ABSTRACT AND REFERENCES

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IDENTIFICATION OF DISTRIBUTION FEATURES OF THE INSTANTANEOUS POWER COMPONENTS OF THE ELECTRIC ENERGY OF THE CIRCUIT WITH POLYHARMONIC CURRENT (p. 6–13)

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Many researchers pay attention to the problem of the distortion electric power. The known theoretical results that are reflected in the acting standards are reasonably criticized in the part of the distortion power generation by current and voltage of different frequencies. The paper deals with the approach based on the order of generation of instantaneous electric power components depending on the combination (sum or difference) of current and voltage frequencies. The analytical expressions for the instantaneous electric power components of a harmonic current circuit consisting of a capacitor, an inductance coil and a resistor connected in series are obtained. With this purpose in view, two components – active and reactive – are singled out from the obtained four components of instantaneous power, as well as the orthogonal power components oscillating with double frequency. It is demonstrated that the sum of the squares of the active and reactive components and the sum of the squares of the mentioned orthogonal components coincide and are equal to the total (apparent) power. The used method is developed for the general case of polyharmonic current and voltage. In this case, it is observed that the active and reactive power components can be singled out from the instantaneous power components as orthogonal quadrature components of zero frequency. Though, it is impossible to single out the apparent power. Two numerical experiments with periodic current and voltage, containing three harmonics each, were carried out. The acting values of currents and voltages in each of the experiments were assumed equal. In this case, the amplitudes of the second and the third harmonics exchanged their positions. This example demonstrates that the integral indices of the apparent power and the distortion power, calculated by conventional methods, proved to be the same in both cases, which is incorrect. Under the same conditions, such instantaneous power components whose values turned out to be different for each of the experiments are found among the proposed instantaneous power components. As a result, it is proposed to use a root-mean-square value of the mentioned components for the assessment of the distortion degree in relation to the root-mean-square value of the instantaneous power.

Keywords: electric energy power, power norm, active power, reactive power.

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RESULTS OF EXPERIMENTAL RESEARCHES INTO PROCESS OF OAK VENEER DRYING IN THE SOLAR DRYER (p. 13–22)

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A new design of solar drying plant with the active solar energy system is developed. It is proposed to use the K1-102 automated control system to diagnose the key parameters of air exchange in the solar dryer and to predict the intensity of heat exchange processes of oak veneer drying. This allows increasing the technological and power efficiency of the process of oak veneer drying in the solar dryer 2 times.

The regularities of the influence of the physical parameters of the environment and weather-dependent factors on the heat, mass, and moisture exchange processes of oak veneer drying in the solar dryer are determined. Estimation of energy, kinetic and dynamic parameters of the oak veneer drying process is given. The duration of the drying process in the solar dryer is experimentally determined. Performance characteristics of the drying object are investigated, depending on the set technological tasks (heating or drying) under standard insolation and meteorological conditions.

It is found that it is necessary to regulate air exchange, moisture release, rational moist coolant removal, solar energy flow in relation to the predicted changes in the minimum and maximum variation peaks of weather-dependent factors. This is important for intensifying the oak veneer drying processes and reducing the specific power consumption of the drying process due to solar energy.

The obtained results can be used in the development and improvement of technical means of oak veneer drying, to improve the technological and power efficiency of the process.

Keywords: solar energy, solar dryer, temperature and humidity fields, heat and mass transfer, intensification, convective drying.

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MOVABLE BLADE VERTICAL SHAFT KINETIC TURBINE VISUAL OBSERVATION (p. 23–30)

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Kinetic energy is the energy produced due to the river water flow speed. This water speed energy can be effectively implemented as a rural power plant. This research has been carried out experimentally and the research is under a laboratory scale research. The turbine tested is a vertical shaft kinetic turbine equipped with eight blades. This study is a continuation of the previous research, which is observed based on the turbine parameters. While in this research the observations are based on a visual test, namely observing the behavior of the water movement and blade movement in the turbine.

