Recent Progress in ARIES compact Stellarator Study

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The stellarator configuration space is quite complex because of the large number of independent physics parameters (*e.g.,* β, α loss, aspect ratio, rotational transform, shear, *etc.*) and engineering constraints (e.g., limited space between plasma and coil, magnet constraints like minimum bend radius and support structure, etc.). An integrated study of compact stellarator power plants, ARIES-CS, was initiated recently to to advance our understanding of attractive stellarator configurations and to define key R&D areas.

We explored several quasi-axisymmetric (QA) and quasi-helical configurations. Configurations with excellent QA have been found with A $\lesssim$6 (both 2 and 3 field periods are possible.) We reduced α losses to ~10% (still higher than desirable). Stability to the linear ideal MHD modes was attained in most cases but at the expense of reduced QA (and increased α losses) and increased complexity of the plasma shape. Recent experimental results indicate, however, that linear MHD stability limits may not be applicable to stellarators.

It appears that the minimum plasma/coil stand-off distance is not as an important a parameter as envisioned previously. By utilizing a highly efficient shield-only region in strategic areas, we were able to reduce the minimum stand-off by ~20%-30% compared to a uniform radial build. This would allow a comparable relative reduction in machine size. The device configuration, assembly, and maintenance procedures appear to impose severe constraints: Three distinct approaches were developed, each applicable to a certain blanket concept and/or stellarator configuration. Modular coils are designed to examine the geometric complexity and to understand the constraints imposed by the maximum allowable field, desirable coil-plasma separation, coil-coil spacing, and other coil parameters. We have developed a cost data basis for components with irregular geometry. A cost-optimization system code has also been developed and is utilized to assess the trade-off among physics and engineering constraints in a self-consistent manner.