ELECTROCHEMICALLY ACTIVATED SOLUTIONS IN VETERINARY PRACTICE

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Unipolar electrochemical activation (ECA) of liquids is based on well-known electrolysis reactions. But the final result of electrolysis of concentrated solutions is pure ready-to-use product, while electrochemically activated are weak (up to 5 g/l) aqueous salt solutions or common drinking water, which contains up to 1 g/l of different salts. The purpose of ECA is to convert a liquid into an activated state. ECA was found to be capable of changing fresh or low-salted water into a highly efficient technological solution possessing numerous functional properties, with no additional expenditures.

ECA phenomenon was first discovered and reported in the USSR in late 1970s by V.M.Bakhir, who at that time worked in the Uzbek Research Institute of Natural Gas. The principal idea of ECA is that liquid flowing through a diaphragm-type electrolyzer under the action of high-voltage electric field transforms into a meta-stable (activated) state with anomalously high oxidative (in anolyte) and reductive (in catholyte) qualities. At the same time, electric energy of non-equilibrium electrochemical action can accumulate and be preserved in the liquid in the form of inner potential energy, which is realized in various catalytic reactions during the liquid’s relaxation (conversion into an inactivated state).

More details about the history of ECA development and prospects can be found in V.M.Bakhir’s monograph Electrochemical Activation (Moscow: VNIIIMT, 1997) and in VNIIII research papers (B.I.Leonov, V.M.Bakhir, V.I.Prilutsky, S.I.Panicheva, 1999).

Since 1985, ECA has been officially recognized in the USSR as an independent sci-tech sector of applied electrochemistry.

Wide practical application of activated solutions was preceded by extensive and painstaking efforts aimed at developing technical systems special diaphragm-type electrolyzers for synthesis of ECA solutions. It was noticed that the quality and stability of resulting activated solutions depended on electrolyzers design. Eventually, in 1989, experts of the VNIIIMT of the USSR Ministry of Health developed (and patented in some countries) a flow-through diaphragm-type electrolytic reactor (FEM) (authors: V. Bakhir and Yu. Zadorozhny). The third-generation model of this reactor (as a module) became the basis for creating three types of devices: STEL for synthesis of sterilizing, disinfectant and washing solutions; AQUACHLOR for synthesis of gaseous activated oxidant and sodium hypochlorite mixture, and EMERALD for electrochemical conditioning and purification of drinking water.

These devices are used in a number of fields.

ECA solutions synthesized in STEL devices are officially approved by the Russian Health Ministry (1994) for application in medical institutions, catering and other facilities. ANK neutral anolyte produced by the said devices demonstrates antimicrobial (bactericidal, virucidal, sporicidal) and washing ability. ANK is used for pre-sterilization cleansing and
disinfection in conformity with the guidelines worked out by the Disinfectology Institute of the Russian Health Ministry.

Instructions for application of ECA chlorides at veterinary control facilities were developed based on investigations carried out by VNIIVSGE, IZhGSKhA, VNITIP, institutes of dairy and meat industries. Investigation findings were examined by experts of the Nutrition Institute of the Russian Health Ministry, reviewed by the Pharmacological Council under VGNKI of veterinary preparations; in 1999, the Veterinary Department issued to VNIIVSGE the registration certificate for anolyte and catholyte and approved the instructions for their application.

Disinfection of cattle-breeding facilities by electrochemically activated sodium chloride solutions is to be carried out in compliance with the guidelines developed by VNIIVSGE, VNIIIMT and other experts (approved by the Veterinary Medicine Department of the Russian Academy of Agricultural Science in 1994), which are meant for veterinary and zoo-technical personnel of cattle-breeding and poultry farms, and other veterinary-sanitation control authorities as well as individual farms.

Activated solutions produced in STEL devices are environmentally friendly; after decontamination exposure anolyte spontaneously decomposes forming no toxic substances and needing no neutralization. The cost of ECA washing and disinfectant solutions is dozens of times lower than the cost of routinely used and new chemicals.

In addition to STEL, other devices such as AQUACHLOR are recommended for practical application, as they produce ECA solutions with high oxidant concentration.

