Chapter 7. History of development of technical systems of electrochemical activation in photographs

Improving technical products usually goes on all the time of its use by the man. The story of wheel is a representative example.

Huge number and variety of well-known technical electrochemical systems confirms a general pattern, but less clearly. Electrochemistry is a "quiet" science. Its phenomena do not capture the imagination of ordinary people, however, it is everywhere. It includes batteries for electronic devices; electrodes measuring properties of various liquids, brain activity, parameters of the heart; LCD televisions and computer screens; giant electrochemical furnace for aluminum smelting; huge electrolyzers to produce hydrogen, oxygen, chlorine, alkali, and ordinary but absolutely necessary protection systems of pipelines and other long metal structures from corrosion and much more.

It was found that the liquid after unipolar electrochemical action acquire new, previously unexplored properties. For practical use of this phenomenon, it was necessary to develop a special previously unknown technical electrochemical systems, find new optimal design and technological solutions with the aim of realization of the unique features of the conversion of chemical technology, which Nature allowed to discovery in electrochemistry.

This is the work and passion of the author.


Пролетарии всех стран, соединяйтесь!

Вышка

Газета Центрального Комитета Компартии Азербайджана

Азәрбајҹан Коммунист Партијасы Мәркәзи Комитәсинин гәзети

№ 205 (12133) ● Среда, 2 сентября 1970 года ● Цена 2 коп.

XXIV СЪЕЗДУ КПСС — ДОСТОЙНУЮ ВСТРЕЧУ!

ГАЗЕТЫ И ЖУРНАЛЫ — В МАССЫ!

ПЯТИЛЕТКА ЗАВЕРШЕНА

СТРОЯТСЯ РЕЗЕРВУАРЫ

СМОТР РЕЗЕРВОВ

ЖИЛЬЕ СВЕРХ ПЛАНА

От съезда к съезду

СССР: РИТМ ЭКОНОМИКИ

СОБРАНИЕ ПАРТИЙНОГО АКТИВА ТУРКМЕНИИ

Коллектив коммунистического труда первого промысла НПУ им. Серебровского, мобилизовав внутренние резервы, улучшив технологию эксплуатации скважин, добыл сотни тонн сверхплановой нефти и 200 миллионов кубических метров газа.

Встав на трудовую вахту в честь полувекового юбилея республики и XXIV съезда КПСС, нефтяники обязались досрочно выполнить пятилетнее задание и сверх плана добыть несколько тысяч тонн нефти и газа.

На снимках: внизу — морские промыслы НПУ им. Серебровского; вверху — операторы Вагиф АББАСОВ (слева), Рафик БУНЯТОВ, Витольд БАХИР и мастер 3-го участка Рафиз ФЕЙЗУЛЛАЕВ. Коллектив этого участка добыл сверх плана большое количество нефти и газа.

Фото Ю. РАХИЛЯ. (АзТАГ).

Electrochemistry is more than science and more than technology, it is epy Nature and Life. No matter which profession you choose in the beginning. Being for a hobby a radio-amateur in 1961 - 1966 Vitold Bakhir went in the early 70's to groundwater hydraulics - the one of the important disciplines in profession of mining engineer. The relationship is very simple. The radius of the nucleus of an atom is about 100,000 times smaller than the radius of the atom. If imagine a nucleus of the size of a pea, then the nearest electron would be from nucleus at a distance of about 500 meters! Any substance is, in fact, an electron gas with rare specks of nuclei of atoms. The speed of electrons in a conductor does not exceed 14 cm/h even if the conductor current flow is thousands of amperes. The voltage generated by the electric eel at the discharge reaches 500 volts, the power of electric discharges of the cramp-fish is up to 500 watts. The electric field strength at the Earth's surface is about 100 V/m, and the electric field of the Earth is the field of a spherical capacitor, the second plate of which is the ionosphere. The voltage between plates of the capacitor reaches a million volts. Current in thousands of amperes continuously permeates the atmosphere and generates telluric currents inside the Earth, which is one of the causes of volcanic eruptions and earthquakes.

Electricity is similar to a liquid. No wonder Maxwell fascinated by this similarity became the founder of the method of electro-hydraulic analogies (EHDA), which is widely used to calculate the motion of viscous fluids (including oil) in porous media. And so water and electricity merged together.

Baku, offshore oil fields, 1970. V.M. Bakhir is third from left at the picture.

Пролетарии всех стран, соединяйтесь!

Коммунистическая партия Советского Союза

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ОБЕРЕГАЯ ПРИРОДУ

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Конструируем растение

ВЕСТИ ИЗ ЛАБОРАТОРИЙ

Тайфун по заявке

РЯДОМ С ИССЛЕДОВАТЕЛЕМ

Изобретения

ИНЖЕНЕРНЫЙ ЦЕНТР

Из разных стран

Водная феерия

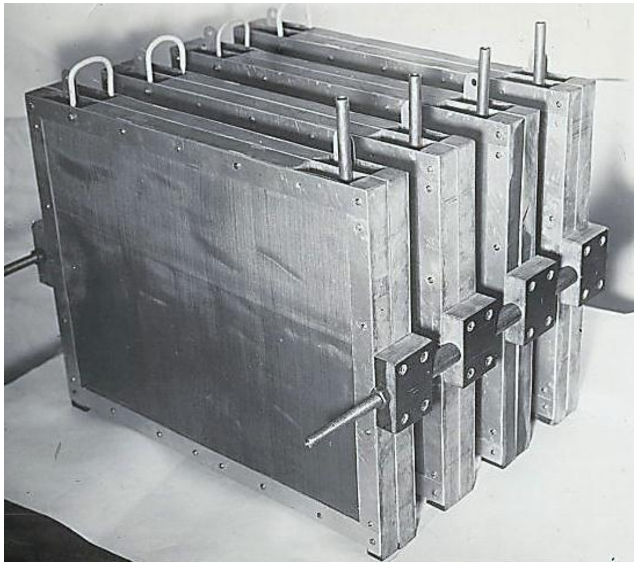
СУДЬБА ОДНОГО ПОИСКА

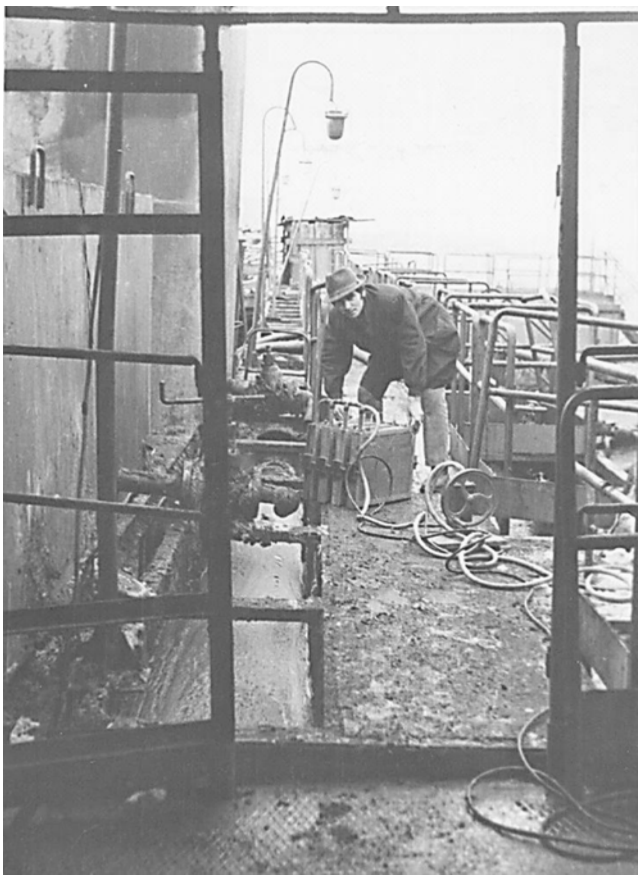
...представляющи... ...еский интерес? Много... ...ленные опыты показали, что идея не была лишена оснований. В 1974 году исследователи подали первую заявку на изобретение нового способа обработки буровых растворов, и хотя не скоро, но получили авторское свидетельство. Научно-поисковая группа, которой руководил молодой специалист В. Бахир, стала усиленно продолжать изыскания. Так начало зарождаться новое технологическое направление, названное электрохимической активацией веществ.

Главное внимание экспериментаторы уделяли созданию способов и устройств обработки воды и буровых раство... Затем стали прицели... ...пользоваеи...

Н. ГЛАДКОВА, Н. МОРОЗОВ, В. РЕУТ

The most authoritative newspaper of the USSR published in 1985 a great article of its correspondents (N.Gladkova, N.Morozov and V.Reut) about electrochemical activation, the successes and difficulties in the development of this direction as well as about prospects of the new technology.



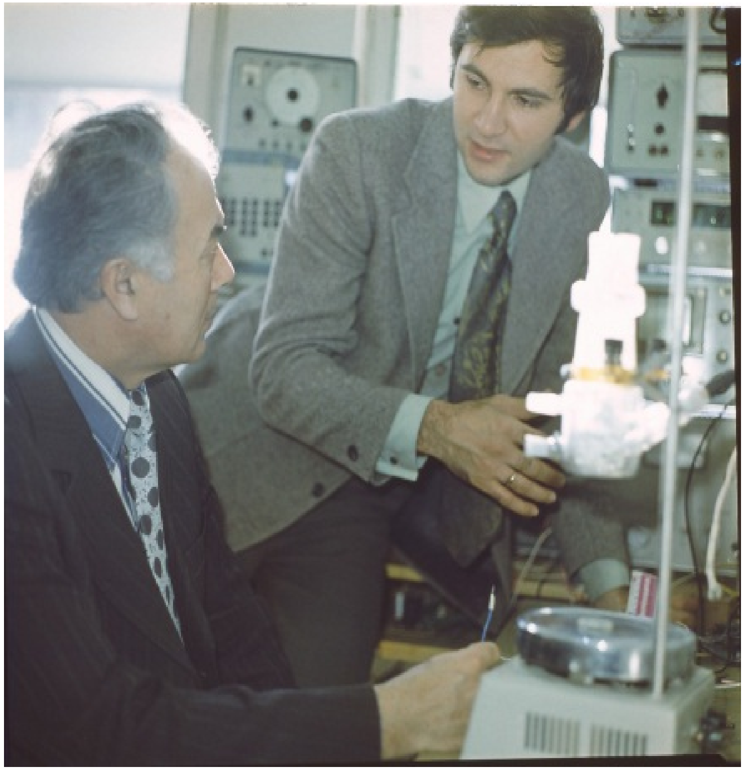


1973. The first electrochemical reactor for unipolar electrochemical treatment of drilling mud, developed and manufactured in SREDAZNIIGAZ.
In reactor design attempts were made to model the processes occurring in the three-electrode tube - triode. The reactor consists of four composite negative electrodes. The main plate negative electrodes are protected on both sides by negative electrodes - meshes with an adjustable value of electric potential. The positive electrode is actually the drilling fluid contacting with an external plate electrode which is located at the bottom part of the reactor (does not shown at photo). The total current flow through the reactor during the test at rig (photo bottom left) varied from 200 to 500 A. Trials have shown promising electrochemical adjustment of the drilling fluid properties.

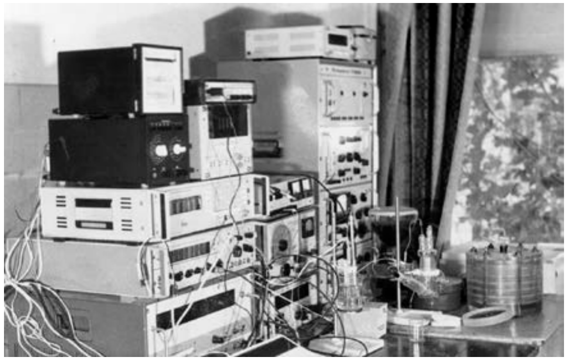
Tashkent (SREDAZNIIGAZ) - Urta-Bulak, 1973.

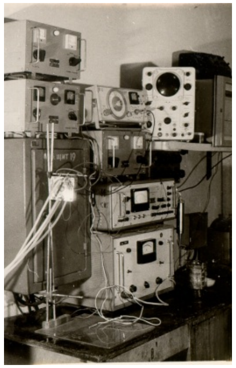
Drill in the desert Kyzyl-Kum (field Urta-Bulak), where in 1973 method of controlling of parameters of drilling fluid by unipolar electrochemical effect was first tested.

Scientific-research Institute of natural gas (SREDAZNIIGAZ) in Tashkent, where in 1975 a phenomenon of electrochemical activation was investigated in the Laboratory of electrotechnology (LET) .

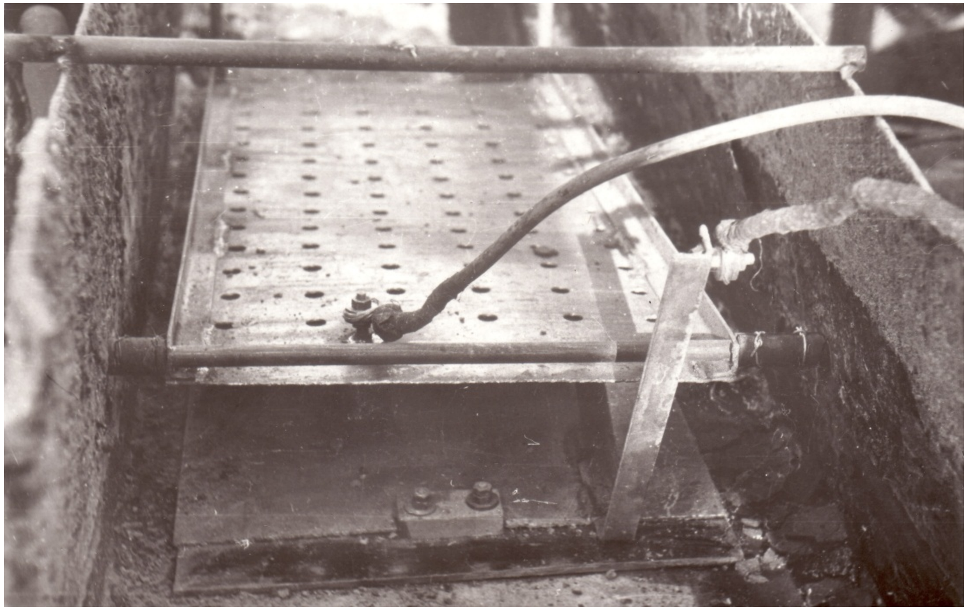
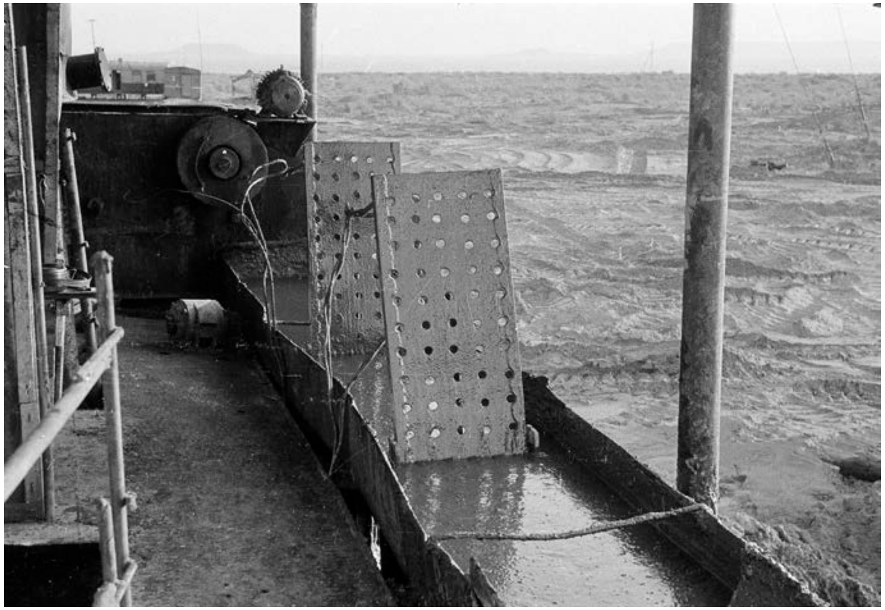
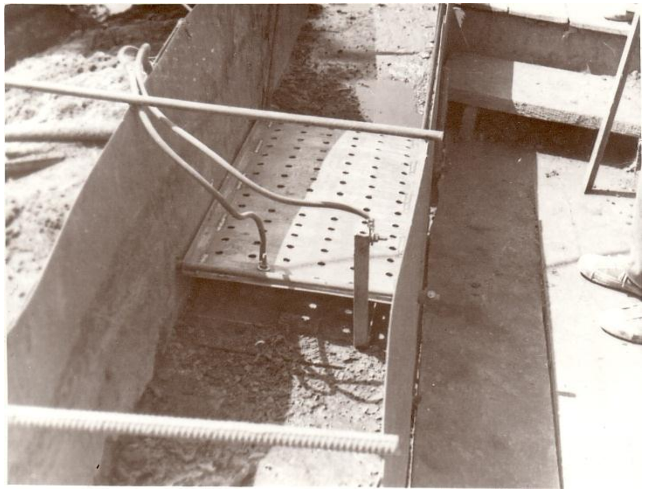


The Director of the Institute SREDAZNIIGAZ U.D.Mamadzhanov and the head of the Laboratory of electrotechnology (LET) V.M. Bakhir. Tashkent, 1976.

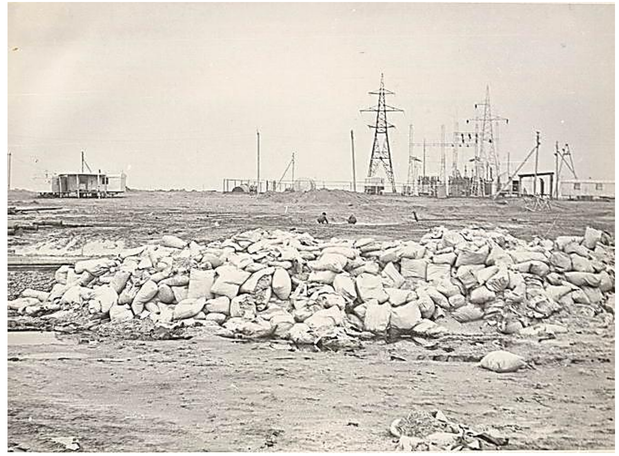




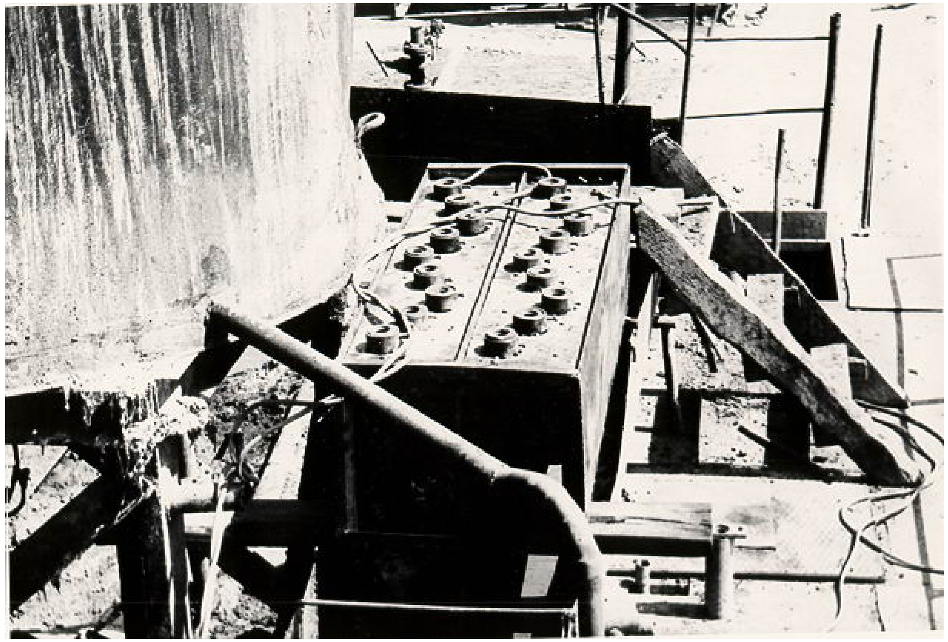
Laboratory of electrotechnology of the institute SREDAZNIIGAZ. Tashkent, 1976.

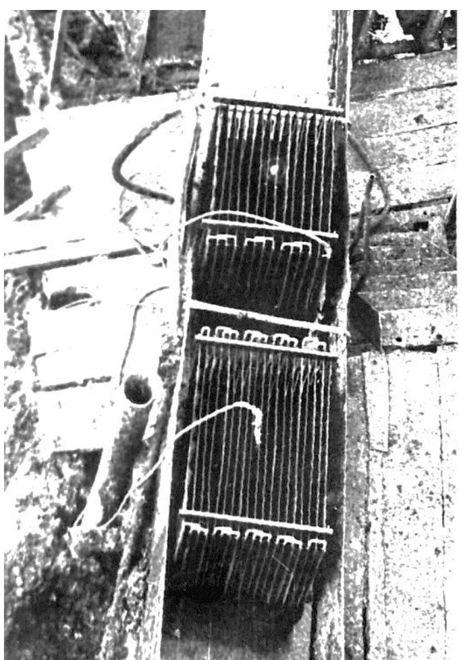
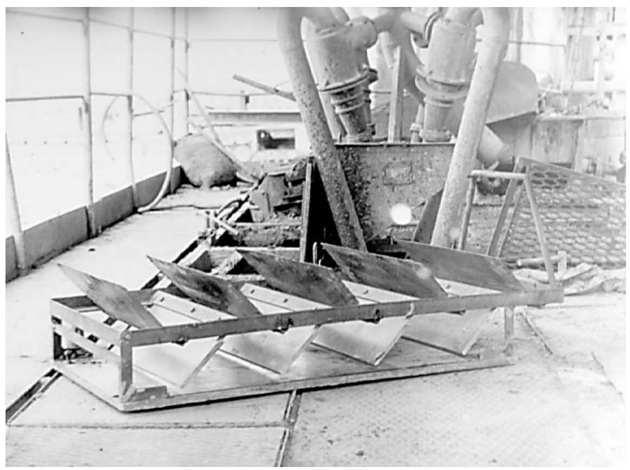




Since 1977 many drills on fields in South-Western Uzbekistan and Eastern Turkmenistan was equipped with devices UOBR for unipolar cathode processing of drilling mud. Due to these devices the consumption of chemical reagents – regulators of viscosity and water loss of a drilling fluid - was reduced by 30 - 70%. Uzbekistan, 1977.

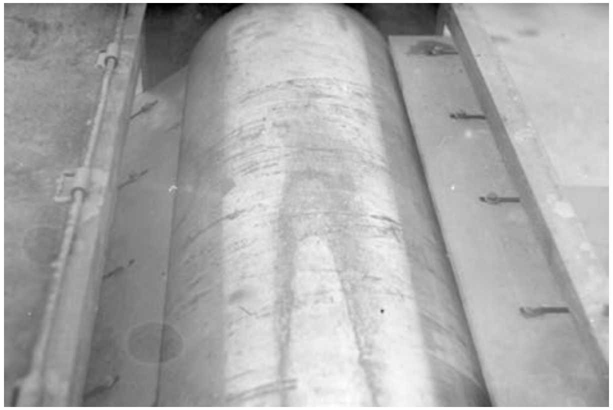


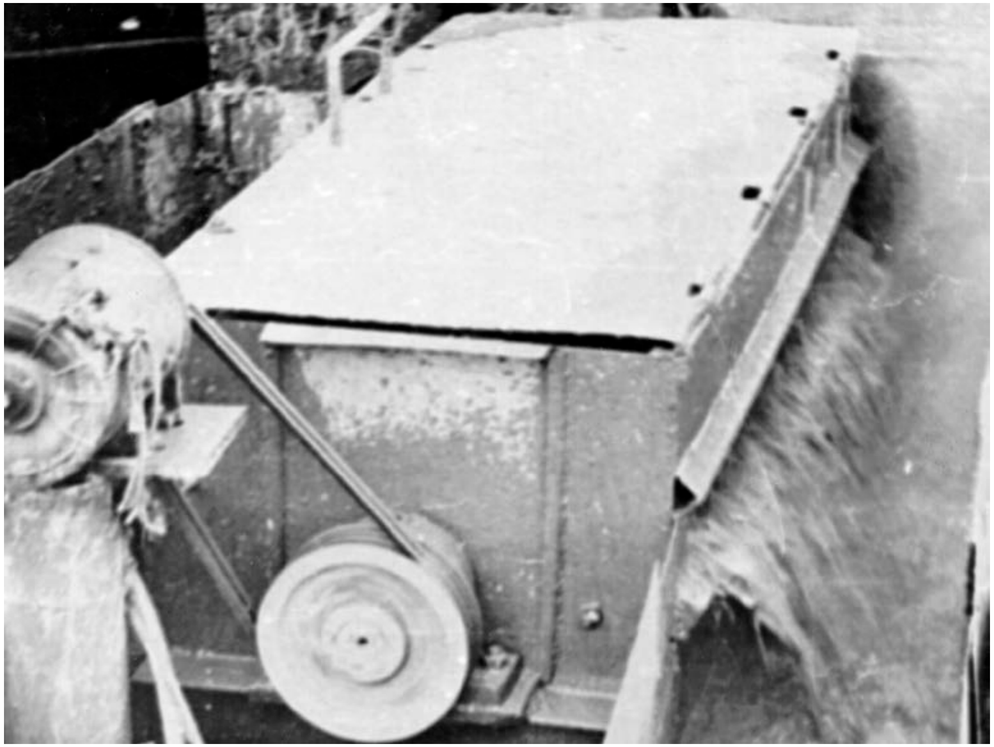
Because of use of UOBR devices a lot of saving chemicals (starch, carboxymethyl cellulose, Okzyl, nitrolignine) after drilling was left lying in the desert, gradually mixing with the sand. Sometimes they were buried in the sand by bulldozers. Fields Shatlyk, Kultak, Pamuk, Sefardy, Dengiz-Kul, Khauzak, Urta-Bulak, Malay, 1977 - 1984.

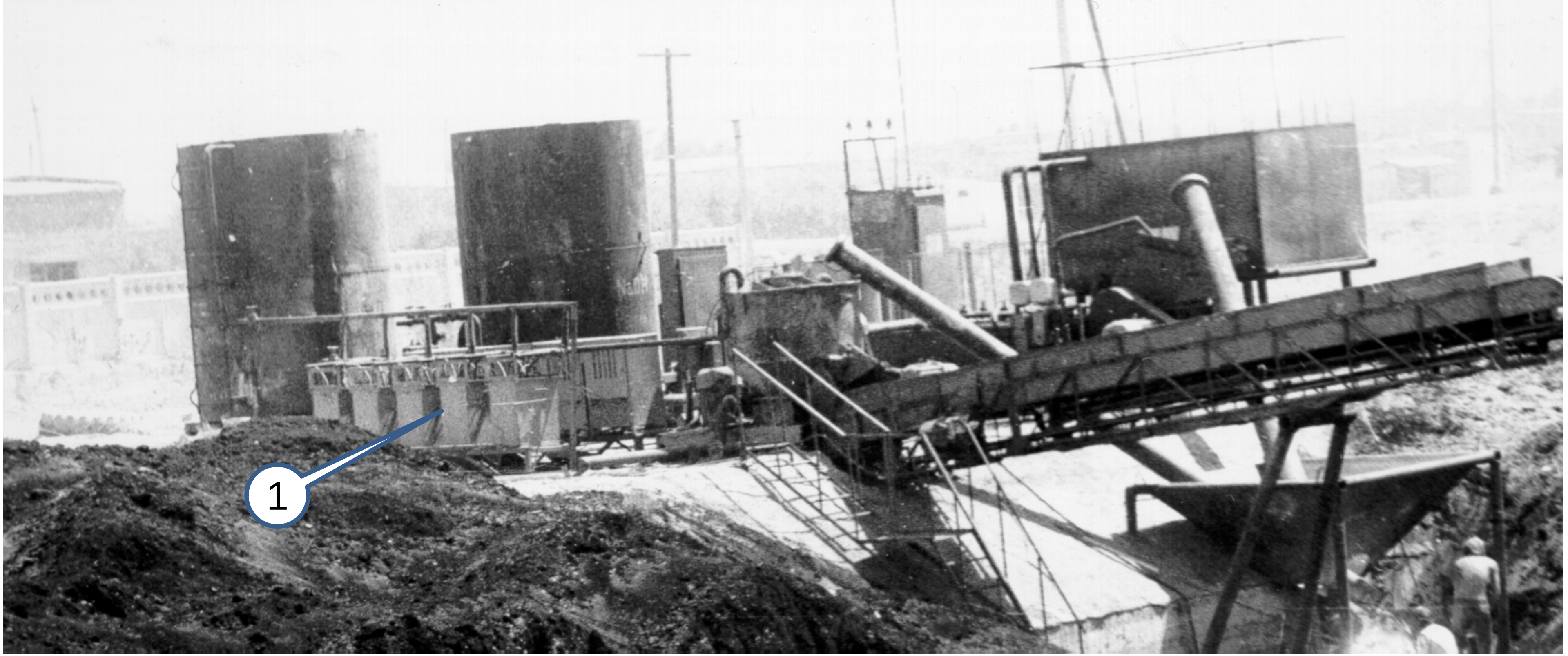

Ongoing experimental studies and immediate practical application of its results in drilling allowed to create and test in the period from 1974 to 1982 a variety of different devices for electrochemical control of physical-chemical and technological properties of drilling fluids. Variants of experimental devices at drills of the South-Western Uzbekistan and Eastern Turkmenistan, 1974 – 1982.

