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ENERGY SAVING, NEW, AND RENEWABLE ENERGY SOURCES

The Heat Supply System for a Self-Contained Dwelling House on the Basis of a Heat Pump and Wind Power Installation

V. V. Chemekov and V. V. Kharchenko

All-Russia Research Institute for Electrification of Agriculture Facilities, Pervyi Veshnyakovskii proezd 2, Moscow, 109456 Russia

Abstract—Matters concerned with setting up environmentally clean supply of heat to dwelling houses in the resort zone of the Russian Black Sea coast on the basis of air–water type heat pumps powered from wind power installations are discussed. The investigations were carried out as applied to the system supplying heat for an individual dwelling house with an area of around 300 m^2 situated in the Tuapse city. The design heat load of the building's heating system is around 8.3 kW. The Viessmann Vitocal 300 AW pump is chosen as the main source of heat supply, and a 4-kW electric heater built into a storage tank is chosen as a standby source. The selected wind power installation (the EuroWind 10 unit) has a power capacity of 13 kWe.

Keywords: renewable sources of energy, wind power installation, wind energy resources, heat supply, heat pump

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Development of the resort complex is one of the most important lines in the economy of the southern regions of Russia; therefore, the use of environmentally clean renewable sources of energy (RSEs) is becoming especially topical for these regions. Heating systems account for 60–80% and hot water supply systems, for 10–30% of the annual amount of energy consumed by private dwelling houses. In view of this circumstance, use of systems constructed on the basis of air–water type heat pumps (HPs) powered from a wind power installation may become a prospective solution of the heat supply problem. Studies have shown that, given the wind energy resources available in the region, the use of power installations on their basis may be quite efficient. Such studies are of great importance for the development of power industry in the resort region, the more so that we are speaking about the use of energy-efficient systems involving installations constructed on the basis of renewable sources of energy.

In the majority of cases, electricity is used for supplying heat to individual dwelling houses and mini hotels, the fraction of which is quite considerable in the resort region. Direct conversion of electricity into heat is very easy and accessible, whereas the use of primary energy resources for this purpose is characterized by poor energy efficiency. The use of air–water type heat pumps has been selected in the considered region on a fairly sound basis, because the efficiency of HPs depends essentially on the temperature of the used source of low-grade heat [1]. With the low-grade heat source temperature equal to around 0°C, the conversion ratio (CR) of the majority of HPs drops to less than three units, and if this temperature is equal to –15°C, the CR drops to less than two units, a level regarded as the lower threshold of efficiency and operability. It should be pointed out that these values of the CR correspond to the operating mode with the heat carrier temperature in the heating system equal to +35°C; i.e., only if the system is made with the "warm floor" loop. At higher temperatures of heat carrier (45–55°C), the CR drops by another 25–50%. The average air temperature in the Krasnodar krai's Black Sea coast in the heating season is around 7–8°C, and in the coldest days it drops below –5°C only in rare occasions. Under such temperature conditions, air HPs can be used with high energy efficiency. Another advantage of using air HPs as compared with geothermal ones is that the former feature a low cost of construction, because there is no need to set up soil headers or borehole heat exchangers.

In studying the effect from using air–water type heat pumps, we considered an individual dwelling house with the total area of 295 m^2 situated in the Tuapse city and equipped as a mini hotel. Three levels can be distinguished in the house. The ground floor comprises a sitting room, a kitchen, a lobby, a lavatory, a boiler room, and a garage. The first floor is fully given for guest rooms and a hall. The second—attic—floor is nonheated and contains a summer guest room and auxiliary premises. It should be pointed out that during the construction of the house much attention was