Abundant experience has been accumulated (in medicine and veterinary practice) of using ECA chloride solutions as antiseptics for applications on skin, mucous membranes, cavities and wounds to treat and prevent local infections; in cases of burns, for combating footrot, and to be introduced into inner body milieu for treating and preventing intestinal and respiratory diseases, in particular of agricultural animal young stock.

STEL devices and technology of on-site production of ECA solutions are available for any consumer from large cattle-breeding complexes to small farms and country households.

Practical experience of a number of cattle-breeding farms indicates that electrochemical activation of aqueous saline solutions is a progressive and efficient technology that allows a considerable reduction of material, power and labor expenditures for production of effective washing, disinfectant and other biologically active preparations.

While using ECA solutions it should be kept in mind that anolyte’s high biocidal activity is observed in the first 24-48 hours after synthesis, that is, during relaxation; only freshly-prepared ECA solutions are recommended to be applied; presence of organic and other pollutants on surfaces decreases anolyte disinfection ability; preliminary treatment of surfaces with catholyte solution eliminates the above-indicated drawback.

Successful use of ECA solutions at veterinary control facilities depends on strict and steadfast compliance with the rules and technological regulations of their synthesis in the offered devices.
In 1999, the Scientific and Methodological Center for studying and practical application of electrochemical technologies in cattle breeding was established in VNIIVSGE on the basis of leading research laboratories. A priority direction of the Center’s activity is counseling and methodological assistance to all interested specialists and business people concerning analysis and practical application of the technology of unipolar electrochemical activation of water and weak aqueous-saline solutions for animal disease prevention, obtaining high sanitary quality products of cattle-breeding industry, and protection of the environment from technogenic pollution.

For consultations and methodological assistance on ECA please contact:
VNIIVSGE: 256-35-81,

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INSTRUCTIONS
for application of electrochemically activated sodium chloride solutions (catholyte and anolyte) produced in STEL-type devices for washing and disinfection in veterinary practice and cattle-breeding

1. GENERAL

1.1. Catholyte and anolyte (neutral ANK, acid AK) are diluted (less than 5 g/l) aqueous sodium chloride (table salt) solutions electrochemically treated in cathodic and anodic chambers of a diaphragm-type reactor; as a result, the former (catholyte) is saturated with alkaline elements (NaON, n·n², n²3n·2, n²n·2, n²2n·2, n·2), imparting washing qualities to it; the latter (anolyte) is enriched with oxidants (n²n||1O, n||2n·, n||n·2, n||l, n·2, n·3, n·n²) giving it disinfectant ability.

1.2. Catholyte and anolyte applied in practice are characterized by the hydrogen ion concentration (\(\text{H}^-\text{n²}\)), oxidative-reductive potential (ORP) value in mV and active chlorine concentration in anolyte (in mg/l).
1.3. Anolyte and catholyte are produced from tap (or from other source) water according to GOST 2874-82 "Drinking water" and common table salt according to GOST 13830-91 or technical common salt TU 18113-85; technical salt solution is pre-filtered.

1.4. Catholyte and anolyte are produced directly at cattle-breeding farms using STEL-type mobile electrochemical reactors (hereinafter referred to as "devices") of 20, 40, 60, 80, 250 l/h and higher capacity (STEL-10 ппп, STEL-10N and others) commercially manufactured by NPO EKRAN (Moscow) and NPO KUPOL (Izhevsk).

The above-indicated devices produce acid (\( \gamma = 3-4 \)) and neutral (\( \gamma = 7-8 \)) anolyte as well as catholyte (\( \gamma = 9-12 \)). If operated in conformity with technological and regime requirements specified in their certificates the above-mentioned devices can produce anolyte with 100, 200, 300, 400, 500 and 600 mg/l active chlorine concentration.

To obtain anolyte with desired active chlorine concentration it is necessary to strictly follow all the instructions in the flowchart attached to each device (with the device certificate).

1.5. Anolyte and catholyte are clear liquids; there is moderate flaky deposit in catholyte; catholyte is odorless, anolyte has a smell of chlorine.

1.6. Anolyte and catholyte shall be kept in a glass, plastic or enamel (undamaged) lidded capacity, in a dark place for no longer than 48 hours after their production; for storage and transportation purposes ferrous metal capacities can also be used, but before use they should be lined with polyethylene film (polyethylene hose tied in a knot at one end and placed into the capacity).

