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EXPERIMENTAL RESEARCH OF HEAT EXCHANGE AT DEEP COOLING OF COMBUSTION PRODUCTS OF GAS-FIRED BOILERS

One of the directions in saving of energy in municipal heat-power engineering is increase of efficiency of use of fuel in boiler plants due to heat-recovery of exhaust-gases [1-8]. Heat loss exhaust-gases in modern domestic boilers are 16 ÷ 18 % under calculations on the maximum heat of combustion of fuel and are the basic heat loss of heat of boiler installations. This level of losses corresponds to exhaust-gases temperature range of 140 ÷ 160°C which was considered as optimum for many years. However, the tendency to higher cooling of exhaust-gases (below than temperature of a dew-point of water pair, which contained in combustion products) is observed recently. Thus not only physical (obvious) heat of exhaust-gases (about 7 ÷ 8 %), but also the latent heat of vaporization (approximately 10 %) can be used.

In this connection the problem of research of the heat and mass transport processes in conditions of high cooling exhaust-gases realization technology and the creation on this basis the highly effective heat exchange equipment for these purposes is actual.

The above-mentioned emissions exhaust-gas with high thermal potential is recovered in exchangers of contact and surface type of heat-recovery plants. The purpose of this research is the establishment heat and mass transfer in pipe bundles with cross-finned pipes in surface condensing recovering.

Researches were carried out at the experimental stand with use of special models in a wide practical range of change of main parameters of exhaust-gases (initial temperature t_0 = 200 ÷ 70°C, moisture content X=0.09 ÷ 0,15 kg/kg of dry gases and Reynolds number Re_g=2000 ÷ 12000).

Heat exchange surfaces of experimental models represented "chess" bimetallic pipe bundles (a steel basis and aluminum finning). Studying of processes heat and mass transfer was carried out for various values of geometrical parameters of pipes and pipe bundles.

Researches included definition of surface average values of the general heat transfer coefficient from gas side α_g and aerodynamic resistance of a pipe bundle in depending on finning pipes geometry, their arrangement, parameters of exhaust-gases (temperatures, flow rate, moisture contents), and also the temperatures of heating up water.

The heat transfer coefficient was represented as two parts – convective heat transfer coefficient α_g^d by so-called "dry" heat exchange (without change of gases moisture content) which was calculated by known techniques, and additions to it α_g^k, related with effect of exhaust-gases water pair condensation.

The received experimental data on heat exchange are generalized by dependence for Nusselt number Nu_g^k corresponding α_g^k:

$$\mathrm{Nu}_g^k = A \cdot \mathrm{Re}_g^n \exp(m \cdot \theta),$$

where θ – average temperature of heated up water which is related to temperature of the water vapor dew point which contained in exhaust-gases,

m =-14, n = 0,6,

A – constant dependent on moisture content X:

$$A = 0{,}001\exp\cdot(87X) + 0{,}3/X.$$

As a result of the carried out researches new technical decisions with high recovery heat of combustion products of gas-fired boilers, which are based creations of effective heat-recovery systems are use surface heat-recovery exchangers, have been formulated and substantiated.

Conclusions. As a result of the carried out researches new technical decisions which are based creations of effective systems of deep heat-recovery of combustion products of gas-fired boilers with use surface heat-recovers have been formulated and substantiated.

Wide introduction of technology of deep recovery of exhaust-gases heat of boiler installations will allow reducing to 5 ÷ 10 % consumption of natural gas in municipal power engineering and it is essential to improve ecological conditions.

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