Hit-pumped step setting with a hydrodynamic kavitation device

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Summary. All modern developments purpose is an quality improvement and production expenses diminishing. Tariffs increase is one of modern Ukraine basic problems, therefore there is a necessity of energyindependent creation, autonomous systems which will be controlled and managed remotely. The combined systems creation, able to work remotedly and regardless of direct energy resource, will result in the considerable protected level increase from instability temperature overfalls and overfalls in an electric network.

The invention behaves to the heating engineering, in particular to the methods and devices for the heat receipt, appearing otherwise, what as a fuel combustion result, and it can be used in the heating system and dwellings hot water-supply and production apartments, and also for a preheat and oil reological properties improvement and products from oil. The sensors presence in this system allows to control, regulate and signal about its state, and also allows to set necessary parameters.

Key words: heat-pump, compressor, kavitator, hydrodynamic setting, reactor.

INTRODUCTION

All types basic energy and power users mediums are enterprises, and necessary part of any enterprise is it's energyeconomy. It is an aggregate of the generating, transforming, transmitter and consuming power settings by means which providing all necessary enterprise types of energy and use it to carry out in the production process. In addition, an energyeconomy plugs in itself devices and automatic control systems with their informative providing, not power settings, buildings and resources, providing reliable and economical enterprise energy work, and also lighting, heating and fuel supply. An enterprise energyeconomy is not only an auxiliary and attendant production but also basis, providing the normal enterprise functioning.

THE ANALYSIS OF RECENT RESEARCHES AND PUBLICATIONS

Known invention behaves to the equipment for dwellings heating and production buildings.

A compression heat-pump is contained by a vaporizer, compressor, condenser, choke valve and liquid separator. [1]

A vaporizer and condenser is executed as casingvortical warmly transmitter, containing the union serve couplings and working agent taking and serve union couplings and taking, accordingly low potential warmly transmitter and highly potential warmly transmitter, snail vivid collector with a sending vehicle and butt-end walls, on the internal and external surface of which ductings are executed, and from exteriority, casing is set.

Invention belongs to warmenergy production [2], in particular to heating settings, small shopfloors hot watersupply, individual dwelling-houses and separate buildings at the use lowpotential natural heat sources, economic domestic flows and other thermal wastes. Method of utilization lowpotential warmly sewages will realize with the heat-pump use and bearing-out warmly transmitter, placed into the hollow erlift column submerged in sewages.

It allows to utilize the unclaimed, for some time past, low potential sewages heat, in enormous amounts continuously sent to cleaning on the sewage metropolis networks, small cities and workings apartments.

Thus, due to such property in-use in the coolant heatpumps, as his ability to evaporate at a temperature, equal $3-5^{\circ}$ C, they can utilize warmly sewages with a temperature, not exceeding $5-8^{\circ}$ C.

A method is known warmly supplies, including the water serve on heating in the system, water heating by one heat-pump and the heated water delivery to the users.

For the thermal energy transformation efficiency increase use different receptions. For example, in the heat-pump maximal heating coefficient achievement method on a patent [3] heat-pump coolantchoose liquid, that his critical temperature was near or equal to the cooled environment temperature.

The warmly transmitter method, which includes the water serve on heating in the system hitpumped setting, water heating with its help and the heated water users delivery, is known. The hitpumping setting consists of heat-pumps, each of which use as the water successive heating stage. [4]

The lack of this method is indicated setting work organization on a hitpump cycle, to close to the quadrangular Lorenca hitpump cycle which, though and provides the electric power economy, but increases the recoupment term to the capital costs value, excelling the financial viability term, at the increase. Thus, the known method with such step water heating does not provide a positive technical and economic result during his realization. At the hitpump this method use for heating, the hitpump step work setting flows with the working body severe choke losses in the heat-pumps contours, than anymore working body condensation temperature, the anymore choke losses which it is impossible to remove structurally.