1.7. Anolyte and catholyte shall be applied when they are freshly prepared and non-diluted, and only once; water hardness within the limits of GOST 2874-82 "Drinking water" requirements does not affect catholyte and anolyte properties.

2. BIOLOGIC PROPERTIES

2.1. According to GOST 12.1.007-76, by toxicometric parameters anolyte belongs to low-toxic compounds of Hazard Class 4. At 300 mg/l and higher active chlorine concentrations it acts as a local irritant; when inhaled it can cause acute toxic irritation of respiratory organs and eye mucous membranes.

2.2. Catholyte belongs to low-toxic compounds of Hazard Class 4; it produces no irritating action, has no skin-resorptive, mutagenic or teratogenic effect.

2.3. After use, anolyte spontaneously decomposes forming no toxic compounds and demanding no neutralization.

2.4. Catholyte possesses a washing ability in relation to various polluted and greasy surfaces.

Acid anolyte AK produces a bactericidal, virucidal, sporicidal, fungicidal and deodorizing effect.

In addition to acid anolyte properties, neutral anolyte ANK also features detergent properties.
2.5. Parameters of solutions having detergent and disinfectant effect:

AK acid anolyte $\gamma = 3-4$, ORP + 1150 ± 50 mV, active chlorine concentration 100-600 mg/l;

ANK neutral anolyte $\gamma = 7-8$, ORP + 1000 ± 50 mV, active chlorine concentration 100-500 mg/l;

Catholyte $\gamma = 9-12$, ORP - 850 ± 50 mV.

Anolyte and catholyte $\gamma$ and ORP values are determined (periodically) using ionometer EV-74, I-120.1 or some other; roughly, catholyte $\gamma$ is estimated using litmus paper strips; chlorine is determined by the iodometric method (see Appendix).

2.6. Presence of organic substances on the surface decreases anolyte’s disinfection effect.

3. ANK (п•п) ANOLYTE AND CATHOLYTE APPLICATION PROCEDURES

3.1. ANK anolyte (neutral) is intended for disinfection and washing of surfaces in cattle-breeding facilities, equipment and means of animal care, indoor surfaces, equipment and tools of slaughter-houses and slaughter floors; animal skin integument; milking and dairy equipment; commercial and incubation eggs; packing, working clothes and transport vehicles.

AN anolyte (acid) is meant only to disinfect the above-listed objects.

Catholyte is intended for washing the above objects.

3.1.1. Before using anolyte, the surfaces of a treated object should be cleaned from dust, manure and other impurities.

3.1.2. Disinfection of premises with ANK neutral anolyte may be carried out both in the presence and absence of animals; AK acid anolyte shall be applied in the absence of animals. If it is impossible to remove animals due to their maintenance technology, mechanical ventilation must be on.

3.1.3. Catholyte is used to treat object surfaces by large-drop spraying with surface wiping, soaking or rinsing 15-30 minutes prior to anolyte hydro-cleansing or disinfection, cold or heated (up to 50°) catholyte consumption being 300-400 ml/m².

3.2. Preventive disinfection of indoor surfaces and equipment is performed using neutral or acid anolyte with active chlorine concentration of 180-350 mg/l and consumption of 600-1000 ml/m²; the agent is applied on the surfaces by fractional (done twice or thrice) large-drop spraying with 15-30-minute intervals followed by general 3-5 hour exposure.

3.2.1. Removable equipment (implements, instruments, remote control units etc.) are treated with neutral or acid anolyte by wiping (done twice or thrice) using a moistened brush or rags; anolyte normally consumed for a single wiping is 250-300 ml/m²; after the exposure (to neutralize anolyte corrosive effect) metallic objects shall be rinsed with catholyte or water.
3.2.2. Greasy and blood-stained surfaces of premises and equipment shall be preliminarily treated with a jet of heated (to 50\textdegree C) catholyte, then (15-30 minutes after) they shall be washed with hot (70-80\textdegree C) water and after that disinfected with neutral or acid anolyte by spraying (done twice or thrice), anolyte consumption being 600-1000 ml/m\textsuperscript{2} and exposure lasting for 3-5 hours. Then metal surfaces shall be rinsed with catholyte or water.