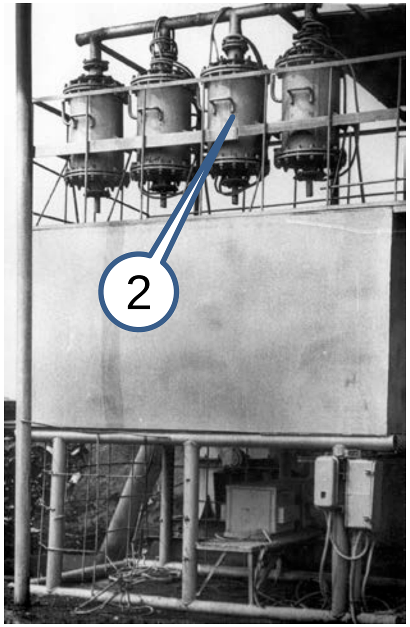
  



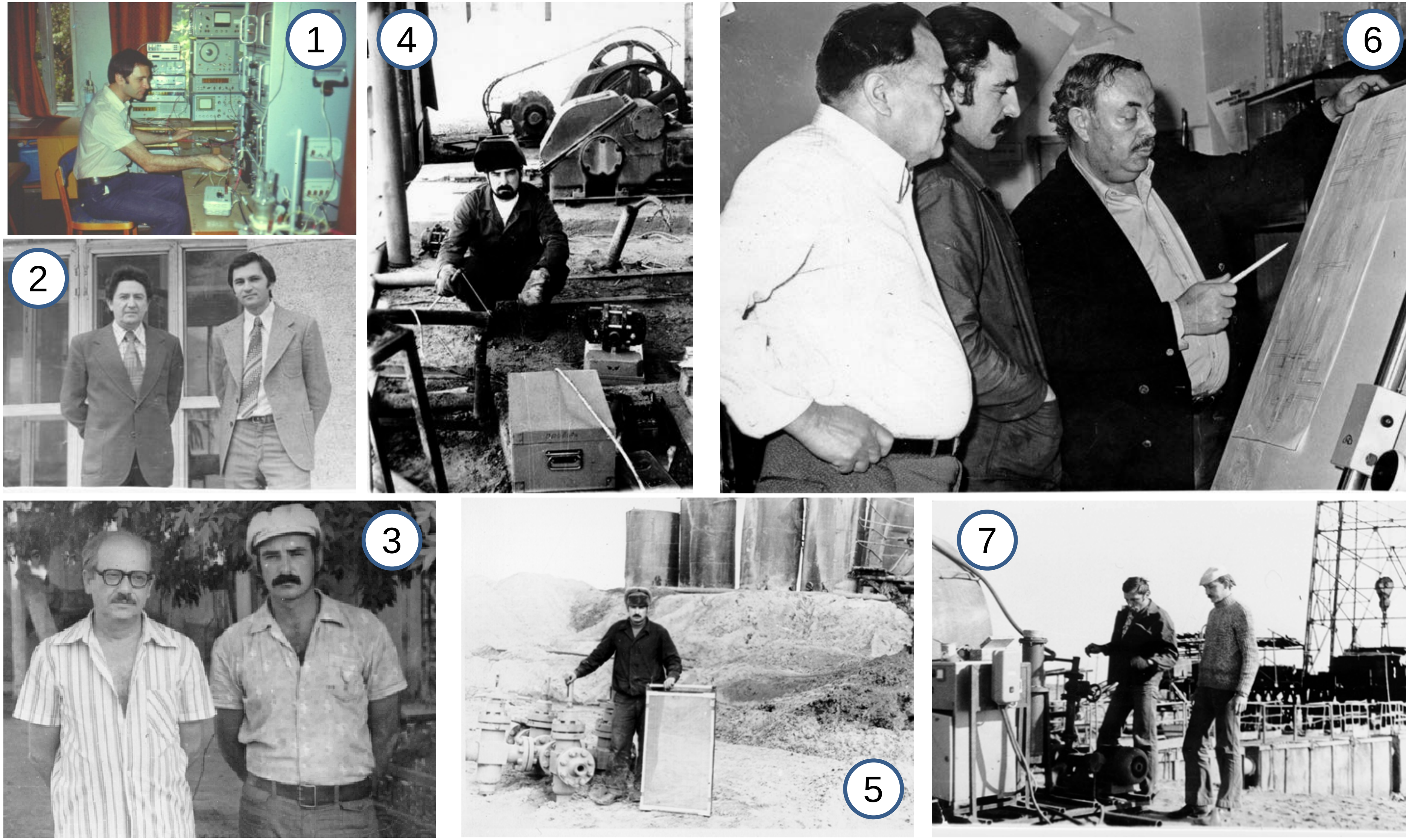
EACO devices with a rotating cylindrical electrode for unipolar cathode electrochemical processing and simultaneous adhesion-centrifugal cleaning of drilling mud were developed by the staff of the Laboratory of electrotechnology in SREDAZNIIGAZ as an effective substitute for shall shakers and UOBR devices. The degree of purification of the drilling fluid from suspended pieces of rocks was determined by the speed of rotation of the cylindrical drum (picture top center), which is the negative electrode (cathode). The diameter of the rotating electrode is 600 mm, length - 1400 mm. Current - 600 A, voltage – 24 V. The rotation speed is from 300 to 1200 rpm.

Devices with one rotating electrode (see pictures left) and two electrodes (top right) were developed and tested in practical drilling. The device capacity was from 100 000 to 180 000 l/h. Due to the presence of the positive electrode with automatic removal of mud cake, EACO devices allowed to produce high-quality cleaning of drilling fluid without use of hydrocyclones and shale shakers. Kokand region of Uzbekistan, 1978.

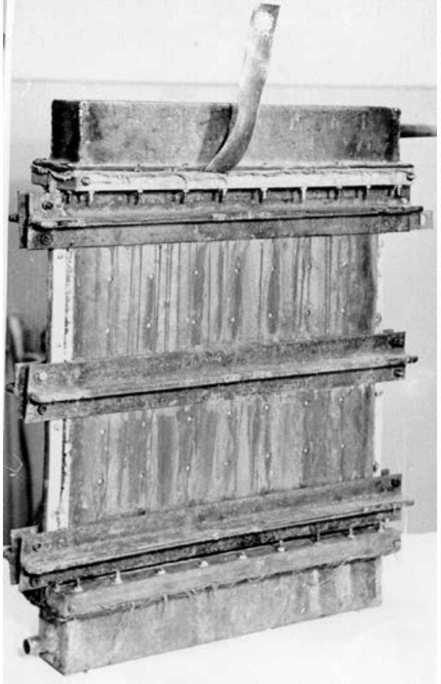


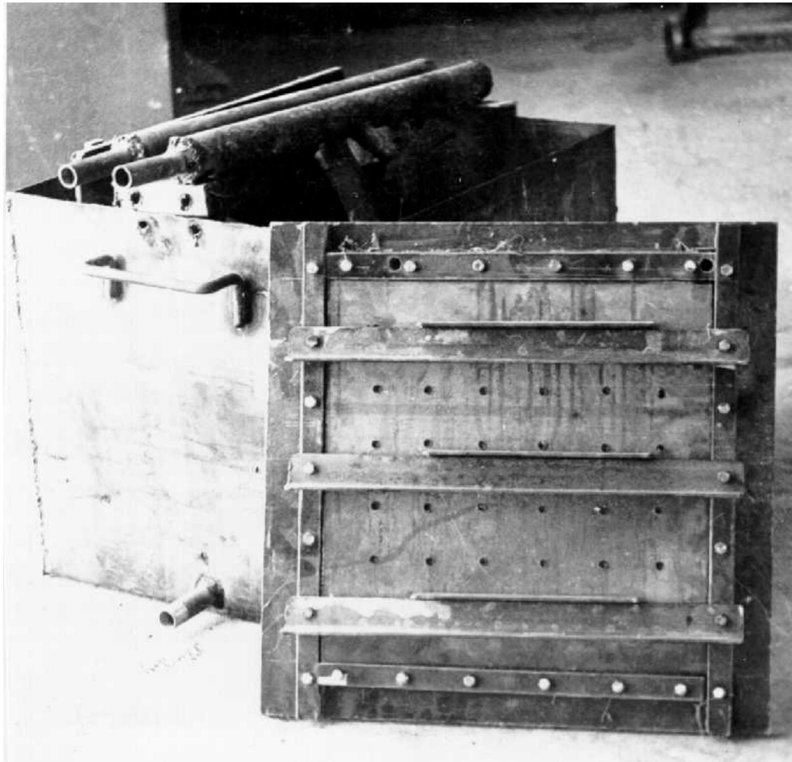


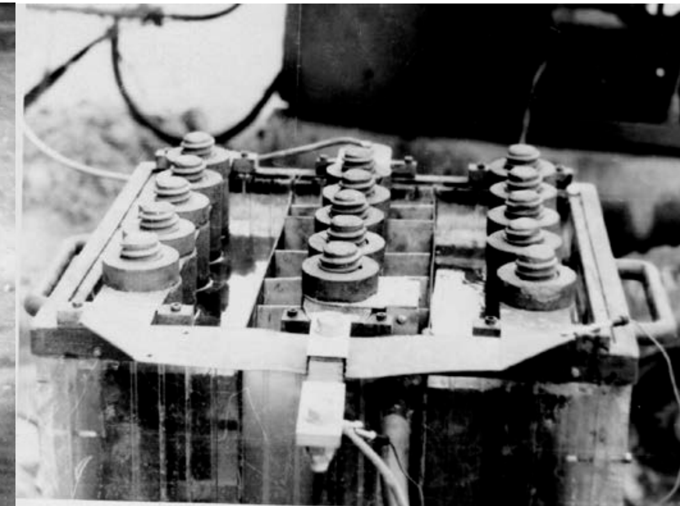
Shop of electrochemical synthesis of humate reagents (ESHR). This workshop was designed and built in 1980 in the village Karaul-Bazaar of Bukhara region by the staff of SREDAZNIIGAZ: Laboratory of introduction of electrochemical techniques (chief lab. Yu. Zadorozhny) and Laboratory of electrotechnology (chief lab. V. Bakhir). The workshop capacity - 25 tons of pasty coal-alkali electrochemically activated reagent (USR A) per shift. Humate reagent USR-A went from this workshop to drills of Bukhara management of drilling operations and provided savings on every hole up to 60% of all funds for preparation and processing of drilling mud. The main shop equipment - electrochemical reactors for production of catholyte of subsurface water with total capacity of 10 m^3/h (1) and electrochemical reactors for processing of pulp reagent with capacity of 2 m^3/h each (2) - are also made by staff of SREDAZNIIGAZ. Village Karaul-Bazaar, 1980.



The history of ECA in persons. Fragment №1. 1 - Head of Laboratory of electrotechnology (LET) V. M. Bakhir, 1975. 2 - senior researcher of LET S.A. Alekhin, PhD, (left) and V.M. Bakhir, 1977. 3 - Head of Laboratory of physics and chemistry of drilling fluids, DSc. N.A. Mariampolski (left) and head of Laboratory of introduction Yu.G. Zadorozhny, 1978. 4 and 5 - Yu.G. Zadorozhny at drill, 1979. 6 - from left to right: chief mechanic PO "UZBEKNEFT" D.Sh. Gaziev, Yu.G. Zadorozhny, leading constructor of LET L.E. Spector, 1979. 7 – V.M. Bakhir (left) and leading engineer of LET O.P. Bitutskov on drilling, 1979.

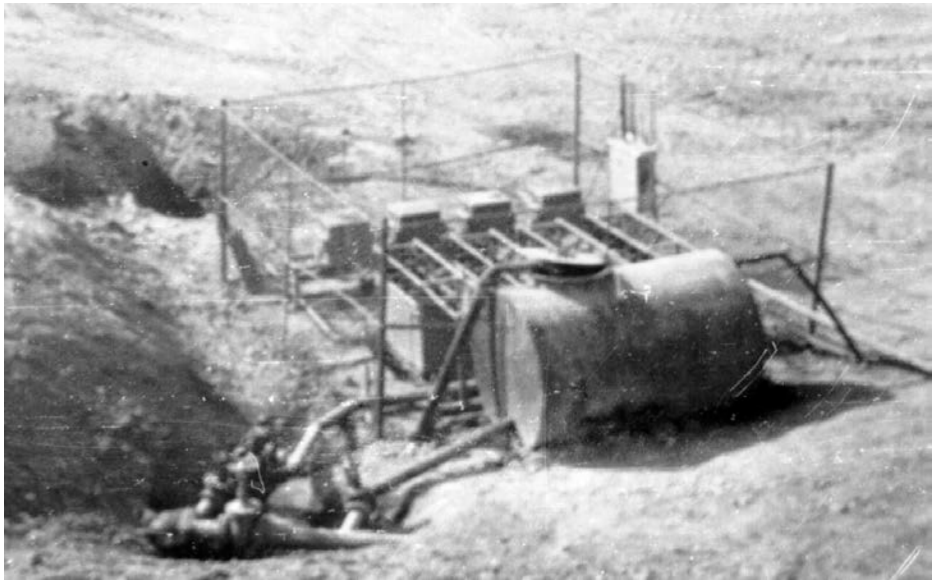


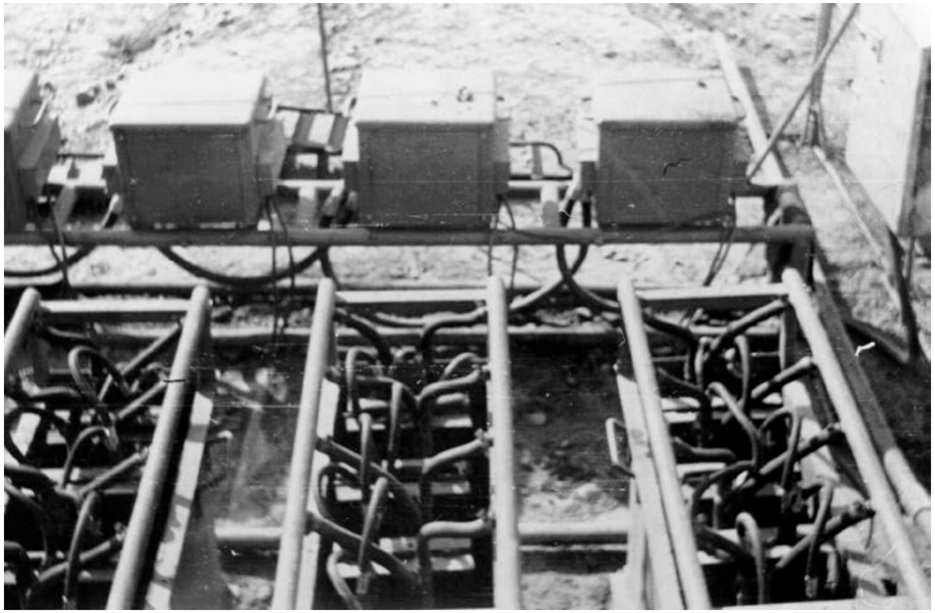




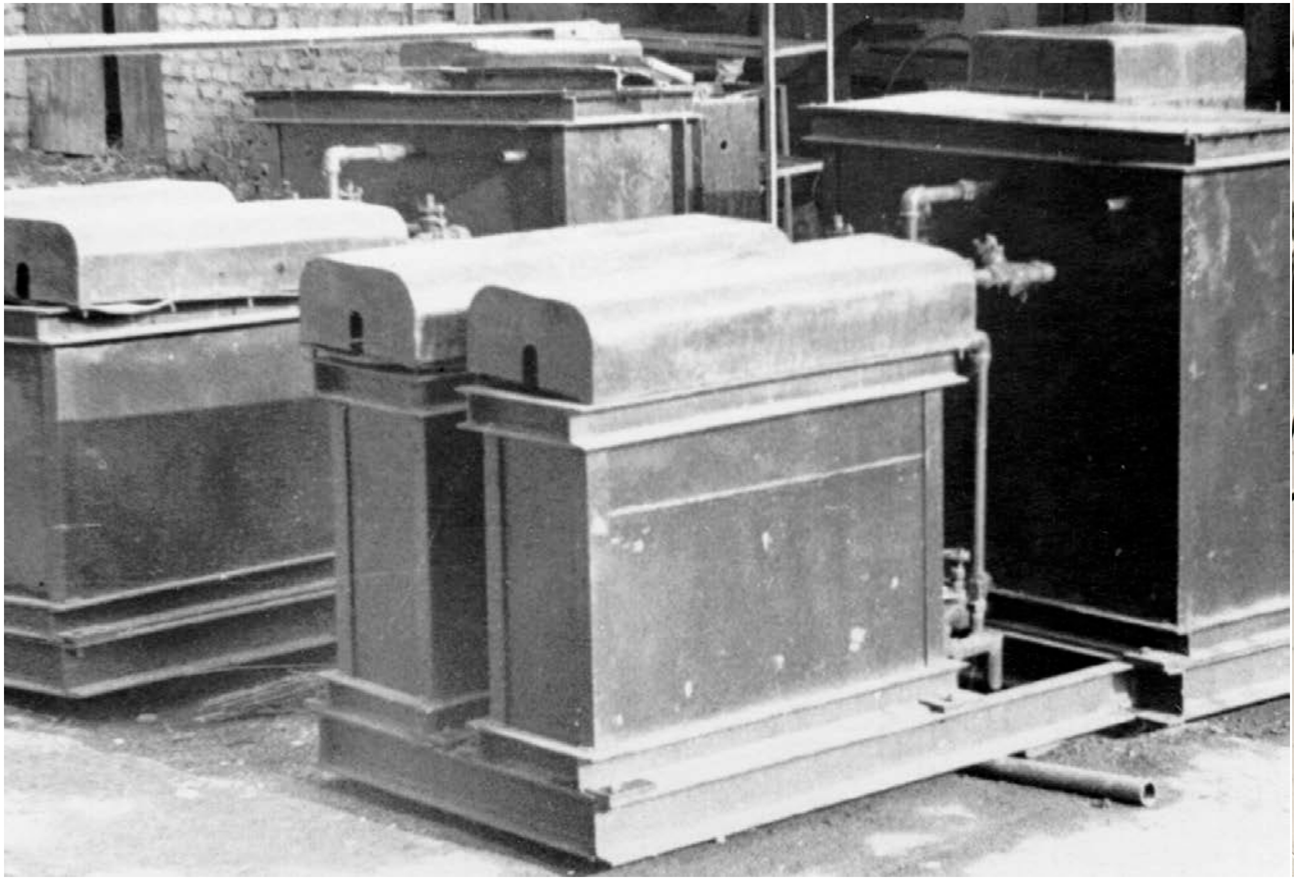
Development and manufacturing of devices for unipolar electrochemical water treatment began in 1975.

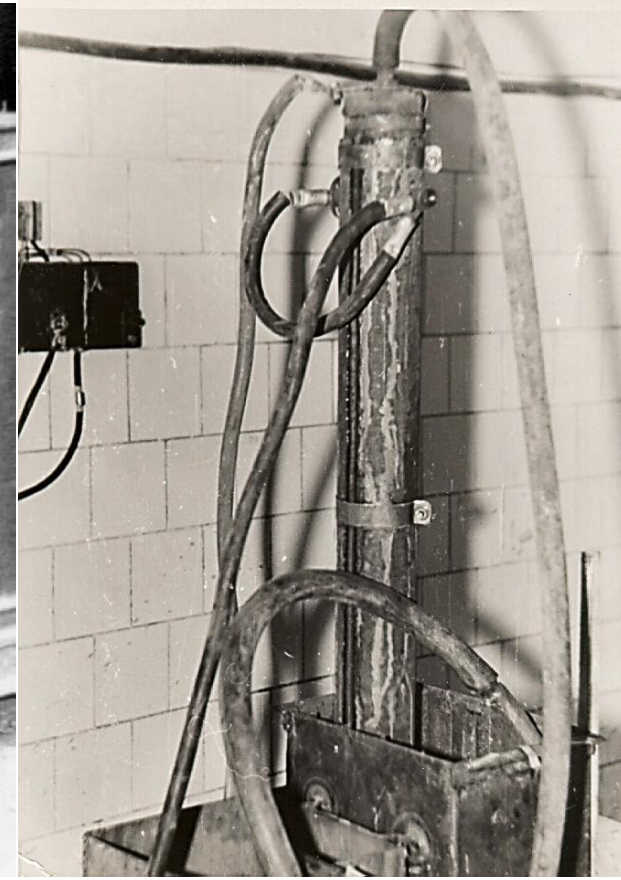
The first electrochemical unit with flat electrodes 50 × 50 cm and PVC fabric diaphragm (top left) was successfully tested on the rig (bottom left) and further work continued on the path of improving designs with flat electrodes (top center and bottom). Steel sheet anodes were replaced by silicon iron plate, dimensions of electrodes were optimized (60 × 60 cm), guide rods were mounted in electrode chambers to organize efficient configuration of flows. Variants of reactors with flat electrodes, collected from graphite rods (top right) were also tested.



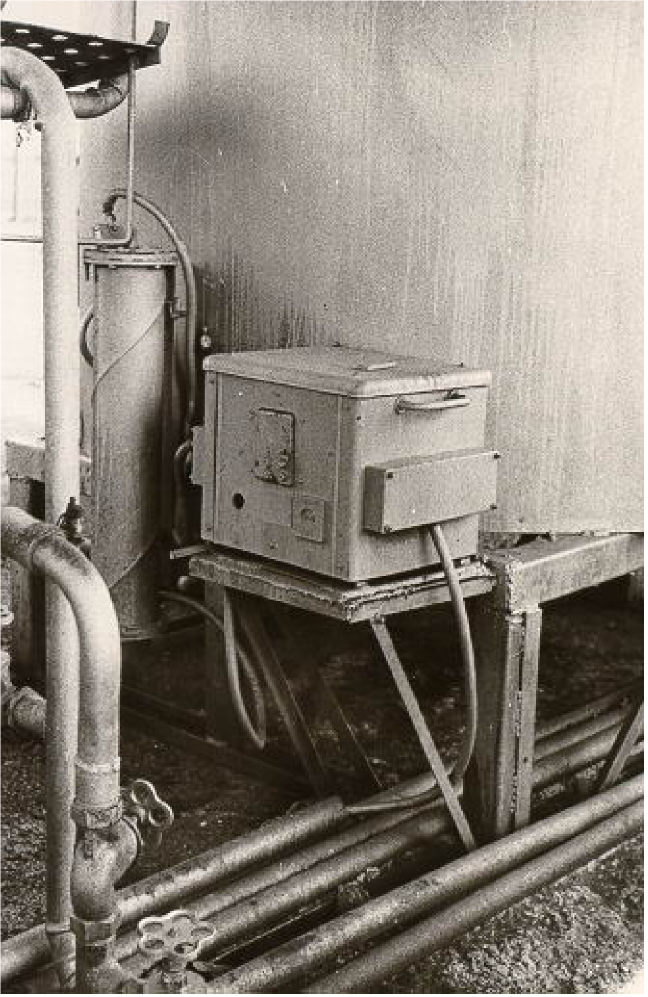


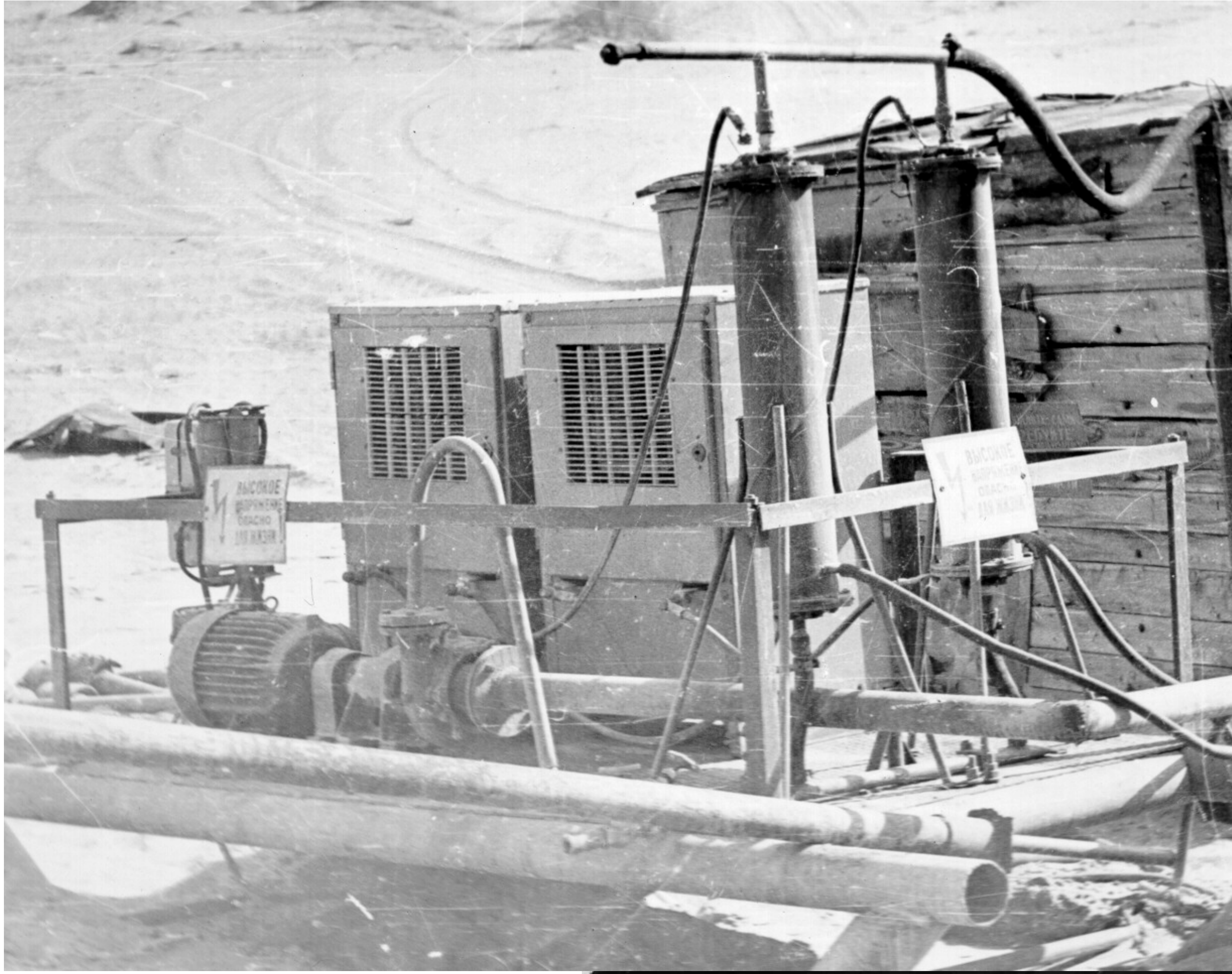
Productivity of individual devices for electrochemical water treatment (UEW) with flat electrodes reached 20 m^3/h by 1976 (photo right). It helped to use it not only for drill, where activated water – catholyte - was used for preparation of drilling fluids and cooling of diesel engines, but also in the process of oil displacement at edge waterflooding and boundary waterflooding. The photo on the left is one of the places of maintaining of formation pressure at the oil field PO "UZBEKNEFT", 1976.



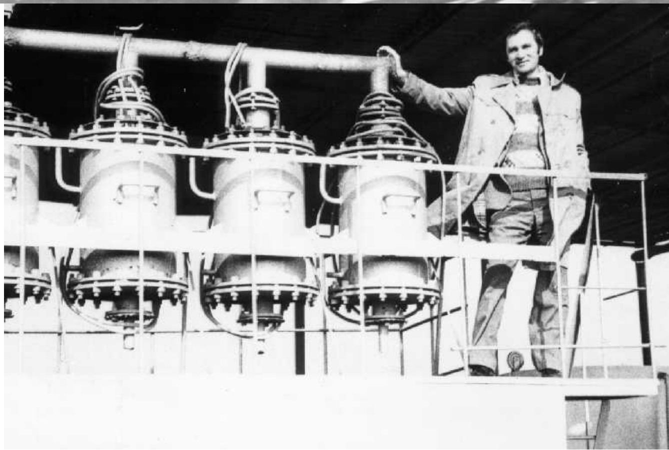


Reactors of UEV devices with flat electrodes could not compete with coaxial reactors neither in productivity, nor in economy, nor in functional parameters of water (catholyte, anolyte). Even the first primitive reactors constructions with coaxial placement of electrodes - anode rod, canvas diaphragm (fire hose) and tubular outer cathode (photo right) showed that one reactor of this type, operating at a voltage of 20 V and a current of 500 A can provide a capacity of 5 m^3/h both of catholyte and anolyte, which was equivalent to productivity of UEV-10 device (photo left), which reactor provided with worse technological parameters of anolyte and catholyte at total current of 800 A and a voltage of 36 V. The reason for differences is in "spotted" conductivity, which is typical for all reactors with flat electrodes operating in dilute aqueous-salt solutions. The lower the mineralization of the solution, the higher the negative effect of "spotted" conductivity. Tashkent, SREDAZNIIGAZ 1977.

