EFFECT OF PULSED OPERATION ON COIL STRESSES AND FATIGUE IN DEMO

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Consideration continues to be given to a pulsed version of a tokamak DEMO, in case steady-state operation, supported by current drive, is unattractive because of high recirculating power or low current drive reliability. One of the most important lifetime-limiting effects for a pulsed reactor, the effects due to pulsing magnets, is addressed here.

Pulsed operation imposes stresses with significant alternating components on all the coils. This paper analyses the effects of fatigue on the coils. (Fatigue of the superconductor itself is not discussed.) The TF coils are of great importance in determining the overall size and cost of the reactor, occupying valuable space in the central region, competing with the central solenoid and the breeding blanket. Initial work has therefore concentrated on the TF coils. In pulsed operation the Central Solenoid (CS) and some of the Poloidal Field (PF) coils reverse their current fully. The TF coil current remains constant, but the forces on the TF coil due to the CS and PF coils reverse.

The TF coil has been modelled as an approximate constant-tension D, with a vertical straight inboard leg. The coil consists of a winding pack, which includes the superconducting cable and its immediate support components, surrounded by a case (shown in the figure). The winding pack is modelled as a homogeneous component. The intercoil support structure has angled apertures for neutral beams (3 m x 1.5 m). Although gravity has not been taken into account, the gravity support is modelled in a simplified way to prevent unphysical vertical and toroidal movement. The parameters varied are: major radius of outer leg; winding pack width; case width; thickness of intercoil supporting shells; and total TF coil current. The form is simple to permit parameterization so that the results can be used in systems studies using codes such as PROCESS, but has been adjusted to reduce localized stresses.

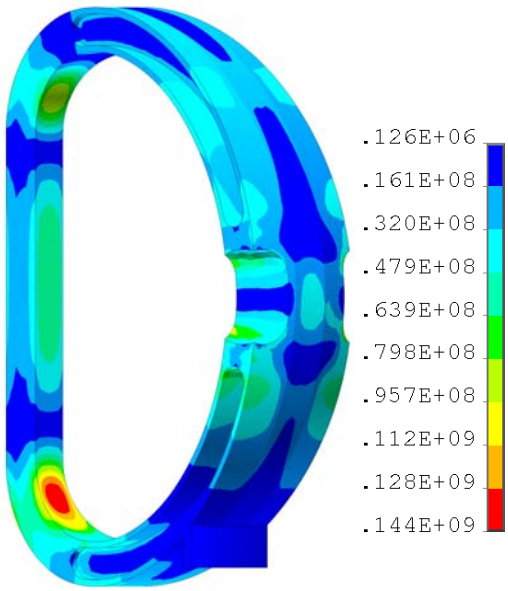

Figure 1: Von Mises stress difference between Initial Magnetisation and End of Burn (Pa)

The magnetic field in the TF coil winding pack due to all the coils is calculated using the Biot-Savart law. This gives the Lorentz force in the winding pack, which is then used for the stress-strain calculation. The coil currents used (load cases) are selected from the states listed in ITER-98. The alternating stress is calculated by subtracting the stress tensors between two different load cases.

In order to meet the lifetime fatigue goal (~40000 pulses) the coil support structure needs to be made stronger, which will add to its radial build. We will quantify these requirements, allowing systems codes to estimate the additional costs.

This work was jointly funded by the United Kingdom Engineering and Physical Sciences Research Council and by the European Communities under the Contract of Association between EURATOM and CCFE.