3.3. Forced disinfection (routine and final) of indoor surfaces (floor, walls), equipment and utensils in cases of salmonellosis and colibacillosis, as well as other infections with similar pathogen resistance shall be carried out as specified in paragraphs 3.1.1.-3.2.2, taking into consideration that anolyte should contain 450-600 mg/l of active chlorine, and decontamination exposure should last for 5-6 hours.

3.3.1. Small-size articles (equipment, tools, packing etc.) contaminated by birds\textsuperscript{-}\textgreek{t} tuberculosis and aspergillosis pathogens as well as similar resistance pathogens shall be decontaminated using neutral or acid anolyte of 500-600 mg/l active chlorine concentration, by full submersion into an anolyte-containing capacity for 3 hours; the capacity shall be tightly hatched.

3.4. Washing and disinfection by ANK anolyte (100-200 mg/l active chlorine concentration) of milk-cans, milking apparatuses, pipelines, milk storage and transportation capacities should be performed in conformity with "Sanitary regulations concerning maintenance of milking apparatuses and milk-cans, control over their sanitary state and sanitary quality of milk".

3.5. The procedure of disinfecting objects using ANK anolyte is determined in conformity with the "Instructions for veterinary disinfection of cattle-breeding facilities" (approved on 25.08.1988)

3.6. Control of the quality of anolyte disinfection shall be exercised according to Appendix # 3 to the Instructions referred to in Paragraph 3.5.

4. PERSONAL SAFETY MEASURES

4.1. STEL devices producing electrochemically activated sodium chloride solutions can only be operated by individuals specially trained for this work and certified for work with electric appliances and equipment.

4.2. Individuals with increased sensitivity to chlorine-containing preparations shall not operate the devices.

4.3. Rooms where STEL devices are installed should be supplied with ventilation.

4.4. Capacities for anolyte reception, storage and transportation should be tightly lidded.

4.5. Operators dealing with production of activated solutions, washing and disinfecting using anolyte must wear respirators and protective sanitary overalls.

4.6. Non-observance of safety measures while working with anolyte with over 300 mg/l active chlorine concentration can lead to chlorine poisoning (respiratory organs irritation,
delacrimation); the victim shall be taken to the fresh air and in case of necessity consult a doctor.

The Instructions were developed by the All-Russian Research Institute of Veterinary Sanitation, Hygiene and Ecology.

Approved and recommended for registration by the Council for Veterinary Preparations of Veterinary Department of the Minselkhozprod of the Russian Federation on 18.06.98 (Protocol No. 3) Registration No. PVR 2.03.0756-98.

Appendix ANOLYTE QUALITY CONTROL METHODS

1. Anolyte quality is controlled by its active chlorine concentration and я—п² value.

2. AnolyteБ─≥s active chlorine concentration is determined iodometrically by the amount of hyposulfite spent on binding free iodine ousted from potassium iodide by active chlorine.

For this purpose, 10 ml of solution is transferred into a cone-shaped or round flat-bottomed 100 ml flask. 10 ml of 10% potassium iodide solution and 1.5 ml of 25% sulfuric acid are added using a pipette. The solution is kept in a dark place for 10 minutes, after which isolated iodine is titrated with 0.1 n solution of hyposulphite, starch serving as an indicator.

Active chlorine content is calculated in percents according to the formula:

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X = \frac{0.00355 \times A \times 100 \times \pi}{10} ,
\]

where

- 0.00355 Б─■ gram-equivalent of chlorine corresponding to 1 ml of 0.1 n hyposulphite solution;
- \(\pi\) Б─■ amount in ml of hyposulphite solution spent on titration;
- 100 Б─■ multiplier for converting results in %; or 1000 for converting active chlorine into mg/l;
- \(\pi\) Б─■ correction factor of hyposulphite solution (when prepared from fixanal, \(\pi = 1\));
- 10 Б─■ volume of analyzed solution, ml.

For analysis result, simple average of two parallel definitions is taken.

3. AnolyteБ─≥s (and catholyteБ─≥s) я—п² value is determined using ion meter I-120.1, or EV-74, or я─п²-150 in conformity with the applianceБ─≥s operation manual.