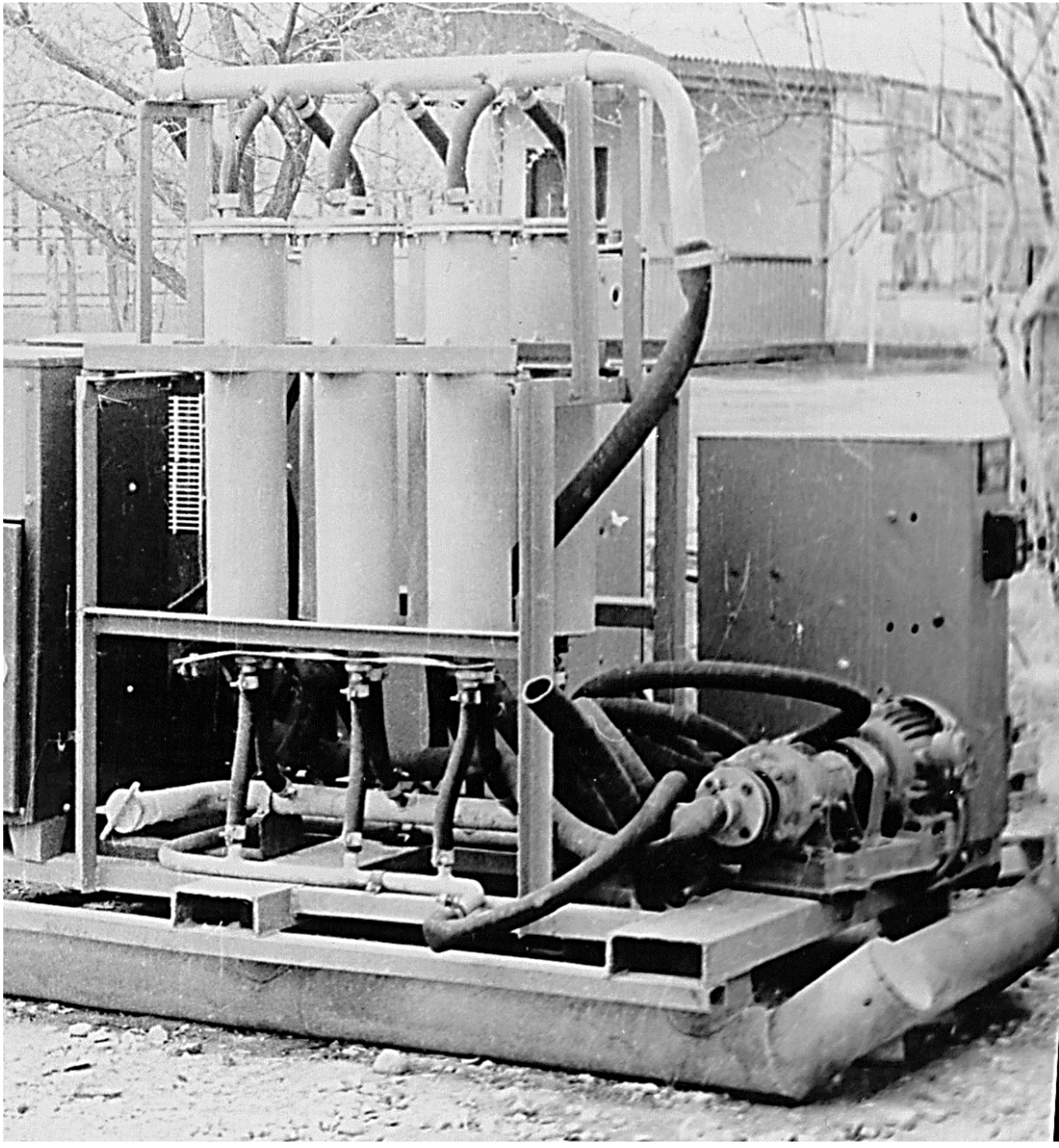


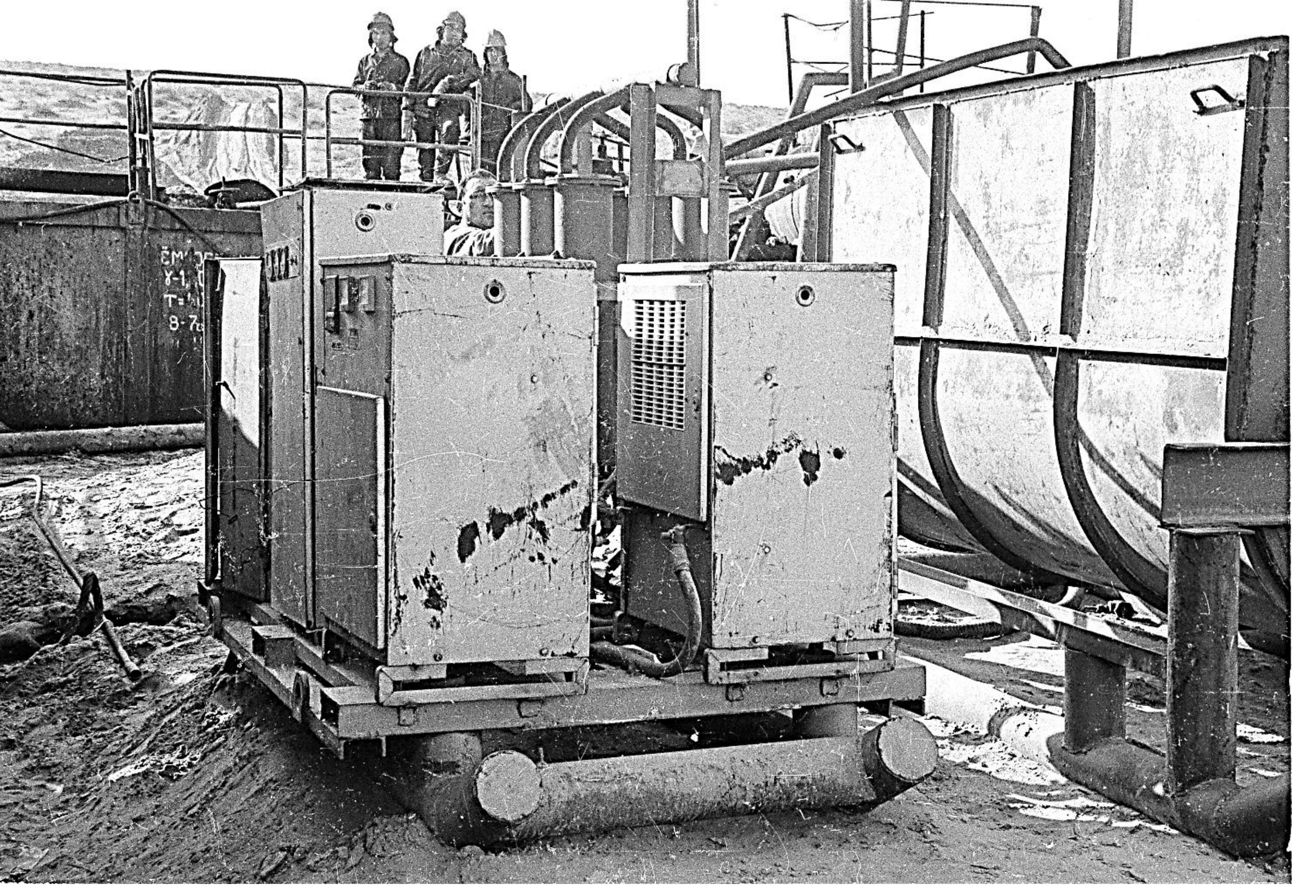


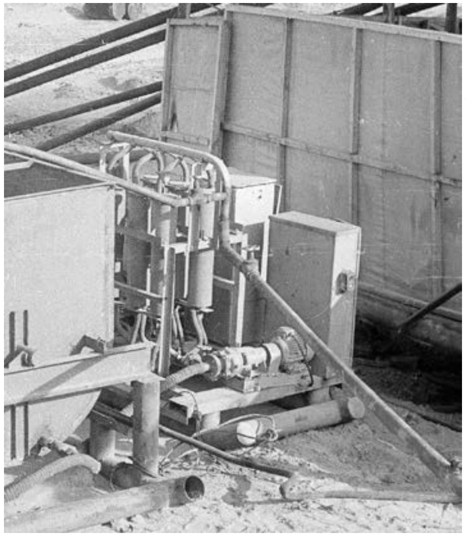
Development and industrial testing of different variants of reactors with coaxial placement of electrodes and diaphragm allowed to determine the optimal correlation of size and shape of electrode chambers, to approach to better understanding of the key role of physical-chemical, mechanical and filtration properties of the diaphragm. Diaphragms of first versions of reactors were made of canvas (belting), however, with the accumulation of experience, diaphragms became mechanically more rigid - from perchloric vinyl on the frame to special porous asbestos cement. Turkmenistan, Uzbekistan, 1977.



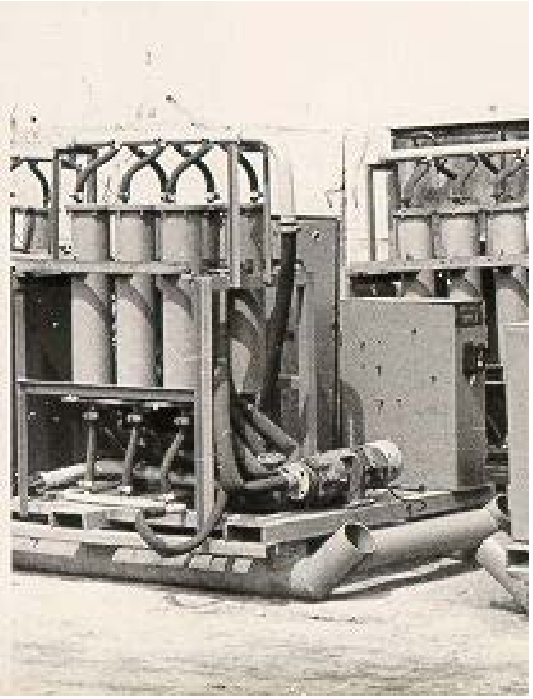
UEV-4 device for production of electrochemically activated water used in processes of preparation and processing of drilling mud, water treatment for cooling systems of gas treatment units, compressor stations of main gas pipelines. Six hydraulically connected in parallel flow-through electrochemical reactors with coaxial placement of electrodes and diaphragm. Anodes are graphite rods with a diameter of 100 mm and a length of 900 mm, diafragm – perchloric vinyl fabric on PVC frame. Interelectrode distance is 10 mm. Catholyte productivity - 25000 l/h, anolyte productivity - 5000 l/h, current -1200 A, voltage - 30 V.
Kokand factory "Bolshevik" produced such devices more than a thousand in the period from 1977 to 1980.





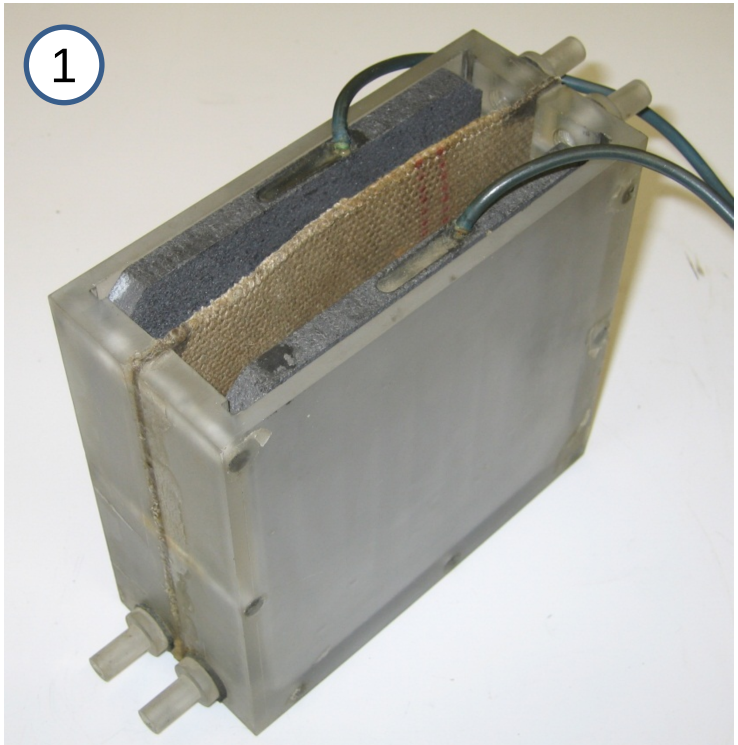


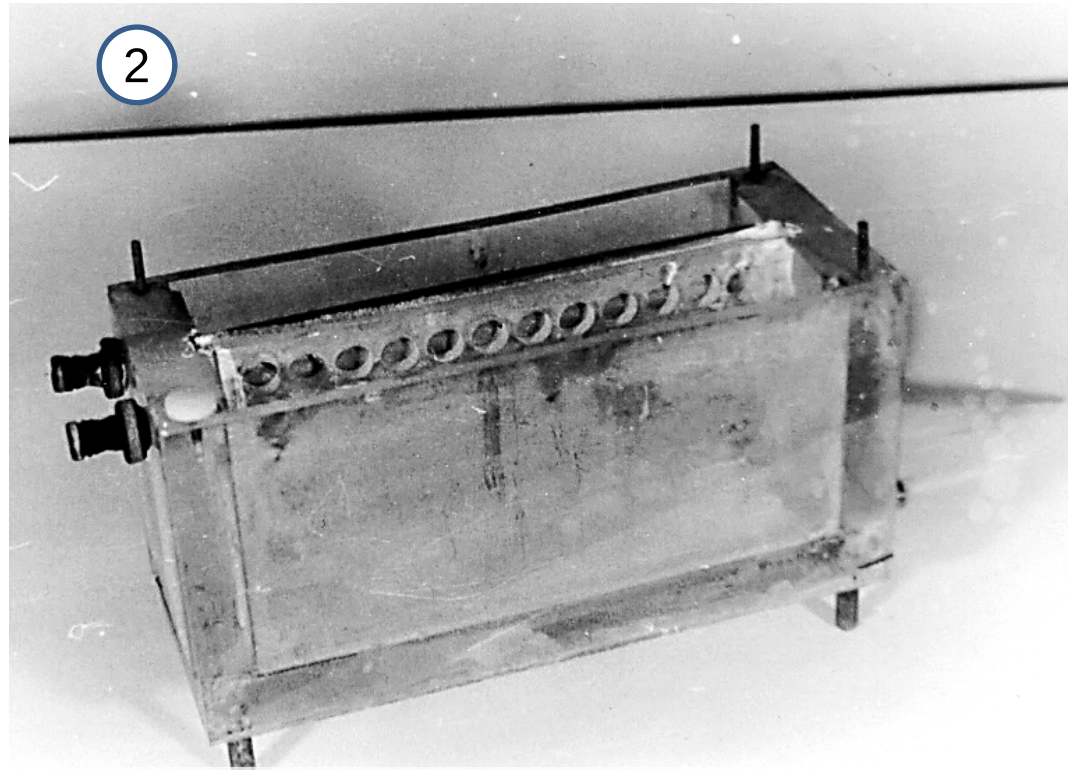
UEV-4 devices at drills of PO "Uzbekhistan" and VPO "Turkmengazprom" allowed to save up to 30 - 40 % of chemicals, increased service life of diesel engines in 5 - 15 times. Turkmenistan, Uzbekistan, 1978.

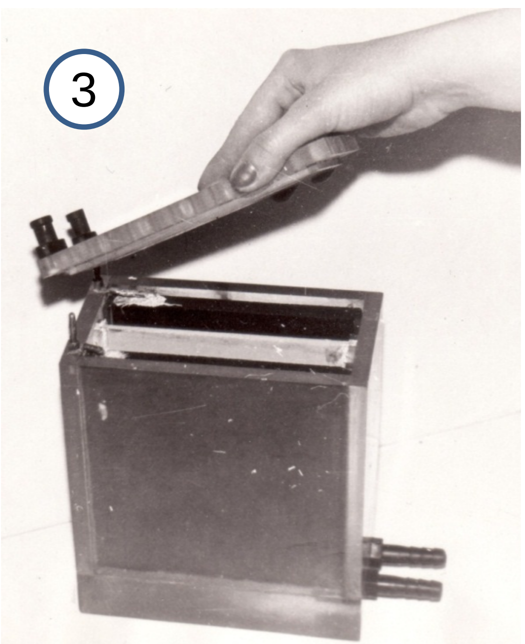


UEV-4 devices were used not only in technological processes of drilling and production of oil and gas, but also in the processes of transport of gas (cooling of gas-engine compressors of pipeline Bukhara-Ural" by softened water), for soaking cotton seeds before sowing (top photo), that allowed to increase the yield by 15 to 20% due to the acceleration of germination, destruction of cotton diseases (wilt), stimulation the growth and development of plants.

UEV-4 devices were also used in processes of underground coal gasification (city Angren) for water purification from phenol and other toxic products of gasification, in system of scrubber purification of flue gases of steel-smelting furnaces (city Gorlovka), in technologies to protect pipelines from corrosion when pumping chemically aggressive groundwater (PO "Nizhnevartovskneftegaz"), in technology of leaching of uranium by preparation of working solution of sulfuric acid with concentration reduced three times on the anolyte of reservoir water, that provided increasing of uranium recovery by 5 - 7 % (Leninabad mining and chemical combine). Uzbekistan, 1979.





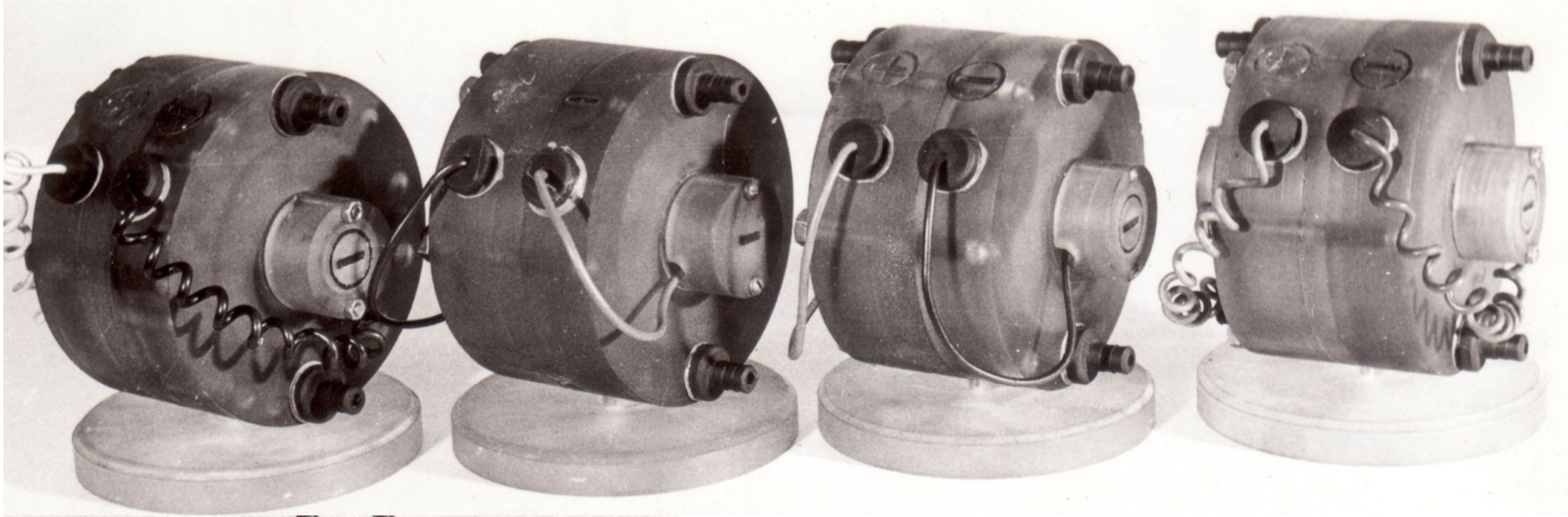


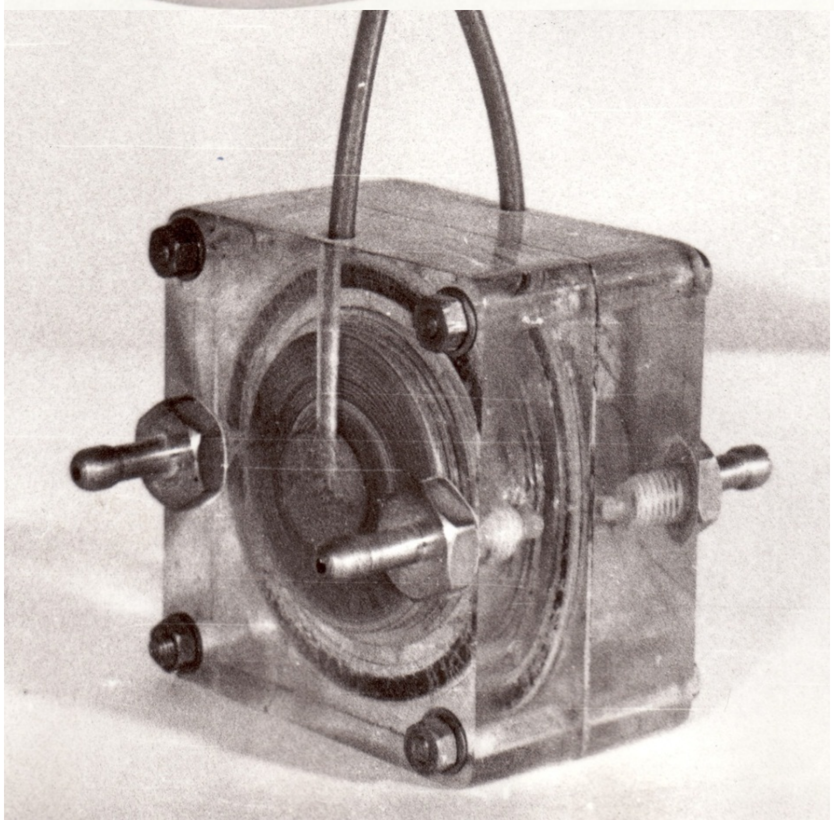
The first laboratory static (periodic action) electrochemical reactors. All models are developed by V. Bakhir and Yu. Zadorozhny and made by Yu. Zadorozhny and specialists of his laboratory. Such reactors helped to work through technological methods of unipolar electrochemical treatment of drilling fluids, chemicals – reducing agents of viscosity and fluid loss, subsurface water, sewage, dilute aqueous-salt solutions.

1 - one of the first models of the laboratory reactor for separation of anode and cathode processing of liquids. The diaphragm is made of canvas, the electrode plates are made of graphite size of 150×150 mm and thickness 12 mm .Tashkent, SREDAZNIIGAZ, 1973.

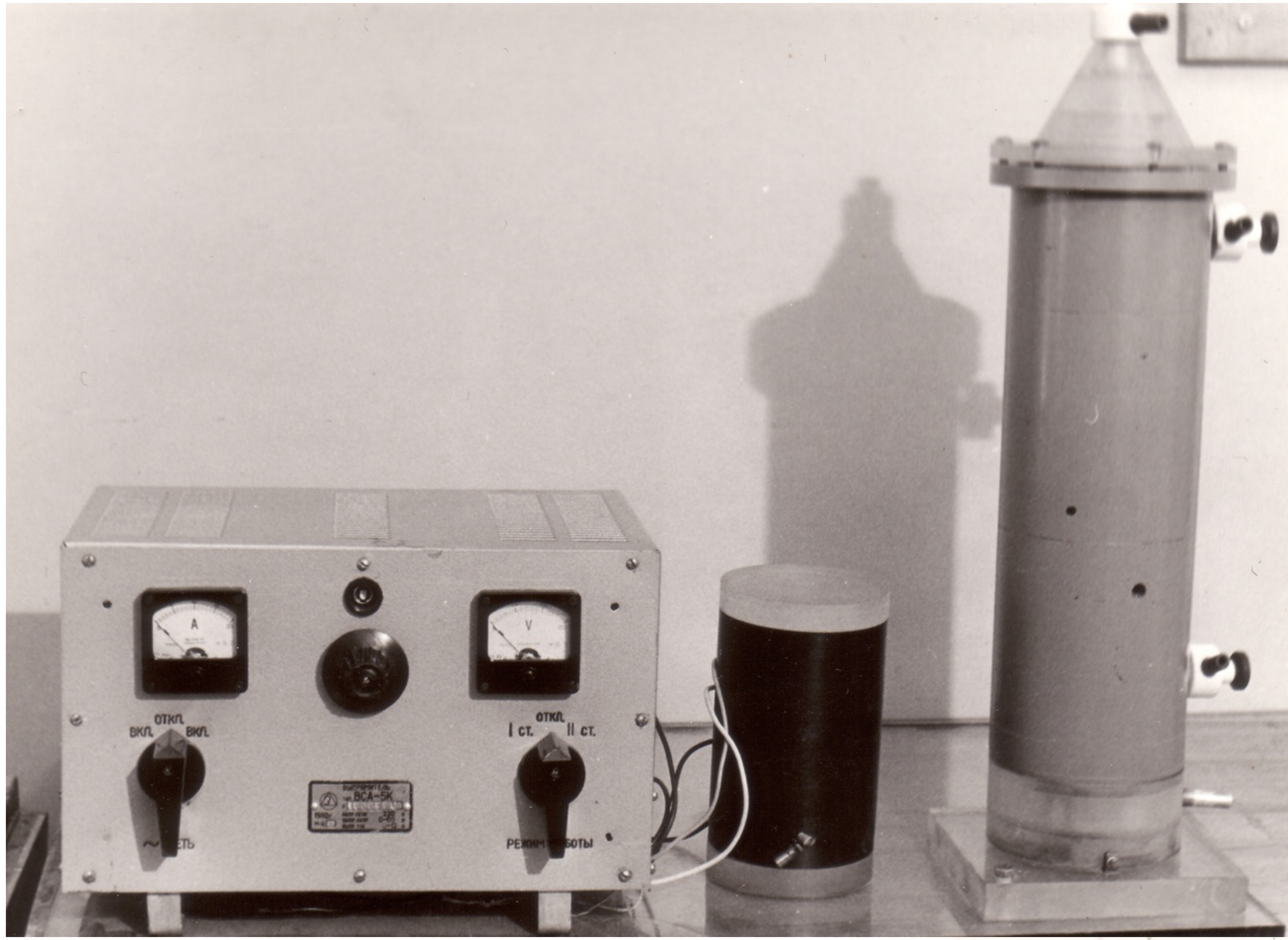
2 - laboratory static reactor with canvas diaphragm and graphite electrodes. Tashkent, SREDAZNIIGAZ, 1974.

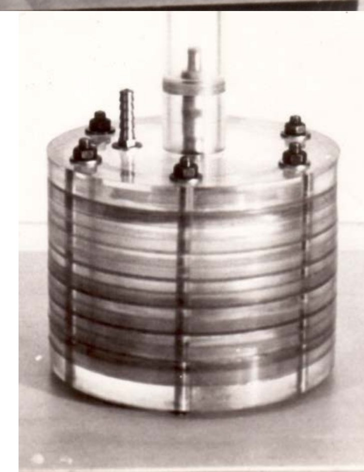
3 - The static reactor with ceramic diaphragm and graphite electrodes. Tashkent, SREDAZNIIGAZ, 1975.



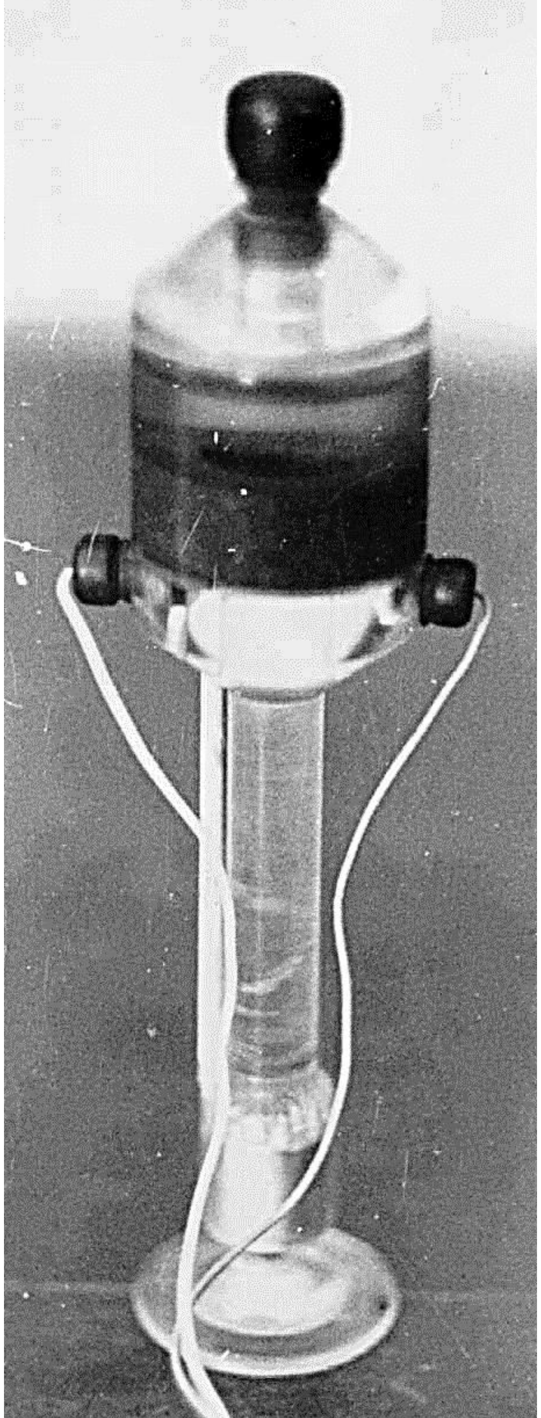


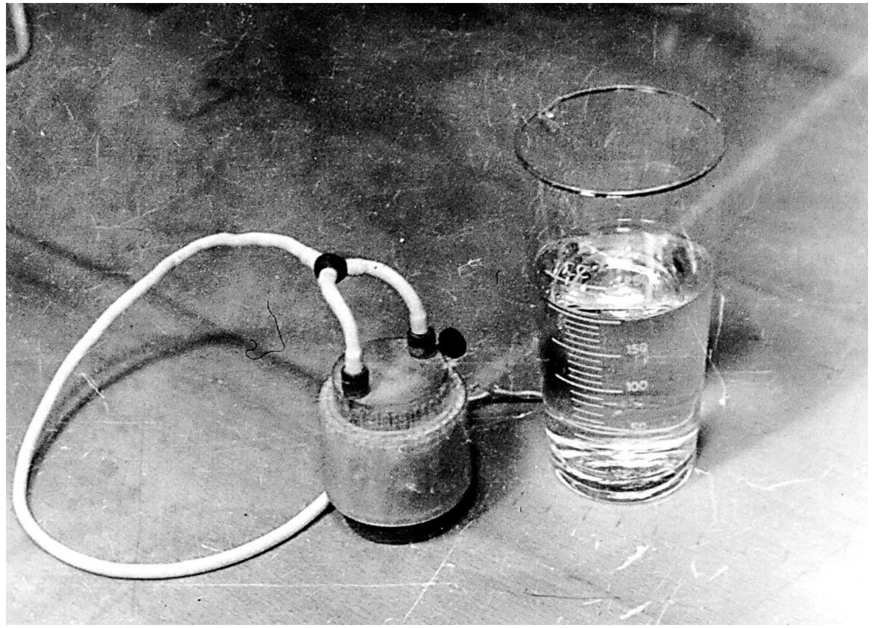
Laboratory flow-through electrochemical reactors ELCA-035 (photo above) and WELCA-03 (photo bottom left), fitted with electrodes made of graphite MPG-6 and separating diaphragms of ultrafiltration fluoroplastic film with separators made of PVC mesh. The interelectrode distance is 3 mm, the productivity of anolyte and catolyte of fresh (up to 1 g/l) water is 15 l/h of each solution at a current of 3.5 A and a voltage of 30 V. The reactor WELCA-03 could work not only with saline water, but with distilled water, gasoline or oil. While working voltage on the electrodes ranged from 5 to 25 kV at a current from 5 to 20 mA.
Such laboratory reactors were used to perform research work in various organizations. Tashkent, SREDAZNIIGAZ, 1979.