The known fluidizer realization of method of achievement of maximal heating coefficient containing a compressor, warmly transmitters, two the unrelated circulation contours with liquid warmly transmitters, each of which consists of two coolant, each of which consists of two warmly transmitters, thus one the second contour warmly transmitter is placed in the heated environment, second warmly obmenniki is placed in a vessel with a working body.

This setting lack it is been impulsive with intervals, equal to duty cycle time, entering of heat the heated environment and impossibility of the use of work of gas at his expansion.

The most near is the known heat-exchange setting[5], containing a heat-pump, plugging in itself a compressor, added to the compressor warmly exchange cavity in which placed two warmly exchangers: first exchanger is united with warmly exchange, for realization warmly exchange with an external environment, and second exchanger is united with warmly exchange for heat exchange realization with an user.

As a working matter freak is used.

For compressor piston moving for the heat-pump working matter compression hydrosystem is used for the working liquid serve under constraint in above piston compressor cavity and working liquid draining from above to the piston compressor cavity.

In this heat-exchange setting there are not energy expenses on pushing through of working matter through the heat-exchange contour of heat-pump, that diminishes the energy expenses during heat-pump work.

Basic the heat-exchange perfection direction systems, using heat-pumps, is an increase of thermal coefficient: heat (colds) amount relation, transferrable an user, to the energy expenses to heat-pump work.

Known heat-exchange fluidizer water heating, containing filled a working matter the reserved contour, plugging in itself a compressor for the working matter compression, exchanger for heat exchange realization with users, connected to the output union compressor coupling, throttle a device on an exit from this exchanger and warmly exchanger -vaporizer for realization exchange warm with an external environment [6]. This heat-exchange system uses the classic heat-pump chart. A high heating coefficient is arrived at due to the waggle use in the working matter heat-pump through the reserved contour, that results in the energy expenses increase to heat-pump work.

Cavitate is the phenomena, consisting in education in the local areas liquid which a gas-steam selection cavities with subsequent their destruction is in, are the result of bubbles steams and cottons condensation fleeting process, attended with high-frequency hydraulic shots and high depressurizations in local area. [7]

Cavitation, usually, arises up in dynamic turbo machines, pipelines, and similarly in all devices, where

the liquid stream veers sharply, exposed to influence running highway narrowing with subsequent expansion in faucets, valves, diaphragms.

About the cavitation phenomenon nature there are a few hypotheses most widespread from which taken to the following. At decompressing in some point liquid stream to the size below than saturated pressure its steams at this temperature a liquid boils(there is its break) up, the selected steam bubbles carry with a stream and carried in the high pressure ridge more, which steam bubbles are condensed(close up) in. Because the steam process bubble(cavities) takes place instantly, particles liquids, fillings its cavity, move to the center with high speed. Theoretical calculations show that closing up walls speeds bubble(cavities) can arrive at sizes, exceedings hundreds meters in a second.

A hydrodynamic cavitation reactor [8], containing a pipeline as Venturi pipe, cellular rectifier and cavitatory, Venturi pipes set in a running chamber, is known. Cavitatory is set on an axial bar in three rows and are disks or cones, servers for the cavities liquid and formation stream turbulization on their back side. At the cavities «slamming» pressure and temperature which operates on properties of the processed liquid rises in their volume.

Lacks of the known device: cavitation does not almost influence on the liquid speed increase and, began to be, on pressure diminishing in a liquid, that reduces liquid heating intensity and effitience devices will be insignificant.

A device[9], in which for the liquid heating temperature increase an insertion, executed as the perforated partition, set in the injection union coupling, is additionally used, is known. At liquid passing through partition ductings toroidal cavities(cavitation bubbles), pulsating on the output of streams on their periphery, appear in a liquid. In cavities with large frequency there are electric digits energy of which at cavities «slamming» passes to thermal, due to what heat generuting is in a liquid. Failing is cavitation absence in all volume.