The visual test is a test by observing the turbine blade movement and water behavior in the turbine area. From this visual test, it can be seen what is the caused of the low turbine efficiency and what is the causes of the unstable turbine rotation.

From the visualization image observing, it is found that the water does not hit the turbine blade completely. The turbine blade opening time is a little bit too late, so that the water could not fully push the blade surface. At a certain blade position, the water flow is not entering the area between two blades, which results in a weak blade push. This means that there is a turbine torque reduction. From these explanations, it is found that these constraints are the points that result in the unstable turbine rotation. For a better turbine performance, it is suggested to add the turbine blade number.

The more the blade number, the smaller the area between the two blades and the more effectively the water flow pushed the turbine blade. The turbine rotation would be more stable and the turbine efficiency would surely be higher.

Keywords: water energy, potential energy, movable blade, vertical shaft, kinetic turbine, visual observation.

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DEVELOPMENT OF A RENEWABLE HYBRID POWER PLANT WITH EXTENDED UTILIZATION OF PUMPED STORAGE UNIT EQUIPMENT (p. 30–37)

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The scheme of a renewable hybrid power plant with the extended use of the installed equipment of the pumped storage unit for the conversion of the photovoltaic and wind generators direct current to the alternating one is proposed.

The scheme is based on existing components with widely used proven technology. To output the power of solar and wind generators to the grid and for DC to AC conversion, a synchronous generator of the pumped storage unit is used in addition to grid inverters. An induction motor, powered through a variable frequency drive from a common DC bus, is used together with a hydraulic turbine to rotate the generator. In addition, batteries and capacitors banks are connected to the DC bus.

The possibility of using various types of electric machines to drive a synchronous generator is analyzed and the preference of an induction motor is shown. The response of an induction motor to rotational speed fluctuations is modeled and its capability to participate in the network frequency regulation is shown. With the example of a typical daily load and generation profile, it is shown that the proposed solution for DC to AC conversion has an efficiency close to that of the grid inverter.

The proposed scheme of the hybrid power plant can increase the reliability of renewable energy sources and the stability of the network frequency. This is achieved due to increasing the inertia of the rotating masses in the power system, the power factor control capabilities of the synchronous generator and the proper response of induction motor to rapid fluctuations of the rotation speed. The creation of such hybrid power plants opens the way for a further increase in the share of renewable energy sources in the power system.

Keywords: renewable energy, hybrid power plant, variable frequency drive, induction motor.

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THEORETICAL AND EXPERIMENTAL ANALYSIS OF SOLAR ENCLOSURE AS PART OF ENERGY-EFFICIENT HOUSE (p. 38–45)

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The use of solar energy as a potential alternative source to ensure the heat supply to energy-efficient houses was explored. We have performed preliminary theoretical analysis of energy indicators for the combined heat supplying system when a solar window is used as part of the enclosure for an energy efficient house. In order to enhance operational effectiveness of the studied plant relative to existing solar collectors and to improve it in the structural aspect, the stratification of a heat carrier in the tank-accumulator of the combined heat supply system with a solar window was calculated.

The study of operational efficiency of the experimental setup for using solar energy was carried out under the mode of circulation and gravitational motion of the heat carrier by the intensity of radiation of the solar energy simulator on the system of 600 W/m^2 and 900 W/m^2. Water was used as a heat carrier.

We have analyzed changes in temperature of the heat carrier in the solar collector and in the tank-accumulator of the proposed combined solar heat supply system with a solar window as part of the external enclosure of an energy-efficient house.

It was established that the heat carrier temperature under the circulation mode reached 26.5 °C. We have also presented comparative

field, laboratory, and theoretical calculations of the average temperature of the heat carrier in the tank-accumulator under the mode of the heat carrier gravitation motion under various conditions.