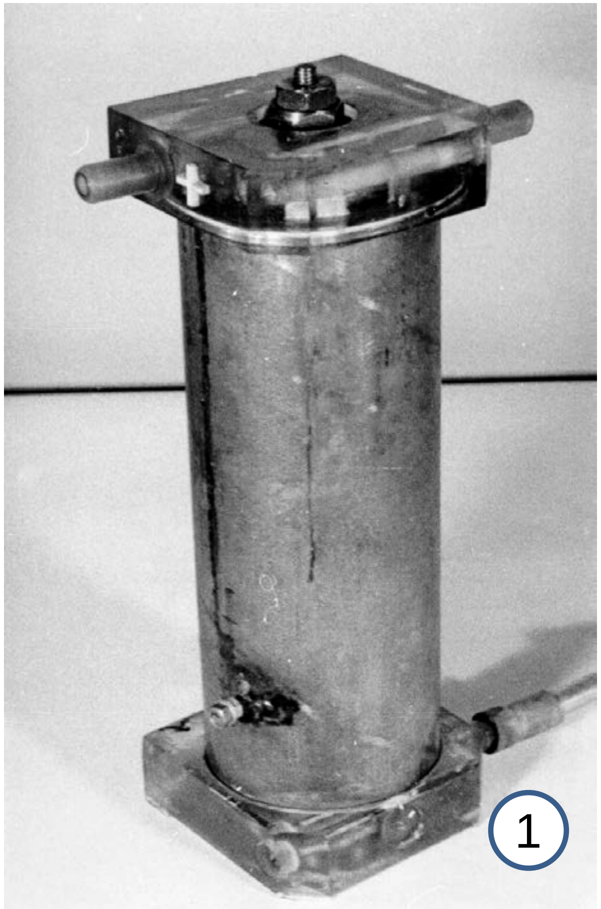


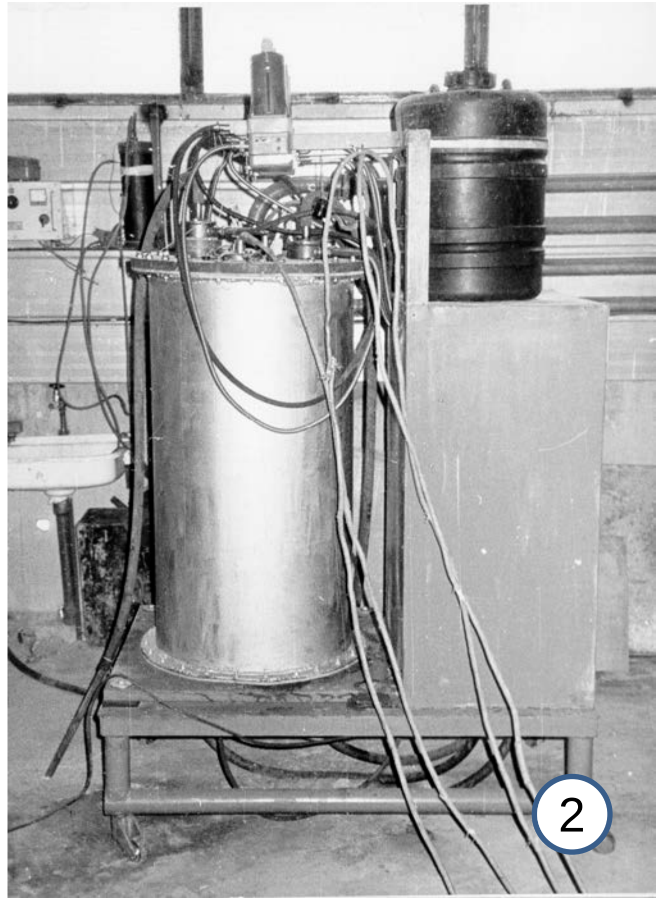
Laboratory electrochemical flow-through reactors with coaxial diaphragm of porous PVC and glass-carbon electrodes (photo left).
Flow-through electrochemical reactor with coaxial diaphragm of porous polypropylene to obtain electrochemically activated anolyte and catholyte of fresh water, dilute aqueous solutions of electrolytes. The anode of the reactor is pyrolitic graphite rod with a diameter of 80 mm and a length of 300 mm, the cathode is made of stainless steel. Current - up to 60 A, voltage - up to 170 V (photo top right).
Laboratory reactor for electrochemical processing of distilled water in flow (photo bottom right). Tashkent, SREDAZNIIGAZ, 1978.

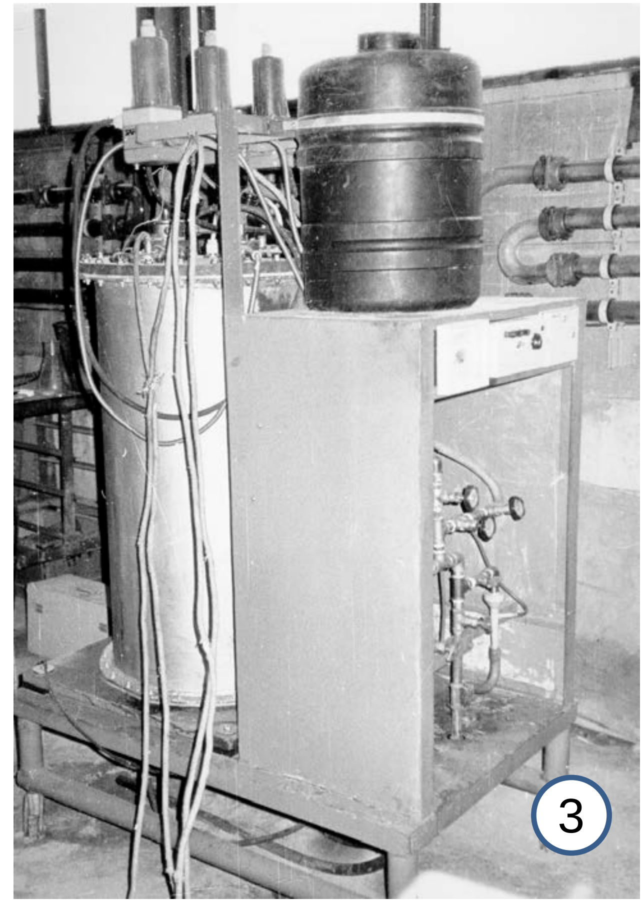




Laboratory immersion electrochemical reactors for unipolar electrochemical treatment of liquids in tanks. The auxiliary electrode of these reactors, protected by a diaphragm, had its own electrolyte flow circuit. Tashkent, 1978

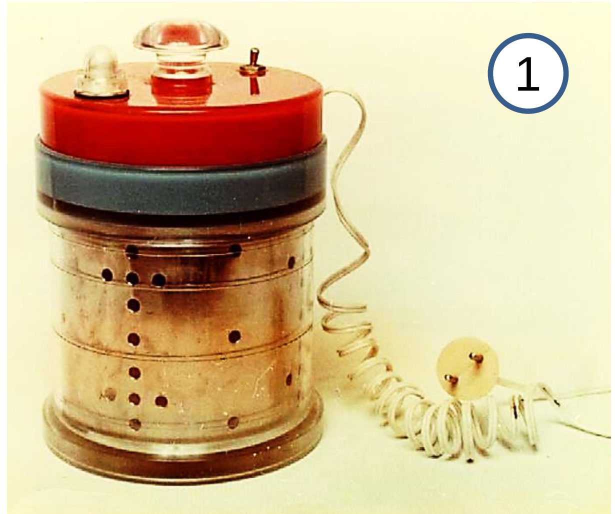






1 - laboratory flow-through diaphragm electrochemical reactor (photo left) is the first in a series of reactors with a ceramic coaxial set diaphragm and a prototype of commercial reactors of high productivity. The anode of the reactor is a pyrolitic graphite rod with a diameter of 80 mm and a length of 300 mm, the cathode is of stainless steel, the diaphragm - alumina ceramics. Current - up to 60 A, voltage - up to 170 V. Tashkent, SREDAZNIIGAZ, 1979.

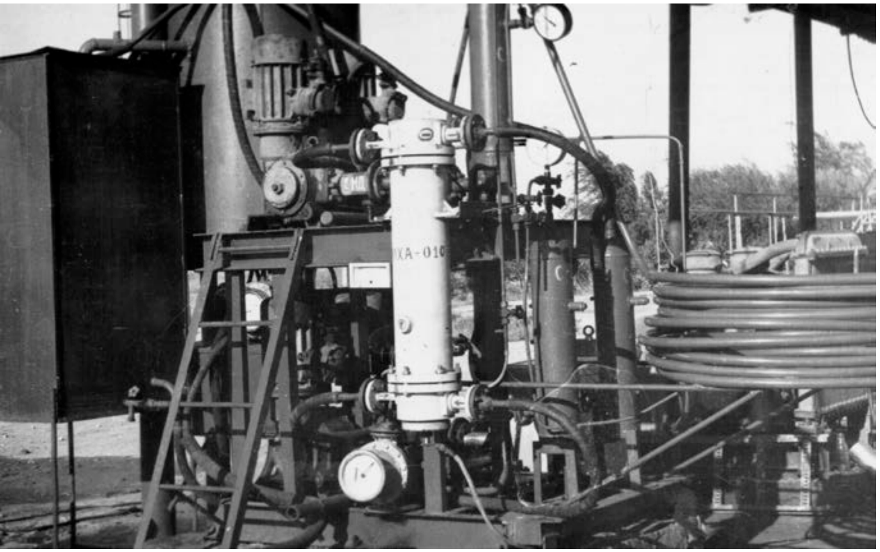
2, 3 - ELCA-002 device for anolyte and catholyte production from tap (potable) water. The cathode is a monoblolck from graphite with a diameter of 600 mm and a length of 1000 mm with seven longitudinal channels with a diameter of 120 mm for fixation of diaphragms of alumina ceramics and anodes made of graphite coated with manganese dioxide placed inside each diaphragm. The device productivity is 1000 l/h of catholyte and 600 l/h of anolyte. Current - up to 500 A, voltage - up to 170 V, Tashkent, UZPTICEPROM, 1984.



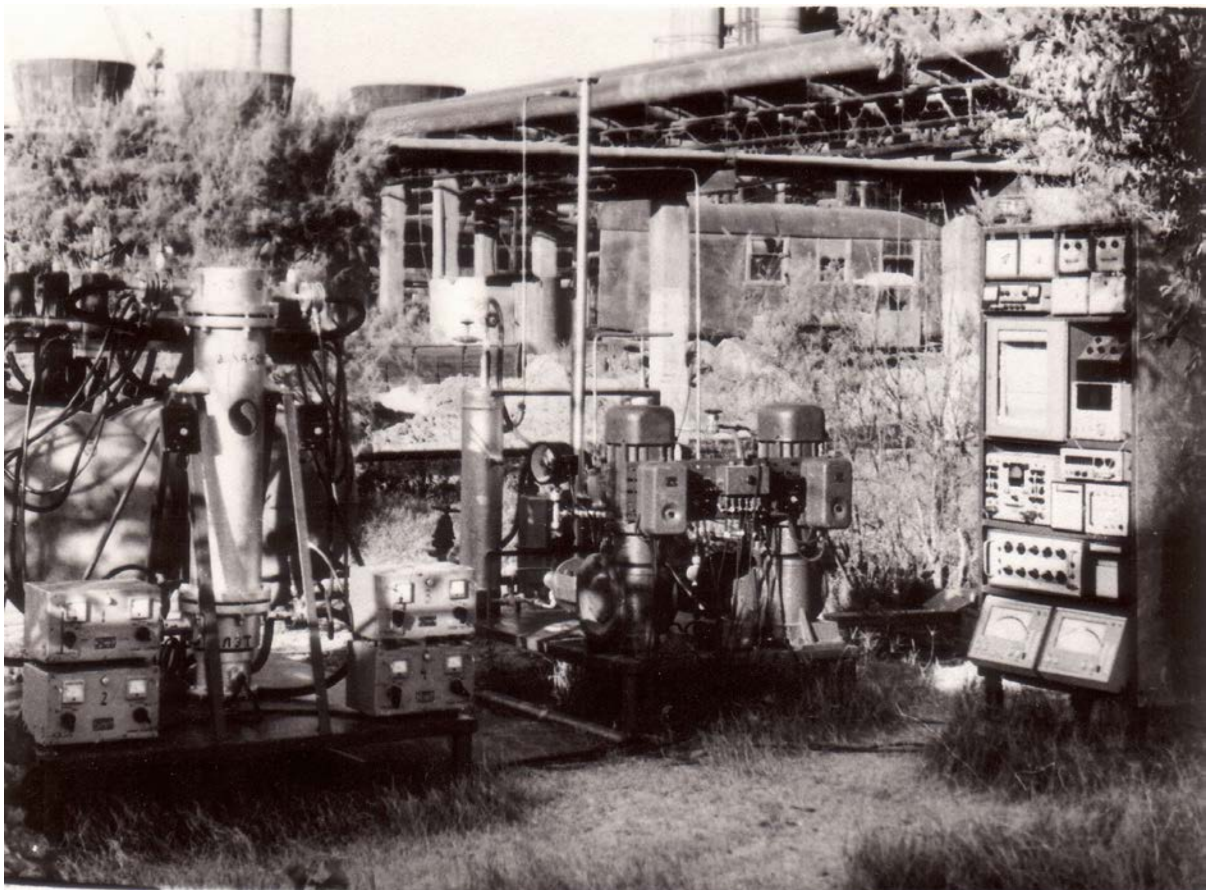
1 - the first prototype of ESPERO device for production of a small amount of anolyte (0.3 l) and catholyte (0.5 l) of drinking water. Designed and manufactured in 1985 by V. Bakhir and Yu. Zadorozhny.

2,3,4 - a prototype of ESPERO device to get activated anolyte and catholyte, designed and manufactured by Vitold Bakhir and Yu. Zadorozhny in 1986 in NPO “VOSTOK". Unlike the first model of 1985, the device is equipped with a timer. The anode is significantly improved. Tashkent, 1986.

5 - household electroactivater to obtain small amounts of electrochemically activated catholyte of drinking water. Developed by V. Bakhir and Yu. Zadorozhny under contract with CNIIAG MOP USSR. In this design immersible electrochemical reactor with platinized titanium auxiliary electrode, a titanium cathode and a polymer (polysulfone) diaphragm on the frame is used. Moscow, CNIIAG, 1988.

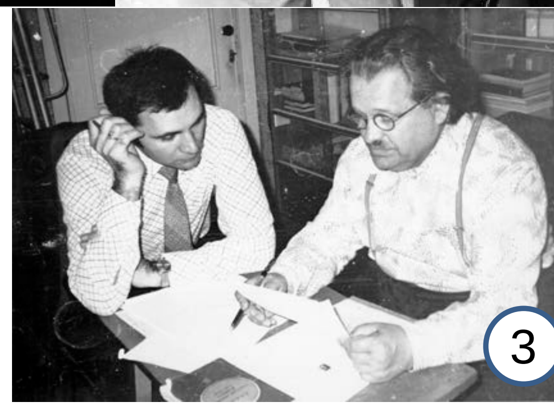


Experimental setup to study the electrochemical process of cleaning of natural gas from hydrogen sulphide at field Sarytash. The device is made by the staff of SREDAZNIIGAZ: Laboratory of introduction of electrochemical techniques (chief lab. Yu. Zadorozhny) and Laboratory of electrotechnology (chief lab. V. Bakhir). The device demonstrated the ability to reduce the treatment cost of treatment of low-sulfur natural gas from hydrogen sulphide approximately five times as compared with traditional technology (monoethanolamine way). Karshin region, 1983.



Experimental setup to study the electrochemical process of cleaning of natural gas from hydrogen sulphide (process “TASHKENT”) at Mubarek gas sulfur plant. The device is made by the staff of SREDAZNIIGAZ: Laboratory of introduction of electrochemical techniques (chief lab. Yu. Zadorozhny) and Laboratory of electrotechnology (chief lab. V. Bakhir). The device demonstrated the ability to reduce the costs of treatment of natural sour gas from hydrogen sulphide by approximately three times compared with traditional technology (monoethanolamine way). Karshin region, 1984.

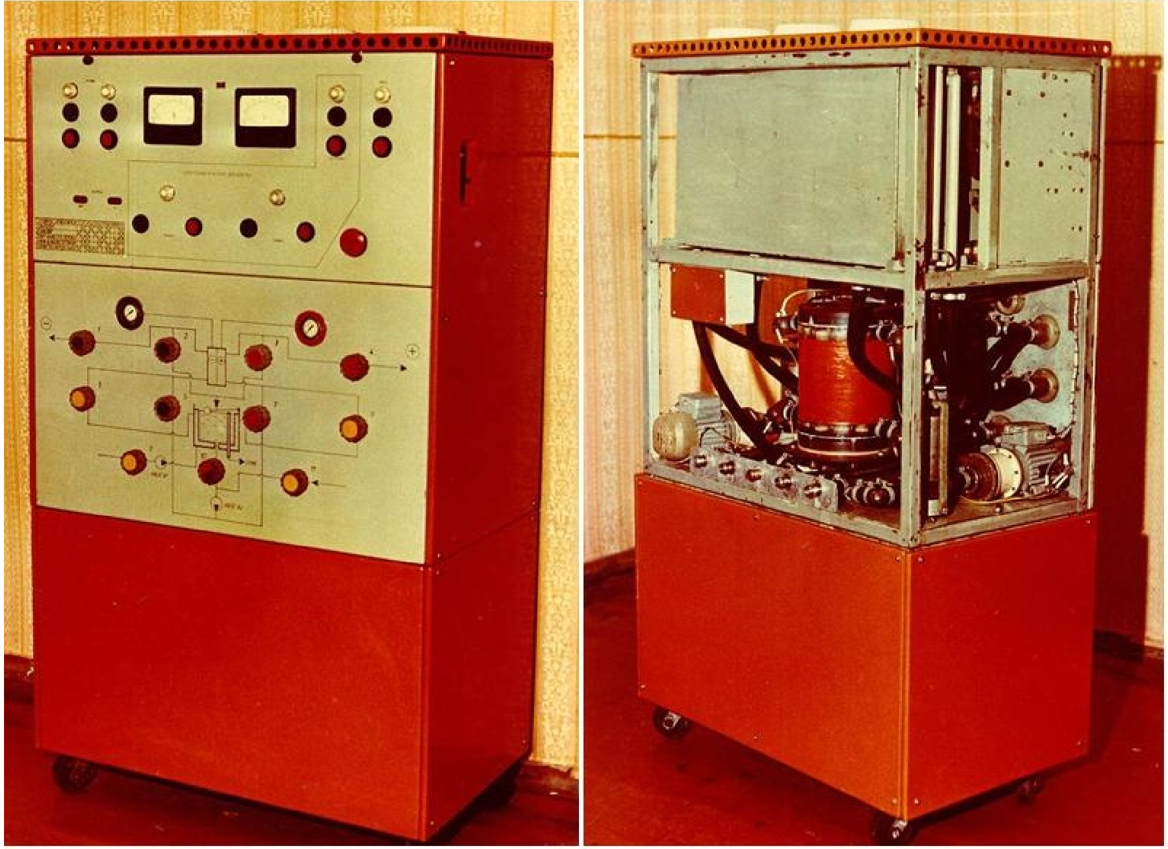
The history of ECA in persons. Fragment № 2. 1 – V.M. Bakhir and Professor of KCTI named after S.M. Kirov (Kazan Chemical-technological Institute) A.G. Liakumovich, who joined the team of ECA researchers in 1981. Creative cooperation between Tashkent and Kazan groups continued until 1991. Kazan, 1982.



2 - academician of the USSR Academy of Sciences Ya.B. Zeldovich (right) meets with the technology of ECA. Next (right to left), rector of the Kazan Chemical-technological Institute (KCTI) Professor P.A. Kirpichnikov; research worker of the Department of physical chemistry of the same Institute B.C. Friedman, PhD in chemistry; leading designer of NPO “VOSTOK", Tashkent, V.M. Bakhir; Director of special installation and adjustment control of ECA systems for agriculture and poultry L.E. Spector, Kazan, KCTI, 1985.

3 – V.M. Bakhir and the Creator of the Unified Quantum Relativistic Theory of the Fundamental Field (FFT) theoretical physicist I.L. Gerlovin, Leningrad, 1984.

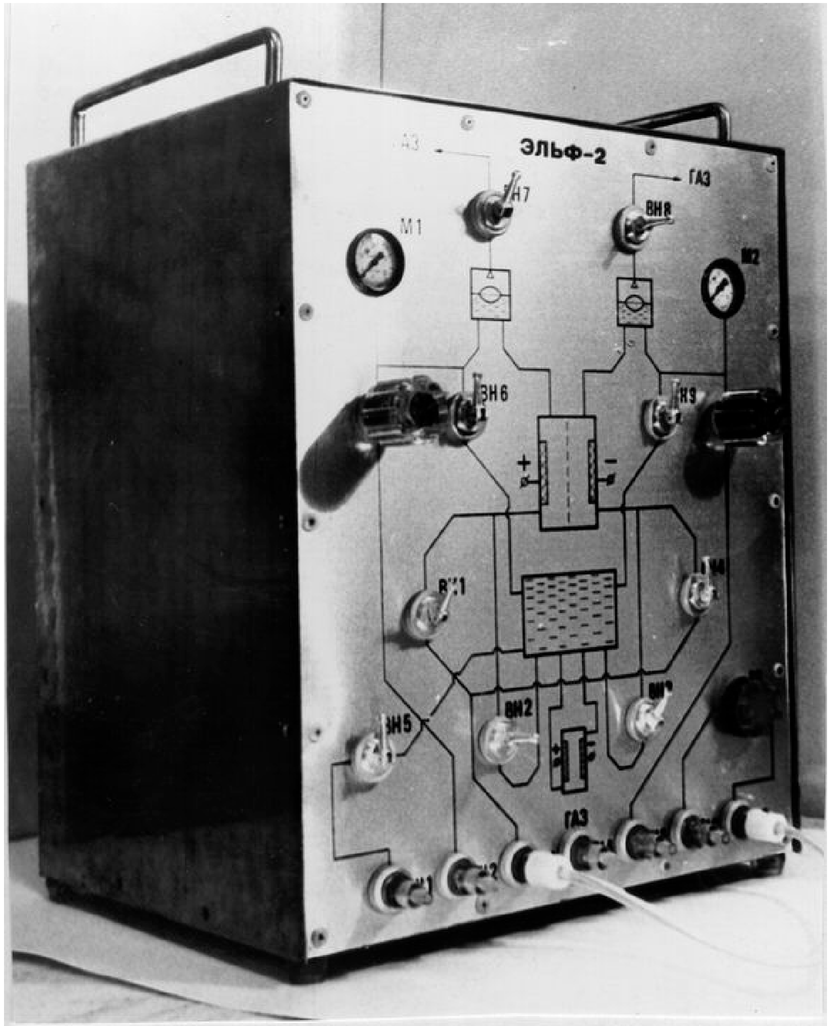
4 - President of the USSR Academy of Sciences academician A.P. Aleksandrov acquainted with the achievements of KCTI including in the field of electrochemical activation. Kazan, 1987.



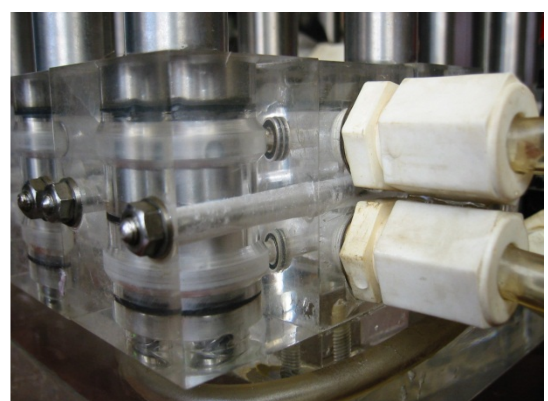
ELCA-003 device to obtain electrochemically activated water for manufacturing processes of circuit boards, galvanic manufacturing and polishing of silicon single crystals of a large diameter. The device is equipped with a hydraulic system with switching circuits circulation of auxiliary electrolyte to any of the electrode chambers. The device is capable of producing electrochemically activated anolyte and catholyte of deionized water containing dissolved salts no more than 2 mg/l. ELCA-003 device is designed and manufactured by V. Bakhir and Yu. Zadorozhny in NPO “VOSTOK" in 1985 – 1986. Later, the NPO “VOSTOK" mastered serial production of this type devices. Tashkent, 1986.

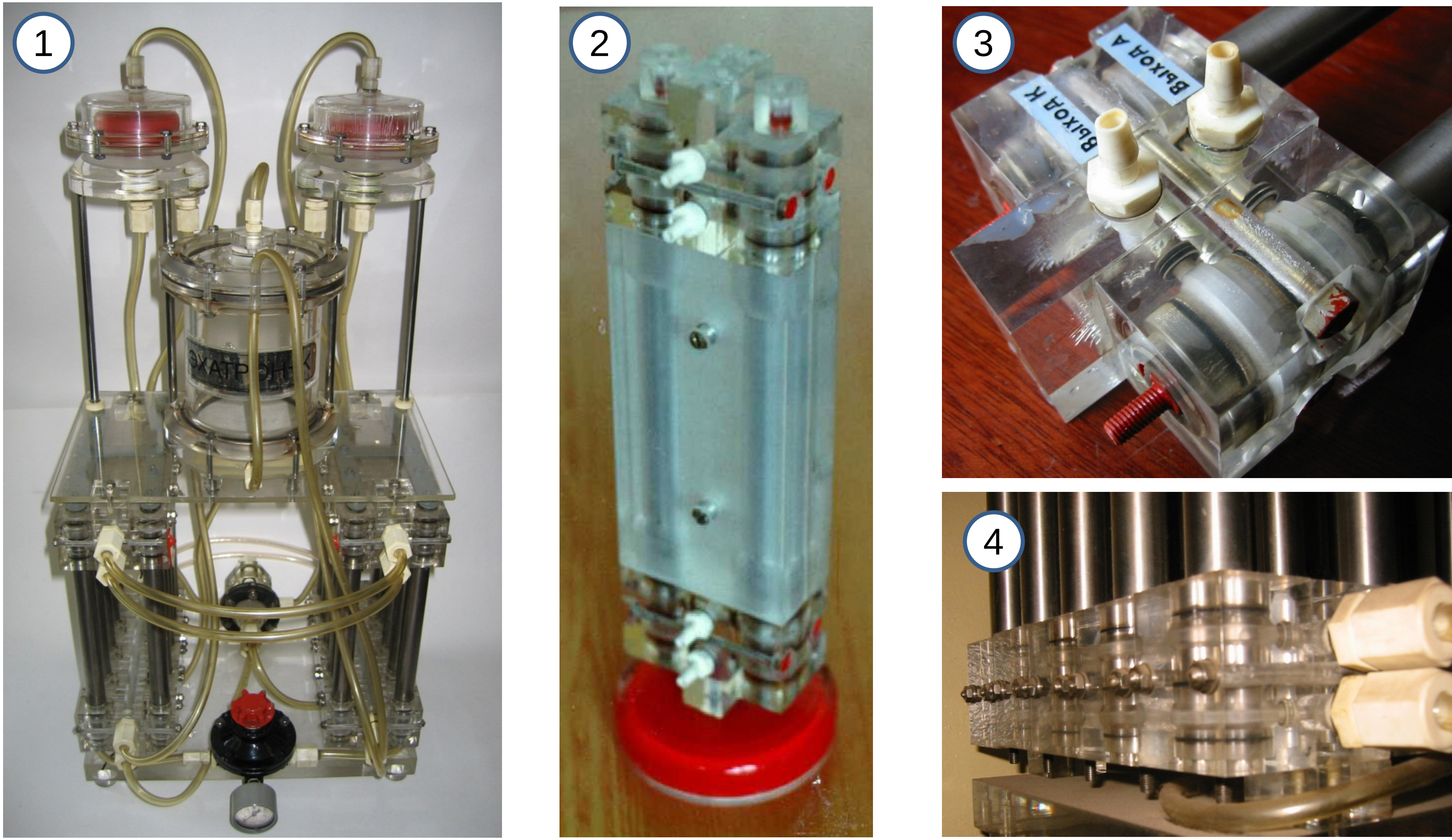
Electrochemical reactor of ELCA-003 device. The cathode - monoblock of graphite MPG-6 with 19 holes to accommodate ceramic diaphragms and anodes of glass carbon or oxide-ruthenium-titanium anodes each with a diameter 20 mm. Tashkent, 1986.