The known device [10] consists of the entrance and output union couplings and kavitator, set in connecting flancakh. In kavitator on a concentric circumference, ductings, broadening to the output of liquid are executed. On an entrance a reflecting cone, narrowing the living section of the entrance union coupling, is set in cavitator. Entering entrance union coupling, where a liquid increases, slamming bubbles with the heat selection. Failings: low cavitation activity process and small cavitation volume areas.

The known invention behaves to the cavitative generators for gas(steam) dispergating in a liquid [11]. Cavitative bubbles with the energy supply to 100 kcal/kg at terms, near to normal, move through a liquid to the processed surface. Surfaces are initiated by steam bubbles slammings and they, giving the energy, exceeding connections energy in a liquid and in a crystalline grate, erudite continuous break surface in a liquid.

Th is device lack is cavitation origin place localization absence cavities.

Most near to the technical decision is a hydrodynamic cavitation reactor containing a running

chamber with set inwardly cavitator and union input couplings reacts components. [12]

Failing is small efficiency and cavitation stream.

OBJECTIVES

The all modern developments purpose is production inputs an improvement and diminishing. Tariffs increase is one of main modern Ukrainian problems, therefore there is a necessity for the energyindependent, autonomous systems creation which will be controlled and managed remotely. The combined systems creation, able to work remotely and regardless of direct energy resorses, will result in the considerable protected level increase from tempreture overfalls and overfalls in the electric system instability. Sensors presence in this system allows to control, regulate and signal about its state, and similarly, enables to set necessary parameters.

All types basic energy and power users mediums are enterprises, and necessary part of any enterprise is it's energyeconomy. It is an aggregate of the generating, transforming, transmitter and consuming power settings by means which providing all necessary enterprise types of energy and use it to carry out in the production process. In addition, an energyeconomy plugs in itself devices and automatic control systems with their informative providing, not power settings, buildings and resources, providing reliable and economical enterprise energy work, and also lighting, heating and fuel supply. An enterprise energyeconomy is not only an auxiliary and attendant production but also basis, providing the normal enterprise functioning.

Users presence (small cities, settlements), being in districts, isolated from existent grids, or provided with electric power, for diverse reasons, with interruptions, require autonomous energy supplien organization. Development actuality and creation of electric power autonomous users energy supply perspective sources is a long ago acknowledged in many industrial-developed countries. Fossil energy sources supplies narrowmindedness, and also situation folded presently with a price advance on a hydrocarbon fuel, along with ecological situation intensifying, are factors, by a stimulant introduction and renewable use of natural resources in the electric energy production field. Autonomous energy problems actuality in our country and its developed abroad determine the research-anddevelopments necessity in regard to the systems, providing an independent energy supply with the receipt effective facilities use, electric power accumulation and transformation. In addition to the users in remote districts, business enterprises and some private communal structures, nevertheless, having connection with general grid, interested in the cheap sources use reserve energy feeds which will provide by it more flexible dependence on the energy supply existent system.

In this work it is suggested to combine a few systems types, with the distance control. We will consider the systems in the differentiated kind. The first is dwelling apartment heating system. The dwelling apartment heating and cooling system is exactly that buildings engineering providing industry, in which principles «Intelligent building» or «clever house» began inculcated at first, because it is a main buildings exploitation expenses item. An expensive equipment and editing must be counted on enough large burn-time on a refuse. The heating system must provide correct temperature in a house, reacting on a drop in temperature or thaw. Taking into account a temperature outside a house, the system must regulate work of all heater elements so that in an apartment a temperature remained a maximally comfort and optimum. The space-heating system with a built-in intellect will allow substantially to save money facilities. The heating market equipment makes gaudy advantageous price suggestions, and prices on energy resources grow steadily. Warm is given by a pump through distributors to every device individually, that provides any radiator heat emission adjusting possibility.

Heat-pump application is offered in this system. Physics of heat-pump work process is based on the known Carnot cycle. From thermodynamics point a heat-pump works by analogy with ordinary refrigerators, only vice versa: takes away warmly and passes it in a house, preliminary warming up it.

