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2014 IOP Conf. Ser.: Mater. Sci. Eng. 69 012009

(http://iopscience.iop.org/1757-899X/69/1/012009)

IOP Conf. Series: Materials Science and Engineering **69** (2014) 012009 doi:10.1088/1757-899X/69/1/012009

Heightening of efficiency fuel using installations due to external recuperation units of waste heat

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Abstract. Energy saving activity on installation of heat exchangers for utilization of afterheat of smoke fumes of industrial furnaces and steam generating units is offered. Problems of their maintenance and methods of elimination of the given problems are considered.

1. Introduction

The main flow of heat in industrial furnaces and boiler installations occurs during fuel combustion. However, if taken the amount of heat received by the burning of fossil fuels as 100%, then directly to the conduction of the technological process in the furnaces and the subsequent heating of the water in the heat recovery boiler (installation of them on the flue gas stoves is mandatory) and for heat generation in boiler units, is consumed only 70 to 85%. The remaining amount of heat energy from 15 to 30% is lost. Efficiency of steam generating units is determined by the formula,%:

$$\eta_{т} = 100 - (q_{yx} + q_{н.о.} + q_{х.н.}) \tag{1}$$

where q_{yx} - losses from the outgoing flue gases, $q_{н.о.}$ - losses of external cooling structures; $q_{х.н.}$ - losses due to incomplete chemical combustion of fuels;

As shown in [1], the most important role (about 75% in the total heat loss) play the losses with the exhaust gases, which is approximately determined by the ratio,%

$$q_{yx} = \frac{t_{yx} - t_{в}}{\theta}\left[C + (h-1)\cdot K \cdot B\right]\cdot 100\%, \tag{2}$$

where t_{yx} – temperature of the flue gases exiting the boiler, °C; $t_{в}$ – temperature of air entering the boiler, °C; θ - theoretical adiabatic combustion temperature without thermal effect of dissociation of the combustion products, °C; *C* – correction coefficient of the specific heat of combustion products; *K* – correction coefficient of the heat capacity of air; *B* – a correction factor for the volume ratio of dry and wet combustion products from the combustion of fuel in a stoichiometric amount of air; *h* – the ratio of the theoretical volume of the dry gas to the actual volume.

2. Basic part

Mainly q_{yx} depends oh temperature $t_{yx,}$ however, the cooling gas in conventional systems below 120-180 C is not realized because of the exploitation nature of problems:

1. Due to the condensation of water vapor and fuel oxidation products which enter into a chemical reaction with the formation of acid on heat transfer surfaces of boilers and ducts, we can observe an acid corrosion;
2. The cooling gases reduces the driving force of the flue gases to the atmosphere through the chimney.
   As an external heat recovery boilers in [2, 3] are considered the contact type devices, however, and their use is associated with a number of negative factors that should be considered when selecting the event:

1. Cooling of gas below the dew point temperature is not economically feasible;
2. Transfer processes in heat exchanger "ballast" (reverse) heat are not excluded;
3. Water in contact with gas is saturated by carbon dioxide which increases its corrosiveness;
4. Installation of the contact heat exchanger creates a significant hydraulic resistance, the overcoming of which requires the additional energy.

Along with the negative factors, there are some positive:

1. Common unit of heat recovery is created, which allows to conduct process automatically in conditions that ensure the highest technically achievable efficiency and safety of the process;
2. Condensation of water vapor in the heat exchanger-utilizer reduces the viscosity of the flue gases, thus reducing energy costs for transporting them through the gas duct. As it is shown in [3], in some cases, the installation of the heat exchanger to exhauster can improve the hydraulic characteristics of the gas path, even in comparison with the original version (without heat exchanger)

Taking into account the above factors the recycling unit scheme is designed based on surface heat exchanger-utilizer of condensing type (Fig. 1). The flue gases are cooled in a surface heat exchanger to a temperature of 40-45 C, heating the feed water to an estimated temperature (raw-water or chemically treated water can be heated).

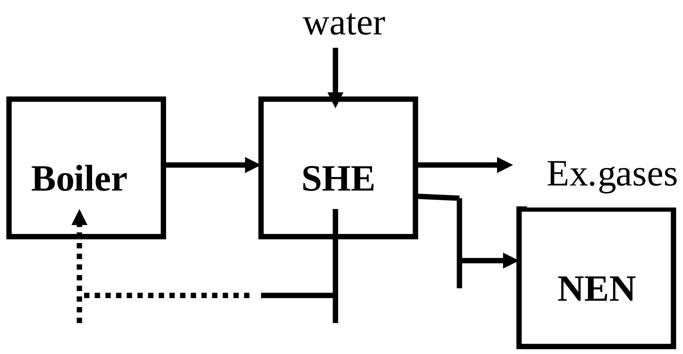

Fig. 1. The heat recovery unit
SHE - surface heat exchanger; NEN - node of effluent neutralization

Condensate is piped to the node of neutralization, where processes of the concentration of effluents and their preparation for recycling are conducted.

As the base object for setting the recycling node is selected boiler of "Gazprom mining Nadym" Ltd. With hot water boilers KBM-5.2 MW, which is supplied with natural gas of Cenomanian mine of Yamsoveyskoye field. Conducted analytical calculations have shown that the proposed system allows to improve the thermal efficiency of the boiler by 8.5%.

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