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THE ASPECT RATIO AND PLASMA ELONGATION DEPENDENCIES OF TOKAMAK-REACTOR PARAMETERS

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ABSTRACT

The major goal of the Physics program of ITER is to obtain the necessary information for the design of a Tokamak-Based Demonstration Power Plant - DEMO.

During DEMO designing the problems, connected with the cost of installation and with the high availability of operation will arise. From this point of view it is interesting to analyze the possibilities of tokamak-reactor with low (A<1.5) and with high (A>4) aspect ratios.

In this paper the method of investigation of aspect ratio dependencies of the major plasma parameters is describe. In this analyze such well known parameters as fusion parameter, the thermal/magnetic energy ratio, β, the plasma energy confinement time (the ITER scaling law), the critical value of magnetic field at the inner toroidal field coil leg, the safety factor, the wall neutron loading and the distance between plasma and the toroidal field coil (i.e.the shield, or blanket, thickness) were used. The dependencies of the major tokamak-reactor parameters, which are necessary for burning, on aspect ratio and plasma elongation are obtained.

It was shown that:

1. It is the optimal value of the aspect ratio (A) for all reactor parameters. This value is unambigually connected with the distance between plasma and the toroidal field coil normalized on the minor plasma radius (δ). The optimal aspect ratio is shifted to the grater values of A when δ rises. For ITER Aopt is about 3.

2. The spherical-tokamak based reactor needs the extremal values of the plasma current, the critical magnetic field and plasma elongation. These problems are very difficult for solving now.

The results obtained indicate that the dimensions of a tokamak-reactor with a low aspect ratio or low magnetic field at the plasma column center are markedly larger than the size of the ITER device with the same values of the safety factor, neutron loading on the wall, fusion parameter, plasma elongation and δ and the critical magnetic field value at the inner toroidal field coil leg.

3. The plasma current which is necessary for reactor operation drops when the aspect ratio rise, and so the problem of plasma current maintaining is simpler.

4. The bootstrap current is rise when the aspect ratio rises. In this case the design of the steady-stead tokamak-reactor is simpler.

5. The aspect ratio rise gives us the possibility to rise the magnetic field value at the plasma center, with the same value of the critical magnetic field at the inner toroidal field coil leg. The conditions for obtaining the high plasma parameters are better for higher magnetic field.

The installation with high aspect ratio has high availability of operation.

6. The rise of the plasma elongation results in the better reactor parameters obtaining. For example, the change of the plasma elongation from 1 up to 3 results in the major plasma radius reduction about one order of value.

So from our point of view the reactor DEMO must be based on the tokamak with high aspect ratio.