GAS SYSTEM FOR MPD TIME-OF-FLIGHT DETECTOR*

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The Time-of-Flight (TOF) will be one of subdetectors used to particle indentification in nascent Multi-Purpose Detector (MPD) at NICA (Nuclotron-based Ion Collider fAcility) complex. To work properly, it needs a system which provides gas at the correct pressure and with specific properties, like mixture composition and purity. Requirements, construction, properties and operation principles of this system are discussed in this proceeding.

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1. Introduction

The Multi-Purpose Detector is going to be built for studying properties of hot and dense baryonic matter created in heavy-ion collisions at the energy range of the NICA collider. The MPD experiment consist of many detection systems which can be divided for four groups: tracking, triggering, centrality/event plane and particle identification. The Time-of-Flight is one of the elements used in the last one.

The modules of the TOF are located in the barrel between Time Projection Chamber and Electromagnetic Calorimeter. The detector is based on multigap resistive plate chambers (MRPC) and provides time resolution better than 100 ps, which is needed for effective separation of charged hadrons. Gaps between plates are filled with gas. Total gas volume of the TOF barrel is approximately 3 m^3.

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The primary purpose of the gas system for TOF is to provide a specific mixture of 90% $C_2H_2F_4$ + 5% i-C_4H_{10} + 5% SF_6 at the correct pressure, which is necessary for stable operation of the detector.

2. Requirements specification and system description

Closed loop circulation system will be used due to the high cost of the gases and destructive influence on the environment. The system will control gas flow and stability of the mixture components proportions. It will also provide monitoring and removing of impurities — moisture and oxygen. Conceptual scheme is shown in Fig. 1.

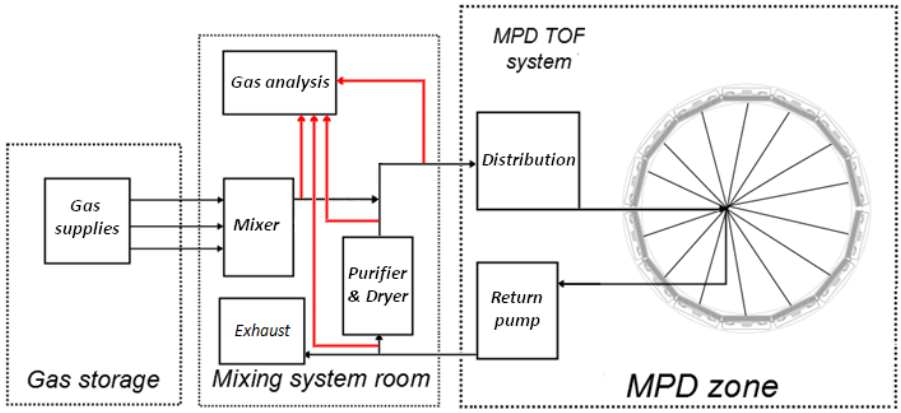

Fig. 1. Conceptual scheme of the gas distribution system.

System will be highly automatized — most processes will be controled remotely, while Data Acquisition will collect system and gas parameters [1].

The mixing unit and purifier will be located in the special room. Circulating rack can be situated near the MPD detector. Gas supplies should be located in a separate building (gas storage). It is a place from where primary gases come into the mixer. Industrial strain-gauge load cells and weighting modules connected with Slow Control software are used to measure amount of the gases in the cylinders.

Gas mixer consists of a driver with two sets of master mass flow controller for $C_2H_2F_4$ and two slaved mass flow controllers for additions. One set will be used for filling operation, where high flow range is necessary, while the second, for running where planned flow is only about 4.2 l/h (equivalent of one 3000 litres volume change per month). One more pipeline in this part of the system will be connected to $C_2H_2F_4$ for pre-purge after installation with the flow about 2 l/min (one detector volume per day).

Returning gas will mostly be pumped for recirculation, however, small amount of it will be sent for recycling. Used freons have a very high global warming potential, so we want to avoid venting them into the atmosphere. A fresh mixture equivalent of recycled gas will be added to returning gas. The volume of the detector is about 3000 litres and the planned recirculation flow is 3 volume changes per day, which equals to flow of about 6 l/min.

The distribution unit will divide pipelines for all TOF segments (Fig. 2). Each of them will also be able to monitor gas parameters by flow, pressure and temperature indicators. With the help of the pump module, the return gas from the detector is compressed and pumped back to the gas mixing room. Small amount of fresh gas will be added to returning and some part of the mixture will be taken for purifying.

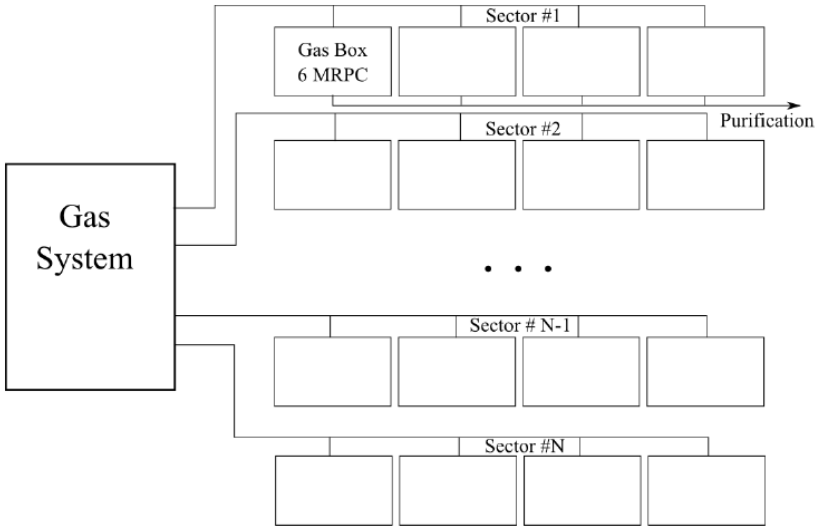

Fig. 2. Gas distribution scheme.

The purifier unit is necessary due to unwanted effects of impurities. The static electric dipole moment of the water molecule increases the inelastic scattering cross section for low-energy electrons what reduces the drift velocity. Oxygen is a strongly electronegative gas and captures electrons before they will achieve electrode [2]. Tolerable impurities contents are 1000 ppm of the oxygen and 100 ppm of the moisture. The purifier unit contains a column filled with copper catalyst and molecular sieve and also other equipment used for regeneration.

Contamination of the water and oxygen will be analyzed on few different steps of the circulation. Isobutane as a flammable gas has to stay under specified limits. Therefore, infrared isobutane analyzers will be installed.

Pressure in the system will be controlled by differential pressure regulators, pressure and backpressure check valves and a compressor with parallel connected solenoidal valve controlled by PID regulator. Pressure in the detector modules will be maintained at the level of about 3–5 mbars over current atmospheric pressure due to mechanical construction of the detector. Independent software and hardware safety system will be used in the case of rapid drop or rise of the atmospheric pressure.

3. Summary

Advanced, modern and highly automatized gas system for MPD Time-of-Flight is going to be built. Detailed project is ready. Gas supply unit is already prepared, works on mixer unit and Slow Control software has started. The system is being built in accordance with the idea of modular and scalable control systems. This approach will provide ability of adapting it to another detectors — works on prototype copy for TOF400 at BM@N experiment has already started.

REFERENCES

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