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Micro Energy Complex Based on Wet-SteamTurbine

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Abstract

This work is dedicated to the development of the micro energy complex concept based on a wet-steam microturbine and mixed use of conventional and unconventional energy sources for standalone supply of distributed energy consumer, adapted to Russia's climate condition. The development is stipulated by absence of low powered micro energy complexes (MEC) for standalone individual low rise energy consumers at the power supply market. This article describes the working out of the energy complex cycle arrangement, the choice of optimal power for a standalone consumer and the development of wet-steam micro turbine

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Keywords : microturbine; energy complex; heat pump; solar collector

1. Introduction.

Previous tendency of single unit power enlargement did not prove its value. Firstly – the costs of heat pipeline laying and thermal transition paths have grown greatly, secondly – functional loss of a TPP (thermal power plant), especially in cold regions causes freezing and heat pipeline abruption and cut-off the housing complexes from space heating and electricity. That induces tendency to decentralized energy supply up to individual power generation system of combined thermal and electric output. The suggested energy complex will manage to provide an autonomous consumer with heat and electricity in the optimal ratio for the Russian Federation. The complex consumes mix of fossil fuel and solar energy and it also can adjust thermal charge regardless of energy intake.

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Nomenclature

N	power of electric complex, kW
G	consumption of steam for a micro turbine, kg/s
H	available heat drop in a micro turbine, KJ/kg
p0	pressure in advance of a turbine, mPA
D	medium diameter of runner, m
L	height of turbine blade, m
N_{el}	electric power output with the micro turbine, kW
N_{heat}	full power of heater consisted of powers output from solar energy and from energy of organic fuel combustion in a boiler (natural gas, diesel fuel etc.), kW
Nsolar	thermal power received from solar radiation, kW

2. Relevance and Scientific Significance of the Subject

The MECs of low power for autonomous low rise energy consumers that are remote from centralized networks are out of the market. These consumers have to make use of different plants producing thermal (water-heating boiler) and electric energy (diesel, petrol, gas piston and gas-turbine units) separately. The constructive decisions for low rise buildings of variable energy efficiency are currently developed . Yet the complexes able to supply them with energy both in autonomous decentralized mode and in combined with conventional and unconventional technologies are absent. Such systems should secure supplement and backup of the centralized systems.

3. Statement of the Problem

In this investigation the MEC is put as an autonomous power plant, the main element of which is a low power wet-steam turbine and a heat source is joint use of fossil fuel and solar energy.

For a solution of this problem it's necessary to determine an electric and thermal power range for an individual complex, to develop a micro turbine for an individual energy supply and to develop a cycle arrangement as a component of an energy complex.

4. Development of the Heat Balance Diagram

Solar energy [1-3] can be used for a fuel saving. This opportunity can be most effectively realized in Rankine cycle [4] that becomes the base of the developed micro energy complex [5-7]. The micro energy complex (fig.1) has a vacuum solar collector 1, where coolant is heated from solar energy and then it goes to steam generator 2 [8], where the coolant gives it's heat to operating heat of steam-power cycle (water) and vaporizes. Purified steam goes into the steam turbine 4 where it loses its energy while gearing a runner of the turbine connected with the electric generator 5. The steam passed through the turbine goes into the condenser 6 [9, 10], where steam is condensed because of heat extraction in the heating system 8 and hot water supply (HWS) 9 through the boiler 7 [11, 12].

The feed-pomp 11 brings back the steam output into the steam generator 2. The boiler 12 runs on organic fuel when power from solar heater is not enough. The bypass from a three-throw valve 3 is used for pass of working steam into the condenser what assures an independent regulation of heating load.

Objectives to the cycle arrangement, heat-transfer agents and construction given in [13]:

- pressure of operating environment in input into a micro turbine is 0,6 MPa and temperature of wet steam is chosen 160 0C(according to conditions of steam saturation under a pressure 0,6 MPa);
- temperature of heat-transfer agent in solar heaters not less than 180 0C;
- maximum electric power of complex for an individual autonomous consumer is determined as 5 kW, with allowance for necessary of regulation of load of daily graphic chart.

Thermal exchange is effected more intensive with heat-transfer agents in liquid. With allowance for this, the heat-transfer agent with boiling point not less than 180 0C is offered to be used in the solar heater.