ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

METHODS OF OVERVOLTAGE LIMITATION IN MODERN DC SEMICONDUCTOR SWITCHING APPARATUS AND THEIR CALCULATION (p. 4-9)

Anatoly Soskov, Natalia Sabalaeva, Yana Forkun, Marina Glebova

The study considers switching surges at semiconductor switches of semiconductor devices of the direct current at the time of switching electric circuits; such surges occur due to the energy accumulated in the inductive elements of the mains at the load disconnection.

As the cost of power semiconductor devices is determined not only by the voltage that they are able to handle but also by the class of the device that determines the amount of the blocked voltage, an important task is to use special measures to reduce these surges down to levels that are close to the network parameters.

The aim of this study was to develop a methodology for calculating the parameters of a regulator of switching surges on the basis of a series of parallel-connected energy-intensive varistors used in semiconductor devices of the direct current.

On the basis of studying the transient processes that occur in such surge restrictors of voltage in semiconductor devices of the direct current at load switching, analytical expressions have been developed for calculating the basic parameters of the voltage regulator.

As a result, an engineering method has been devised for calculating the parameters of varistor surge regulators in hybrid and contactless semiconductor devices of the direct current at a given level of surge admissible for this class of devices. The research findings facilitate high accuracy at a small amount of time in choosing fully controlled semiconductor devices with regard to the current and voltage when designing modern switching semiconductor apparatus that work with the direct current; this helps solve the basic tasks of planning.

The suggested voltage regulator for semiconductor switching apparatus of the direct current effectively limits switching surges in the circuits of power semiconductor devices to below 2.5 U_{nom}. It significantly surpasses such parameters as the dimensions, weight and cost of resistive-capacitive surge limiters previously used in semiconductor contactors. Moreover, it can reduce the class level of fully controlled power semiconductor devices that are used in semiconductor switches of such apparatus.

Keywords: switching surge, voltage regulator, varistor, semiconductor apparatus, semiconductor device.

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DECISION SUPPORT SYSTEM'S CONCEPT FOR DESIGN OF COMBINED PROPULSION COMPLEXES (p. 10-21)

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It is shown that there are many mathematical models (MM) of ship power plants for various purposes. Such MM are integrated into decision support systems (DSS) and used in the design and power optimization of ship power plants (SPP) of various constructional configurations. Experimental research and scientific literature analysis prove that such integrated MM into DSS are not always adequate to real physical processes in some modes, for example, dynamic ship positioning.

That is why integrated MM SPP into DSS need clarification as well as the existing DSS need further development.

The approach for the creation of specialized DSS SPP of the ship combined propulsive complexes (CPC) is proposed, which allows predicting the number and type of thrusters (T), pods, power system, and does not require the application of similarity criteria, allows a multiple analysis of the structure at minimal initial data.

The designed DSS applies the principles of the construction of DMI-models ships and methods of implementation of characteristic spatial vectors of power processes, gives a possibility to synthesize recommendations to T designers, controllers and power systems for ships operating in the dynamic positioning modes. Created DSS can be used practically for any type of vessels and adapted for the modes of dynamic ship positioning.

It is established for a given rotation speed of the pods, traction, torque and stepper ratio with the help of created DSS, that traction coefficient grows with the change in mutual location of T relative to each another and diametrical plane of the vessel. It is proved that the interelation of thrusts coefficients are correlated better with the power coefficients than with the stepping pods coefficients, allowing increasing energy efficiency of SPP CPC in the dynamic positioning modes.

The results of the research can be implemented into data bases of similar DSS and provide researchers with verified information needed for creation of new concepts of SPP CPC design for modification of existing systems.

Keywords: ship power installation, propulsive complex, simulation, power transfer process, decision-making.

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USAGE OF SOLAR AND WIND ENERGY FOR HOT WATER SUPPLY OF COUNTRY (COTTAGE) HOUSE IN NATURAL CONDITIONS OF ABSHERON (p. 22-29)

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The calculations show that it is becoming possible to generate the powers of wind device and solar water heater approximately up to 4 kVt due to the use of the offered system SWH+WED.

Using the developed system for the purposes makes possible, first, to improve the ecological situation in the region for the summer period and secondly, to reduce fuel and electric energy consumption used in the region standard conditions.

Usage of solar and wind energy may save fuel, heavy fuel oil and electric power up to the average 15–20 % percent in natural conditions of Absheron. These data were found by us on analyses of common records from statistics of corresponding departments and institutes.

The authors have offered and build practically for the first time the SWH+WED system considered for heating the country (cottage) houses in native conditions of Absheron where solar radiation intensity and wind speed are approximately 500–600 Vt/m^2 7–10 m/sec. respectively in the studied period of the year.

It may use the developed system effectively for the hot water supply to the residents of this Region.

To our opinion, that may save heavy fuel oil and electric power up to 30–35 % percent taking into account negative data of the departments corresponding.

Keywords: solar panel, wind electric unit, solar radiation, wind velocity.

