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## THE ANALYSIS AND THE TRENDS OF ELECTROCLEANERS DEVELOPMENT

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*On the basis of the analysis of practical use of electrocleaners the urgency of development of their classification is necessary. As an Low-concentrated diluted emulsions and suspensions destruction, using for offered classification, the decision methods of the multipurpose complex problems directed in the search of the effective technologies of electrotreatment for providing working liquids cleanliness of aircraft functional systems have been forecasted.*

### Introduction

The practical reason of application of materials electrotreatment during last 100 years is confirmed with the effective use of such technologies and methods in many industries and first of all in oil-refining for the manufacturing of light oil (aircraft oils, fuels, special liquids etc.).

The application of energy-consuming methods and electric fields in particular give the basic for problems solving in the area of emulsions preparation, suspensions, ore enrichment, separation and division of multi-component systems into fractions according to sizes and materials till the fine gas and liquid cleaning from mechanical contaminations and free water.

At present, there have been found wide application of the technological processes on the basis of devices where the electric field is used as main method of realization of such technologies are applied in world practice.

### The researches and publications analysis

There is a variety of methods and constructive decisions [1–3] of energy methods realizations for the decision of specific applied problems at manufacturing and application of light oil which with different level of effectiveness is used for providing cleanliness of aircraft oils, fuels, specific liquids for transport ground complexes.

The results of the purification efficiency estimation from mechanical contaminations [4] are shown in fig. 1.

The comparative analysis of Pall mechanical filters and electrocleaners [5] shows, that electrodehydrator-cleaner (EDC) provides higher purification efficiency (diagr. 1).

Mechanical polypropylene filters (diagr. 3, 4) and P200 mechanical filter produced by the Pall firm (diagr. 2) yield to electrocleaning on the filtering capacity and efficiency of the particles number reduction for one liquid flow through the purifying device.

Thus, at filtering capacity of 5 microns electrocleaners (EC) reduces the number of particles more than to 300 times and the best of mechanical P200 filters to 5,68 times.

There is practically equal purification efficiency at EC and mechanical filters in the area of a fine filtration from 20 microns and higher.

The energy losses of EDC for electrical filtering do not exceed  $200 \text{ W}\cdot\text{m}^3$  per hour, and differential pressure is not more than 0,06 MPa and practically does not depend on the quantity of a purifying fuel.

The application of electrocleaning gives higher quantitative indexes and but also higher purification quality.

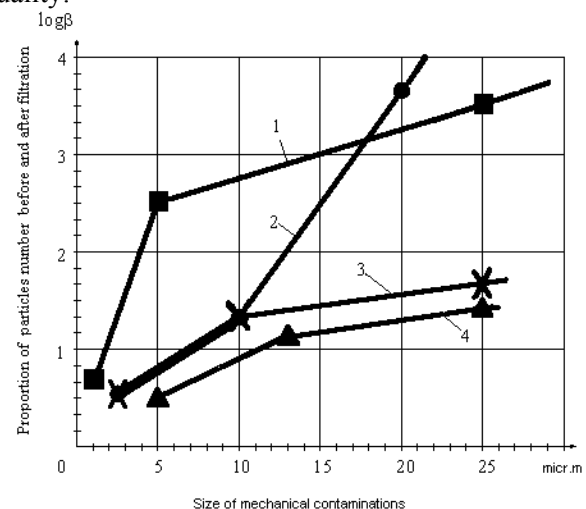


Fig. 1. Comparative estimation of efficiency of cleaning of aviation oils from mechanical contaminations:

1 – electrocleaners; 2 – P200 filter; 3, 4 – W1 and W2 polypropylene mechanical filters

The results are shown in fig. 2.

Comparison of the purification factor  $\psi$  depending on the size of dispersed phase  $d$  shows, in case of electrocleaner [3] (fig. 2, curve 1) this index is equal up to 86 % at  $d=1$  micron.

And for polypropylene filter (fig. 2, curve 3), it is 56 %, for P200 filter it is less than 46 %, hence 0,5 micron particles are removed only by electrocleaners at  $\psi = 80\%$ .

The analysis of fig. 1, 2 shows that with filtering capacity increases, the electrocleaning filtration efficiency on qualitative (reduction ratio) and on indicators of a purification degree becomes obvious.

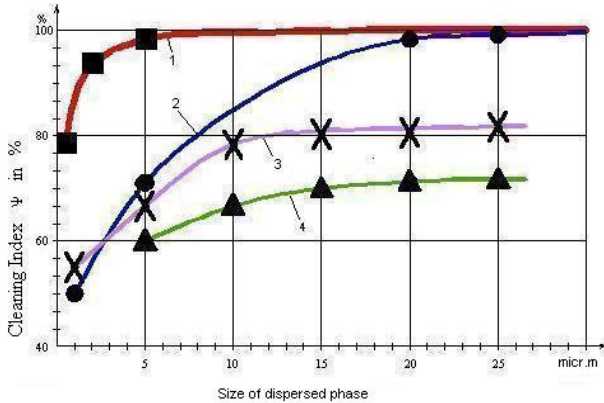


Fig. 2. Dependence of cleaning factor vs. the size of a dispersed phase:  
 1 – electrocleaners; 2 – P200 filter; 3, – W1 and W2 polypropylene mechanical filters

Application of electrocleaners for final purification of not only operating fluids of aircraft (AC) functional systems, but also for low-concentrated fine-dispersed suspensions and emulsions destruction on the basis of light oil is very promising for practical objectives.

