Features of the Boiler (Centralized Heat Supply) During the Heating Season and Hot Water Supply

Marta Martynyak

Thermal Engineering, Thermal and Nuclear Power Stations Department, Lviv Polytechnic National University, UKRAINE, Lviv, S. Bandery street 12, E-mail: marta.martynyak@gmail.com

***Abstract* – The work is relevant as it concerns the unresolved issues of municipal heat supply, heating supply industrial and household objects, as well as contributing to the development of decentralized heating. Currently during operation of district heating systems that exceeded their technical resource and upgraded systems we required only generalizing methods of calculation and analysis of exploitation and efficiency. For the first time developed a method for analysis boilers work in the district heating boiler plants during the heating season and hot water. It is shown that depending on the period, the heat loss into the environment must be considered as part of warmth or useful for own needs ΔQ_5^{κ} and ΔQ_5^{hl}.**

Key words – boiler, heating, heat loss, centralized heat supply, heat consumer.

I. Introduction

The current state of outdated boilers and centralized heating systems require huge one-time expenses for their renewal. Often the new consumer dos'nt have possibility to connect to the already overloaded district heating system or it is a long way from centralized networks. The article deals the features of the boiler (DH) during the heating season and during summer.

II. Results of Research

At the the heating season boiler working modes provide hot water and heating for municipal and industrial facilities. During the summer boilers in boiler rooms working in a hot water mode.

The amount of heat-generating boilers n in boiler rooms in period τ during the summer can be defined:

$$Q_1 = \sum_{i=1}^{i=n} \int_0^{\tau} Q_i d\tau \qquad (1)$$

and for the year considering heating system facilities we will find as:

$$Q_1 = \sum_{i=1}^{i=n} \int_0^{\tau_p} Q_i d\tau_y \qquad (2)$$

The amount of heat that goes to heating system for residential and industrial objects we can define as:

$$Q_{hs} = Q_y - Q_1 \qquad (3)$$

or

$$Q_y = \sum_{i=1}^{i=n} \int_0^{\tau_p} Q_i d\tau_y - \sum_{i=1}^{i=n} \int_0^{\tau} Q_i d\tau \qquad (4)$$

The total heat Q_n which is generating in boilers is defined by:

$$Q_n = Q_\kappa + \Delta Q_\kappa^{hl} \qquad (5)$$

Q_κ – useful heat that generates in the boiler; ΔQ_κ^{hl} – heat loss in the boiler.

During heating season to enable secure and trouble-free operation of boiler in the boiler room is necessary to maintain at plus temperature equal to 10 °C and above. Sustaining that temperature provided certain expenses of heat for heating and for hot ventilation of air Q_{on} that goes for own needs.

In this case in regulatory documents and in the relevant calculations do not include the component of heat loss to the environment Q_5, which in this period need to refer to your preference boiler as useful heat, the total heat Q_{on}^{sum} and for own needs will consist of the amounts Q_{on} and Q_5^{on}

$$Q_{on}^{sum} = Q_{on} + Q_5^{on} \qquad (6)$$

Figure 1 is presented the boiler heat flow diagram in district heating system during the heating season.

In this case, the net efficiency of boiler will be find:

$$\eta_b^{н} = \eta_b (1 - e_{on}) \qquad (7)$$

where $$e_{on} = \frac{Q_{on}^{sum}}{Q_\kappa} = \frac{Q_{on} + Q_5^{on}}{Q_\kappa} \qquad (8)$$

e_{on} – coefficient characterizing the cost of heat for own needs; η_b – gross efficiency of the boiler.

Depending on the season, and perfect surfaces enclosure boiler e_{on} could significantly vary from 0.5 to 5.6 %.

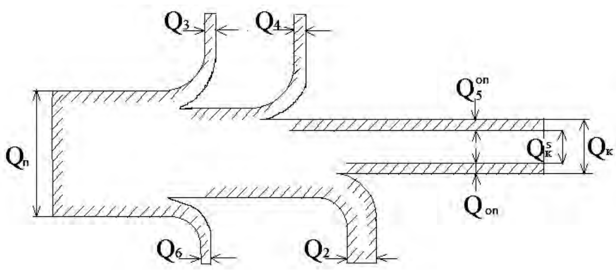

Fig. 1. Figure of the heat flow boiler in the district heating system during the heating season.

Q_n – the warmth of fuel, which is formed during its combustion fuel; Q_2 – the loss of heat from the exhaust gases; Q_3 and Q_4 – respectively heat losses from incomplete combustion and chemical mechanical air-dried brick Q_6 – heat loss of physical warmth of ash Q_5^{on} – heat used for own needs obtained through the boiler surface protecting.

$$Q_{on}^{sum} = Q^{on} + Q_5^{on} \qquad (9)$$

Q_{on}^{sum} – the total amount of heat used for boiler own needs; Q^{on} – the amount of heat spent for boiler own needs; Q_{κ}^{c} – useful heat entering the consumer; Q_{κ} – heat considering for own needs.