ECATRON-01 device to obtain catholyte and anolyte from drinking water, used in technologies of industrial poultry farming. In the device the electrochemical reactor of ELCA-003 device is used with the cathode in the form of a graphite monoblock with 19 cells. Productivity is 250 l/h, current - up to 100 A, voltage - up to 70 V. Moscow, NPK “ASPECT”, 1989



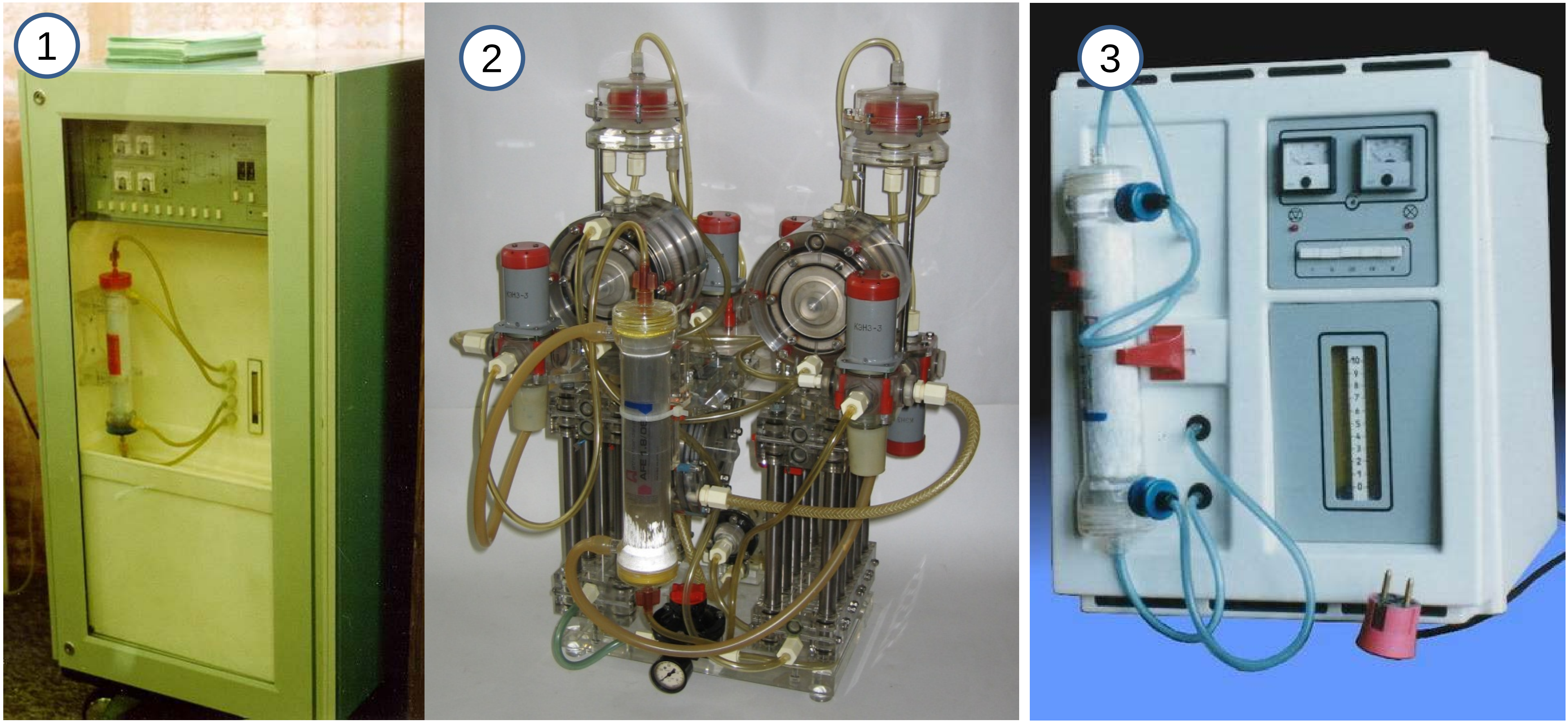
ELF-2 device for production of activated anolyte and catholyte from drinking water. The device is designed for use in food industry according to requirements specification of professor K.A. Kalunyants. Electrochemical reactor with a cathode in the form of a graphite monolock with seven cells for coaxially installed ceramic diaphragms and oxide-ruthenium-titanium anodes is mounted in the device (two photo below left). Device productivity is 300 l/h of catholyte and 100 l/h of anolyte. The device is equipped with a hydraulic system with switching circuits circulation of auxiliary electrolyte to any of the electrode chambers, which allows to increase anolyte output to 400 l/h or catholyte output to 600 l/h. Just in 1989 NPC “ASPECT” made 20 such devices. In 1990 15 ELF-2 devices were produced with RPE-10L reactors from10 FEM-1 elements developed in 1989 by V.M. Bakhir. FEM-1 elements are hydraulically connected in parallel with the help of collector heads and collector plates (two photo bottom right).





1-experimental model of ECATRON-K device for obtaining gaseous hydrogen chloride as an effective agent for straw saccharification. Manufactured according to requirement specification of professor K.A. Kalunyants. RPE-10L reactors (4) with FEM-1 elements (3) are used in the device for the first time. Moscow, Moscow technological Institute of food industry, 1989.

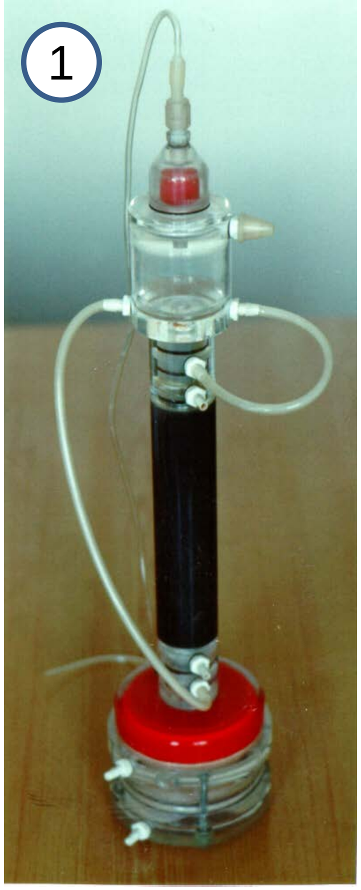
2 - electrochemical reactor of two hydraulically parallel-connected FEM-1 elements. Moscow, VNIIIMT, 1989.



1 – REDOX device for cleaning and sterilization of artificial kidney dialyzers with the purpose of its reuse. In the device a modified electrochemical reactor from ELCA-003 device is used. Device productivity is 250 l/h, current - up to 40 A, voltage - up to 70 V. Moscow, NPO “CHEMAVTOMATIKA", 1989.

2 - experimental model of the device for disinfection, pre-sterilization and sterilization of artificial kidney dialyzers with RPE-10L reactors from FEM-1 elements with productivity of 100 l/h of anolyte and 150 l/h of catholyte of tap water. Moscow, VNIIIMT, 1990.

3 – RENOFILTER device for disinfection, pre-sterilization and sterilization of artificial kidney dialyzers with RPE-10L reactors from FEM-1 elements with productivity of 100 l/h of anolyte and 150 l/h of catholyte of tap water. Moscow, NPO “CHEMAVTOMATIKA", 1992.



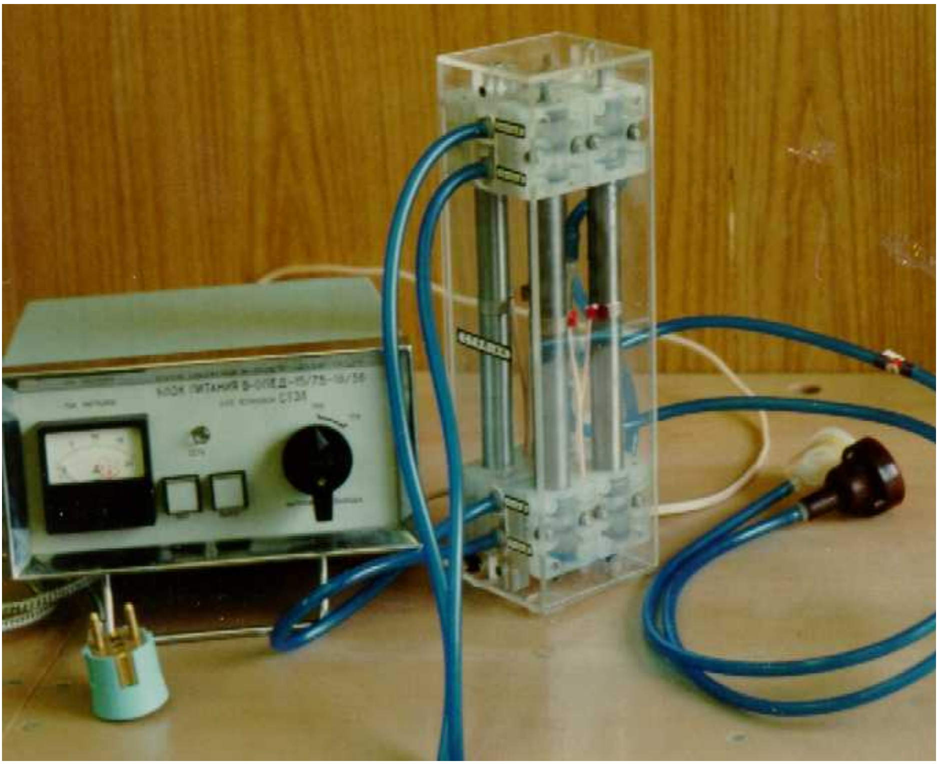
1 - STEL-MT-1 device developed under the direction of V. Bakhir in VNIIIMT in 1989 by demand of the Ministry of health of the USSR. Electrochemical reactor is represented by FEM-1 element. In 1990 STEL-MT-1 device was authorized by the Ministry of health of the USSR for serial production and wide use in medical institutions. Device productivity - 20 l/h of neutral anolyte (AN), electric power consumption is 100 W.

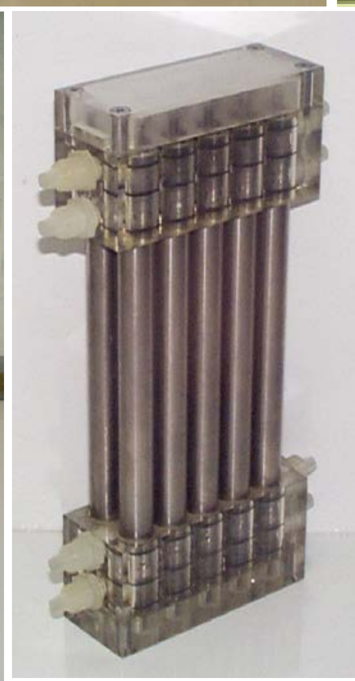
2 - STEL-MT-1 modification based on one FEM-1 element. Neutral anolyte AN is produced under catholyte flow rate 10 - 15 times less than anolyte flow rate. This allowed to simplify the design by removing the circulation tank of catholyte, to speed up three times the process of optimal start mode after switching on and bring it up to 30 - 40 seconds. Moscow, VNIIIMT, 1992.

3 - STEL-10N-120-01 device (model 40-01) for synthesis of electrochemically activated anolyte ANK. Productivity - 40 l/h, power consumption - 150 W. Moscow, VNIIIMT, 1994.

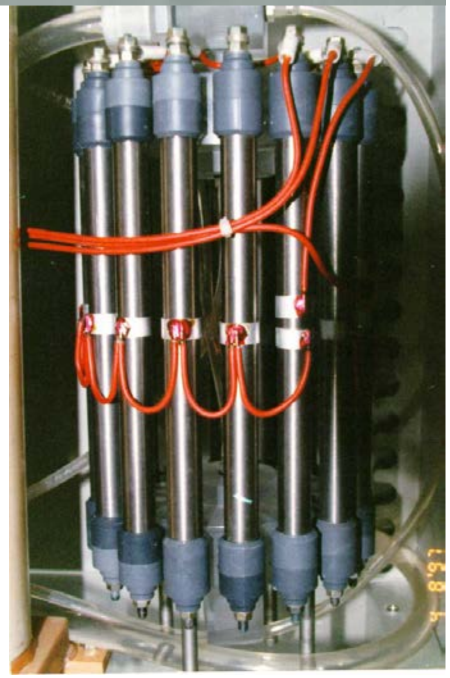


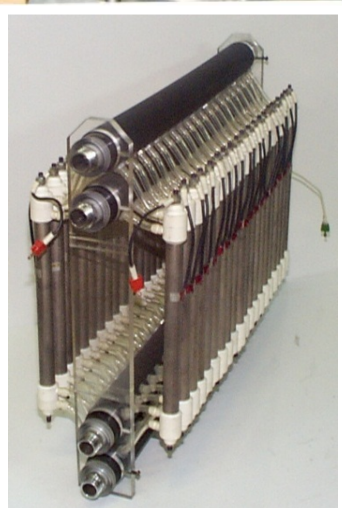

The history of ECA in persons. Fragment № 3. Disinfection of water by anolyte from two STEL devices during the crisis in Rwanda saved many lives. Princess Anna had conversation with Bob Borwick, Vitold Bakhir and Ian Woodcock about STEL devices in Rwanda and wished success in the development of electrochemical activation. 1994.



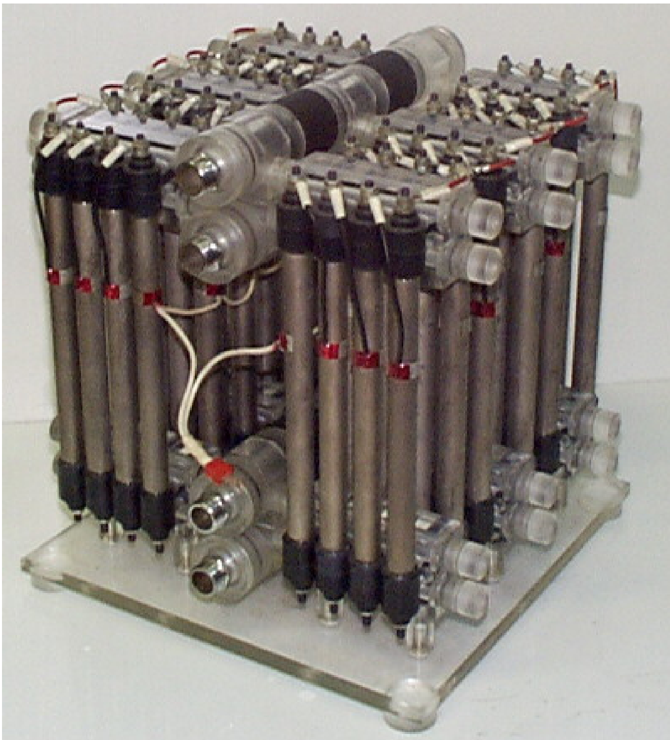


First STEL devices and electrochemical reactors with FEM-2 elements with a number of advantages in comparison with FEM-1 elements. The Laboratory of electrotechnology (LET ltd) manufactured in the period from 1989 to 1995 altogether thousands of FEM-1 and several tens of thousands of FEM-2 elements.
Moscow, LET ltd, EMERALD JV, VNIIIMT, 1994.

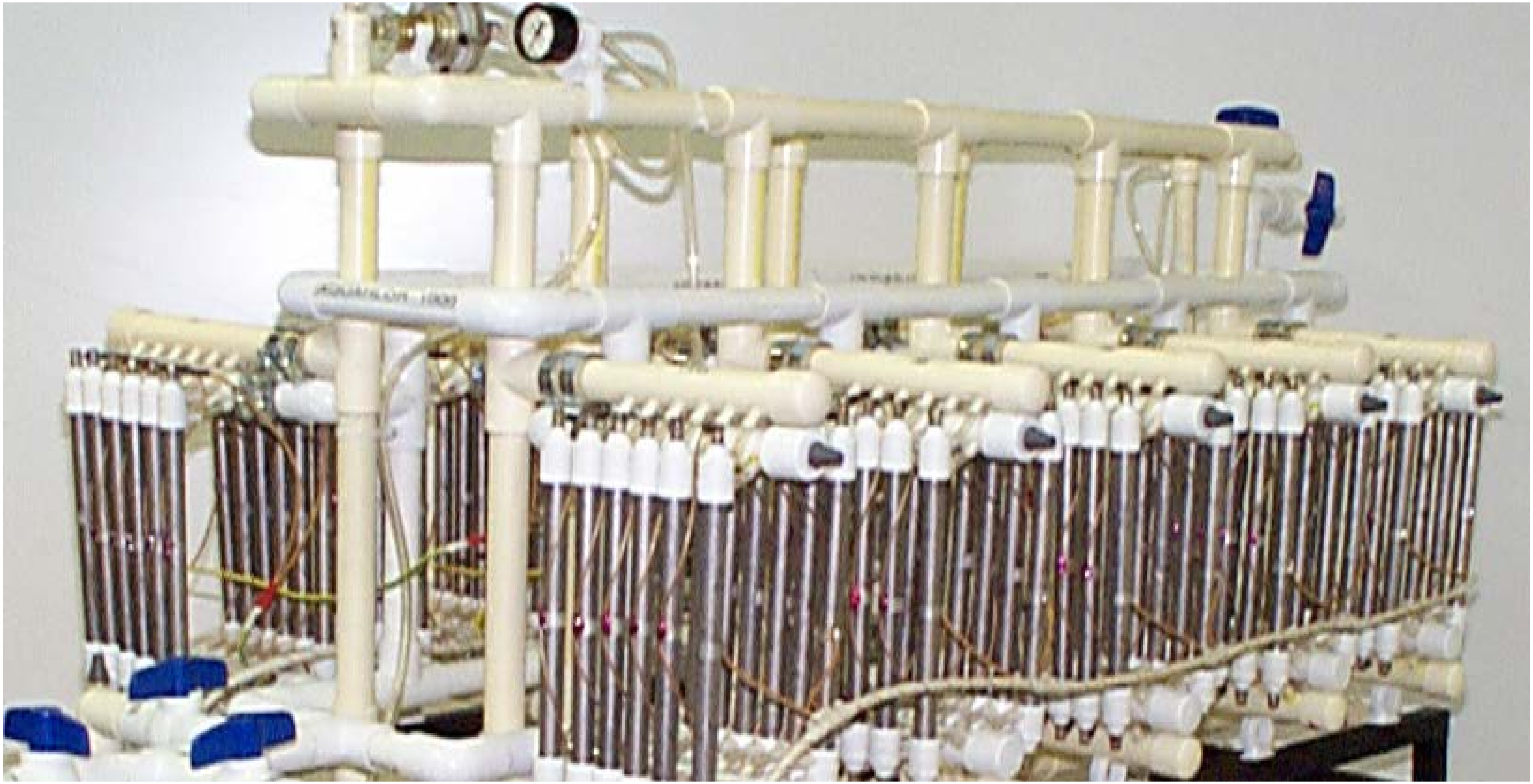


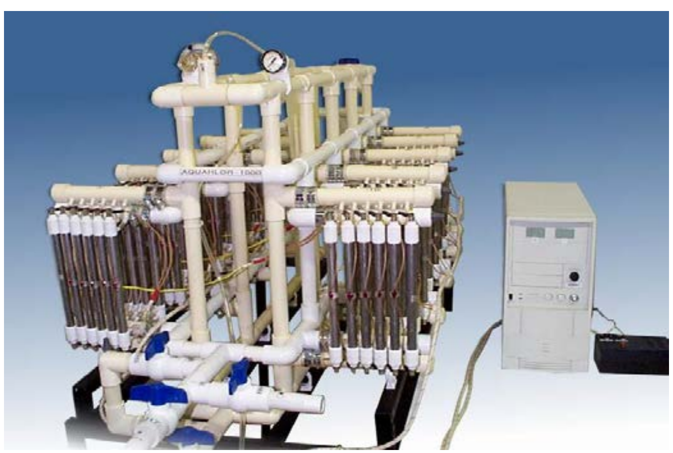


With the creation of flow-through electrochemical FEM-3 element (1995) a period of intensive development of the design of electrochemical devices of a wide range both of low and high individual productivity began. Possibility of parallel, serial and mixed both hydraulic and electrical connections of FEM-3 elements in one reactor provided the flexibility and ease of realization of a variety of technological processes of electrochemical conversion of water and aqueous solutions of various electrolytes. Just in the period from 1995 to 2009 "Laboratory of electrotechnology" ltd has produced more than 1 million FEM-3 elements. 1995.



The principle of joint of flow electrochemical modular elements (FEM) in reactors of great productivity is borrowed from nature. Joining up compact, reliable, high-productive, easy-to-change, simple to external influences and resistant to overloads, elements of simple design into unified system makes it easy to solve problems that are currently solved using heavy, bulky systems, inertia in the work and sensitive to the slightest deviations from the optimal conditions (industrial electrolyzers), or have not solved up to the present time due to the lack of adequate technical systems.

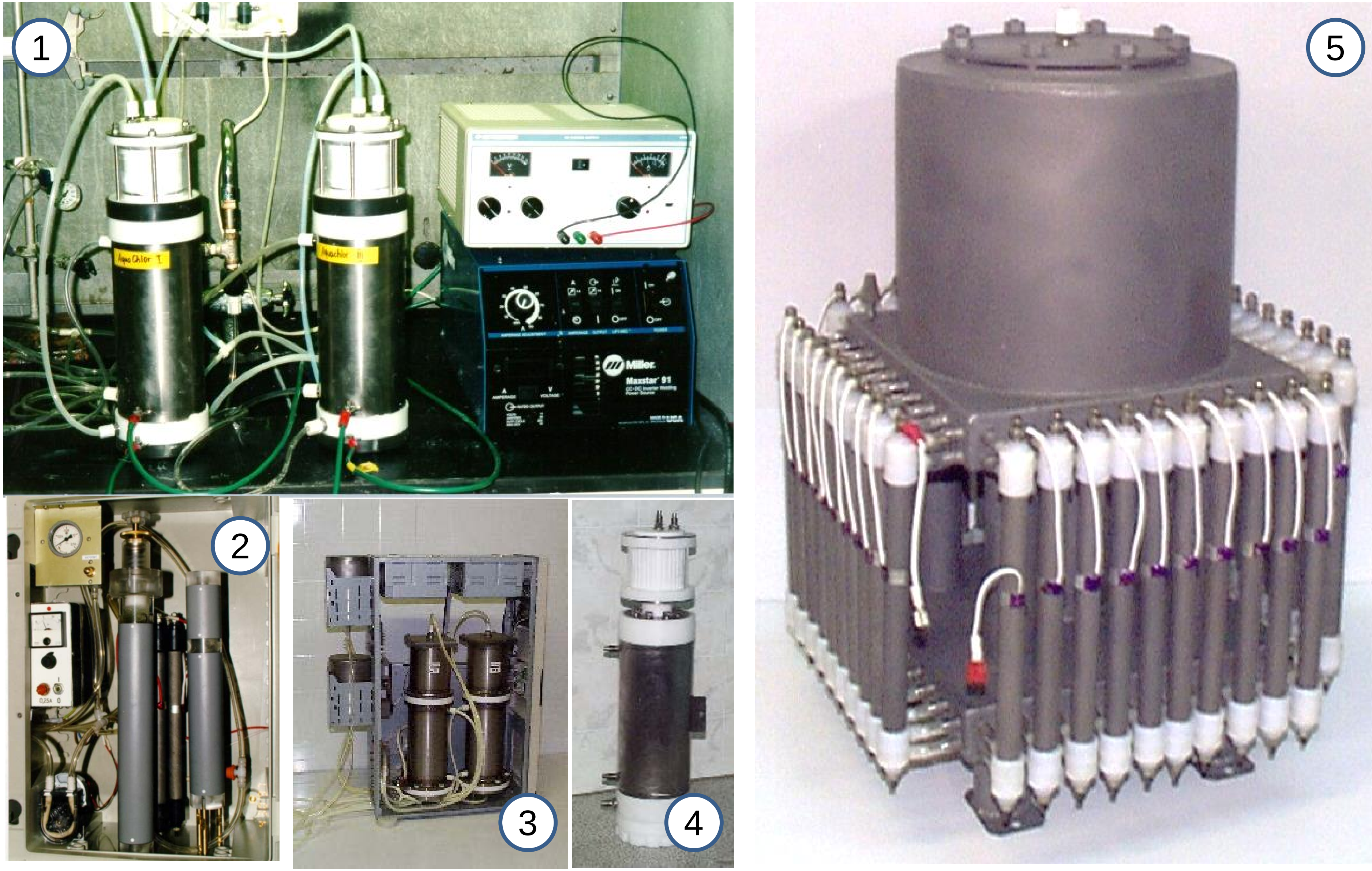




Hydraulically parallel combining of FEM-3 elements into a single reactor in 1998 and 1999 were experimentally tested at AQUACHLOR devices with productivity on chlorine 1 kg/h. The extremely hard conditions of the process of ion-selective electrolysis in AQUACHLOR devices required development of electrochemical elements of a type other than FEM-3, which proved to be unsuitable for long-term continuous operation.

AQUACHLOR-1000 devices of productivity 1 kg/h of oxidants at water treatment station in the Republic of Kazakhstan (1999)

Overall productivity on chlorine of AQUACHLOR devices with reactors of FEM-3 elements installed in 1998 is 2.5 kg/hour. Oxidants solution comes directly into an ejector mixer bypassing a storage tank.
The state sanitary and epidemiological supervision of the Republic of Kazakhstan set the lower threshold of active chlorine in the water being supplied to consumers, for water systems using AQUACHLOR devices, at the level of 0.1 mg/dm^3 instead of 0.3 - 0.5 mg/l in accordance with SanPiN (sanitary rules and norms).

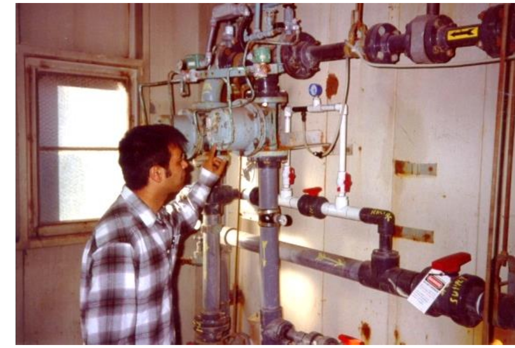


The search for optimal constructions for realization of the process of ion-selective electrolysis is associated with the development of new reactor designs.

1 - 4 - variants of reactors designs of AQUACHLOR devices on the basis of FEM elements with diaphragm of 11 mm diameter.

5 - reactor of 40 FEM-3 elements with productivity of 400 g/h of gaseous oxidants mixture. Power consumption - 800 W. Moscow, VNIIIMT; St. Louis, Monsanto (USA), 1997.




Tests of experimental models of AQUACHLOR devices at the industrial object – system of cooling water recycling of power plant of company American Pacific Corporation in Nevada, USA - have been identified deficiencies in the design, but also showed very promising technological properties of oxidants solution: unmatched antimicrobial activity under the absence of corrosion. For the first time in many years biofilms were removed from the internal surfaces of the cooling system, that enhanced the efficiency of heat transfer and provided significant cost savings. USA, 1997.

STEL-1000-SK device with productivity of 1000 l/h of anolyte ANK used for silage feed. Two reactors RPE-20 of 20 FEM-3 elements in each reactor are used in the device. Power consumption 2.5 kW. Moscow, 1994. In the period from 1990 to 1994 in STEL-1000-SK device the reactor from two graphite monoblocks in titanium cases was used (right).

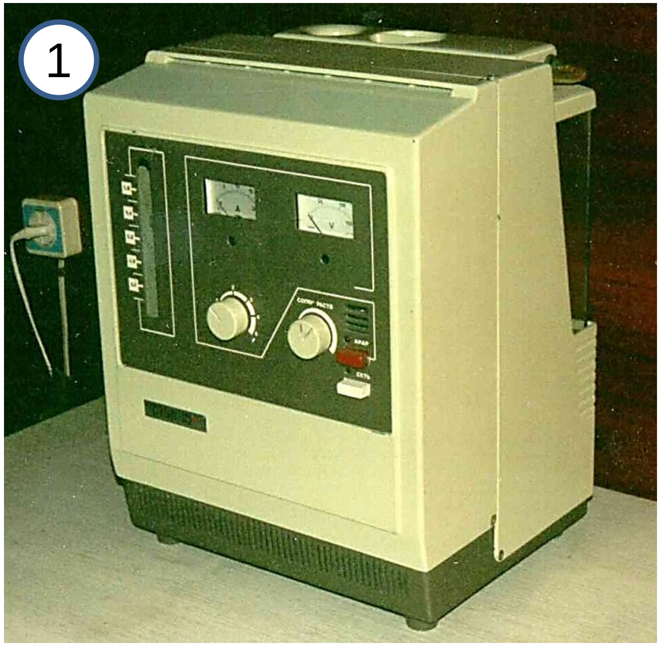
1, 2 - modification of STEL-10N-120-01 devices (model 1000-05, -06) for production of anolyte ANK with a productivity of 1000 l/h from the initial solution of sodium chloride with concentration of 5 g/l. the Oxidants concentration in anolyte ANK is 500 mg/l, the power consumption - 3.5 kW. Devices were used in large agricultural complexes and industrial plants. 1995.

3 - STEL-10N-120-01 device, model STEL-NERL-2500-03 with anolyte ANK productivity of 2500 l/h. Devices of this modification were applied for disinfection of water used in the displacement of oil from reservoirs. 1995.

STEL-10N-120-01 devices for anolyte ANK production

Model STEL-80-01 (80 l/h)

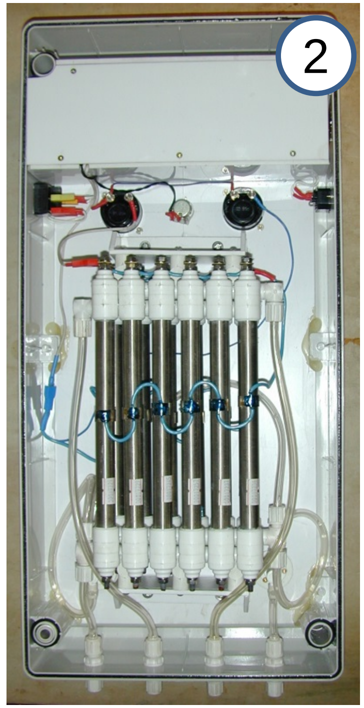
Model STEL-40-02 (40 l/h)

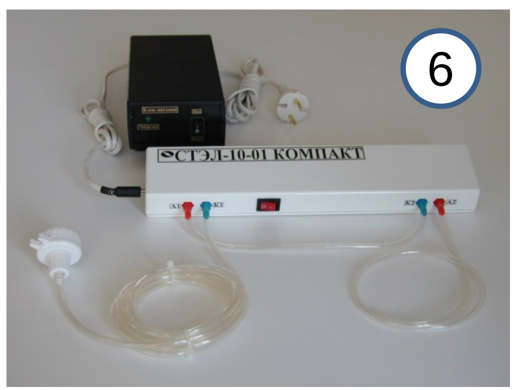


1 - STEL-4N-60-02M device for producing of electrochemically activated anolyte for disinfection, pre-sterilization and sterilization. Productivity - 60 l/h of anolyte ANK. Electric power consumption - 300 W. Electrochemical reactor RPE-6L of four FEM-2 elements. The device is developed in VNIIIMT in 1994. The tank for concentrated salt solution is made transparent and placed in the rear part of the device, which increased its usability. One filling of tank by saline solution is sufficient to produce 750 liters of anolyte ANK.