There are a lot of constructive decisions of the devices implemented in the technologies of electrocleaning, for specific.

Practically we can not find classifications of such devices in the reference sources. This situation complicates the constructive analysis at the development of effective technologies for electrocleaning which can be applied to the solving of specific multifunctional problems connected with providing standardized purification level of operating fluids of AC functional systems and ground transport complexes.

The purpose of the present work is to develop EC typical and constructive classifications, and to outline the trends in the constructive development of such devices.

At the first stage EC it is possible to elaborate the EC general-typical and constructive classifications.

The typical classification criteria do not take into account the EC type and specific characteristics.

Proposed typical classification is shown in fig. 3 and assumes, that according to power supply EC are subdivided into direct, alternating and combined electrical current, providing the electrocleaning in the uniform and nonuniform electric fields which can be:

- stationary;
- mobile.

Depending on purifying products, EC are classified:

- gas;
- liquid.

Electrocleaners for gaseous mediums provide aerosols destruction with solid or liquid dispersed phase, liquid ones are for the flow medium purification of mechanical contaminations, emulsion water and mixed dispersed phases.

According to the principle of operation, EC may be distinguished by the applied physical process which is the basis of its functioning.

The following physical phenomena, as electrophoresis, dielectrophoresis, diepolophoresis may be basis of electrocleaning device principle of operation.

It is necessary to note, that such division has conditional character as one or several of above listed processes may be accompanied by any these processes.

It is advisable to make classification of the constructive principles according to specific targets to realize they are intended.

Such approach is very positive because depending on the function and field of application, EC constructive features can be essentially changed.

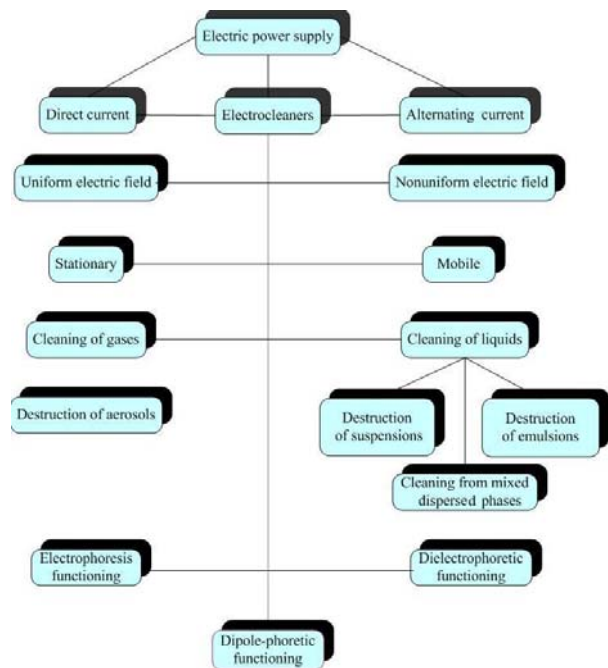


Fig. 3. Typical classification of electrocleaners

Fig. 4 shows the proposed EC classification according to the constructive principle depending on specific problems to be solved for provision of light oil and operating liquids in AC functional systems.

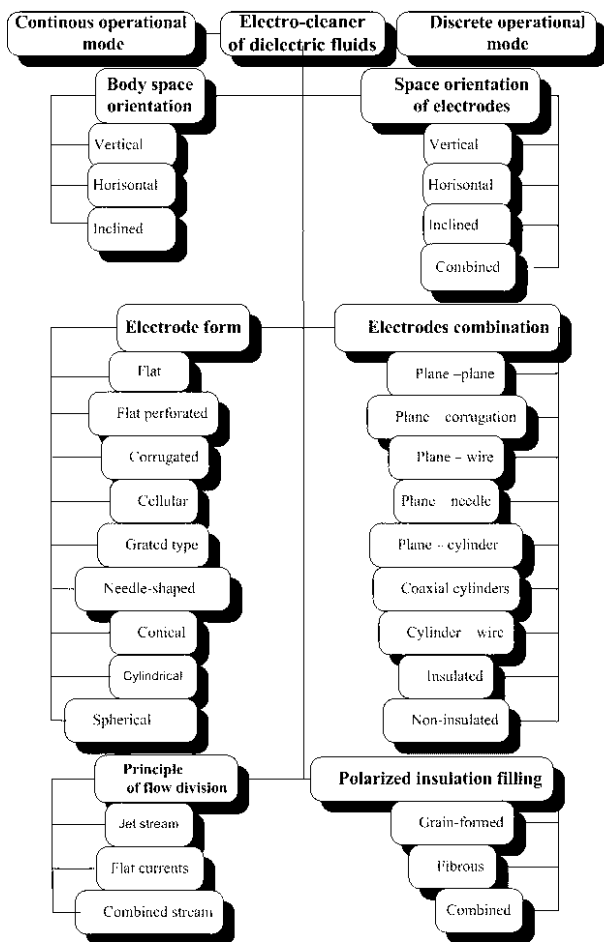


Fig. 4. Classification of electrocleaners according to constructive characteristics

It is possible to allocate EC discrete and continuous modes of operation.