The task, on the decision of which an invention is directed, there is the heat-exchange setting development with a heat-pump, providing an enhanceable thermal coefficient due to power expenses diminishing on the working body compression in the workings heat-pump cavities, and also due to application on the second hydrodynamic device stage. The put purpose is arrived at that for the power loading decline on a compressor and working body choke losses diminishing setting is supplied a hydrodynamic cavitative device, in which kavitator presents a cylinder, the internal surface, which consists of truncated cones so, that sloping and horizontal «n» surfaces are created by «cavities» slams before a narrowing nozzle, which binds a cavitation stream to dissecting, having a curvilinear surface. In addition, step between openings of cones varied, and as a working body noncombustible mixture is used.

A heat-pump works as follows:

In a vaporizer a refrigeration agent (liquid freon) is due to the low temperature warm water source, acting on a pipeline, evaporates with warmth absorption. The freon steam a on a pipeline enter compressor. In the compressor chamber by piston motion freon compresses. At a compression due to an adiabatic process freon is heated to the temperature $65-70^{\circ}$ C. Further heated freon on a pipeline enters condenser. In the freo steam condenser condensed, giving the warmth of pipeline water and a temperature rises to 55° C. Liquid freon drosels in a drosel device and in a state of moist saturated steam acts back in a vaporizer.

The heated thermal transmitter (water or antifreeze) to the temperature 50-60°C on a pipeline acts from a circulation pump in the streams delimiter from which enters two directions hydrodynamic cavitation reactor.

We will consider an example: one litre of water with a temperature in 1°C is approximately 4.192 kDzh heats. The same energy in 4.192 kDzh will have 100 gramme of water, but with a temperature 10 °C. That a heat-pump provides hot water with a temperature 60 °C, does not mean that it simply warmed it electricity on 50 °C. A

heat-pump outlays electric power only on a compression and transfer of heat, and in itself warmly — charge free. Thus, heat-pumps give 10 kWt heats, expending 1.5-2.5 kWt/hour electric power.

And in practice it looks so: under earth there are waters. The such water temperature is stably high — about 10 °C. Since a heat-pump will do the work (compression), a water temperature on an output in a heating contour will be already 60°C. It is necessary to notice that directly water is not added a compression. A mediator — freon which is temperature-sensitive compresses. It easily will take away warmly at ground-water through a vaporizer (from 10°C through a freon contour it will be selected about 4 °C and also well gives the got heat a heating contour through a condenser.

That heat-pump work principle is a reverse Carnot cycle, and when a heat-pump works on conditioning — Carnot cycle.

In the case of death heating equipment by power supply failure or stopping reason the system about it will inform and will shut down defective elements, but it can be avoided.

The second system is the autonomous power supply system. A energy consumption problem was and will be actual at any time. Adding to the system a few autonomous energy (for example, sun panels, wind turbines) and accumulator sources is increased by the systems work stability. The photo-electric elements and sun collectors production develops in various directions. Sun batteries are different size: from built in microcalculators to the occupying roofs cars and buildings. Sun radiation stream power on included in the Earth atmosphere (Am0), makes about 1366 watts on a square meter. At the same time, specific sun radiation power in Europe, in very cloudy weather, even in the daytime, can be less than 100 Wt/m². By widespread industrially producible sun batteries is possible to transform this energy in electricity with efficiency 9-24 %. Thus the cost of battery will make about 1-3 the USA dollars for Watt of nominal power. During the electricity industrial generation by photocells a price after kWt•h will make 0,25 dollars. In European Associations opinion (EPIA), to 2020 electricity, produced the «planetary» systems, charges will go down to the level less than 0,10 € after kWt•h for the industrial settings and less than 0,15 € for kWt•h for settings in dwellings buildings.

