ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

SELECTION OF PARAMETERS COMBINATION OF THERMOELECTRIC MATERIALS FOR DEVELOPMENT OF HIGH-RELIABILITY COOLERS (p. 4–14)

Vladimir Zaikov, Vladimir Meshcheryakov, Yurii Zhuravlov

The possibilities of constructing two-stage high-reliability thermoelectric devices using the same combinations of parameters of raw materials in stages with equal efficiency at the series electrical connection of the stages were considered. The calculation data of the basic reliability parameters and indicators of the two-stage thermoelectric device using different combinations of parameters in stages for temperature changes from 60 K to 90 K and operation modes: maximum cooling capacity, maximum cooling capacity at a given current, maximum coefficient of performance, minimum failure rate were given.

It was proved that the approach to the thermocouple material selection by average efficiency, electrical conductivity and thermal conductivity indicators, adopted in the industrial production of thermoelectric modules is not optimized in terms of reliability of thermoelectric modules.

As a result of the analysis of reliability indicators of thermoelectric cooler for different combinations of parameters of raw materials, the possibility of increasing the probability of failure-free operation by more than 10 % for all operation modes was revealed.

It was shown that an increase in thermoelectric cooling capacity in stages increases the cooling capacity or decreases the number of thermocouples, which together with the use of raw materials with high electrical conductivity allows to reduce the total failure rate and increase the probability of failure-free operation of two-stage devices.

Keywords: reliability, thermoelectric coolers, stages, materials, efficiency, temperature.

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DEVELOPMENT OF A NUMERICAL MODEL FOR GAS-SOLID FLOW IN THE INDUSTRIAL CYCLONE-CALCINER FURNACE (p. 14–21)

Roman Havryliv, Vladimir Maystruk, Valeria Biliak

This work is focused on the numerical simulations of gas-solid flow in an industrial cyclone-calciner furnace. «ANSYS Fluent 15» software was used for numerical simulation. The computer model allows us to investigate modes of work with different fractional composition of material.

For different boundary conditions of inlet gas flow, the trajectory of the particles and residence time in the apparatus, as well as hydrodynamic flow structure were determines. In addition the influence of additional revolving flow in the furnace on a distribution of particles was investigated too. The simulation results show good agreement between predicted and experimental data. This means that the behaviour of complex furnace system can be predicted using the CFD.

The obtained results will be used in the future to optimize the design of the furnace and determination of optimal modes of operation.

Keywords: numerical simulation, cyclone-calciner furnace, particles distribution, gas-solids flow, particle residence time.

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THERMODYNAMIC ANALYSIS OF POWER EFFICIENCY FOR DUAL-FUEL MONIC COMBINED-CYCLE PLANTS (p. 21–25)

G. Lyubchik, Nataliia Fialko, Aboubakr Regragui, Raisa Navrodskaya, Olga Kutniak, Ludmila Shvetsova

Materials on developing dual-fuel monic combined-cycle plants, including additional steam generator – forced-circulation boiler, operating on fuels-substitutes for natural gas were given. Cases, when a heat recovery circuit operates in the feed-water heating mode and heating-evaporation mode were considered. For these modes, corresponding schematics were designed. It was shown that in order to replace deficient natural gas, forced-circulation boiler may use low-grade solid or liquid low-calorie fuels in the first case and average-calorie fuels-substitutes in the second. Regularities of thermodynamic processes in dual-fuel monic combined-cycle plants with forced-circulation boiler were determined. It was found that using the remote steam generators in the circuit allows to transfer a part of heat recovery circuit functions on it. This reduces the thermodynamic overload of the circuit and improves the cycle efficiency. The analysis of work processes in the combustion space and steam generating circuit of the forced-circulation boiler was performed. The assessment of power efficiency of dual-fuel monic combined-cycle plants with forced-circulation boiler was conducted. The comparison of the key technical and economic parameters of the proposed monic combined-cycle plant, basic GTP and the “Vodoley” (“Aquarius”) type monic combined-cycle plant was carried out.

Keywords: dual-fuel monic combined-cycle plant, forced boiler, fuels-substitutes for natural gas.

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DISTINCTIVE FEATURES OF ANALYSIS OF RELIABILITY OF OVERHEAD DISTRIBUTION NETWORKS WITH SOURCES OF DISTRIBUTED GENERATION (p. 26–32)

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The authors have shown that the existing reliability management experience abroad because of the topology specifics, switching devices, relay protection and automation tools used is not fully applicable to domestic distribution networks. In this regard, new modeling and optimization methodology of power supply reliability parameters, oriented also at the appearance possibility of distributed generation sources in the structure of electric networks was proposed. The paper presents the results of a comparative analysis of the application conditions of distributed generation tools with different equipment of electrical networks by automatic and non-automatic switching devices, in order to substantiate optimal connection zones of generating sources under different application conditions. Recommendations for setting relay protection tools under the joint use of reclosers and fuses in the networks with distributed generation sources to eliminate false alarms and unwarranted disconnection of fuses at transient faults were developed. It is shown that under the valuation of reliability indicators, cost estimate of measures on providing electricity networks with required switching and protective devices serves as private objective function during multicriterion substantiation of optimal integration options of distributed generation into electric networks.

