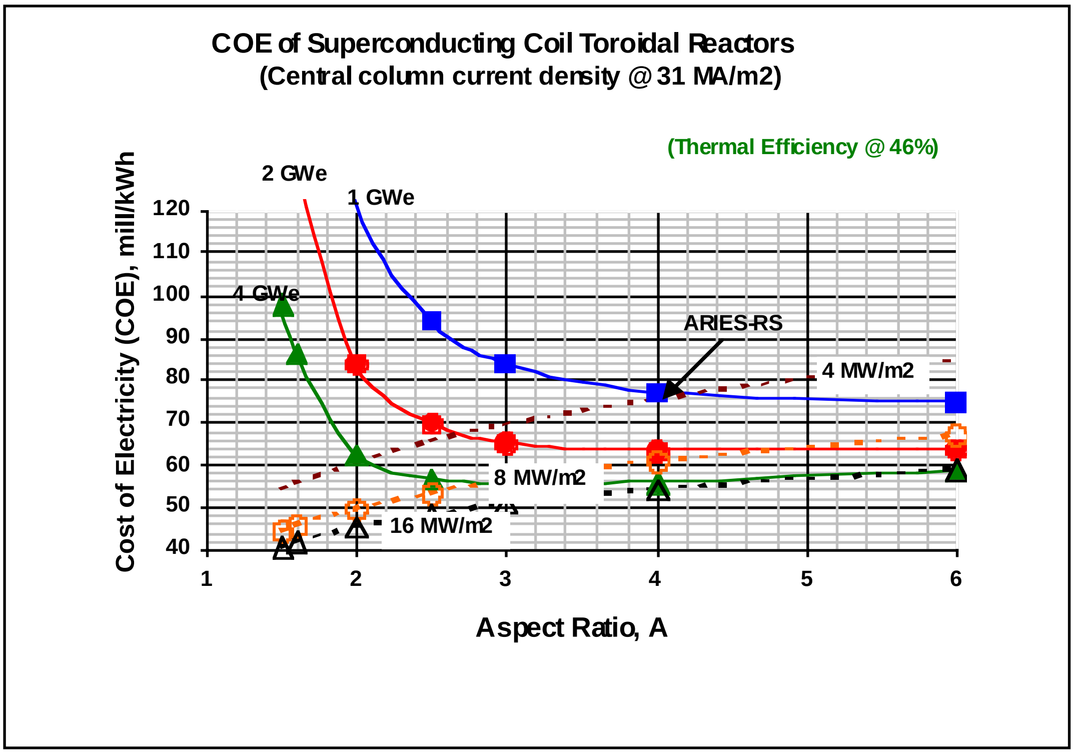

Fig. 1. Parametric results of superconducting coil toroidal reactor designs.

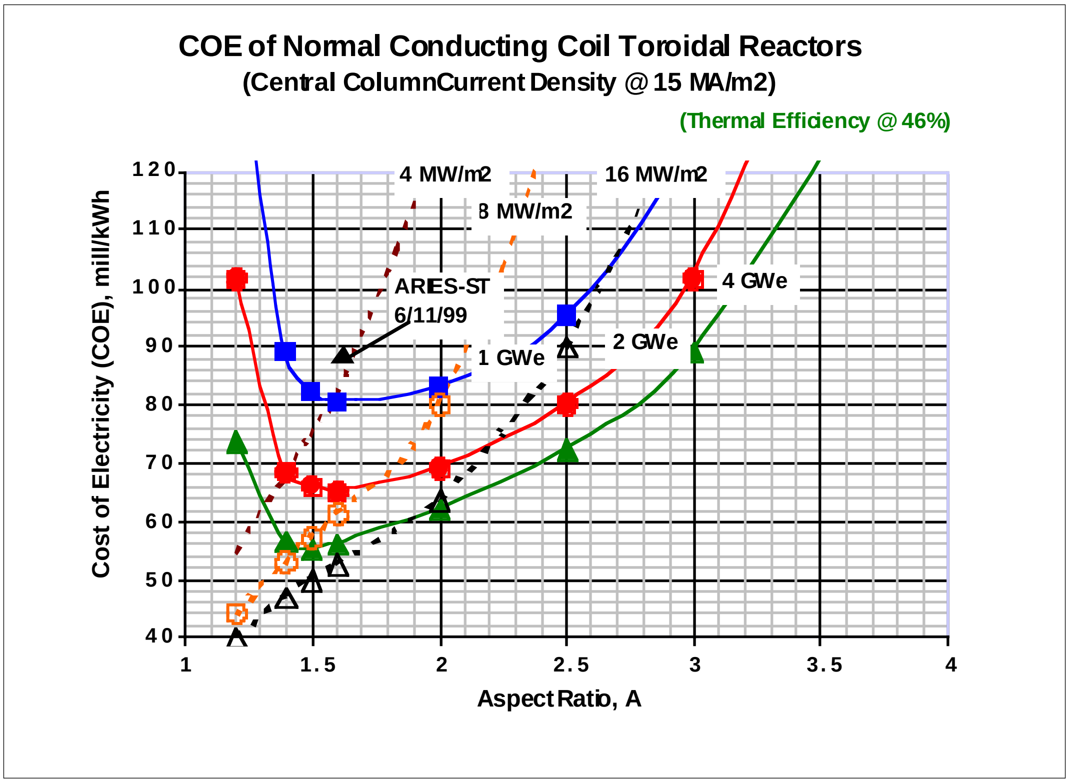

Fig. 2. Parametric results of normal conducing coil toroidal reactor designs.