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COMPLEX HEAT-RECOVERY SYSTEMS TO IMPROVE THE EFFICIENCY OF BOILER PLANTS

One of the areas of energy conservation in power engineering is to increase the efficiency of fuel use in boilers through the deep recovery of the heat of exhaust-gases. Traditional heat-recovery technologies, in which only the return heat-network water is heated, provide cooling of flue-gases to a temperature of 70-80°C. This temperature level of flue-gases corresponds to an increase in boiler efficiency by approximately 2-4%.

For a greater increase in boiler efficiency or the coefficient the use heat of fuel of boiler (CUHF), it is necessary to ensure the mode of deep heat-recovery of exhaust-gases throughout the entire heating period. For this purpose, it is necessary to use an additional heat exchanger in which the heated heat-transfer agent has a lower temperature than the return water of the boiler. This heat-transfer agent can be cold water that enters the chemical water-purification system, or combustion air. In this case, in the heat-recovery installation will be carried out the complex use of heat to heat two heat-transfer agents with different temperature potentials [1-3]. In fig. 1, 2 as an example, the schemes of boiler plants with the specified combination. So, in the scheme (Fig. 1), an installation with an additional second heat exchanger for heating the water of the chemical water-purification system (CWPS) is proposed. The scheme in fig. 2 corresponds to the combination of hot water and air heat exchangers. In this scheme, the water heater is located in front of the heater along the way exhaust-gases. In this case, all the recovered heat is used in the boiler: for heating the return water and the combustion air. The specified combination of heat exchangers will provide condensation operation of the heat-recovery equipment throughout the heating season, because in the coldest period of the year, the deep heat-recovery of gases can be achieved through cold air, and in the spring period by reducing the temperature of the return heat-network water.

In fig. 3 shows the results of calculations of the level of efficiency increase (CUHF) Δη of the boiler for two options for using the recovered heat, namely: only for the needs of the boiler and with the combined use of heat. The calculations were made for the following conditions: the heat-exchange surface of these heat exchangers consists of finned bimetallic pipes (steel base and aluminum fins), the calculated environment air temperature of the heating system is t_e^c = -20 °C, its temperature difference ΔT = 70-115 °C, water consumption on the CWPS meets the standards of feed (1.5% of the water consumption to the boiler), the initial temperature of the raw water is 5 °C, the final temperature is 30-40 °C.

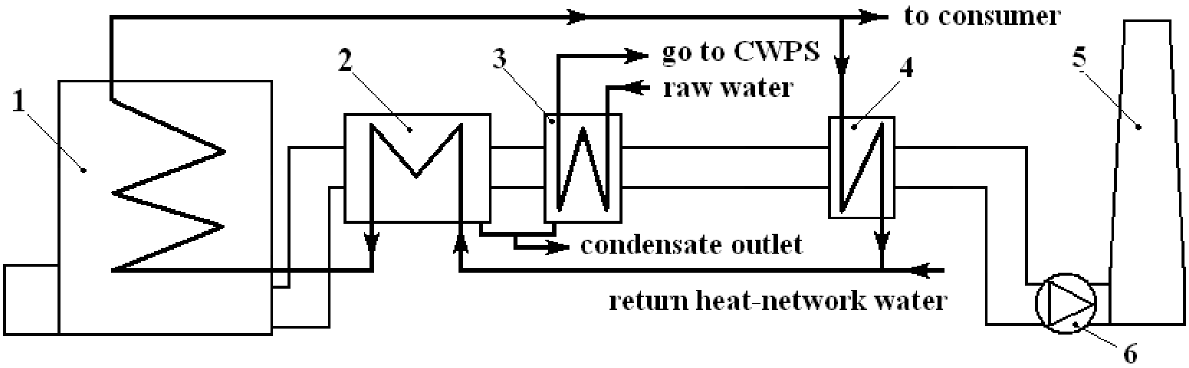

Fig. 1. Schematic circuit of the heat-recovery installation with the complex use of two hot-water heat exchangers:

1 – boiler; 2 – heater of return heat-network water; 3 – raw water heater; 4 – exhaust-gas heater; 5 – chimney; 6 – exhauster.