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A PROBABILISTIC AND STATISTICAL APPROACH AS A MEANS OF PREDICTING THE EFFICIENCY OF HYDRAULIC FRACTURING (p. 30-36)

Clara Gabdrakhmanova, Flyura Usmanova, Gennady Khramov

The study considers mathematical data on the efficiency of using a single-stage and multistage types of hydraulic fracturing for petroleum field development. The research is based on the geological and physical characteristics of the deposits in the latitudinal segment of the Ob River area, which has helped justify the method of choosing the HF technique. The probabilistic and statistical analysis of the commercial efficiency statistics has determined the quantitative criteria for selecting the crack parameters such as length, height and the amount of proppant injected, which can facilitate making estimates for the use of a single-stage and multistage types of hydraulic fracturing. The productive horizon AC-12-3 has a complex geological and physical structure and low reservoir properties, which greatly complicates its development but facilitates active formation of its hard-to-recover deposits.

The study has revealed that the technology used to enhance oil recovery from the horizon BC-8-1 on the basis of a single-stage hydraulic fracturing can be effective for quite a limited time not exceeding 3–4 years. Meanwhile, the use of the multistage HF technology on the horizon AC-12-3 showed its higher efficiency compared to the single-stage HF technology.

The results of the probabilistic and statistical analysis of the commercial application of the multistage hydraulic fracturing technology have proved that it is necessary to take into account the geological and physical peculiarities of a horizon in order to choose an appropriate technology of petroleum recovery.

Keywords: single-stage hydraulic fracturing, multistage HF, producing formation, formation thickness, clay content factor.

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THE BRANDON METHOD IN MODELLING THE CAVITATION PROCESSING OF AQUEOUS MEDIA (p. 37-42)

Zenoviy Znak, Yuriy Sukhatskiy

A 4-factor multiplicative mathematical model was built in order to find the best mode of cavitation processing of aqueous media, in which the value of heat energy released during cavitation is maximal. The model links the heat energy value with technological (inlet pressure in the cavitator) and design (nozzle diametre, the number of nozzles, the angle of attack jets) parametres. The adequacy of the derived regression equation is confirmed by the Fisher criterion ($F<F_T=0.203<1.51$). The accuracy of the model has been assessed by the coefficient of determination and the mean relative error of approximation (ε_{MRE}=5.85 %). The analysis of the 4-factor multiplicative model allowed finding the optimal conditions for cavitation processing of liquid-phase media; they are as follows: inlet pressure – 0.54–0.6 MPa, nozzle diametre – 1.6 mm, the number of nozzles – 4–5, and the angle of attack jets – 144–170 degrees. It is found that, in comparison with the absence of air, the content of air of 2±0.25 % by the volume of an aqueous medium greatly intensifies the formation of the "flotation" layer (its height, dispersibility of bubbles, and gas saturation). The derived multifunctional dependence allows controlling the effectiveness of cavitation processing of aqueous media by means of changing the design parametres of cavitating parts.

Keywords: cavitation, flotation, hydrodynamic jet cavitator, multiplicative mathematical model, the Brandon method.

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DEVELOPMENT OF ENERGY-SAVING TECHNOLOGY MAINTAINING THE FUNCTIONING OF A DRYING PLANT AS A PART OF THE COGENERATION SYSTEM (p. 42-48)

Eugene Chaikovskaya

The technology of the drying plant functioning at the level of decision making for the production of pellet fuel was suggested. The use of the integrated system of the estimation of a change in the air moisture content in the drying chamber, obtained on the basis of the mathematical and logical simulation as a part of the cogenerating system, allows coordinating the temperature and aerodynamic drying modes of timber drying on the basis of a change in the rotation frequency of the electric motor of the air fan by measuring the air temperature at the inlet into the heat exchanger.

For example, with the production of 5,8 thousand tons of wood pellets per year, it is possible to provide 860 apartments of the area of 120 m^2 with the pellet fuel, which allows reducing the cost value of the electric energy and of the heat production by 20–30 % and obtaining savings of financial resources up to 40 % with the use of pellet fuel for heating and hot water supply on the condition of considering the frequency regulation of the electric motor of the air fan for the timber drying

Keywords: technology, drying plant, air moisture content, mathematical and logical simulation, cogenerating system.

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EFFICIENCY IMPROVMENT OF SHIPS OPERATION BY WATER-FUEL EMULSION USING (p. 48-53)

Aleksey Malahov, Gudilko Gudilko, Palagin Palagin, Igor Maslov

The technology of using water-fuel emulsions during operation of vessels serving oil platforms is investigated. When considering the process of burning water fuel emulsions the diffusion theory of combustion with the scheme effective film. The mechanism of combustion of water-fuel droplets is described and the main theoretical expressions were applied. The results of physical experiments relating to the influence of water concentration on the combustion process of the

emulsion were obtained during the operation of the main engine of the vessel. It was established how the concentration of water components influence the burning process water fuel emulsions. For different load modes for the main engine of the set numerical values of fuel economy depending on the water concentration in the feed for the combustion of water-fuel emulsion. The result of maximum fuel economy equal to 13.42 % is obtained at the engine load of 80 %. It is shown that with the increasing humidity of the fuel from 1 % to 15 % the temperature of exhaust flue gases of ships is reduced by 52.7 ^{o}C.

It is established that the presence of water in a lightweight diesel fuel under certain conditions can have a positive effect on the combustion process, which leads to improved characteristics of the resulting torch of fuel burning and heat dissipation.

Keywords: emulsion, of the engine, the mixture of water and diesel, dispersion, flash point, concentration of water.

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