Keywords: overhead distribution networks, distributed generation, power supply reliability, switching and protective devices.

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INVESTIGATION OF THE CHARACTERISTICS OF ELECTRIC HEATING CARBON FIBER FABRIC FOR INFRARED SPACE HEATING SYSTEMS (p. 33–39)

Dmytro Filin, Vita Ivanova

The results of experimental studies of low-temperature electric heating carbon fiber fabric, used for space heating were presented in the paper. Flexible carbon fiber fabric is quick-response electric heating device, which consumes 242 W of power per running meter at a voltage of 48 V. The dependence of heating temperature on voltage in the range of 36–48 V is linear. Current-voltage characteristics, the dependence of the fiber fabric heating temperature and radiation spectrum on supply voltage were found, the temperature distribution throughout the fiber fabric at nominal voltage values was investigated using the thermal imager. It is shown that it is uniform. With the vertical fiber fabric fixing, temperature distribution unevenness is associated with convective cooling. The proposed method to determine the ratio between radiant and convective heat transfer component has allowed to estimate the radiation component in heat flow that goes for space heating as such that does not exceed 30 % when fiber fabric heating to 50–60 °C, which is essential, but does not allow to classify these low temperature heaters as solely IR heating elements. However, this does not exclude positive qualities of such systems, namely compactness, durability, easy installation on any surface and coverage. Research of alternating low-frequency electromagnetic field and current-voltage characteristic after the damage of CFF have proven the CFF safety.

Keywords: carbon fiber fabric, space heating, convection heating, infrared heating, heat transfer components ratio.

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SOME FINDINGS ON THE MARINE DIESEL USING GAS CONDENSATE FUELS (p. 40–43)

Haci Babaev

The paper presents a comparative analysis of the main physical and chemical characteristics of various fuels, including mixtures of heavy diesel fuel and gas condensate. It reveals the findings of comparative experiments on the marine 2CH10.5/13 auxiliary diesel engine using the above-mentioned fuels. The research showed that mixtures of gas condensate (GC) with the boiling (heating) start point not less than 120 °C and furnace fuel oil (M) with the flash-point not less than 130 °C meet the requirement of the Maritime Register and can be used in marine diesels if the concentrate ratio makes up 15.0 % GC+85.0 % M. The use of the devised mixture (15.0 % GC+85.0 % M) in marine internal combustion engines would increase diesel fuel resource and reduce the environment pollution.

Keywords: marine diesels, diesel fuel, engine fuel, furnace fuel oil, gas condensate.

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DEVISING AN ENERGY SAVING TECHNOLOGY FOR A BIOGAS PLANT AS A PART OF THE COGENERATION SYSTEM (p. 44–49)

Eugene Chaikovskaya

The paper suggests an operation technology for a biogas plant that allows setting a heating medium temperature at the inlet to the heat exchanger built in a digester and measuring the heating medium temperature at the outlet. An integrated system for assessing the varied temperature of digestion (that is based on mathematical and logical modeling within the cogeneration system) secures a continuous gas outlet, a timely unloading of fermented mash and loading of a fresh matter. For this purpose we have devised the following structural schemes: (1) a complex mathematical modeling of the dynamics of a biogas plant and a heat exchanger built in a digester, (2) a logical modeling of a biogas plant efficiency control, which allows obtaining functional data at the level of making decisions, (3) a logical modeling of making decisions within the cogeneration system, (4) a logical modeling of a biogas plant state, which allows confirming the made decisions. The devised operation technology for a biogas plant as a part of the cogeneration system enables saving 25.4 thsd m^3 of biogas per

year, if we use, for instance, a heat pump and manufacture 352.5 m^3 of biogas per day. Raising a biogas plant marketability by 13.94 % would reduce the cost of electricity and heat within the range of 20.0–30.0 %.

Keywords: technology, biogas plant, digestion temperature.

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DEVELOPMENT OF REFRIGERATION SYSTEM FOR THE PRIMARY LOW-TEMPERATURE PROCESSUNG AND STORAGE OF SMALL-SEEDED CROPS GRAIN (p. 50–56)

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The analysis of various aspects of the refrigerated storage of grain on elevators in Ukraine, CIS and the world was performed. The advantage of the refrigeration method in terms of quality and energy saving was shown. A comparative analysis of various types of refrigeration machines operating on ozone-friendly refrigerants – gas, vapor compression, absorption, steam jet was carried out.

It is shown that at the presence of waste heat, using heat-driven refrigeration machines is economically advantageous. Natural refrigerant – ammonia, which has also superior environmental characteristics has the greatest prospects in mobile grain refrigeration systems.

Experimental studies of convective heat exchange between the stationary bulk of small-seeded grain and cooled air were conducted, criterion equation which takes into account the physical and geometrical parameters of refrigerated processing was obtained. It is shown that small-seeded crops grain refrigeration to the temperature below ambient temperature is accompanied by a partial draining for rapeseed and millet, the maximum moisture entrainment occurs at the beginning of refrigerated processing.

Keywords: small-seeded grain storage, refrigeration systems, heat transfer in dense fixed bed, container and stationary primary refrigerated processing systems.

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