Efficiency of the experimental setup was calculated. The dynamics of change in efficiency of the solar heat supply system with a solar window were described. Efficiency was ≈55 % under the mode of heat carrier circulation for heat energy accumulation in the tank-accumulator, depending on heating duration. Under the mode of gravitational motion of the heat carrier, we calculated efficiency for the design of a solar window only, which was 53 %.

Keywords: solar window, solar power engineering, energy balance, gravity/circulation mode, radiation intensity.

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THE USE OF HEAT CIRCULATOR FOR FLAMMABILITY IN MESOSCALE COMBUSTOR (p. 46–56)

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The mesoscale combustor is a part of the micropower electric generator. The function of the mesoscale combustor is to convert hydrocarbon to become thermal energy through combustion reaction. It is difficult to maintain the flame stability of a mesoscale combustor due to its millimetre-scale size.

This study aims to determine the performance and recognize mesoscale combustor phenomena that have stainless steel heat recirculators. This study is to test the combustion characteristics of liquid and gas fuels in meso-combustors which use heat recirculator. The heat circulator is made of stainless steel tube with an inner diameter of 3.5. The parameters observed were flammability limits, temperature distribution and flame visualization.

It is confirmed that the stainless steel heat recirculator; is useful for liquid fuel preheating and evaporating inside of mesoscale combustor. The flame of liquid fuels can be stabilized at an equivalence ratio of 0.9 to 1.25, and up to about 900 centigrade Celsius. Thus recommend for liquid fuel micropower generator. It is noted that when the heat recirculator is too close to the flame, excessive flame cooling occurs and causes the flame extinguished. The mesocombustor, which has no heat recirculator, and designed for gas fuel only, can stabilize flame at an equivalence ratio of 0.7 to 1.5. It is also confirmed that the inaccurate selection of the material of thermal recirculator risks reducing the flame stability. It is important to note that when the gas fuel exits the storage tube, there is an

expansion and a decrease in temperature which can affect flammability limits.

Keywords: micro-combustor, flammability, heat recirculation, liquid fuel, micropower generator.

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DEVELOPMENT OF COOLING SYSTEMS ON THE BASIS OF ABSORPTION WATER-AMMONIA REFRIGERATING MACHINES OF LOW REFRIGERATION CAPACITY (p. 57–67)

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An analysis of the cycles of an absorption water-ammonia refrigerating machine (AWARM) is carried out in a wide range of operating parameters (temperature of the heating medium: 45...145 °C, outdoor temperature: 10...43 °C, temperature of the cooling object: minus 25...5 °C). It is shown that under the considered operating conditions, the AWARM positive effect on the energy efficiency of the AWARM is low outdoor air temperatures and high temperatures of the heating heat source.

A promising cooling system based on low refrigerating capacity AWARM is developed using solar thermal energy and the technology of using natural seasonal and daily temperature potential of atmospheric air, including using night radiation cooling (NRC).

The key elements of the cooling system are: storage tank; cooling system based on AWARM with combined sources of heat load; heat removal system in the mode of convection and radiation at night.

It is shown that AWARM in combination with a cold storage tank allows to provide a wide range of refrigeration processing by selecting a working substance with a phase transition (melting-solidification). Working substances with a temperature level are recommended: minus 25 °C (for products of animal origin); 0 °C (primary refrigerated processing of milk); 5 °C (for fruits and vegetables).

It is advisable to ensure the guaranteed heat removal from the cold storage tank of the cooling system in the passive «thermal diode» mode with the help of two-phase thermosyphons.

When working with solar collectors with water, as a coolant for the AWARM generator, the AWARM scheme with a booster compressor in front of the condenser is proposed.

It is shown that the greatest effect of the NRC technology in heat removal systems can be achieved in the high-mountainous regions of the planet with minimal atmospheric humidity, for example, in Kazakhstan.

Keywords: absorption water-ammonia refrigeration machine, refrigerating capacity, solar collectors, night radiation cooling.

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