During the summer, when the boiler does not need to waste heat to maintain the positive temperature a certain heat loss into the environment Q_5 – must be considered as a useful heat and partly provided with air supply into the boiler fireplace. Boiler heat Q_5 through the building surface transferred to the environment and the air temperature in the boiler room can vary considerably by getting extra energy. Taking air from the boiler and feeding it into the boiler fireplace energy regeneration of occurs partial compensation of heat Q_5^{κ}.

The total amount of heat Q_5^{κ} will consist of two parts: a useful heat ΔQ_5^{κ} and heat losses ΔQ_5^{hl}

$$Q_5 = \Delta Q_5^{\kappa} + \Delta Q_5^{hl} \quad (10)$$

Diagram at fig. 2 shows the heat flow of boiler in district heating system with hot water supply in summer.

ΔQ_5^{hl} – heat loss into the environment; ΔQ_5^{κ} – useful heat entering the of boiler fuel with air; Q_{κ}^{s} – boiler useful heat that goes consumer with water or water steam; Q_{κ} – heat considering for own needs; Q^{on} – heat used for own needs.

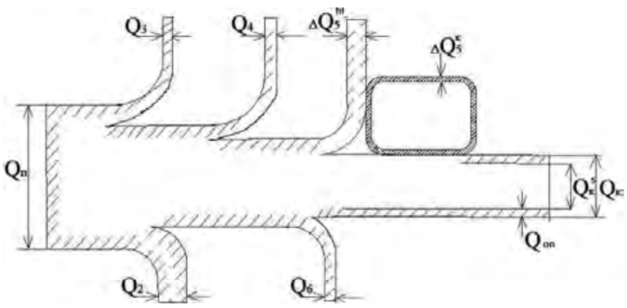

Fig. 2. Figure of the boiler heat flow in the district heating system used only for the hot water supply facilities during the summer

As we can see from the chart (Fig. 2) share of heat ΔQ_5^{κ} is a useful and it enters into the boiler fuel with air.

Implementing experimental research 4 boilers KVHM-50 in boiler room during the year shows that useful heat ΔQ_5^{κ} varies seasonally and varies from 0.25 % in winter to 0.06 % during the summer.

Fig. 3 shows the change of heat from the boiler room according to the time of year.

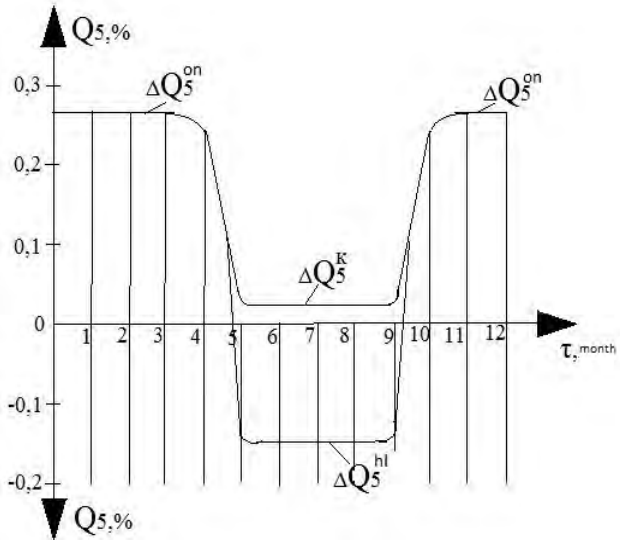

Fig. 3. Diagram of the distribution of heat boiler room with heating capacity 200 Gcal/h with 4 boilers KVHM-50 per months during the year (for the Western region of Ukraine)

Conclusion

The current state of outdated boilers and central heating systems requires huge one-time investment for their renewal and modernization. However we have not enough information in the literature about the analysis of complex systems of centralized and decentralized heating. There are no methods for calculating efficiency of their work as the only heating system including taking into account the heat consumers. In considering such systems changes in the heat balance are not taken into account, which leads to some errors in the calculation of their efficiency. So improving methods of analysis efficiency and development of centralized and decentralized heating and heat consumers is a topical task.

The experimental research of changes the efficiency of different types of boilers to the district heating system in different periods in Western Ukraine shows that during the winter boiler heat goes to heating equipment of boiler plants for its own needs and it changes depending on the operating conditions, such as boilers and seal constructions in a wide range from 0.2 to 2.5 %, also during summer useful heat fuel goes to the boiler room and it directly depends on the particular operation, such as boilers or buildings construction and it ranges from 0.04 to 0.7 %.

References

[1] V. P. Preobrajenskij, “Teplotehnicheskie izmerenija i pribory” [“Thermal engineering measurement and instrumentation”]. – Moscow, Russia: Energy Publ., 1978, 704 pages.