ACCELERATOR ELV-12 AND ITS APPLICATIONS IN ENVIRONMENT PROTECTION TECHNOLOGIES

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For the environment protection purposes, at BINP we developed, designed and manufactured an accelerator of a new generation ELV-12 with the following parameters: electron energy ranges from 0.6 to 1.0 MeV, beam current is up to 400 mA, beam power up to 400 kW. At present, the accelerator is already manufactured, assembled and all the systems are under adjustment and test.

At present, the world electron accelerator market is rather saturated by the reliable and efficient machines in the energy range 0.3…3 MeV and power of the beam of extracted into air of up to 150 kW. However, these accelerators do not satisfy to the full extent all the requirements of the energy consuming electron beam technologies (mainly of ecological purposes). To this end, accelerator facilities of the extracted beam power of a few and tens of megawatts are required. It is quite natural that the complexes should consist of modules a unit power of the order of a few thousand kilowatts.

At Budker Institute of Nuclear Physics, Novosibirsk, the ELV-12 accelerator of a new generation was developed for application in the environment protection technologies with the following parameters: the energy range of accelerated electrons is 0.6…1.0 MeV, maximum beam current is 500 mA, maximum power of the beam extracted into atmosphere is 400 kW. In the development of this accelerator, the experience and some technical solutions acquired during the development of the earlier ELV-type accelerators were used. So, the high voltage power supply and gas feeder were tested at the "Torch" accelerator and the extraction system was tested at the ELV-6M accelerator. Schematic diagram of the ELV-12 accelerator is given in Fig.1.

Inside the tank filled with SF6 gas there are two primary winding and two columns of the high-voltage rectifier (one above another) operating in parallel to the common load. Each column comprises a rectifying section connected in series-parallel so that at the output we have a two half a-period rectification. For the reduction of ripples of the output voltage, an individual power supply of ~1000 Hz is developed for primary windings with a phase shift by 90^0.

The accelerator is equipped with three accelerating tubes. One of them is located inside the column of high voltage rectifier column and two others are placed in separate modules and they are connected to the rectifier through the gas feeder. The accelerating tube has a large aperture of the same type as that in the conventional ELV accelerators. Such a structure has been tested at the "Torch" accelerator whose electron current reached 0.8 A at the energy of 0.5 MeV and 0.5 A at 0.8 MeV. The cathode is of non-direct heating made of LaB_6, the tablet diameter is 10 mm. The beam current value is regulated by the cathode temperature thereby providing the required beam stability at the input of the extraction device. The beam is controlled with the optical system. The beam current in each accelerating tube is controlled independently thus providing to vary the distribution of the power dose inside the reactor in a wide range.

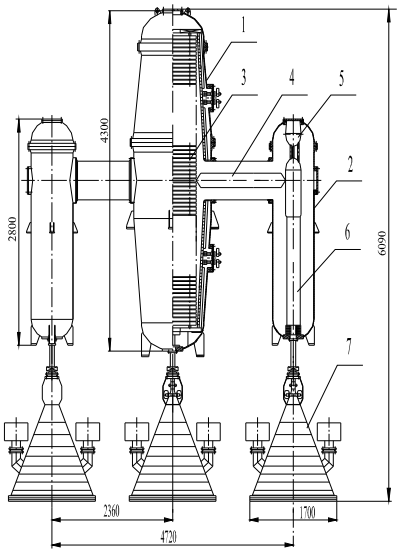

Fig.1. Schematic diagram of the ELV-12 accelerator:
1 – high-voltage power supply source; 2 - accelerating tube module; 3 – high-voltage rectifier column;

PROBLEMS OF ATOMIC SIENCE AND TECHNOLOGY. 2004. № 1.
Series: Nuclear Physics Investigations (42), p.178-180.

4 - gas feeder; 5 - injector power supply system; 6 - accelerating tube; 7 - extraction device

The foil-type extraction devices are fixed directly to the tank bottom. For this accelerator we specially designed and tested the device to extract into air currents of up to 200 mA (Fig.2). The device uses two windows made of titanium foil placed in parallel. The beam is scanned both along and across the windows by the conventional bending magnets. The beam is transferred from one window to another by the reswitching magnet. The beam transfer moments are synchronized with the scanning frequency along the beam in such a way that the current polarity variation in the current reswitching magnet is made when maximum beam deviation is achieved at the ends of the window. Approximate kind of the beam trajectories on the extraction window foil is shown in Fig.2,c. For protection of the foil rubber sealing against direct beam action during the beam transfer, a water cooled cylinder (Fig.2,d) is installed that is simultaneously the structure strength element. For improvement of vacuum we have installed two additional ion pumps (not shown in Fig.1) for pumping out directly from the extraction device.

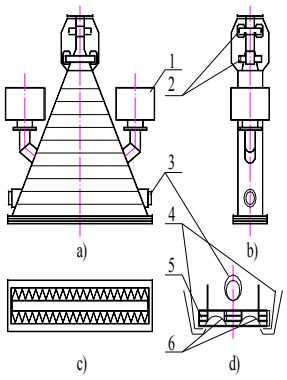

Fig.2. Two-window extraction device:
1 - ion pumps; 2 - coils and cores of the beam scanning system; 3 - flange of the protection cylinder; 4 - protection cylinder, foil blowing; 5 - cooling air nozzle; 6 - foil fixation frame; 7 - extraction foils

The extraction window foil is cooled with compressed air. For each window an individual high compression fan is used. The maximum average foil current density value does not exceed 100 μA/cm^2. This is approximately twice as less than the maximum admissible value (at this cooling regime) and provides large lifetime of the foil. At present, the accelerator is already manufactured, assembled and all the systems are tested. The accelerator was tested during few hundred hours with the parameters as follow:

E=0.7 MeV, I=500 mA, P=350 kW, E=0.8 MeV, I=500 mA, P=400 kW, E=0.9 MeV, I=450 mA, P=400 kW

Now we are in the progress of precontract discussions of the projects with the use of the ELV-12 accelerator for cleaning wasted water (one accelerator), as well as, for thermal station flue gas treatment with the simultaneous operation of a few accelerators.

