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NUMERICAL STUDY OF THE EFFICIENCY OF ANTENNA-PLASMA COUPLING FOR WAVES IN THE ION-CYCLOTRON FREQUENCY RANGE *)

[1,2]Nedbailov K.O., [1,2]Naumenko P.R.

[1]*National Research Center "Kurchatov Institute", Moscow, Russia*
[2]*Moscow Institute of Physics and Technology (National Research University), Moscow, Russia*

Ion cyclotron resonance heating (ICRH) is one of the key methods of additional plasma heating in magnetic confinement devices. One of the most important tasks of ICR plasma heating is to maximize the efficiency of antenna-plasma coupling (coupling resistance). The RF power introduced into the plasma is equal to:

$$P_{RF} = \frac{1}{2} I_{ant}^2 R_{coup} \qquad (1)$$

where I_{ant} is the amplitude of the high-frequency current flowing through the antenna, R_{coup} is the coupling resistance (the real part of the antenna-plasma impedance). Thus, in order to transmit the greatest power to the plasma, it is necessary to achieve the maximum possible antenna-plasma coupling resistance. The impedance of the antenna-plasma system depends on the plasma parameters, the phasing of the antenna excitation currents, and the design of the antenna assembly.

The main tool for analyzing the efficiency of the antenna-plasma coupling is a proprietary computer simulation code based on a flat-layered cold plasma model that does not take into account the longitudinal magnetic field component of the electric field of the wave [1, 2]. To solve the wave equation in cold plasma, a linearized expression for the square of the transverse wave vector of the fast magnetosonic (FMS) wave $k_\perp^2$ is used. Within this model, an estimate of the error introduced by the linear approximation into the accuracy of determining the antenna-plasma impedance is made. The effect of phasing of the antenna exciting currents on the coupling efficiency is studied. Calculations of the antenna-plasma impedance of a 4-band antenna for the geometry and plasma parameters of the T-15MD tokamak presented in [3, 4] are performed. The possibility of ensuring maximum coupling efficiency by selecting optimal parameters of the antenna unit, such as the position of the antenna in the nozzle, the distance from the antenna to the plasma separatrix, the width of the nozzle, the width of the straps and the distance between the antenna straps, is demonstrated. The dependence of the impedance on the value of the central plasma density is studied.

The obtained results are consistent with the work on various world devices [5, 6]. Thus, the implemented code is a useful tool for designing an ICR heating antenna and studying the empirical behavior of the antenna-plasma coupling efficiency.

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