

Computer modeling of the thermal stabilization system for the MPD detector of NICA

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High energy and elementary particle physics are the leading fields of science in recent decades. Since this, investigations of the properties of matter and the processes of collision and birth of new particles with subsequent detection and identification of the latter are being held all over the world. One of such mega-science projects is the NICA (Nuclotron-based Ion Collider Facility) founded at the Joint Institute for Nuclear Research (Dubna). Within the framework of NICA project, development is underway to create an MPD (Multi-Purpose Detector) facility for detecting high-energy beam collision products using a TPC (Time-projection chamber), ECal (Electromagnetic Calorimeters) and other subdetectors. The TPC consists of two coaxial cylinders, the space between which is filled with a working gas mixture. The total power of the MPD electronics exceeds 1 MW, so during its functioning, significant heat may be released both inside and outside the volume of the facility. It may lead to a deviation of the thermal stabilization of the working gas volume and, as a result, negatively affect the accuracy of event detection.

To control heat generation on the TPC and ECal subdetectors, the MPD is equipped with a water cooling system for electronics and thermal stabilization of the TPC working gas volume. The cooling system must meet the following requirements:

1. ensure leakless regime. The coolant pressure in the circuits must not exceed atmospheric pressure. Thus, in case of a mechanical defect in the pipe, the coolant will not leak;
2. at the same time, as the pressure decreases, the risk of cavitation increases, which is unacceptable.

The presentation describes the design features of the MPD cooling system. The 3D finite-element model of the cooling system was developed and numerical calculations of the coolant flow through it were performed. The model allowed to identify non-compliances with requirements in the initial prototypes of the cooling system, so the new piping layouts were designed. Pipe volumetric flow rates and pressures were estimated, which can be used for calibration and startup of the real system. The results of the numerical experiment were verified using data obtained from a full-scale experiment on a specially designed stand. The presentation also shows the results of a test of the cooling system's resistance to water hammer shock.

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