2 - STEL-10N-120-01 device, model 80-01 with productivity of 80 l/h of anolyte ANK. Moscow, VNIIIMT, 1998.
3 - STEL-10N-120-01 device, model 60-01 with productivity of 60 l/h of anolyte ANK. Moscow, NPO “CHEMAVTOMATIKA", 1995.
4 - STEL-10N-120-01 device with productivity of 120 l/h of anolyte ANK. The basic model for STEL devices of this type. Moscow, VNIIIMT, 1995.

Modifications (models) of STEL-10N-120-01 device





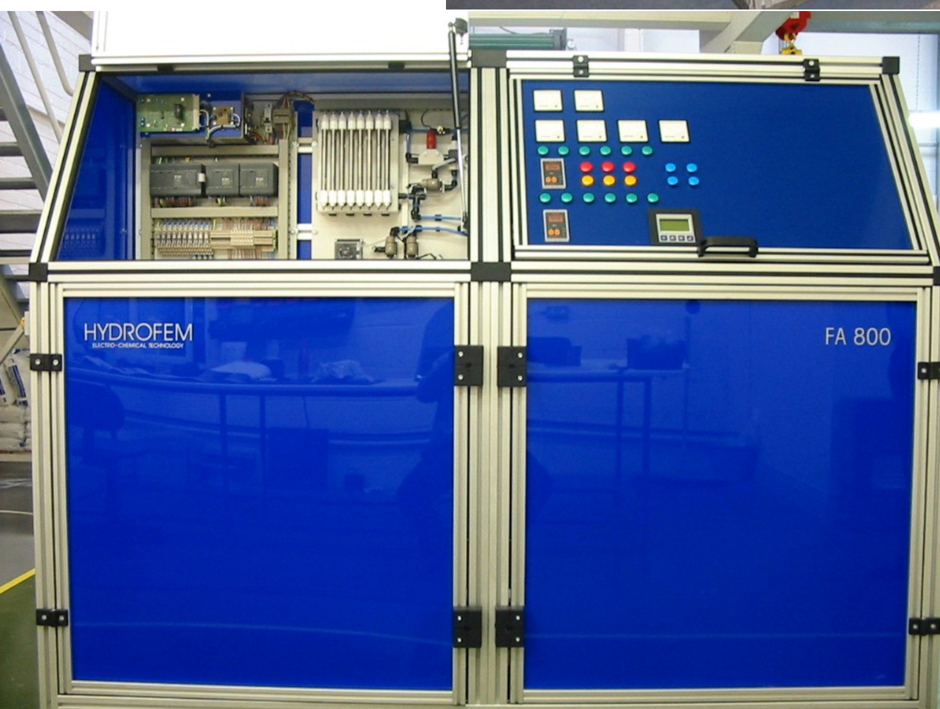
1, 5 - STEL-80 devices.

2, 3, 4 – stages of manufacturing of STEL-120 devices.

6 - STEL-COMPACT device with anolyte ANK production of 10 l/h for use in the field and transport.

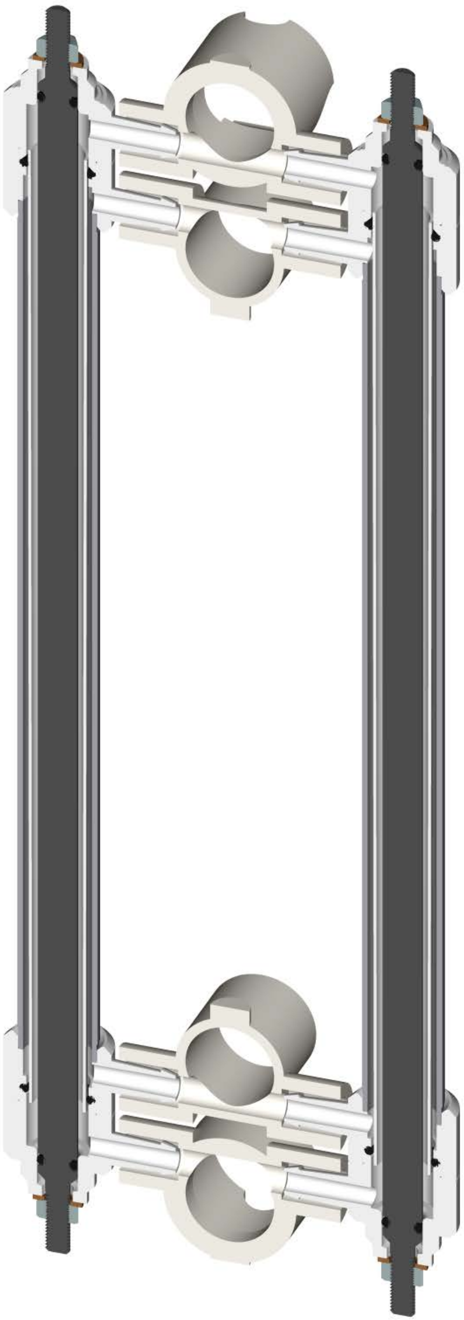
7, 8 - STEL-40 and STEL-20 devices for rural hospitals.

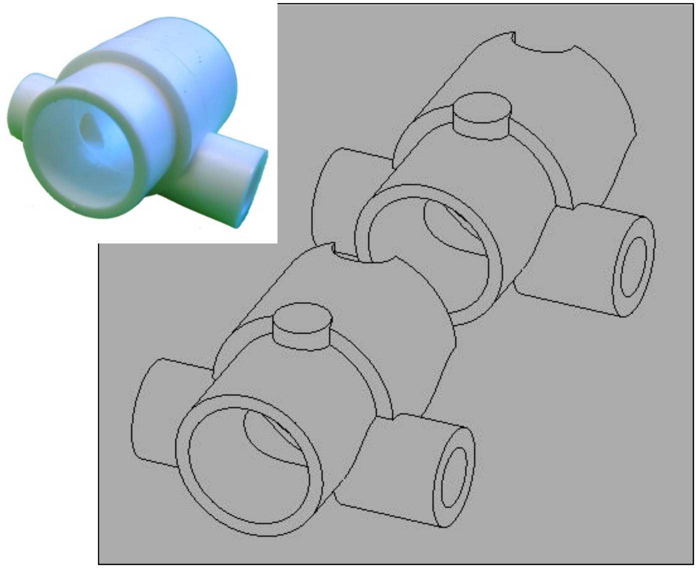
STEL devices with RPE reactors of 2 and 8 FEM-3 elements for anolyte ANK production at livestock farms. Manufactured by Hydrofem (Ireland) under license. 2003.

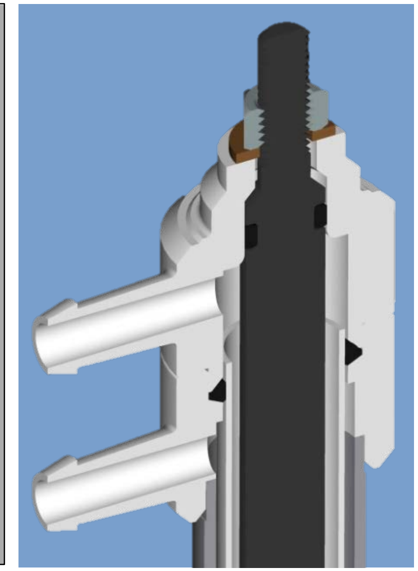


The first experimental model of BAZEX device for adjustment of biocompatibility of dialysis solution by reagentless changing its pH and oxidation-reductionl potential (ORP).

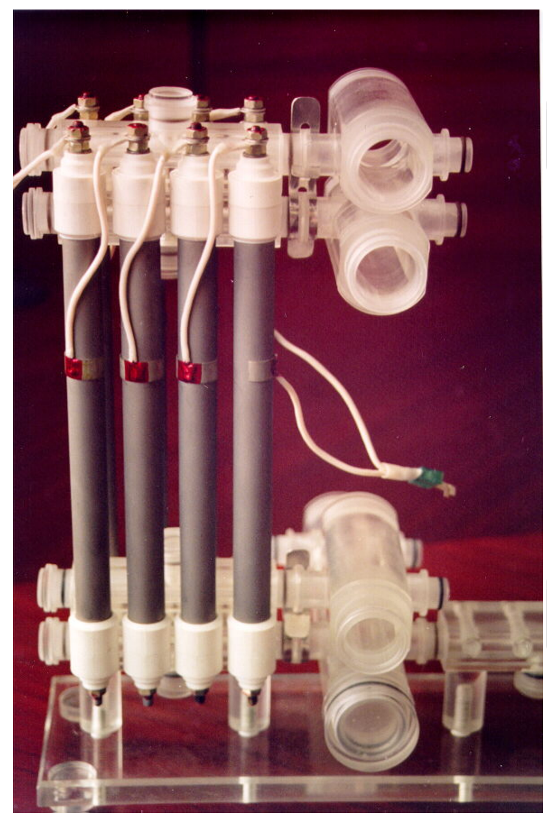
The use of BAZEX device normalizes ORP of dialysis solution and makes it equal to the redox potential of the internal environment of a patient, that allows to increase the degree of extraction of creatinine and urea because of the selectivity of hemofiltration, reduce the time of hemodialysis by 30 - 40 % and also helps to normalize blood pressure of patients due to that they begin to stand the hemodialysis procedure better. Moscow, VNIIIMT, 1992.

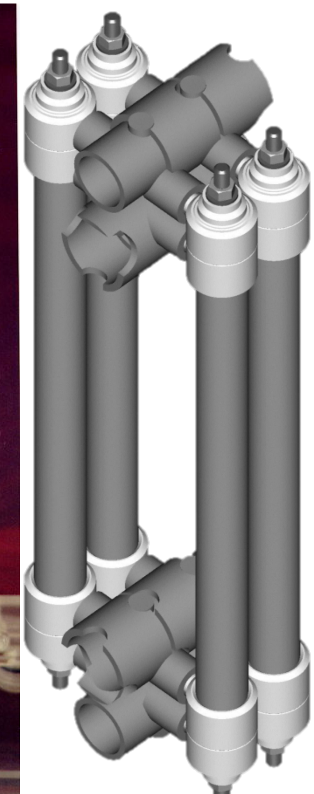


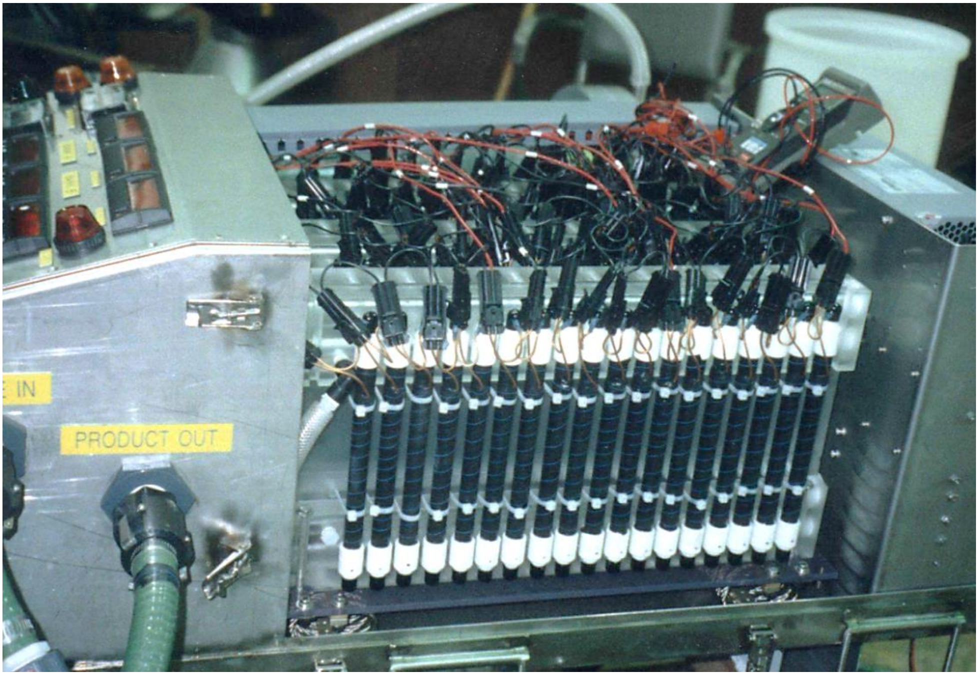




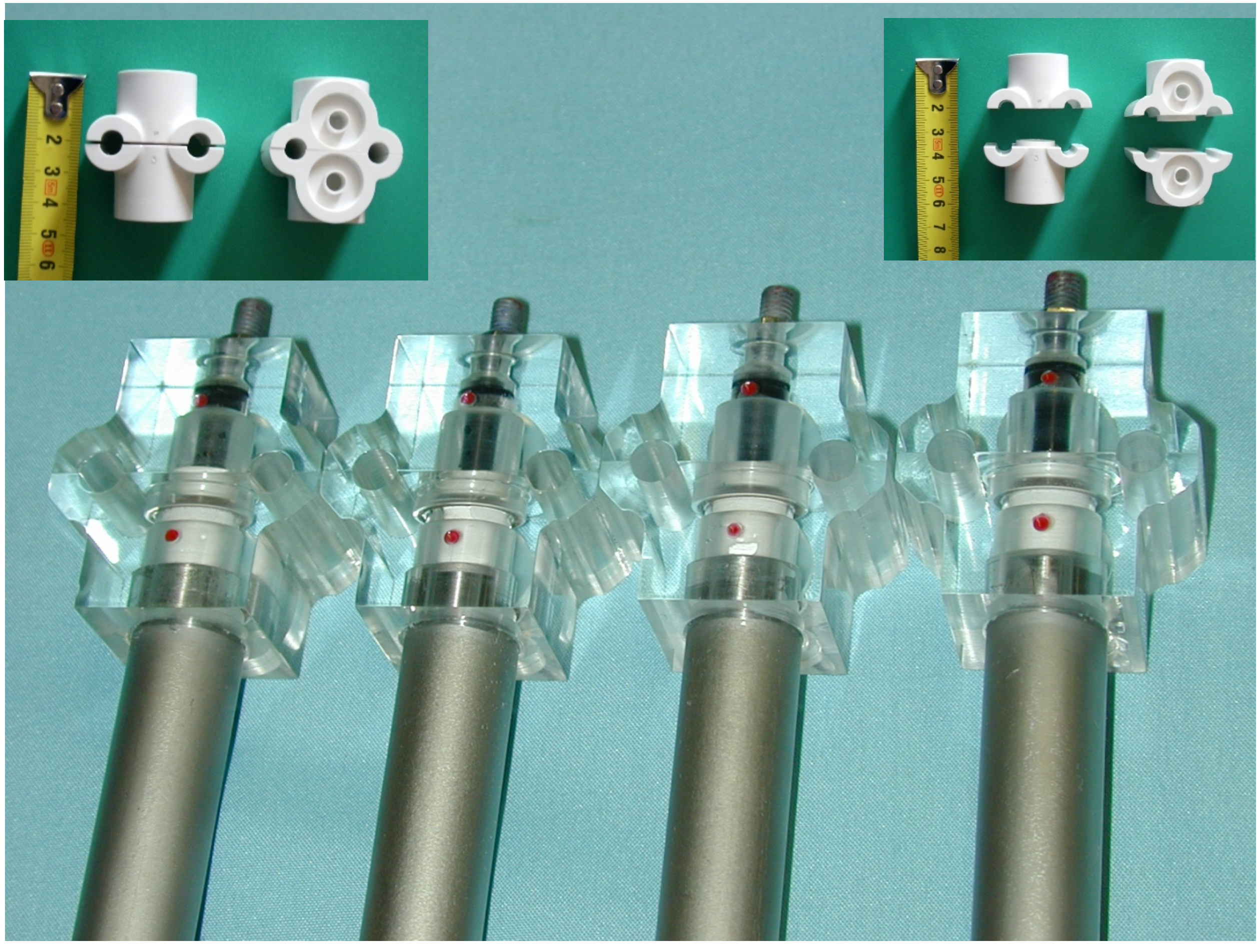
FEM-3 – MB-11 elements are combined into RPE reactor of desired productivity by using gathering collectors, formed from the similar collector PVC items EKS-1 joining by nipple-spigot connections. Reactors of this type are named as RPE-S. 1996.

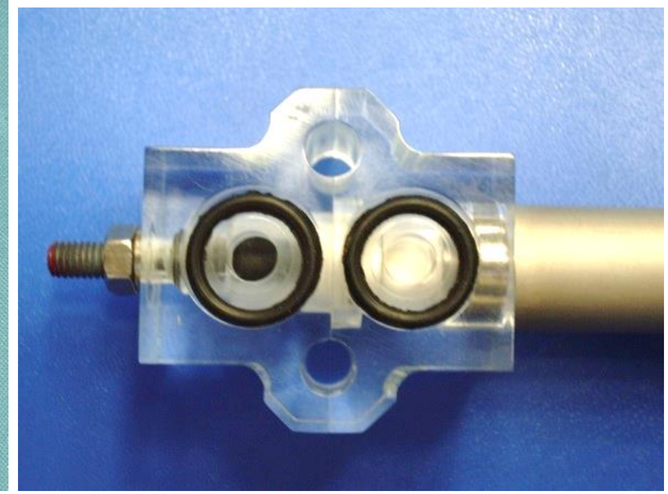


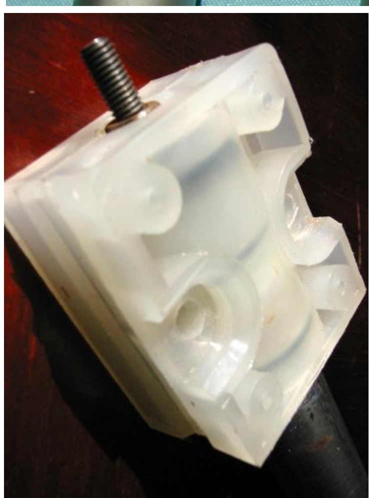


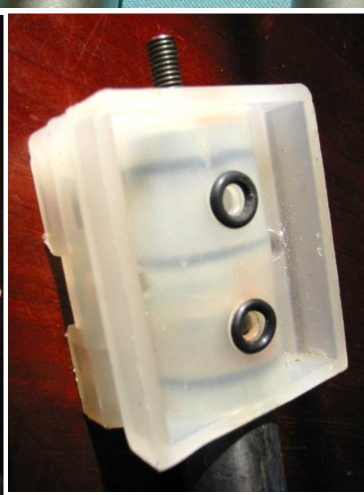


STEL device with FEM-3 elements for US Marines during the field tests on the ground in Atlanta, 1996. FEM-3 elements are mounted in three RPE-S-36 reactors (36 FEM-3 elements in each reactor).

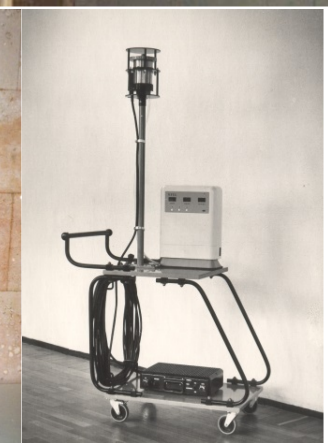








In 1997 technicians of memorial Institute Battelle (USA) together with the authors of FEM-3 elements designed collector sleeves for FEM-3 elements in order to achieve greater compactness of RPE-S-36 reactor. The prototype of this design were collector sleeves for FEM-2 elements previously created in 1992 by Yu.G. Zadorozhny and V.M. Bakhir (photo bottom left).

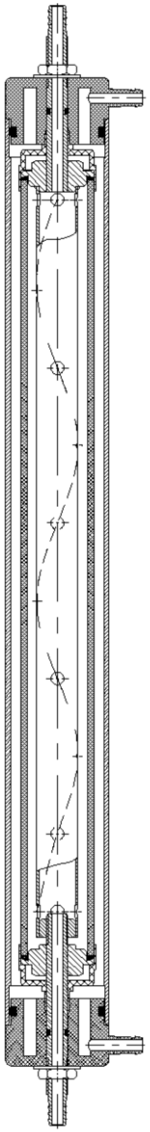


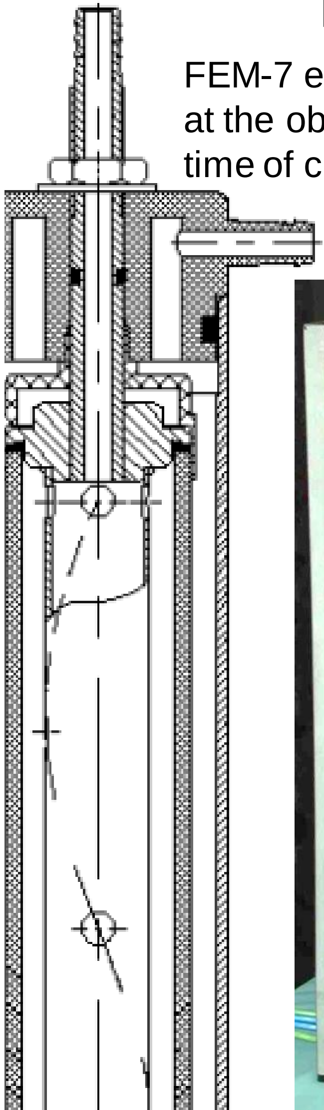
Aerosol of anolyte is a very effective tool of volume disinfection.

For the first time the idea of using anolyte in aerosol form was expressed by Professor Nodar G. Tsikoridze (photo top left) in 1986. Thanks to the ideas developed by him about technology and techniques for the production of anolyte aerosol in the nineties there were created dozens of different designs of anolyte aerosol generators become very widespread in various fields.

FEM-7 elements for AQUACHLOR devices

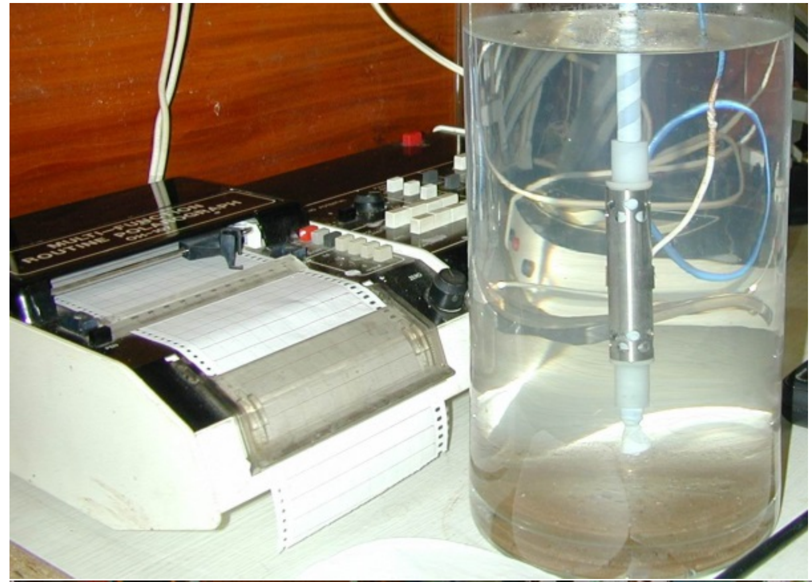
FEM-7 elements were developed in 1999 and immediately tested under practical conditions at the object "Salavat water station" (Bashkortostan).Tests confirmed engineering design: time of continuous operation of the elements was calculated in years instead of months.

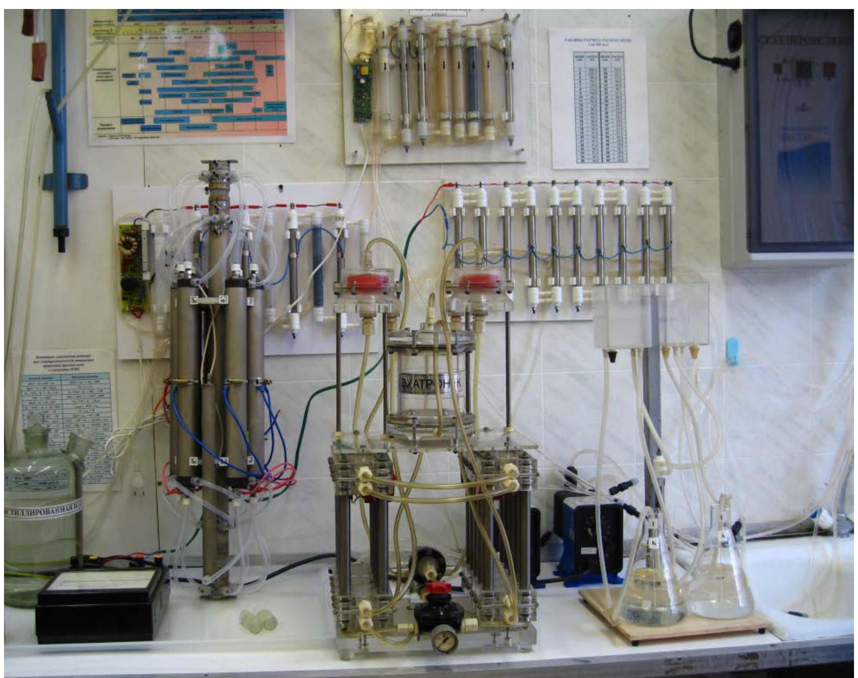




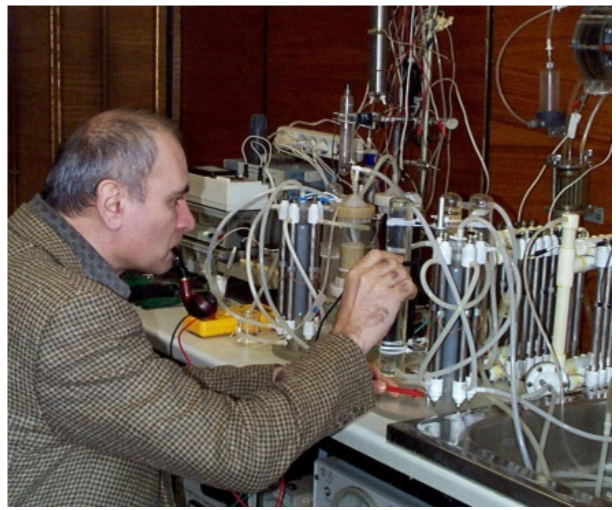
Further development of AQUACHLOR devices design was carried out to determine the optimal conditions for convective circulation of solution in the electrode chambers and the length of the hydraulic junctions of FEM-7 elements. As a long work time of devices was required for determination of these parameters, such researches were carried out on real objects in coordination with competent and thoughtful professionals who understood the potential and the importance of this work.

The practical application of ion-selective electrolysis with diaphragm required in-depth study of processes in FEM elements.

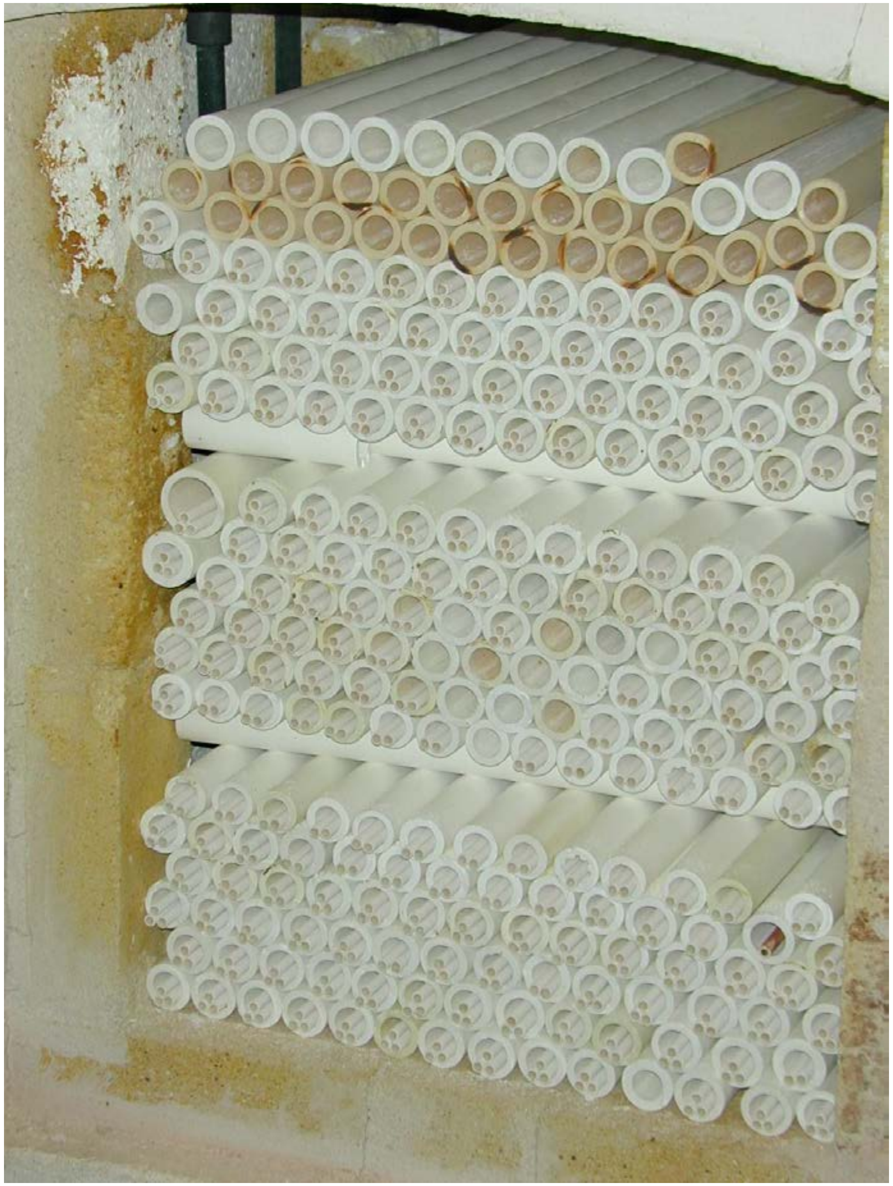




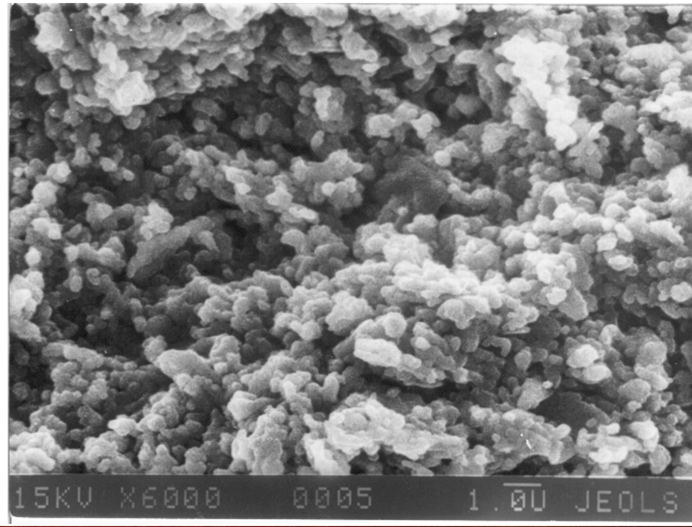
New knowledge about the physical-chemical processes in FEM elements immediately used to improve the quality of mass-produced reactors.