The Sun — ecologically clean energy source which does not contaminate an environment. Sun panels exploitation does not result in the extrass of hotbed gases or wastes formation, sun energy is inexhaustible, unlike the traditional fuel types, sun batteries after setting require minimum service and produce energy without man participation, similarly among other dignities of batteries on sun energy it is needed to mark the protracted service term. It makes — 25 years and more without operating descriptions worsening. And yet the sun energy use is subsidized the state. For example, in France for house battery setting compensated to 60% from a cost.

A necessity to set a wind turbine near a private house can arise up in two cases — if the centralized power supply is not present quite or it abandons to wish the best or you decided substantially to economize on payment for electric power. Wind — ecologically clean endless source energies which humanity uses already thousands years. Technique progress trends simply specify on the use perspective for the complete or partial house supply electric power and heat of various alternative sources: sun panels, wind generators, thermal konvectors, new effective materials for thermo-insulation. The inexpensive and effective system for the fully creation energyindependent dwelling from science fiction gradually grows into an enough widespread technical decision, and a wind turbine can appear in it meaningful elements.

Another system is offer wind generator, as additional electric energy source. Power that wind generator depends on current power (N) of air, by the determined wind speed and blown area:

$$N = \rho S V^3 / 2 \tag{1}$$

where: V is speed of wind, $\rho\,$ it is air density, S is the blown area.

Wind turbine possible with lightness to use for autonomous feed providing various domestic users for the irregular central energy supply serve or at his absence. Except for it, is necessary to know that such devices can be used everywhere: for apartment illumination, for functioning various kitchen electric devices, audio- and TVtechnique, technical means and equipment, domestic electric appliances, pumps.

On the average for a year a low-powered wind generator (to 5 kW) is able to produce 12000 kW. This energy, got from such wind turbine, will be enough for small production providing, middle dwelling-house, technical service, farm, shop station.



Fig. 1. Trial laboratory setting

For the leadthrough of alpha tests setting which consists of compressor K, batteries, was developed, throttle Dr, temperature sensors systems Ti and pressductors PI. For liquid motion on pipes a pump is foreseen on the laboratory setting entrance. Water, entering setting passing through a compressor, where a compression and coolagent steams moving is, as in the refrigeration settings. At the steams compression there is not only pressure increase but also temperature. After a compressor the compressed refrigeration agent enters condenser, where the compressed gas cools down and grows into a liquid, a liquid after through a choke device enters vaporizer (its pressure and temperature goes down thus), where it boils, passes to the gas state, the same taking away warmly from surrounding space. After it the coolagent pair enter again compressor for the cycle reiteration. Thus, on an output water will have a temperature much higher, than on an entrance, what provides radiator heating. The liquid further used and reducing a temperature passes through a throttle, for hydraulic resistance creation the liquid stream. Additional hydraulic resistance is created due to the liquid stream communicating section change. The hydraulic resistance change is create the necessary pressures overfall, that results in the yet greater stream temperature decline.

THE MAIN RESULTS OF THE RESEARCH

The cavitation efficiency and degree increase coolant is arrived at by process intensification on the phases section border due to liquid stream co-operation kinetic energy and cumulative effect slam of strings. In the bubble disappearance moment (in the moment of his slamming) kinetic energy will be transformed in elementary particles collision energy. Energy, selected at bubble slamming on a few orders exceeds elementary particles (nucleons) connection energy in a kernel. As a declared method kernels collision result energy, selected between elementary particles, will be transformed in thermal energy in a liquid and it is taken from an area by treatments of hydrodynamic kvitation reactor.

On Fig. 2 a hydrodynamic cavitation reactor is schematically represented.



Fig. 2. Hydrodynamic cavitation reactor

A reactor contains: union coupling of input 1 second coolant stream; lid 2; running chamber 3; cylinder 4; reverse cut cones 5; cavities slam 6; nozzle 7; dissecting 8; dividing perforated partition 9, which sinews for dissecting; diffusor 10; union total coolant stream conclusion coupling 11, consisting of the first and second streams; union coupling of input the first collant stream 12. Now about streams: heated coolant on a tube 8 circulation pump 5 gives on a delimiter 9, in which the first stream is sent in the union coupling 12, and the second stream is sent in the union coupling 1.

