Nenad Miloradović, B.M.Sci.
JKP »Beogradske elektrane«
Savski Nasip 11, Beograd

Outside temperature impact on the operation method of heating source

Abstract:

Heating source that heats the objects (buildings) can have different operation methods: nightly reduced operation method, operation method with night stopping, permanent operation method. This work compares operation methods from the aspect of fuel consumption and commodity condition. Fuel consumption is to be calculated by EXCEL, based on the mathematic module that simulates inside object temperature, in relation to distributed heat and outside temperature. For differ outside temperature that could be monitored from hour to hour, this operation method have got some advantages and some faults: when the outside temperature is high the method with night stopping has the advantage for the reason of fuel saving, and when the outside temperature is low the nightly reduced operation method has the advantage for the commodity reasons and the difference in fuel consumption is insignificant.

INTRODUCTION

During the heating season that is from October to April, conditions of the heating installation usage are variable. This is related to the change of outside temperature during the heating season and to the change of outside temperature during the day (24 hours). It's known that the morning temperature is lower than maximal daily temperature. The JKP »Beogradske elektrane« still applies the regulation system with temperature sliding in the supply and return line of hot-water network to provide proper distribution of heating energy. This temperature is primarily related to the outside temperature and wind velocity.

The question is: How should the heating source operate (in what operation method) in relation to meteorological parameters to achieve adequate temperature by minimal fuel consumption? These are the possibilities: nightly reduced operation method, operation method with night stopping and permanent operation method. These different operation methods could be compared from the aspect of fuel consumption and commodity condition. For this it is important to know about unsteady processes that are taking place in the heating system.

This work contemplates characteristics of heating source methods of the operation when tested by mathematic module of simulation at the customers inside temperature with different outside temperatures. Simulation program that is able to monitor changes for hour to hour is EXCEL and has been explained in literature [2] and [3].

TESTING OF HEATING SOURCE DIFFERENT OPERATION METHODS

Testing has been done for different values of proximate daily outside temperature: +6°C, +3°C, 0°C, -3°C, -6°C, -9°C and -12°C. These temperatures are important for Belgrade because there are the most frequent outside temperatures during the heating season. **During the testing it is considered that outside temperature is constant during the day.** This simplification has been done to make impact of outside temperature obvious. This simulation program could consider change of daily outside temperature from hour to hour but at this time still is not able to consider wind velocity. Temperatures during the day can be taken from the real meteorological data that were monitored during the heating seasons and has been kept in the information center of JKP »Beogradske elektrane«.

Temperature regime for the outside temperature of -15°C hasn’t been considered because theoretically there is not possibility of heating this regime since the heating source already operates with maximal capacity

For outside temperature of +9°C analyze has been conducted but it is not included in this work. For this outside temperature it is necessary that interruption of heating during the day had been made to prevent over heating of apartment. There no reason to compare different operation methods of heating sours for this outside temperature because in this situation permanent operation method or nightly reduced operation method is not justified.

In this article following operation method of heating source has been discussed:

1. Nightly reduced operation method (During the day heating energy is to be delivered in accordance with outside temperature at sight, and during the night minimal energy is to be delivered; inside temperature in costumers pace during the night goes below allowed value and in the morning returns to the permitted temperature by heating. Minimal operation regime, that takes place during the night, depends on the minimal power of the boilers.);
2. Operation with night stopping (Similar to reduced night stopping but during the night heating source is to be shout down and there is no distribution of heating energy);
3. Permanent operation of heating source (All day long, day and night, heating energy is delivered in accordance with outside temperature at sight – heating source operates permanently. As constant outside temperature has been given the temperature of supplied and returned line of heating are constant all day long. It is assumed that temperature in the heating line changes for one degree so after 24 hours of operation the imposed temperature of the object is to be achieved).

It should be mentioned that temperature regimes of the methods that have periods of non-adequate delivery of heating energy are higher in relation with heating source permanent operation method.

As JKP »Beogradske elektrane« heating of the objects performs by starting the facility earlier, change of temperature regimes during the morning haven't been consider. Apart from that, constant outside temperature has been used in calculation so changes of temperature regime are insignificant

Chosen temperature regimes are in accordance with real temperatures that are to be applied for the operation of the heating source use in practice.

It is possible to do the correction of heating resistance in the buildings, so the result of simulation of inside temperature is equal to real measured temperature in the apartments. In this case the lower temperature of supplied and returned hot-water pipelines are to be received from the projected once.

Object where the simulation of inside temperature has been made is heating area TO "Cerak" that has got 206 MW of installed power in demand. Heat accumulation of the building has been chosen with the assumption that the object with the outside degree +5°C cool down from 22°C to 18°C during the eight hours night stopping. Also, the

correction of heating resistance in the object has been made in the way that real measured inside temperature values are to be received.

