

Tokamak T-15MD –preparing for physical start-up

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At the present time, the preparing for physical start-up of tokamak T-15MD is completed in the National Research Center “Kurchatov Institute”. Tokamak T-15MD has the following parameters: $R=1.48$ m, $a=0.67$ m, $B=2.0$ T, $I_{pl}= 2.0$ MA. The electromagnetic system is capable of maintaining without overheating (more 60°C) the plasma current of 1MA for 40s, 700 kA for 120 s, 500 kA for 250 s and 300 kA stationary. Plasma current drive can be provided by both injection of fast neutrals and EC- and LH - waves.

Experimental study program on Tokamak T-15MD 2 is goaled on the obtaining of physical and technological data for both ITER support and creation of the fusion neutron source for atomic energy needs. Tokamak T-15MD will be used as the test bed, on which the stationary injectors of neutral particles, ICR-, ECR- and LH- plasma heating systems will be mastered, the materials and technologies for the first wall and divertor, including graphite, tungsten and lithium, will be studied.

In the first stage of T-15MD tokamak assembly the 16 D- form toroidal field (TF) coils (Fig.1) have been installed with the required tolerance in the vertical plane (< 2 mm/5m height). In August, 2019 the electromagnetic system, consisting of TF and poloidal field (PF) coils, together with the four sectors of vacuum vessel have been assembled in experimental hall (Fig.2). Four sectors of the vacuum vessel have been welded and tested. The leaks were not found out in the shell welds. The accuracy of the TF coils installation and the efficiency of the PF coils will be verified by means of electron beam in argon after vacuum vessel evacuation.

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For high vacuum pumping of the vessel the four turbo molecular pumps with total productivity ~ 10 m³/s (H₂) and two cryogenic pumps with total productivity of 8 m³/s (H₂) will be used. All vacuum pumping equipment was tested both in manual and automatic mode using a control system.

The magnet system, in-vessel components, the turbo molecular pumps, equipment of auxiliary plasma heating systems are all cooled by distilled water with pressure of 0.5 MPa and 1.0 MPa. The total delivery for distilled water cooling by pumps is 2000 m³/h and the total mass flow rate of river water in the heat exchangers is 1500 m³/h. The equipment for water cooling system was mounted and tested.

Power supply system for Tokamak T-15MD includes: two substations 110/10 kV, two substations 10/0.83 kV, thyristor convertors and different equipment. Total power consumption during the pulse with plasma current 2 MA and additional plasma heating of 20 MW will consist of 300 MVA. Substation No745 (NRC “Kurchatov Institute”) is connected with heat electro power station by means of oil-filled cable 110 kV. Two oil transformers 80 MVA, 110/10 kV each and one oil transformer 40 MVA, 110/10 kV, designed for pulse loads during experiments with plasma, were installed and tested. The 96 vacuum switchgears (10 kV, $I=1000\text{A}$, 2000A, 3150A), placed in building 95 were introduced into the operation. Substations Nos.1, 2 are intended to supply power to the magnet system of tokamak T-15MD and auxiliary plasma heating systems. Sixteen new three-phase pulsed transformers were installed in substation No1 and four transformers were installed in substation No2. Each of the transformer is connected with the thyristor convertor. Twenty new thyristor convertors made in Czech Republic to supply power to toroidal winding and three coils of inductor were installed.

Tokamak T-15MD will be operated using the information and control system. All the information and control system equipment, required for the implementation of physical start-up of tokamak T-15MD in 2020 is available. Final adjustment of the control and information system after connection of all technological subsystems to tokamak T-15MD will be done.

Tokamak T-15MD will be equipped with contemporary physical diagnostics. Inside the vacuum vessel more than 250 different electromagnetic probes are installed to measure the plasma current, loop voltage, magnetic fields, MHD activity, etc. Plasma density, electron and ion temperatures, radiation losses will be measured

too. Tokamak T-15MD is surrounded by wooden entresols for experimental equipment allocation. The gyrotron with frequency 82.6 GHz and power of 1 MW will be used for preionization. The physical start-up of T-15MD is scheduled for the end of December 2020.

References

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