A hydrodynamic cavitation reactor works as follows. First stream on the union coupling 1 given in a cylinder 4, where the reverse are set cut cones 5, which the horizontal and sloping surfaces are form slam «cavities» 6. The horizontal surfaces of the cut cones execute the brake element role as circular ledges, at flowing around of which n cavitation cavities appear (cavities). The heated stream is given forcedly in «cavities» and, getting in the closing them areas due to the turbulization of flow and cumulativ microstructures e plenty presence, appearing at slamcavitative bubbles, exposed to enhanceable temperatures formation.

Thus, formed conical surfaces, attachments are provided by the nozzle «second» high-speed stream appearance terms 7.

At some distance from the butt-end nozzle surface 7, hollow cone liquid stream shell at a speed of v_0 slams and the second high-speed stream appears by a radius r_0 . In slamming moment working stream environment the second high-speed stream speed v_c increases approximately on an order in relation to speed v_0 , that follows from the hydrodynamic stream theory. [21]

Further the second high-speed stream heads for dissecting 8. It was paid regard to streams hitting place flat-back and appearance so-called «wings» - structures, reminding the arrow plumage is set. Power more expedient is hitting realization with a curvilinear surface and achievement high navigation level. In addition got coolant mixture the first and second streams pass a dividing partition 9, pass diffusor 10 and hatch through the union coupling 11. Heat-exchange efficiency ability on-the-spot shallow drops increases yet and the Tompsons effect– surface-tension forces influence.

CONCLUSIONS

This job performance is the development and pilot laboratory plant testing. Sun and wind power technologies, environmentally clean and accessible, fully can replace or complement the traditional energy receipt methods. The autonomous energy supply systems existent developments analysis and producible equipment descriptions allowed to expose this area trends basic progress, form perspective direction testimonies fluidizer removal practical realization from sensors.

A positive effect from the power loading decline on a compressor and working heat choke losses diminishing in the heat-pump contours is arrived at at the middle temperatures of condensation, and the all setting thermal coefficient increase takes place in a hydrodynamic cvintative reactor which is examined the second degree heating of the generator setting, that is very important for houses heating, cottages and, especially, for a preheat and improvement of rheology properties of oil and oil products.

1. Heat-exchange setting, contains a heat-pump, plugging in itself a piston compressor, heat-exchange cavity two heat exchangers is accommodated in which added to the compressor: first for realization of heat exchange with an external environment, and second - for realization of heat exchange with an user, throttling a device, vaporizer, and circulation pumps, different that for the power decline loading on a compressor and working body choke losses diminishing in heat-pump contour and thermal coefficient increase, setting is supplied a hydrodynamic kavitation device, in which kavitator is a cylinder, the internal surface of which consists of «p» of the vivid truncated cones so, that sloping and horizontal surfaces are created by «cavities» slam before a narrowing nozzle, which binds a kavitirovannye stream to dissecting, having a curvilinear surface.

2. Heat-exchange setting on a point 1, different that a step between openings of cones is varied.

3. Heat-exchange setting on a point 1, different that as a working body noncombustible gas or mixture of gases is used.

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СТУПЕНЧАТАЯ ТЕПЛОНАСОСНАЯ УСТАНОВКА С ГИДРОДИНАМИЧЕСКИМ КАВИТАЦИОННЫМ УСТРОЙСТВОМ

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Аннотация. Целью всех современных разработок улучшение качества и уменьшение производственных затрат. Повышение тарифов является одной из основных проблем современной Украины, поэтому возникает необходимость создания энергонезависимых, автономных систем, которые будут контролироваться и управляться удаленно. Создание комбинированных систем, способных работать дистанционно и независимо от прямых энергоресурсов, приведет значительному к повышению уровня защищенности от нестабильности темпиратурных перепадов перепадов И в электрической сети.

Ключевые слова: тепловой нассос, система управления, энергоресурсы, кавитация, гидродинамическая установка.