Analysis that has been done in EXCEL enables comparison of different fuel consumption in dependence of operation methods and enables simulation of inside temperature of object. In this way delay of inside temperature of object could be determined. This is important for the reason of heating that would be necessary if at one time distribution of heating energy is insufficient. Time of reached set temperature could be determined too. It indicates how different operation methods of heating source achieve commodity conditions of a costumer.

Program has been made so that total daily value of consumed heating energy could be read out. In this way consumed energy can be compared in relation with distributed parameters, and method of operation that is more effective for certain outside temperatures from the aspect of energy saving, can be determined.

For each day (for which the simulation has been done) the data has been monitored from midnight to midnight. It is assumed that start temperature in object is 19°C. The temperature regimes are determined in that way that after 24 hours of operation the object has the same temperature.

PRESENTATION AND ANALISIS OF THE RESULTS

Simulation results are presented graphically and tabular. The figure 1 shows inside temperature of apartment that has been made by simulation. The first part refers on nightly reduced operation method, center of the diagram refers on the operation method with night stopping and third part shows permanent distribution of heating energy. As the figure shows with permanent operation of heating source the temperature of the object is constant, and bigger temperature differences are with night stopping operation method then with nightly reduced operation method. The figure shows simulation results for outside temperature of +6°C, and similar curve is to be attained for different values of outside temperature.

Due to reduced distribution of the heating energy during night the costumer's temperature decreases in depends of thermal inertia of object (that is in relation with volume of material for construction and its thermal characteristics). When the heating starts inside temperature increases and after one period of time (that depends of thermal inertia of object but depends of temperature regimes that are used while heating as well as of period of heating), reaches imposed value that has been defined by commodity

conditions. As outside temperature is lower, the costumer's temperature decreases more during the night with heating methods that have stopping of heating energy distribution.

Figure 2 shows temperature regimes for different operation method at the outside temperature +6°C.

The fuel consumption has been given in the figures 3, 4 and 5, and in table 1. For each operation method of heating source the total daily heating energy consumption has been given. It's prominently that **when outside temperatures are relatively high the best possible operation method is with night stopping**. In this situation, the nightly reduced operation method is out of question - supplied and returned temperature in the pipeline are relatively low due to high outside temperature. Nightly reduced operation method wouldn't be useful in this situation as temperature regime during the night is close to the temperatures of distribution during the day. This is why there will be no energy saving.

But, when the outside temperatures are lower, with nightly reduced operation method the relative fuel consumption is reduced if compared with operation method with night stopping. In this case, difference between operation methods is a little so commodity conditions and safety operation is considered.

It's interesting that some limit temperature can be identified as a base for determination what operation method is more suitable. Within this work the limit temperature is not precisely determined but from given data (figure 5) it can be seen that limit temperature is very close to -2°C. Close to this temperature the lines that stand for relative daily fuel consumption are intersecting.

When the outside temperature is relatively low best possible operation method is nightly reduced operation method. Even permanent operation method is acceptable because difference in fuel consumption is insignificant and this operation method has the best commodity conditions.

Though percentage difference in fuel consumption between some operation methods of heating source during the low outside temperatures are relatively small, due to great consumers the energy saving is possible.

In table 2 delay of inside temperature has been shown for operation method with night stopping or nightly reduced operation method. It can bee seen that during the lower outside temperatures period of stopping or period of reduced regime is shorter and period of heating is longer. This is why during the low outside temperatures the difference in fuel consumption for this three stated operation methods of heating source is small.

When using the operation method with night stopping the imposed object temperature takes more time to be reached (see figure 6).

CLOSURE

The outside temperature is factor that dominantly affects fuel consumption Operation methods of heating source are less important. Stopping the distribution of heating energy during the night just partly effects the fuel consumption. When the outside temperature is higher (over 0°C), approximately 2 to 4 % of fuel could be saved. When the temperature is below zero, the fuel consumption of different heating energy distribution methods is almost a same. To reach imposed temperature in the objects the nightly reduced or permanent operation methods are recommended because they provide slighter cooling of the object. They impede freezing of the installation during the stopping of heating energy distribution, and provide safety operation of burners, pumps, ventilators, (i.e. equipment that can fail during the start of facility).

Electrical energy consumption used for the starting of equipment hasn't been included because consumed electrical energy is used during the chipper, night tariff. When outside temperature is low, the consequences of heating equipment failure are serious.

There is established critical temperature limit that defines moment when it is necessary to make change in operation methods from night stopping to nightly reduced operation method. Within this work the limit temperature is not precisely determined but it has been established that outside temperature is very close to -2°C. (see figure 5).

Foreign experience about permanent operation of the heating source during whole heating season should be taken restrainedly. Under our conditions, nightly reduced or permanent operation method are necessary only when the temperature is below -2°C. As our clime has a lot of days with temperature over zero it is better to use the operation method with night stopping.

To provide imposed temperature of the apartment, **within our region it is necessary to combine operation method with night stopping and nightly reduced (or permanent) operation method, in relation to the outside temperature.**

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MAIN WORDS

Energy consumption
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Nightly reduced operation method
Operation method with night stopping
Permanent operation method
Comodity conditions