



UTILIZATION OF WASTE HEAT AT THERMAL POWER PLANTS

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Annotation

Information is provided regarding the types of waste heat at thermal power plants and the methods and means for its effective utilization; specifically, the study examines opportunities to harness waste heat—using technologies such as the Organic Rankine Cycle, the Kalina Cycle, heat pumps, economizers, air preheaters, and heat exchangers, or through the modernization of steam generators and combined-cycle systems—and evaluates the associated reliability levels.

Keywords

Organic Rankine Cycle, Kalina Cycle, heat pumps, economizer, air preheater, heat exchangers.

At thermal power plants, heat recovery processes are employed to capture heat—primarily from flue gases, condenser cooling water, steam cycle losses, or auxiliary streams—and convert it into additional energy or useful heat suitable for various applications.

Data gathered from an analysis of research in this field indicates that widely adopted solutions among global researchers and engineers include the implementation of heat recovery systems—such as the Organic Rankine Cycle (ORC), the Kalina cycle, heat pumps, heat exchangers/economizers, and upgraded steam generators. These



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technologies enable increased efficiency, fuel savings, and a reduction in heat and other emissions across various thermal power plants [1,2,3,4,5,6,7].

Information regarding the significance of heat recovery systems at thermal power plants is presented in the table below (Table 1).

Table 1

Heat recovery systems at thermal power plants

WHR options	What it utilizes	Efficiency
ORC	It recovers heat from low- and medium-temperature flue gases or exhaust gases	Increased electricity generation boosts the efficiency of thermal power plants and can be economically beneficial; in one thermal power plant model, the use of an Organic Rankine Cycle (ORC) system for flue gases enhances efficiency and electricity output [1], while in the case of a solid-fuel or industrial power plant, it has been found that ORC systems can recover low-temperature waste heat and reduce CO ₂ emissions [2].
Kalina cycle	Heat rejected from the condenser	Electrical energy is gained by recovering losses from the condenser; in a solid-fuel thermal power plant with a capacity of 500 MW, this results in a power increase of 13.49 MW and a reduction in CO ₂ emissions of 3.3 tons/hour [8].
Heat pumps	Condenser-based or water heating	Increased thermal output and overall efficiency; studies on thermal power plants indicate that significant savings in coal, water, and heat emissions can be achieved [3, 6].



Economizers/air preheaters/heat exchangers	Flue gas heat	Increases the efficiency of the boiler or cycle and can reduce fuel consumption; examples include studies on aging thermal power plants and the recovery of heat from boilers/flue gases [7].
Improvement (modernization) of steam generators and combined-cycle systems	Heat from exhaust gases or steamgases downstream of the gas turbine	Increased exergy and economic efficiency in combined-cycle systems or solar-thermal systems [7].

In general, the scientific significance of the research results regarding their impact on the efficiency of thermal power plants and centers can be characterized as follows:

- Efficiency is effectively increased, depending on the specific source. Research on thermal power plants indicates improvements ranging from a partial increase in cycle efficiency to a significant change in power output, depending on the source of recoverable heat and the degree of design optimization [1,3].

- Losses associated with condensers and flue gases are a primary focus. Numerous studies highlight that heat discharges from condensers and flue gases represent streams with significant potential for recovery in power plants utilizing organic fuels (solid and gaseous) and combined-cycle (steam-gas) units [2,4,5].

- If the design of the improved device is selected in accordance with the basic device, the level of economic compatibility will be very high. It has been determined that the payback period for the device itself, when optimizing the condenser and water systems, is 1.8 years; this figure rises to 3.37 years when integrating the device with the Kalina cycle, and to 5.75 years when integrating high-temperature waste heat recovery using an ORC configuration [7].



- Environmental benefits accompany the increase in energy efficiency. Several studies have concluded that improvements enabling the utilization of waste heat at thermal power plants lead to reduced coal consumption and lower CO₂ emissions into the atmosphere [3, 6, 7].

Consequently, waste heat recovery systems at thermal power plants should be viewed as an improvement strategy that converts unavoidable heat losses into useful energy; solutions based on ORC, the Kalina cycle, heat pumps, and economizers demonstrate the highest efficiency in terms of boosting plant performance, saving fuel, and reducing harmful emissions. The most suitable option depends on the temperature and quality of the waste heat stream, as high-temperature flue gases, condenser heat, and low-potential waste heat streams each require the application of specific heat recovery technologies [1, 3, 5].

In characterizing the reliability of the obtained results, the assessment relies on the fact that reliability depends on confirmation through various independent studies and analyses, and that while WHR TPPs enhance operational efficiency, the choice of the optimal technology depends on the specific heat source and constraints inherent in the improvement process [1,2,3,5].

References

1. Nemade, A.C., Ponsankar, S. (2020) Efficiency improvement in thermal power plants using waste heat recovery of flue gas - Simulation study.. *IOP Conference Series: Materials Science and Engineering*.
<https://doi.org/10.1088/1757-899X/912/4/042015>
2. Zhang, Q., Gao, J., Wang, Y., (...), Song, D. (2019) Exergy-based analysis combined with LCA for waste heat recovery in coal-fired CHP plants. *Energy*.
<https://doi.org/10.1016/j.energy.2018.12.017>
3. Mi, Y.-H., Feng, L.-K., Bai, J.-H., Zhao, K. (2022) Analysis of Thermal



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TARAQQIYOTNING USTUVOR YO'NALISHLARI" nomli Respublika
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Economy and Environmental Benefits of Subcritical Cogeneration Units Coupled with Absorption Heat Pump System. *Reneng Dongli Gongcheng/Journal of Engineering for Thermal Energy and Power*.
<https://doi.org/10.16146/j.cnki.rndlgc.2022.04.013>

4. ILIEV, I.K., Beloev, H.I., Terziev, A.K., Georgiev, A.G. (2021) Novel flue gases waste heat recovery methodology avoiding wet gas cleaning technologies in thermal power plants. *Bulgarian Chemical Communications*.
<https://doi.org/10.34049/bcc.53.B.0054>

5. Zhang, X.-R., Zhang, Y. (2013) Experimental investigation on heat recovery from condensation of thermal power plant exhaust steam by a CO₂ vapor compression cycle. *International Journal of Energy Research*.
<https://doi.org/10.1002/er.3018>

6. Anikina, I.D., Sergeev, V.V., Amosov, N.T., Luchko, M.G. (2017) Use of heat pumps in turbogenerator hydrogen cooling systems at thermal power plant. *International Journal of Hydrogen Energy*.
<https://doi.org/10.1016/j.ijhydene.2016.04.256>

7. Elistratov, S.L., Mironova, N.V. (2023) Absorption thermal transformers for heat recycling at thermal power plants. *Thermophysics and Aeromechanics*.
<https://doi.org/10.1134/S0869864323020191>