Fig .3,4,5 show an external view of the accelerator and extraction device.

Fig.3 External view of a two-window extraction device (from the side of extraction windows)

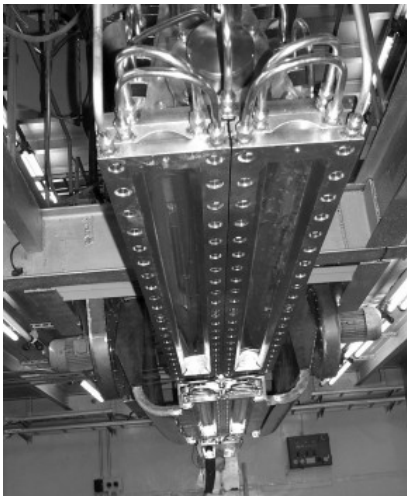

Fig.4. ELV-12 accelerator external view

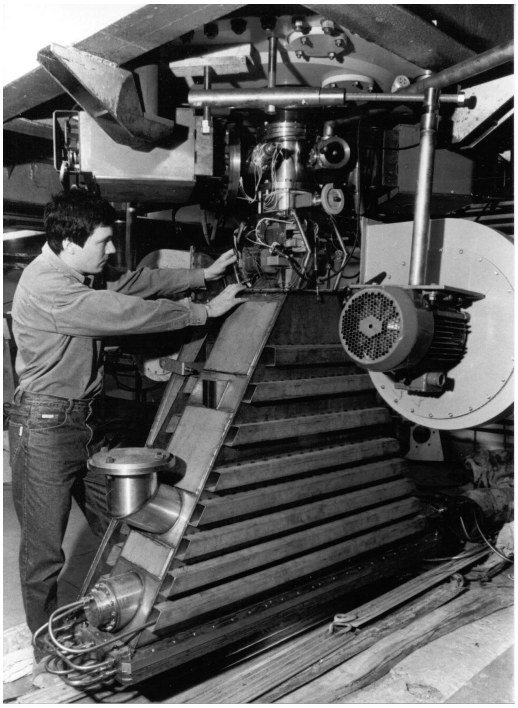

Fig.5. External view of a two-window extraction device (view from below)

At present, the world market is saturated with the efficient and reliable electron accelerators with an extracted beam power of up to 150 kW. However, these accelerators cannot completely satisfy the demand of the energy consuming electron-beam technologies for ecological purposes. To this end, the megawatt accelerator facilities are required, which in its turn, consist of modules with a power of the order of few hundred megawatts.

For the environment protection purposes, at BINP we developed, designed and manufactured an accelerator of a new generation ELV-12 with the following parameters: an electron energy ranges from 0.6 to 1 MeV, beam current is up to 500 mA, beam power up to 400 kW. In the development of the accelerator we made use the long-term experience and technical solutions proved in accelerators of the ELV series.

The accelerator is equipped with three accelerating tubes and three extraction devices. One accelerating tube is located inside the high voltage rectifier and two remaining tubes are in separate modules and connected to the rectifier via the gas feeder. The beam current is controlled independently in each accelerating tube.

For the beam extraction into air, two double-window foil extraction devices are developed. The beam current density at the extraction window foil is twice lower that that maximum admissible value thereby providing the longer lifetime of the foil.

At present, the accelerator is already manufactured, assembled and all the systems are tested. Now we are in the progress of precontract discussions of the projects with the use of the ELV-12 accelerator for wasted water cleaning as well as thermal station flue gas treatment.

МОЩНЫЙ УСКОРИТЕЛЬ ЭЛЕКТРОНОВ ЭЛВ-12 ДЛЯ ПРИМЕНЕНИЯ В ПРИРОДООХРАННЫХ ТЕХНОЛОГИЯХ

М.Э. Вейс, Ю.И. Голубенко, Н.К. Куксанов, П.И. Немытов, В.В. Прудников, Р.А. Салимов, С.Н. Фадеев

Для природоохранных применений ИЯФ СО РАН разработал и изготовил ускоритель нового поколения ЭЛВ-12 со следующими параметрами: энергия электронов 0.6…1.0 МэВ, ток пучка до 400 мА, мощность пучка до 400 кВт. В настоящее время ускоритель изготовлен, собран, ведется отладка его систем и тестирование.

ПОТУЖНИЙ ПРИСКОРЮВАЧ ЕЛЕКТРОНІВ ЕЛВ-12 ДЛЯ ЗАСТОСУВАННЯ В ПРИРОДООХОРОННИХ ТЕХНОЛОГІЯХ

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Для природоохоронних застосувань ІЯФ СВ РАН розробив і виготовив прискорювач нового покоління ЕЛВ-12 з наступними параметрами: енергія електронів 0.6...1.0 МеВ, струм пучка до 400 мА, потужність пучка до 400 кВт. В даний час прискорювач виготовлений, зібраний, ведеться налагодження його систем і тестування.