In turn, on accommodation in space of a cone, equally as well as electrodes, it is possible to consider vertical, horizontal and inclined orientation of EC.

It is possible to distinguish EC according to form and combination of configuration of the forms of electrodes in the classification.

Electrocleaners can be subdivided in accordance with the realized principle of flow division of purifying liquid and the type of polarized grain, fibrous and combined. Starting from the analysis of classification for effective EC work on purification of low-concentrated diluted emulsions and suspensions it is possible to offer polarization type of EC with the system of electrodes plane – cellular corrugated electrode with filling of interelectrode space with the polarizing filling material. Use of such system of constructive decisions will allow to divide the general stream of purifying product into number of flat currents, and grain-formed filler will

provide creation of structure of nonuniform electric field with spatial pattern of mechanical mixtures purification.

Beside grain-formed filler will allow to laminate the stream in flat channels and to level the field of velocities.

It is known from references [6–10], that by the dielectrophoretic process formation the purification efficiency in EC is determined basically by the ratio ponderomotive  $F_p$  and the Stocks forces, affecting particles of continuous phase at their migration to the surface of the polarization filling material. In the case of grain-formed filler the ponderomotive force acting in the part of the electric field on the particle may be determined using the formula:

$$F_p = \frac{24 \pi \epsilon_0 \epsilon_{oil} (\epsilon_p - \epsilon_{oil}) (\epsilon_{gra} - \epsilon_{oil})}{(\epsilon_p - 2 \epsilon_{oil}) (\epsilon_{gra} - 2 \epsilon_{oil})} \times \frac{a^3 R^3 E_0^2 \cos^2 \theta}{\rho^4} \left[ \frac{2 (\epsilon_{gra} - \epsilon_{oil}) R^3}{(\epsilon_p - 2 \epsilon_{oil})} + 1 \right],$$

where  $\epsilon_0$ ,  $\epsilon_{oil}$ ,  $\epsilon_p$ ,  $\epsilon_{gra}$  are accordingly the dielectric permeability of vacuum, oil, particle, granules, and  $R$ ,  $\rho$ ,  $E_0$ ,  $a$ ,  $\theta$  correspondingly granule radius, vector radius, averaged intensity of the external electric field, the size of the particle, the tilt angle of the vector radius relative to the external electric field intensity vector of EC.

By analyzing the formula, one can recommend the following variants of increase of the cleaners overall performance with polarization dielectric filling material:

- to place polarization filler with discrete increase of dielectric permeability along electrode filter-element;
- to make electrode filter package by the multistage power supply with independent supply for each stage;
- to use threadlike fibrous filler for polarization filler.

In the first case the discrete increase  $\epsilon$  of the filler along EC allows at  $E_0 = \text{const}$  to vary  $F_p$  without change of voltage on electrodes. Voltage step change along the filter package will allow to reduce probability of the particles dispersion development which have reached the limiting size at typical critical  $E_{cr}$  of intensity of the electric field. The recommended use of threadlike fibrous filler instead of grain-formed is caused by the opportunity to receive more advanced deposition surface with higher nonuniform electric field as vector radius  $\rho$  for fibrous is not less than the size of granules at the minimum. The part of predicted constructive improvements is realized in the work [4].

## Conclusion

Comparative analysis has shown, that it is more effective to apply EC for final cleaning of light oil at which quantitative and qualitative indices of purification efficiency are higher 50 and 1,5 times correspondingly than in mechanical filters.

Offered EC typical and constructive classification allows to outline the problems by specific device.

The trends of EC improvement are outlined.

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Аналіз і перспектива удосконалення електроочисників

За результатами аналізу практичного використання електроочисників розроблено їхню класифікацію. На прикладі руйнування малокоцентрованих розведених емульсій і суспензій, використовуючи запропоновану класифікацію, розглянуто методи вирішення багатофункціональних комплексних задач, спрямованих на застосування ефективних технологій електрообробки з забезпечення чистоти робочих рідин функціональних систем повітряних суден.

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Анализ и перспектива усовершенствования электроочистителей

По результатам анализа практического использования электроочистителей разработана их классификация. На примере разрушения малоцентрированных разбавленных эмульсий и суспензий с использованием предложенной классификации рассмотрены методы решения многофункциональных комплексных задач, направленных на применение эффективных технологий электрообработки по обеспечению чистоты рабочих жидкостей функциональных систем воздушных судов.