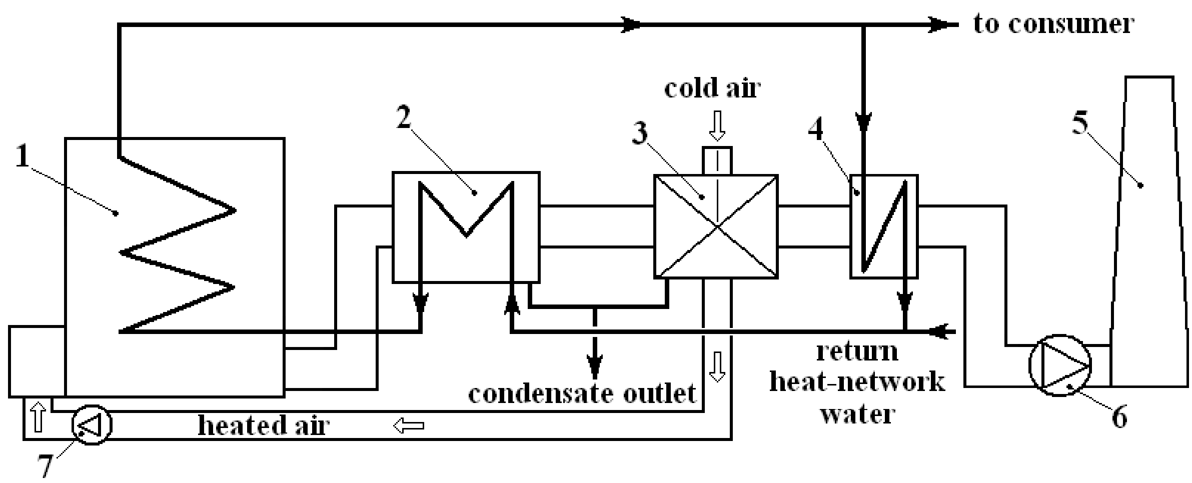

Fig. 2. Schematic circuit of the heat-recovery installation with the complex use of water and combustion air heat exchangers:

1 – boiler; 2– heater of return heat-network water; 3 – combustion air heater; 4 – exhaust-gas heater; 5 – chimney; 6 – exhauster; 7 – blower.

As can be seen from the obtained results, the combination of heat exchangers can provide deeper cooling of exhaust-gases and an increase in CUHF of the boiler plant during the heating period by 6-10%, and when using reclaimed heat only for heating the return heat-network water, the boiler efficiency increases by 4.2-6%.

In fig. 4 shows the results of computational studies of the levels of increase in boiler efficiency when combining water and air heating heat exchangers. The results show that the use of an air heat exchanger (in particular of a panel type) for additional cooling of exhaust-gases (see Fig. 2) provides an additional increase in boiler efficiency by 1-2.2% compared to using only a heat exchanger for heating return heat-network water, which correspond to the data of Fig.3. However, at the same time, the heat exchange surface of the air heater is more than 2 times greater than the heat exchange surface of the water heat exchanger. The further increase in boiler efficiency is associated with a more significant increase in the dimensions of the air heat exchanger.

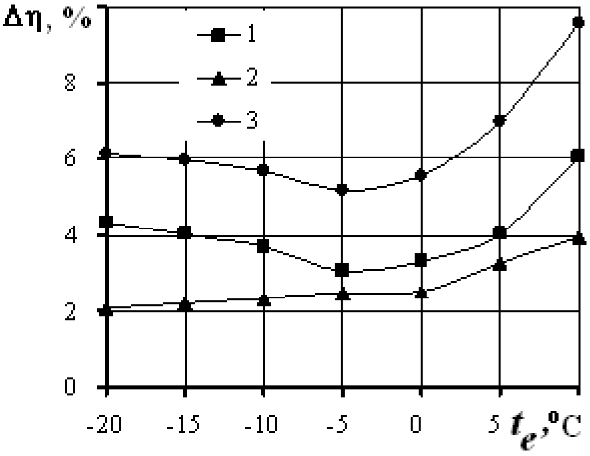

Fig. 3. Dependence on environmental temperature t_e the level to increase efficiency (CUHF) boiler Δη using recovery-heat for heating return water (1), raw water to the CWPS (2) and the complex use of heat (3)

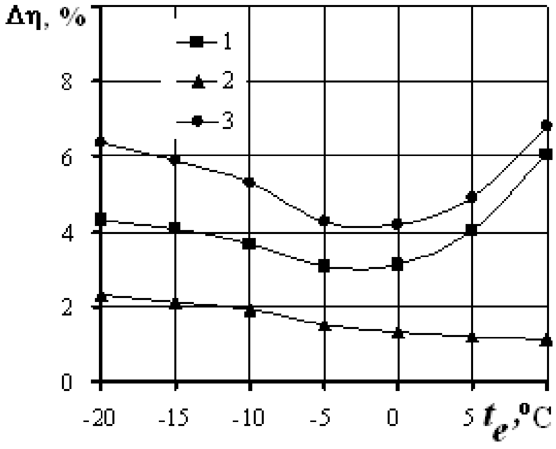

Fig. 4. Dependence on environ-mental temperature t_e the level to increase efficiency boiler Δη using recovery-heat for heating return water (1), combustion air (2) and the complex use of heat (3).

In both proposed heat-recovery circuits (see fig. 1, 2), thermal protection of the exhaust-ducts (installation of the exhaust-gas preheater) against condensate formation is provided.

According to the estimates, the payback period for the introduction of heat-recovery plants with two water-heating heat exchangers does not exceed 1.5 years, and when combining water- and air-heating heat exchangers – 2 years.

Conclusions

1. The applying of the complex use of recovered heat to heat the return heat-network water and the raw water for the chemical water-purification system (or combustion air) can provide an increase in boiler efficiency (CUHF) by 6-10%.

2. The complex use of water heat exchangers is preferable to the combined use of water and air heat exchangers due to the significant dimensions of the latter.

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