SYSTEM FOR REMOTE TARGET REPLACEMENT OF THE TARGET SYSTEM FOR THE CC-SERIES CYCLOTRONS

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Abstract

An automated system for remote replacement of target devices of the target system for cyclotrons of the CC-series has been designed. The system allows 1 of 5 available targets to be positioned under the beam of the cyclotron at the operator's choice. Such a technical solution allows us to have sufficiently smaller overall dimensions of the equipment and less time for servicing water and gas targets.

Separate system for target replacement is provided for each beam extraction, which allows the cyclotron to be equipped with 10 different target devices, and makes possible simultaneous irradiation of 2 targets.

INTRODUCTION

Nowadays, positron-emission tomography (hereinafter PET) is the most effective method for diagnostics of a wide spectrum of diseases including oncologic cases. This diagnostic method applies radiopharmaceticals, i.e. substances labeled with radionuclides, which are actively used in various metabolic processes occurring in a human organism.

To produce radionuclides, beams of accelerated particles are used to bombard targets containing target materials. [1]

In clinics and in commercial production of radioisotopes, of the first priority are the operational stability of radiopharmaceuticals' production systems, compactness of their size, multifunctionality, easy maintenance, low radiation exposure of the attending personnel and updating flexibility to meet the requirements of modern medicine and market [2].

In JSC "NIIEFA", energetic works are now underway on designing and preparation of serial equipment for production of radionuclides. Three models of cyclotrons for 12 MeV [3], 18 MeVB [4] and 30 MeV [5] as well as target systems for these machines have been designed and constructed.

At the end of 2013 in JSC "NIITFA", Moscow, a system for the production of radionuclides for PET on the basis of the CC-18/9M cyclotron was installed. At the stage of testing of the system, we managed to obtain the target yield ranges comparable with those of the latest-generation equipment of leading producers in the world. The main tasks to be solved when designing target systems are the reliability, easy maintenance-repair and versatility of the target system [6].

SYSTEM FOR TARGET REMOTE REPLACEMENT

To meet the demanding requirements of customers on widening the functionality of the target system, work on designing a system for targets' remote replacement was done. This system is intended for automatic setting of a chosen target under the beam of the cyclotron. The use of this system will allow: optimization of the cyclotron system configuration and minimization it's overall dimensions because of possibility to refuse part of ion transport system; possibility to furnish the cyclotron with larger number of targets; remote taking out of target devices from under the beam to reduce the induced activity before its removal and maintenance/repair.

The system for targets' remote replacement consists of 2 systems: a system for disconnection of a vacuum-tight joint between target devices and the ion tube of the cyclotron and system for the transport of target devices (see Fig.1).

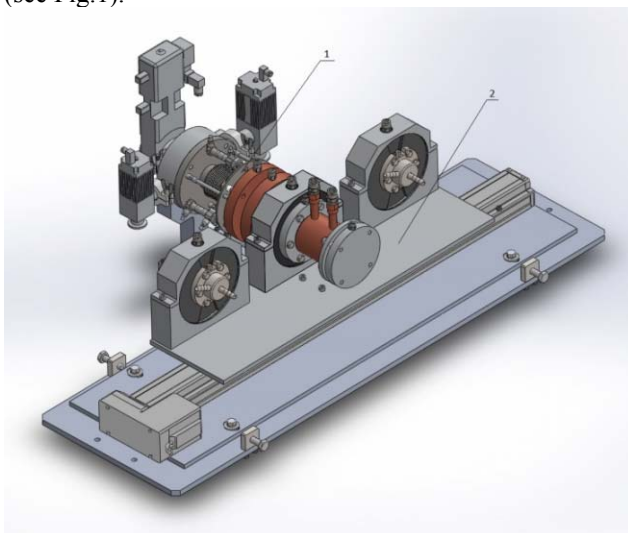

Figure 1: System for targets' remote replacement: 1- system for disconnection of the vacuum-tight joint between target devices and the ion tube of the cyclotron; 2- system for transport of target devices.

The first system provides remote disconnecton and connection of the vacuum-tight joint between the end flange of the ion tube and the target device flange. This operation is performed with 3 pneumatic cylinders compressing an intermediate bellow.

The system for transport of target devices consists of a linear electric drive with a step motor and target devices fixed on it. It makes possible transportation of a chosen

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target device and makes it coincident with the ion tube axis accurate to ± 0.1 mm.

The process of a target device replacement is as follows:

1. A vacuum gate valve separating the ion tube of the cyclotron and the vacuum volume of the system for target remote replacement is closed. Air is in-leaked into the volume of the system for targets' remote replacement through a pneumatically-driven leak valve.
2. The vacuum joint between the ion tube and installed target device is disconnected when the intermediate bellow is compressed with 3 pneumatic cylinders.
3. The chosen target device is made coincident with the ion tube axis.
4. The vacuum joint between the chosen target and the ion tube is re-connected.
5. The volume of the system for targets' remote replacement is pumped out with the forevacuum pumping system of the cyclotron.
6. The gate valve is opened, and the system volume is pumped out with the high-vacuum pumping system of the cyclotron.

The use of standard collimator units and helium cooling systems allows the system for targets' remote replacement to be furnished with a set of target devices of different types and volumes produced in NIIEFA.

CONCLUSION

The system for targets' remote replacement allows us the following:

- to furnish the cyclotron with a set of targets of different types and yield ranges.To optimize the cyclotron system configuration and to minimize it's overall dimensions because of possibility to refuse part of ion transport system;
- to reduce the radiation exposure of the attending personnel.

This innovation technology can be applied:

- in commercial production of radionuclides and for widening the range of isotopes produced;
- when locating cyclotron systems in places limited in size.

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