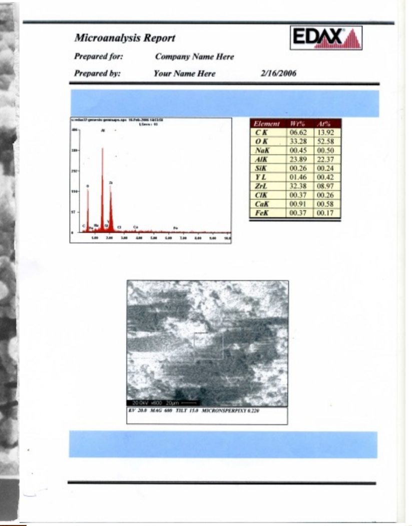


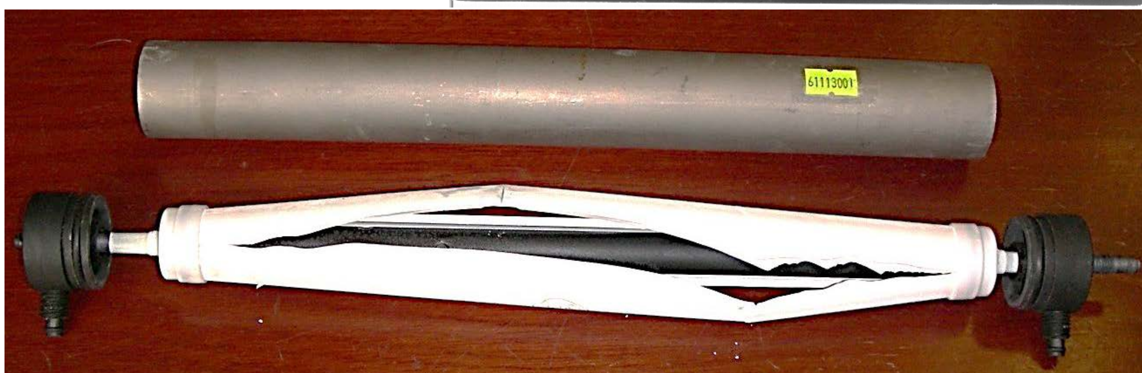
Experts of ceramic diaphragms manufacture in 1995 - 2008 carried out in-depth research of their products working in a variety of conditions and adjust the recipe and settings of ceramics kilning in accordance with the results of scientific research.

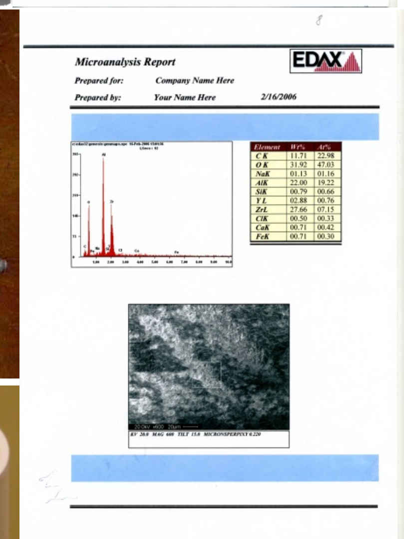


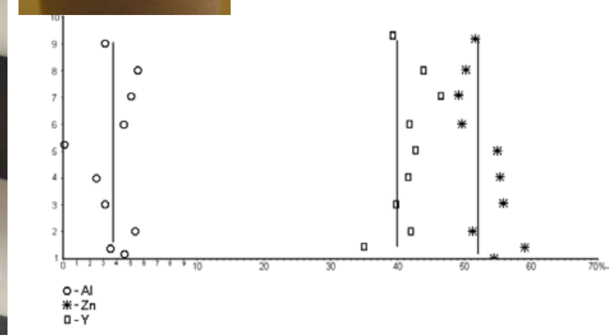
A deep study of the structure and properties of ceramics of different composition, working in extremely aggressive environments, enabled by 2011 to create an absolutely reliable ceramic diaphragm used in new generation electrochemical systems - AQUACHLOR-M, STEL-ANK-SUPER, IZUMRUD-REDOX and other devices.



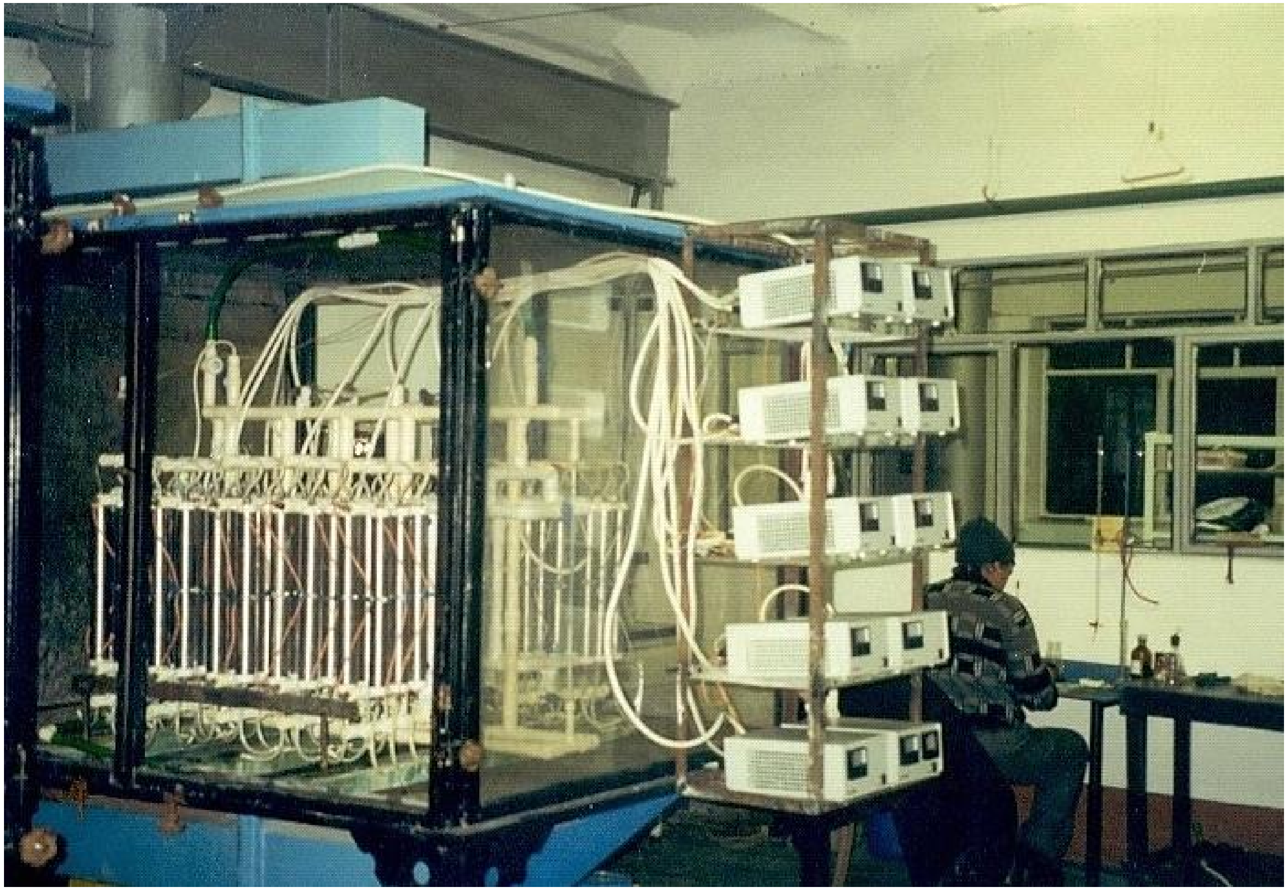








Capability to create new while searching for the optimal design and technological solutions under development of electrochemical systems with new reactors has always attracted a partners-enthusiasts. They bought reactors and tried to create a working system on their taste and mood. Sometimes these attempts were successful, but more often ended in nothing. The example for the device for oxidants solution production using the technology of ion-selective electrolysis with FEM-7 elements is more a positive experience. The device, which can be called as AQUACHLOR-type device, has a productivity of chlorine 4.5 kg/h (160 000 m^3/day of disinfected water). It was mounted in chlorination room, Chimkent city (Kazakhstan), in 1999. It was structurally changed and has worked for more than 20 years, which is confirmed in special journals by publications of persons responsible for water supply in the Republic of Kazakhstan.



The history of ECA in persons. Fragment № 4.

The widespread use of FEM elements in various electrochemical devices sharply intensified research and innovative work not only in CIS countries, but also in many other countries. In 1991 - 1999 a team of scientists and experts together and under the guidance of the authors of FEM elements was engaged in the optimization of the design and intensively explored the possibility of using of new reactors in various technological processes. To review the scientific community and specialists in various fields with the results of these works conferences and symposia were annually convened, and monthly scientific and technical journal "Activated water" was published. This practice of public lighting and discussion of new works was moved from the Soviet past in the emerging capitalist present and gave rise to a large number of firms around the world that were created by enterprising participants of these conferences and used the resulting information for purposes too far from disinterested scientific cooperation.

For example, a South African company Radicals Water, whose members consistently participated in such conferences, used information taken from six hundred page book of V. M. Bakhir "Electrochemical activation" 1992 edition to apply for several dozen patents in South Africa, not paying attention to the existing copyright certificates of the USSR for inventions. Such examples are numerous.

At the photo among the participants one of the early conferences on electrochemical activation one can see S.A. Alekhin, the founder of the company "ESPERO“; Dina Aschbach (Gitelman) - specialist on treatment by electrochemically activated water and solutions; N.N. Naida, one of the founders of AQUASTEL company, later ENVIROLYTE.

In such conferences and symposia also attended the founder of EMERALD company V.V. Vinogradov; the founder of the firm IKAR V.G. Shironosov from Izhevsk and the second founder of the company ENVIROLYTE V.N. Ilchenko and many others.

The history of ECA in persons. Fragment №4 (sequential)

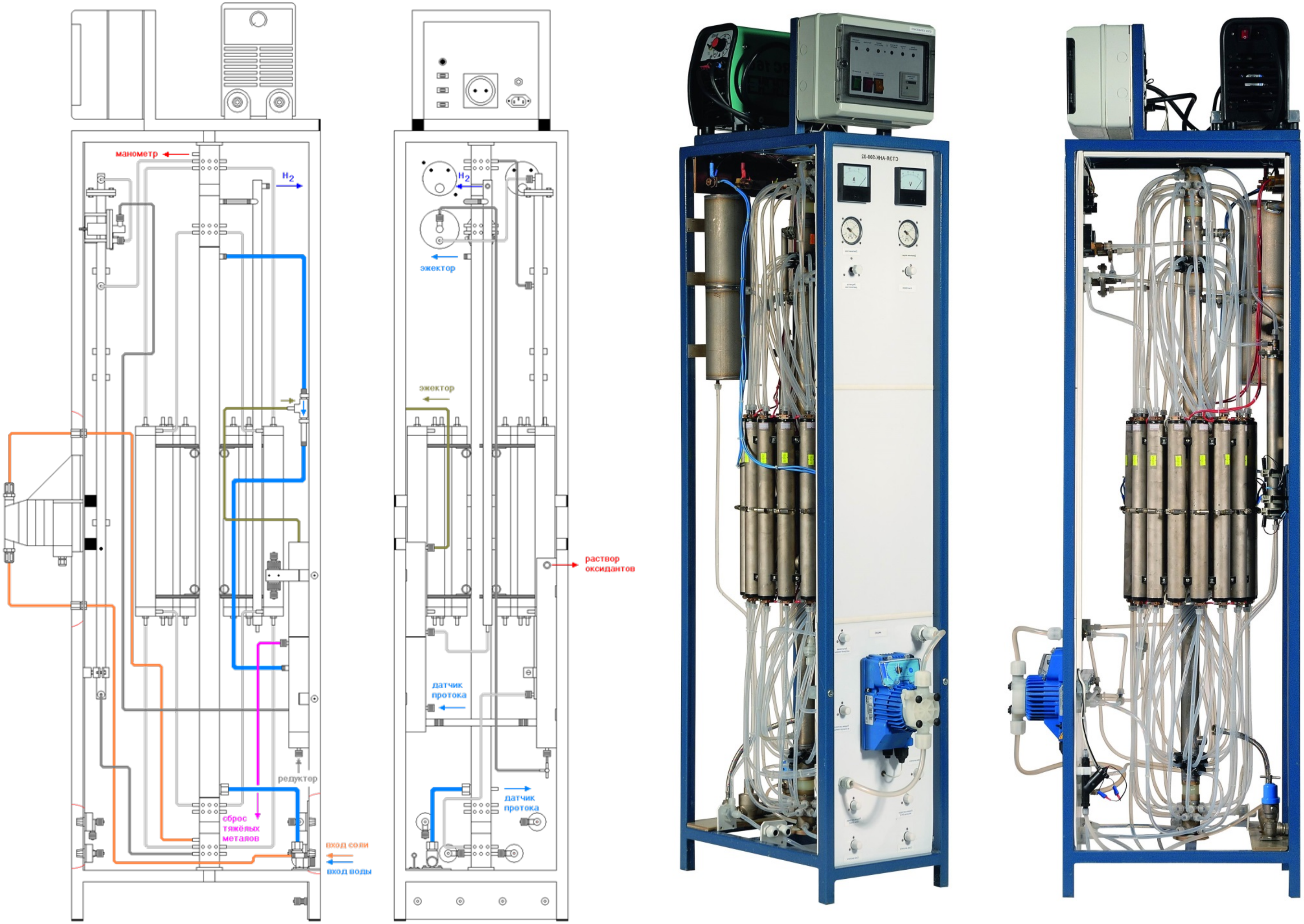
Most accurately the relationship between the companies and the people who used the information obtained from the authors for unfair obtaining of commercial advantage can be described by words from the song of Alla Pugacheva about Paper kite: "I'm flying a kite in the clouds. The kite thinks that he can fly. It seems to the kite that he can whirl away in the sky if he will manage to cut off the thread".

Without understanding the ideological basis of the new technology, without in-depth knowledge and contacts with composite author, such persons and companies quickly lost the initial potential and moved down to the path of misleading consumers by copying statements from the original publications and presentations.

At the same time, the cooperation of specialists and scientists of composite author of electrochemical activation with serious companies such as SAMSUNG ELECTRONICS (top photo), MONSANTO (photo below), Memorial Institute BATTELLE, De NORA and others, contributed to the scientific and practical progress in the field of electrochemical activation. In particular, cooperation with Monsanto company licensed the technology of electrochemical activation, and with the Genoa University (Professor Alessandro Cabrera) helped a lot to understand about the nature of long-term preservation of active substances in the anolyte ANK and about structural changes in electrochemically activated water and solutions.

The optimal design solution for AQUACHLOR devices with FEM-7 elements was found in 2003, which allowed to proceed immediately to new installations.

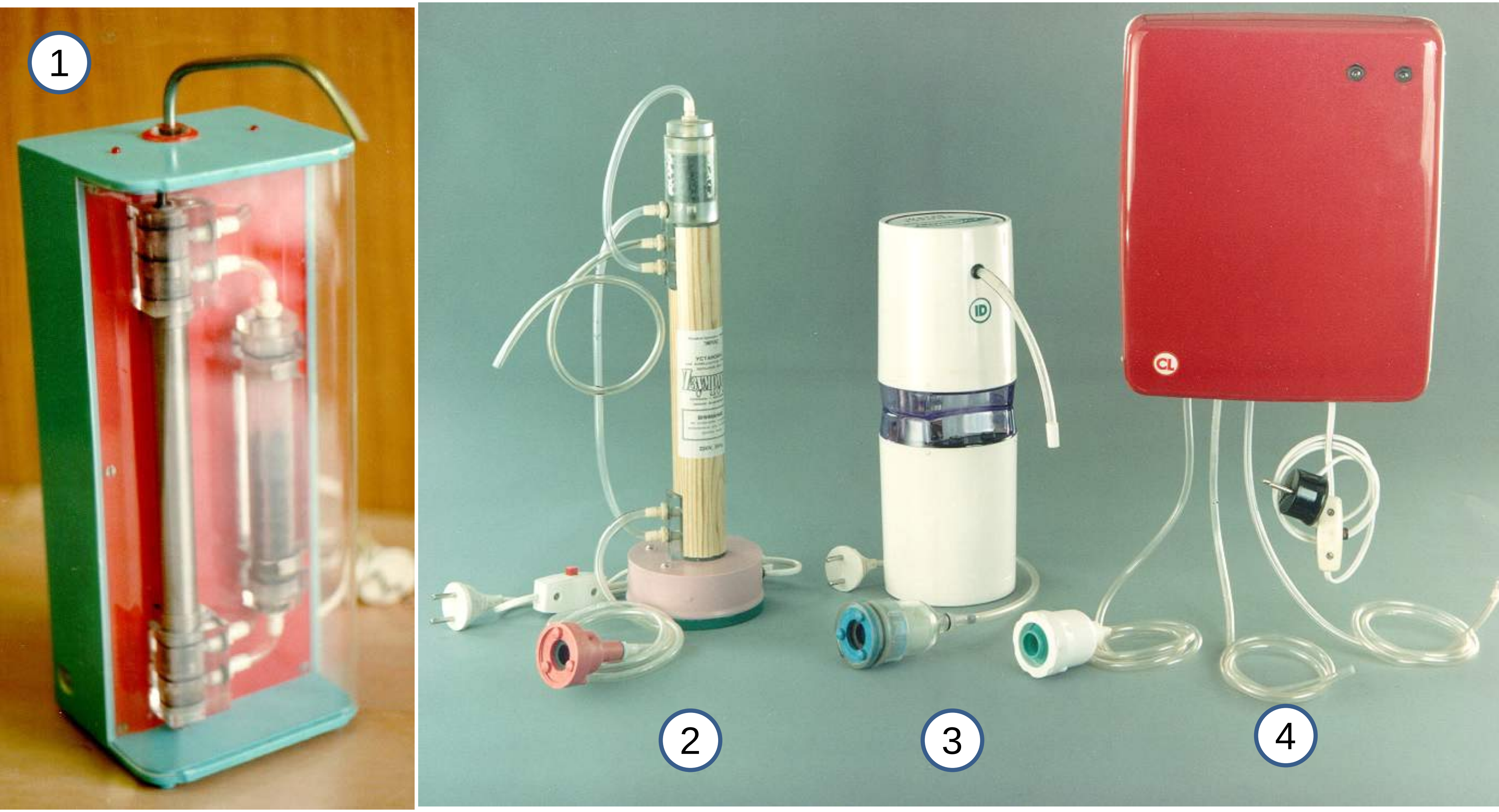
1 - AQUACHLOR-500 devices at water treatment station for drinking water with total capacity of 200 000 m^3/day. Productivity of oxidants - 8 kg/h (c. Odessa, 2003).
2 - AQUACHLOR-500 devices with total productivity of oxidants 4 kg/h on the object №1 of concern "STYROL", c. Gorlovka, 2004.
3 - AQUACHLOR-500 devices with productivity of 1 kg/h of oxidants at water treatment station "SALAVATVODOKANAL" in the Republic of Bashkortostan, 2003.
4 - AQUACHLOR-500 devices with productivity of 1 kg/h of oxidants at water treatment station with capacity of 25 000 m^3/day of water, USA, 2003.
5 - AQUACHLOR-500 devices with productivity of 1 kg/h of oxidants at water treatment station in the Republic of Komi, 2003.
6 – Two AQUACHLOR-100 devices at wastewater treatment station of sanatorium in the amount of up to 800 m^3/day. Cheboksary, 2004.



Lay-out diagram and general view of AQUACHLOR-500 device (model 2005).
The floor area occupied by a single device is 0.2 m²; device weight - 60 kg.

AQUACHLOR devices with productivity 30, 50 and 100 g/h of oxidants are produced not only as individual units, but also in the form of systems assembled on the frame with tank for salt solution (right), tank for oxidants solution with a level sensor that turns off the device when filling the tank and turns on again, when emptying. There is also tank on the common frame (built-up) with 5% hydrochloric acid solution used for cleaning of electrochemical reactors without interrupting the operation of the plant, which is achieved by simple valves switching (on the panel at the bottom left) on the supply lines to the pump inlet of salt solution and acid solution. Usually for washing one should fill the device with the acid solution for no more than 20 minutes per day under round-the-clock operation.

EMERALD devices for disinfection, cleaning and conditioning of water



EMERALD device. 1 - the first EMERALD device designed and manufactured by V. Bakhir and Yu. Zadorozhny in 1990. The first sample of FEM-2 element was used in the device. The cooperative ASPECT, Moscow, 1990. 2 - model of 1991. 3 - model of 1993. 4 - model of 1995. Moscow, EMERALD JV, 1995. The devices shown in the photo 2 - 4 were produced serially by Russian-British joint venture "EMERALD", among the founders of which there were authors.

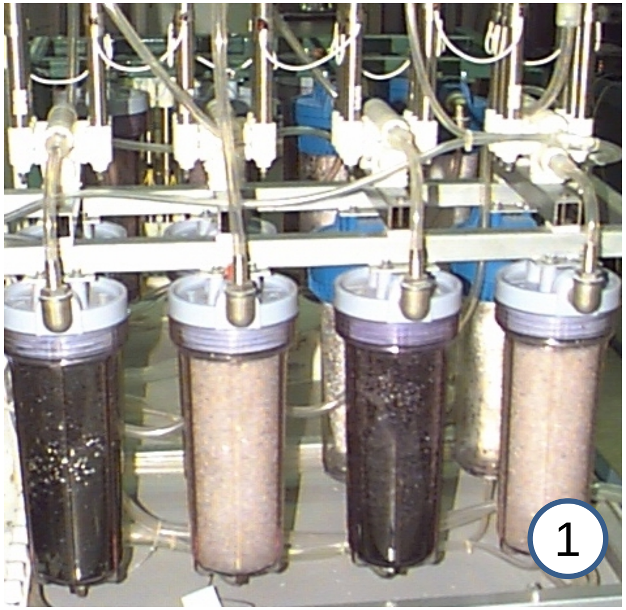
Household EMERALD devices manufactured by "Laboratory of electrotechnology" ltd (LET ltd) in the period from 1996 to 2011. During this period there were tested 15 different technological schemes of treatment and conditioning of water. Technological scheme of water treatment differed in the sequence of stages of water treatment, its number, depth of processing (current strength, weight load of the auxiliary reactors (electrokinetic sedimentation, catalytic, flotation reactors).

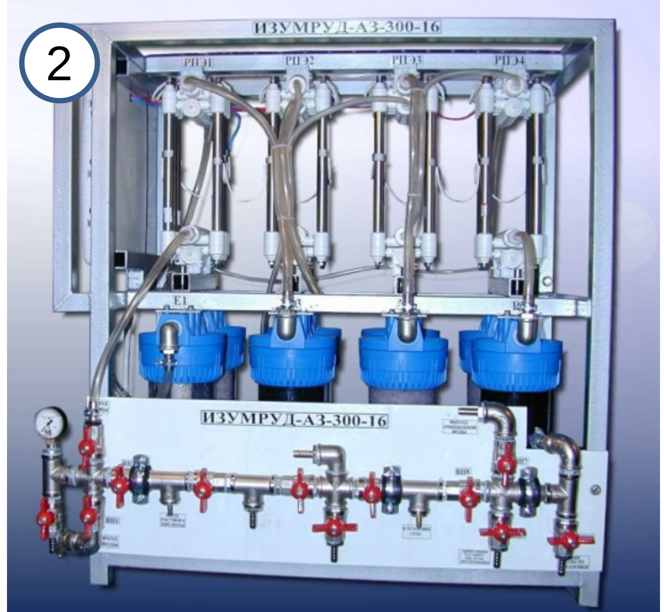
Componentry inside EMERALD device with the technological scheme of water treatment AMETHYST. The device was intended for use in offices. Productivity - 100 l/h. Auxiliary reactors of increased volume made of quartz glass. Moscow, 2000.

EMERALD devices for food industry, model of 1998 year. Productivity – 1000 l/h, the power source current - 1200 W. Reactors of mixing, flotation, destructive cleaning by microbubbles, catalytic are manufactured from standard cases of cartridge filters.

EMERALD device, model “FOUNTAIN” for installation in places of collective use. Productivity - 40 l/h, power consumption is 100 W. Moscow, 2000.

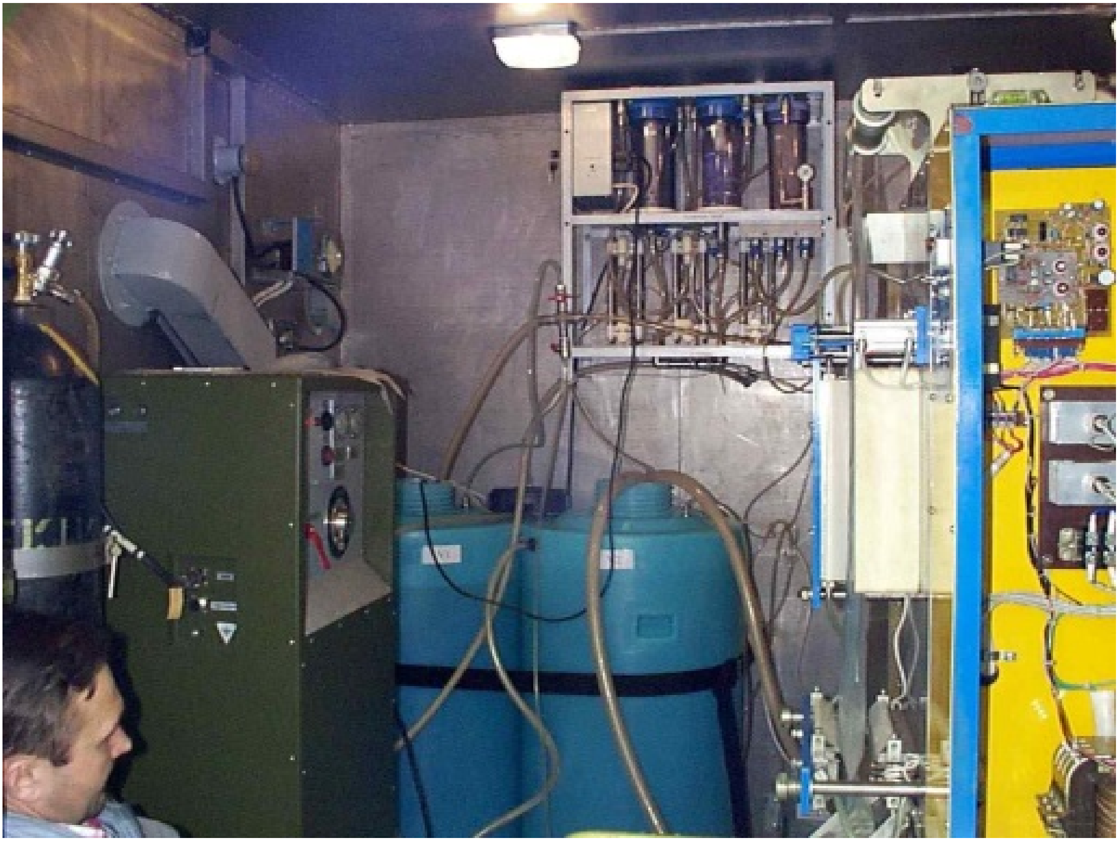
EMERALD device with productivity 5000 l/h is designed to supply a small village Samofalovka with purified water. Source water comes from wells, contains a large amount of hydrogen sulfide.
In the device five electrochemical reactors with productivity 1000 l/h are used. At the photo two reactors are shown. Yeysk, 2001.





EMERALD devices for water purification in cottages.
1 - 3 EMERALD devices with productivity of 500 l/h, power consumption is 900 - 1200 W. Designed to remove iron, manganese, microbes and microbial toxins, organic compounds (phenols, oil products, surfactants) from water. Moscow, 2000 - 2006. The cleaning frequency is from one to two times per month. Indication of need of cleaning is determined by the pressure sensor before electrokinetic sedimentation reactor.
EMERALD-500K device with expanded auxiliary reactors and storage tank. Moscow, 2009.

EMERALD-300C devices for water purification in the field. Hydraulic diagram of devices meets the technological process TOPAZ of water purification. Hydroperoxide oxidants are entered the purified water at a concentration of 0.1 mg/l. Device productivity is 300 l/h, Moscow, 2001.

