

MODULAR COIL SYSTEMS OF ADVANCED STELLARATOR REACTORS

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Only one single super-conducting non-planar coil set is necessary to generate the magnetic field of an advanced stellarator reactor. This concept of modular coils offers a wide range for field optimization with respect to plasma performance. Two HELIAS configurations are considered; one similar to Wendelstein 7-X with 5 field periods and a major radius of 22 m and a more compact configuration with 4 field periods and a major radius of 18m. Both configurations uses 10 coils per period with 5 different coil shapes. The shapes depend on the magnetic field structure and on the distance between plasma and coils. The minimum distance is given by the thickness of blanket and shield and is an essential parameter for the size of the device. The winding packs with trapezoidal cross-sections are split in double pancakes which are wound on steel shells. The trapezoidal cross-section is used in order to reduce the maximum field strength at the conductor on the high-field side. The favoured choice is a Nb-Ti super-conductor because of the established industrial technology and good mechanical properties. Super-fluid helium at 1.8K is used as coolant to ensure safe operation at 10 T. More advanced conductors like Nb-Sn or Nb-Al offer higher magnetic fields at higher coolant temperatures. Their drawbacks are the lower technological development and brittleness. The magnetic force distribution in the coils is inhomogeneous and has radial and lateral components of about the same value. The coils tend to become more circular and planar under the magnetic load. Stiff coil housings with local reinforcements and a system of inter-coil support elements keep the resulting mechanical stress values within technical limits.