ELECTROMAGNETIC ANALYSES ON RADIAL FIELD SECTOR COILS FOR JT-60SA

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In the framework of EU - JA "Broader Approach" Agreement, the JT-60SA satellite tokamak will be built in Naka, Japan.

In JT-60SA, to achieve the steady-state high beta plasma, suppression of Resistive Wall Modes (RWM) is necessary. Therefore, a RWM active control system based on in-vessel coils is foreseen for JT-60SA. In the present design, this system consists in 18 sector coils, 6 in the toroidal, 3 in the poloidal direction, rated for a maximum current of 2.5kA and fed by a dedicated fast power supply system. The coils shall produce sufficient radial magnetic field at the plasma edge, and the active control system shall be so fast to react in real time to the plasma instabilities. These stringent requirements pose constraints on the design both of the sector coils and of the power supply, which shall produce the desired voltage and current with the required dynamics. Moreover, during fast transients of the plasma current, significant loop voltage could be induced along the sector coils, which could result in over-currents in the coils and in the power supplies.

In support to the development of the sector coils and power supply design, these constraints shall be translated into electrical and functional requirements; their identification and the design definition is an iterative process.

The coil design has been outlined on the basis of dedicated studies on RWM control [1], which give the first input in terms of maximum current and dynamics. Then, the electrical characterisation of the coils is needed to quantify the voltage rating of the power supply. To achieve this goal, dedicated electromagnetic studies have been carried out. Beside that, these analyses allow also supporting the mechanical design of the sector coils, providing indications on the effects of design choices on the amplitude of the produced magnetic field.

Finally, the estimation of the over-currents induced by fast plasma transients permits to better address the coil and power supply requirements in order to cope with them.

This paper deals with the electromagnetic analyses on the sector coils of JT-60SA, with the main aim to determine the voltage/current characteristic of the coils and, at the same time, to have a first estimation of amplitude and shape of the produced magnetic field; different sector coil design solutions were considered and evaluated. The studies on the coil over-currents during plasma disruption or vertical displacement events are also presented. This work is mainly based on computer simulations carried out using Finite Elements models derived from simplified geometries. The paper describes the models and the analyses performed; then, the results are presented and discussed.