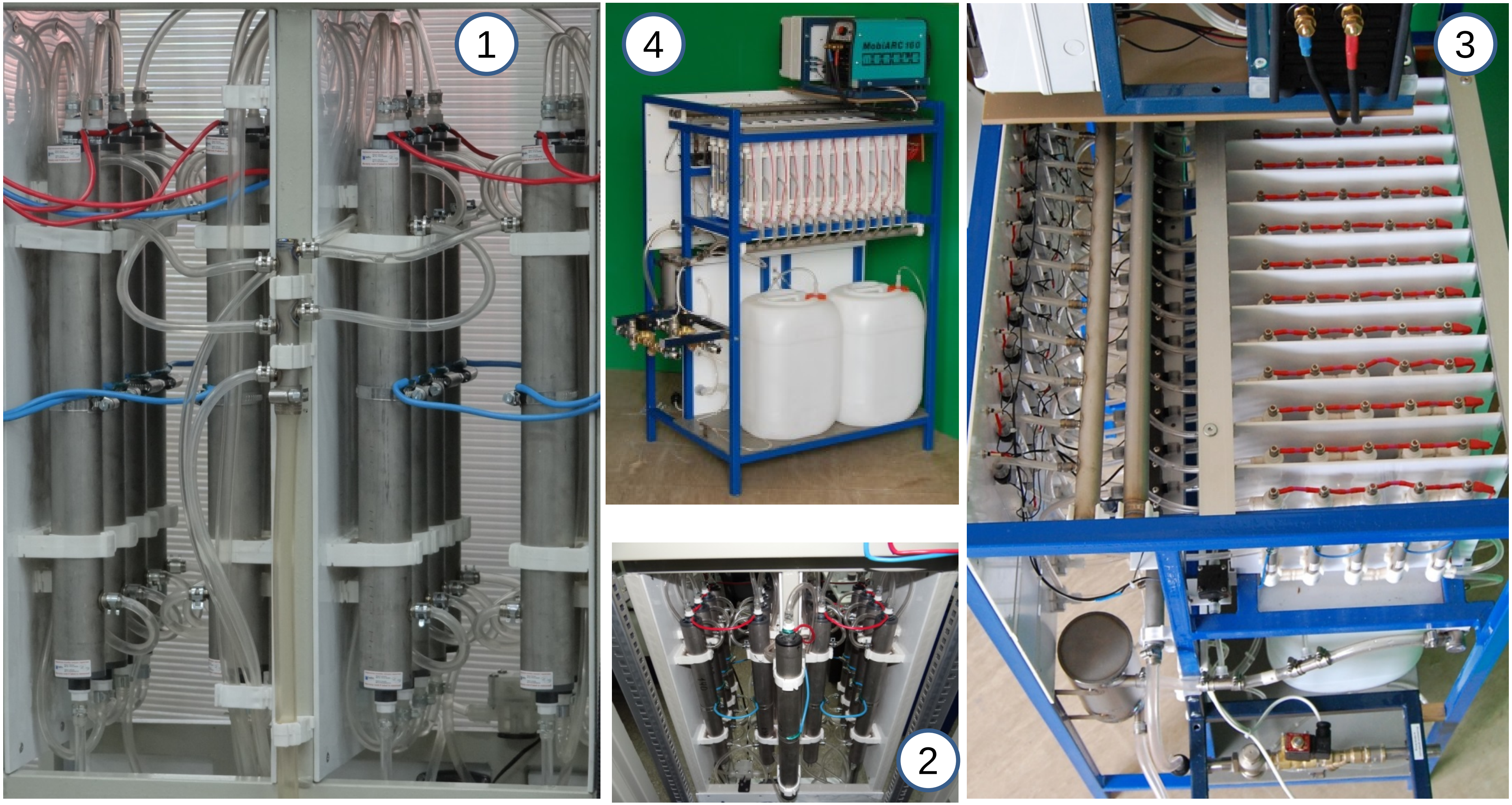


Mobile systems for water purification with EMERALD-300S devices. Moscow, 2002.

Combined devices STEL-EMERALD.

Work on the creation of combined devices EMERALD and STEL for water purification and synthesis of low-mineralized anolyte ANK was carried out since 2003.

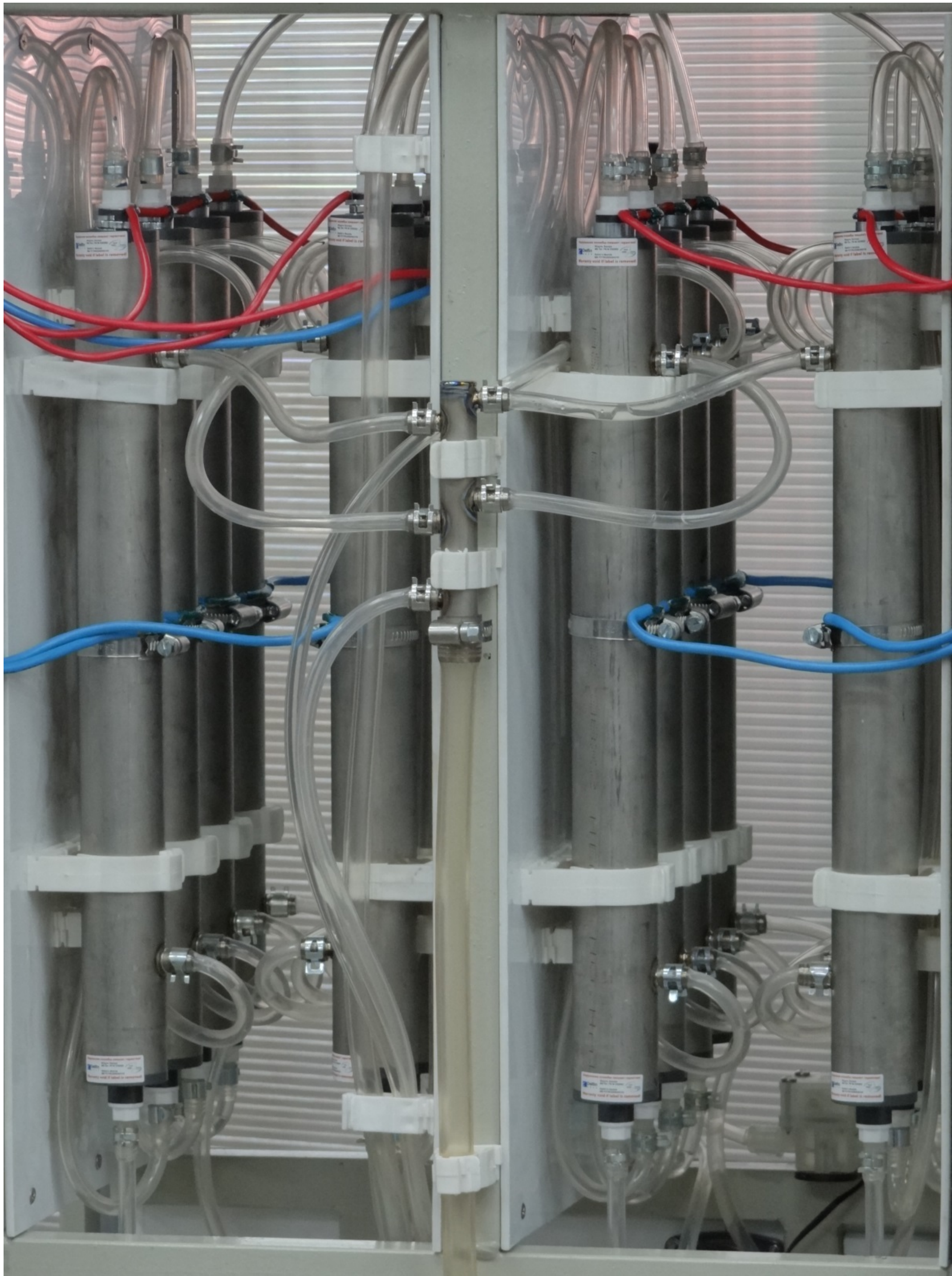
STEL-UNIVERSAL devices with productivity of 500 l/h for anolyte and catholyte.
On the right is the model of 2008, on the left - model of 2011 year.



Electrochemical reactors of STEL-UNIVERSAL devices of 2011 (1 and 2) and 2008 years (3 and 4). The reactor of STEL-UNIVERSAL device of model 2011 consists of 16 flow-through electrochemical elements MB-26-09-01 in contrast to the reactor of STEL-UNIVERSAL device of model 2008, which reactor consists of 60 MB-11 elements. The design of MB-26-09-01 element provides with increased reliability of operation when working in the field and at electrochemical conversion of viscous liquids, such as glycerin.

The reactor of 8 MB-26 elements developed in 2009 (left) was replaced in 2011 by two MB-26-01-01 elements (right). Advantages: one diaphragm instead of four ones; self-cleaning from the cathode deposits; work resource greater by an order. On the path between these two reactors there were many experimental models of elements - reactors of different design, many variants of ceramic diaphragms, many choices of anodic coatings (bottom). New design principles has opened an opportunity to significantly expand the range of work of electrochemical modular systems.

Significant design improvements of MB-26 elements allowed to create new, highly reliable MB-26-09-1 elements with a number of additional features (photo right), which can be used to replace outdated elements (FEM-7, FEM-9, MB-26 - photo bottom left) in AQUACHLOR and STEL-ANK-PRO devices.
MB-26-09-01 elements have a number of additional features, that allows to apply it in STEL-UNIVERSAL devices with direct flow (without gas outlet chamber) passing through the anodes chambers.



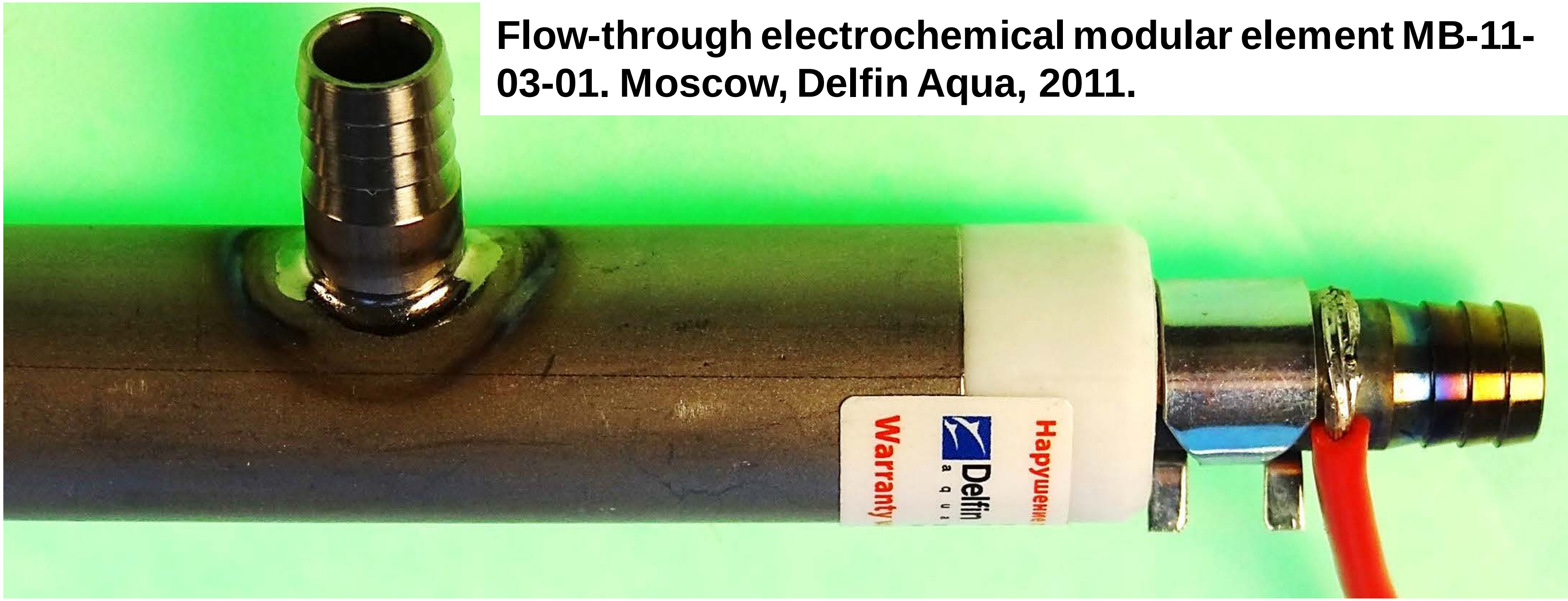
With the appearance of a new generation of reactors, since the beginning of 2011 costly and time-consuming processes of manufacturing of anodes for FEM-7, FEM-9, MB-26 elements have gone.

Electrochemical reactor of AQUACHLOR-500M device (1, 2) has the ability of self-cleaning from cathode deposits of hardness salts in contrast to the reactor of AQUACHLOR-500 device (3, 4). It is due to differences in the intensity and direction of electromigration transfer of mass and energy through the diaphragm of MB-26 elements in AQUACHLOR-500 device and MB-26-01-01 elements in AQUACHLOR-500M device.

AQUACHLOR and ECOCHLOR devices with one reactor MB-26-02-02 provide productivity on chlorine 1.5 kg/h during operation in nominal mode and 2.0 kg/h at the maximum load within 24 hours.

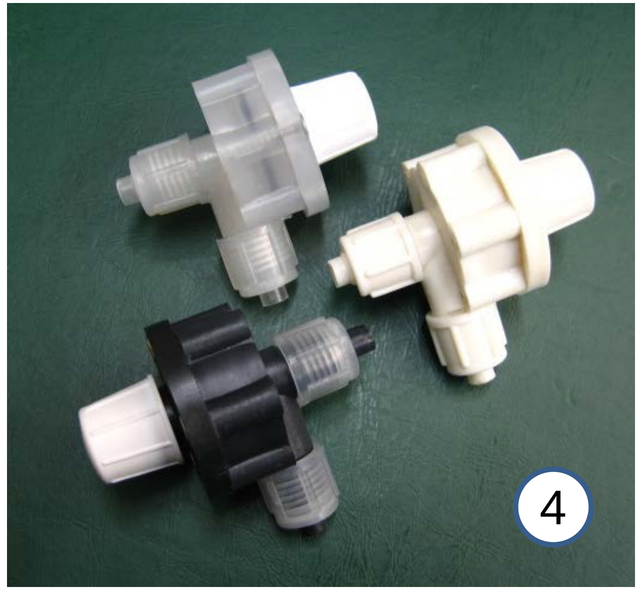
Fundamental structural and technological changes in series of MB-11 elements allowed in 2011 to create a number of new designs with significantly improved parameters: MB-11 element with cooled cathode (left), MB-11 element with a porous anode (center), MB-11 element with improved hydrodynamics of gas-liquid flows.

Flow-through electrochemical modular element MB-11-03-01. Moscow, Delfin Aqua, 2011.



The need of deep electrochemical conversion of liquids at high temperatures, which was identified under the inversion of sugar syrup (90ºC) in MB-11 elements mounted with silicone sleeves on the titanium collectors (photo bottom left), forced to develop MB-11-03-01 element capable working continuously at temperatures up to 150 º C.

Locking and regulating valves and fittings for systems of electrochemical activation with diameter of throat (Du) from 4 to 8 mm



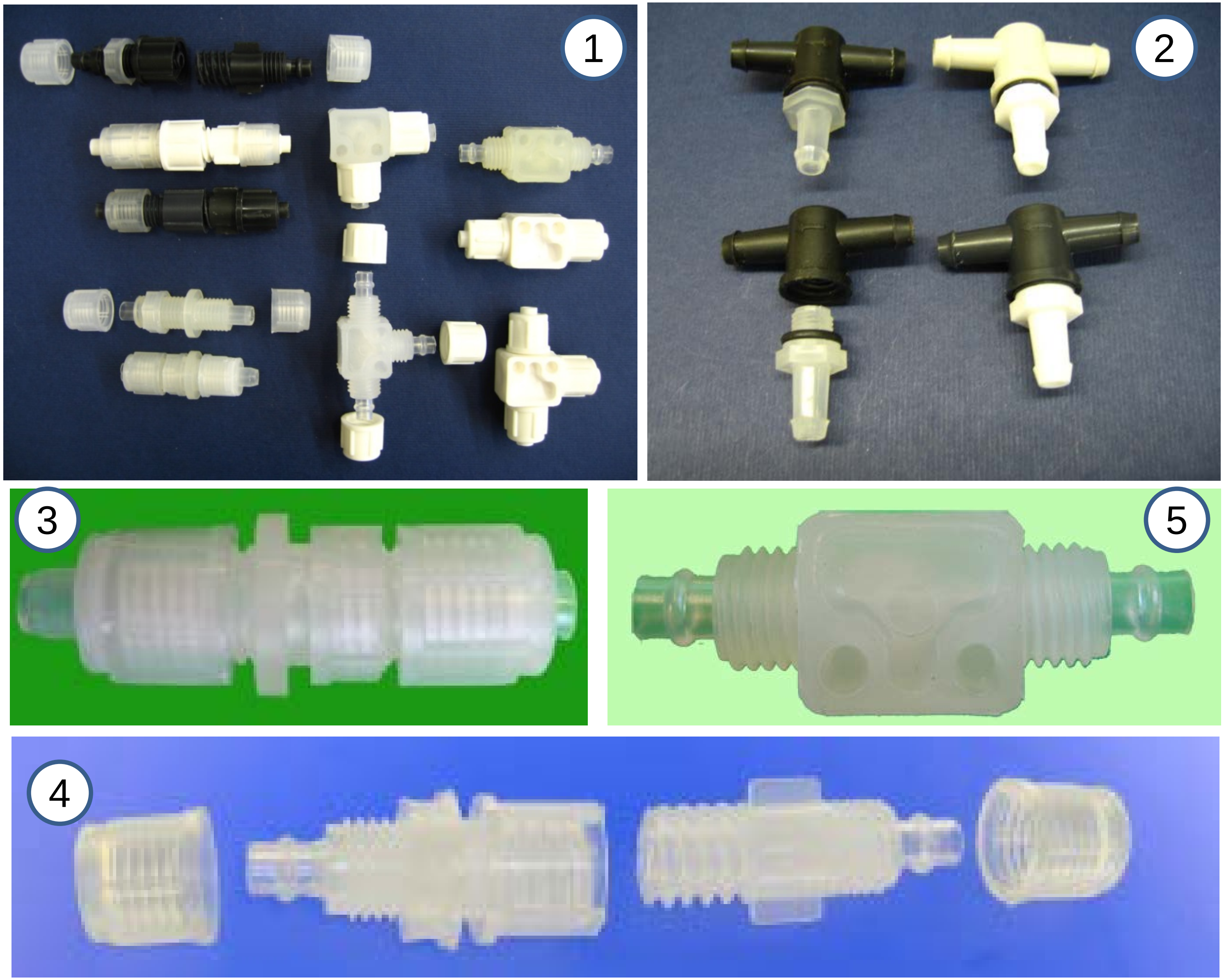
Needle valves VIT-4 (1) and VIP-4 (2,3) with titanium and polypropylene closures Du4. Diaphragm valves VM-5 (4,5,6) Du5 and VM-8 (7) Du8. Case material is polypropylene, diaphragm - rubber IRP-1314.



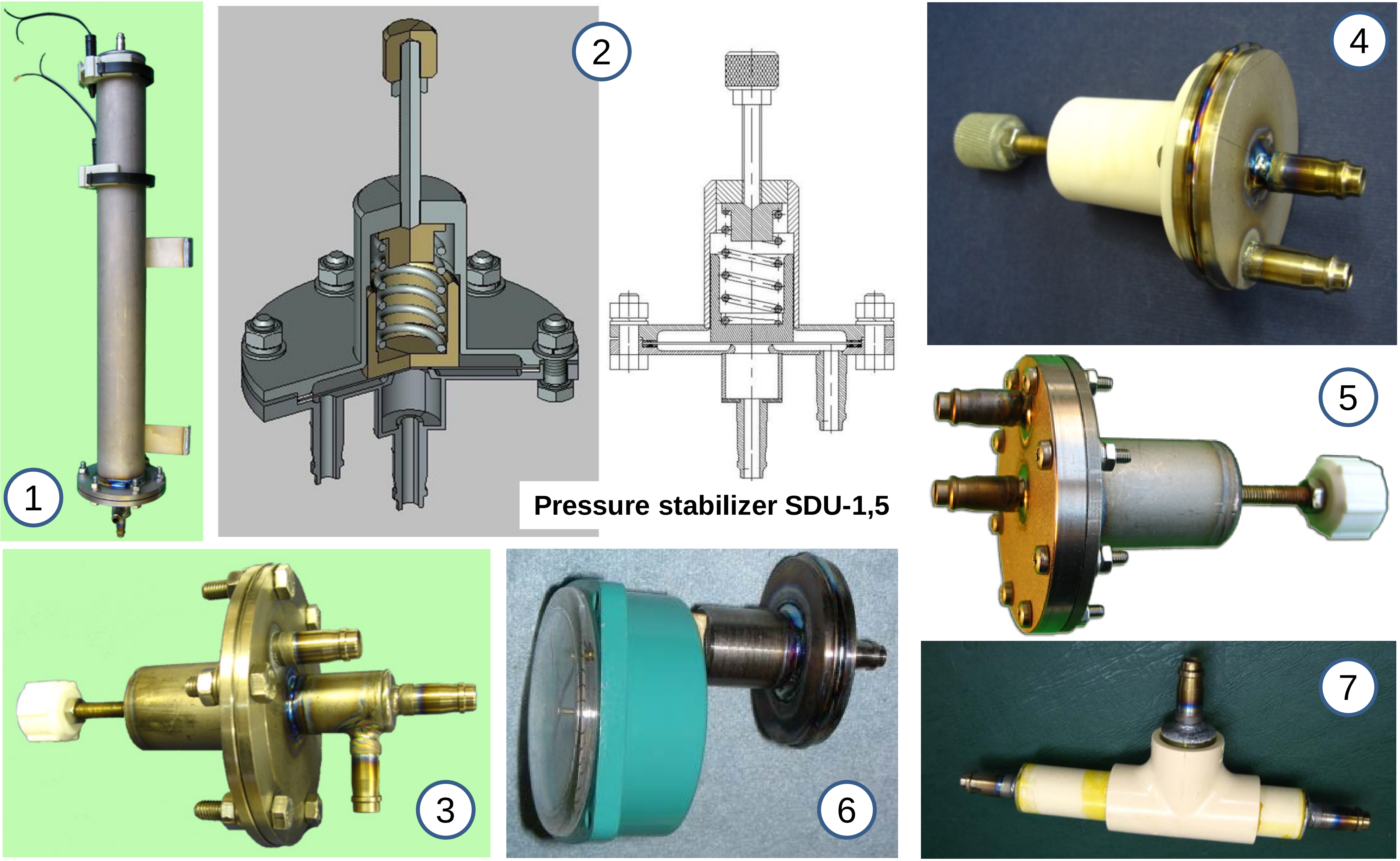




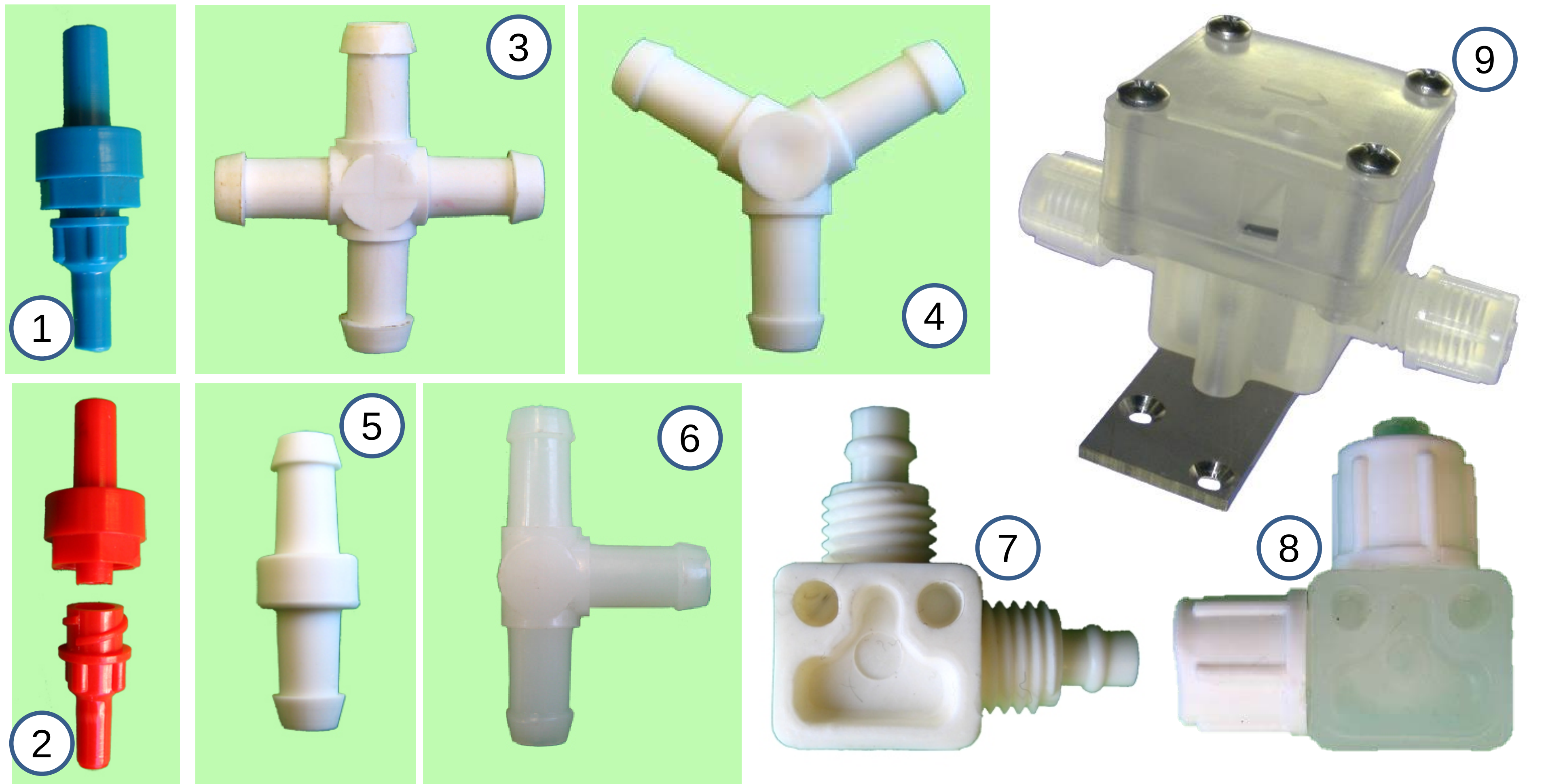

Fittings made of titanium VT1-00. The diameters of throats (Du) is from 4 to 8 mm. Used for connection of flexible tubes made of PVC or PTFE F4-MB.



1, 5, 8 - fittings with Du 4 and 5 mm; 3, 4 – quick disconnect coupling, Du 4 and 5 mm; 2, 6, 7 - water-jet injectors Du 4 with capacity from 20 to 80 l/h. Vacuum is from -0.5 to -0.9 kgf/sm^2 at inlet pressure from 2 to 3 kgf/sm^2.



1 - level sensor of anolyte saturated with chlorine; 2-5 – pressure stabilizers "to itself" of gas-liquid, gas (chlorine) or a liquid medium. The range of pressure regulated is from 0.1 to 3.0 kgf/sm^2. The capacity for liquids is up to 150 l/h. 6 - separator for manometer, protecting it from the corrosive environment. Pressure range is from 0 to 6 kgf/sm^2. 7 - the water-jet injector VNH-200 for mixing chlorine with water, 200 l/h.



1,2 - quick coupling, Du 2 mm; 3-8 - fittings Du4; 9 - sensor of liquid flow. The operation threshold -30 l/h, the range of flow rate is from 0 to 150 l/h; fluid pressure is from 0 to 6 kgf/sm^2; 10 – end mesh filter (stainless steel mesh, cell 0.3 mm), Du 5 mm; 11, 12 - pass mesh filter, Du 5 mm.

ECOCHLOR-002 - modular device with dimensions 60 × 60 × 180 cm and productivity 2 kg/h of gaseous chlorine and electric power consumption 6,0 - 7,0 kWh

Advantages:

- conversion level of initial solution of sodium chloride - 99,5 %;
- no need for complex purification technology of initial salt solution.
- does not require approval of Gosgortechnadzor (state municipal technical supervision).
- chlorine yield from 1 m^2 of space occupied by ALL equipment of modular device is 6.0 kg/h of chlorine or 144 kg/day of chlorine.
-specific energy consumption for synthesis of 1 kg of chlorine is 3,0 - 3,2 kWh
- does not require building of new special rooms. All equipment is placed in dry and ventilated rooms, equipped with lines of supply of energy, water, initial salt solution and usual sewerage.
- each of modules of the device is completely self-contained unit and can be replaced if necessary at any time without stopping the whole production.

Since 2011 all production of advanced electrochemical systems is concentrated in Russian company Delfin Aqua ltd.

The uniqueness of Delfin Aqua is based on the direct participation of the author of electrochemical activation and group of scientists and professionals led by him for many years in the design and manufacture of electrochemical systems, that allows the company to take a leading position in the world in the field of creation and implementation of "green" technologies defined the future of humanity.

Electrochemical activation is a technology and techniques of production and application of metastable substances in various technological processes.

What electrochemical activation can do today?

- ➔ **To synthesize in unlimited quantities of environmentally friendly effective disinfectant solution - anolyte ANK SUPER - safe for people and animals, disappeared after the destruction of microbes, mineralization of which is less than 1 g/l, i.e., which is essentially fresh antimicrobial water (STEL-ANK-SUPER device);**
- ➔ **Without the use of chemical reagents and consumable materials to clean water from microorganisms of all types and forms, from heavy metal ions, harmful organic compounds (herbicides, pesticides, phenols, hormonal drugs, antibiotics, microbial toxins), to give water antioxidant properties by increasing the activity of electrons (IZUMRUD-REDOX devices);**
- ➔ **To replace chlorine, sodium hypochlorite, ozone, ultraviolet at municipal facilities of any capacity for treatment of drinking water, domestic and industrial wastewater, water of swimming pools (AQUACHLOR-M devices);**
- ➔ **To converse fresh water for plants watering into effective solution of nitrogen (or phosphorus) fertilizers (ROSTOK devices) similar to water after thunderstorms;**

and much, much more.