ENERGY, ECOLOGICAL AND ECONOMIC ASPECTS OF EFFICIENCY OF STEAM COMPRESSOR HEAT PUMP INSTALLATIONS WITH COGENERATION DRIVE FOR HEAT SUPPLY IN UKRAINE

Olga Ostapenko

Candidate of Engineering Sciences, Ph. D, Associate Professor,
Associate Professor of the Department of Heat Power Engineering,
Vinnytsia National Technical University,
Vinnytsia, Ukraine

Usage of cogeneration heat pump installations (CHPI) in heat supply systems of Ukraine will provide the economy of fuel, finance resources and protection of the environment, according to the results of researches [1 - 4].

Aim of the research is determination of energy and ecological advantages and economic preconditions of usage of steam compressor heat pump installations (HPI) with cogeneration drive and different sources of low-temperature heat for operation in heat supply systems of Ukraine, as compared with gas-fired boilers operation; evaluation of energy, ecological and economic efficiency of CHPI in heat supply systems of Ukraine, as compared with gas-fired boilers operation for heat supply.

The study of energy, ecological and economic aspects of efficiency of CHPI with thermal capacity 1 MW, with cogeneration drive from gas-piston engine (GPE), at various sources of low-temperature heat, on condition of annual operation of CHPI and variable temperature modes operation during the year for heat supply was performed. Table 1 show the results of complex assessment of energy-ecological-economic efficiency of CHPI with thermal capacity 1 MW, with cogeneration drive from gas-piston engine, as compared with the operation of gas-fired hot-water boiler house for heat supply in Ukraine.

Table 1. Indices of energy, ecological and economic efficiency of cogeneration HPI with thermal capacity 1 MW, as compared with the operation of gas-fired hot-water boiler house for heat supply in Ukraine

Source of low-temperature heat for CHPI	Annual economy of equivalent fuel (in %) for CHPI	Annual reduction of CO_2 emissions (t/yr) for CHPI	Annual cost saving **on fuel for CHPI,** mil. Hrs/yr	**Annual cost saving** on emissions for CHPI, mil. Hrs/yr
Heat of the soil and air	41,00	867,59	4,08	0,47
Heat of surface and ground waters	45,27	957,91	4,50	0,52
Heat of sewage waters	47,32	1001,27	4,71	0,54
Heat of recycling water of circulating water supply system	52,56	1112,16	5,23	0,60
Heat of geothermal waters and industrial heat emissions	63,89	1351,86	6,35	0,73

Energy, ecological and economic efficiency of steam compressor CHPI was compared with the efficiency of alternative source of heat supply (gas-fired boiler house). Energy efficiency of CHPI with cogeneration drive from GPE was evaluated by the index of equivalent fuel saving. Reduction of CO_2 emissions while using 1 MW CHPI as compared with the operation of gas-fired hot-water boiler of the same capacity is evaluated. Emissions of CO_2 while gas fuel combustion in boilers (for alternative sources of heat supply), while combustion of working fuel in GPE (for compressor drive of HPI) were taken into account. For evaluation of the amount of CO_2 emissions statistical data from the research [1] were used.

The results of the research of energy, ecological and economic aspects of efficiency of CHPI with cogeneration drive from GPE, at various sources of low-temperature heat, for operation in heat supply systems of Ukraine, as compared with gas-fired boilers operation, are presented in the given research. As it is seen from Table 1, that the economy of equivalent fuel, annual reduction of the amount of CO_2 emissions and annual saving of finance resources on fuel and emissions are observed for all the studied variants of CHPI application for heat supply in Ukraine, as compared with gas-fired boilers operation.

References:

1. Ostapenko, O. P. (2019). *Analysis of energy, ecological and economic efficiency of steam compressor heat pump installations, as compared with alternative sources of heat supply, with accounting the concept of sustainable development*. Sustainable Development Under the Conditions of European Integration (pp. 312 – 329). Part II. – Ljubljana: Visoka šola za poslovne vede

2. Ostapenko, O. P. (2019). *Study of energy-economic efficiency of energy supply systems with cogeneration heat pump installations, using the heat of the industrial and natural sources, in industry and municipal heat power branch of Ukraine*. Social and Legal Aspects of the Development of Civil Society Institutions (pp. 292 – 308). Warsaw: Institute of European Integration, Bmt Eridia Sp. zo. o.

3. Koval, V. (2018). State regulation of energy security in national economy. Economics, Ecology, Socium, 2(3), 57–64. doi:10.31520/2616-7107/2018.2.3-6

4. Ostapenko, O. P. (2016). Scientific basis of evaluation energy efficiency of heat pump plants. Saarbrücken: LAP LAMBERT Academic Publishing.