Transactions of the VŠB – Technical University of Ostrava, Mechanical Series
No. 2, 2017, vol. LXIII
article No. 2035

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INCORRECT CONNECTION OF THE PUMP IN THE HEATING SYSTEM

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Abstract

The expert literature describes the adaptive mode of a pump as one possibility for the significant savings in electricity consumption for heating in residential buildings. However, there are examples where a project, based on the superficial knowledge of advertising leaflets leads to mistakes and does not save energy. The end user is mistaken that no better solution exists. One example of incorrect boiler project is rectified and calculation of electrical energy savings is made.

Abstrakt

V odborné veřejnosti a literatuře se popisuje autoadaptivní režim čerpadla jako jedna z možností výrazných úspor spotřeby elektrické energie na vytápění v obytných domech. Existují však příklady, kdy už v projektu, na základě povrchních znalostí z reklamních letáků, se vyskytují chybná zapojení, která úsporu elektrické energie nepřináší a konečný uživatel je v omylu, že nic lepšího v současnosti neexistuje. Na konkrétním příkladu chybného projektu kotelny je provedena náprava chybného zapojení a vyčíslena úspora elektrické enrgie.

Keywords

Heating system, adaptive pump connection, energy saving.

1 INTRODUCTION

The algorithm according to which the heating circulator pump is set is described in the literature (1) and is protected by number of patents. Nothing can be objected to the optimum pump setting. Problem occurs when the pump is switched off and subsequently switched on. If the pump is switched off and subsequently on the internal memory is deleted. It means that the collected data about the system operation is cleared. During each start the pump must re-recognize the system and search for the optimum settings. In practice, this means that the maximum power of the pump is set for an instant and this power is subsequently reduced. Optimum pump parameters are set for a number of days when the pump tries to optimize the setting according to the embedded algorithm. It is not expected that the pump will often be turned off because it is part of a heating system.

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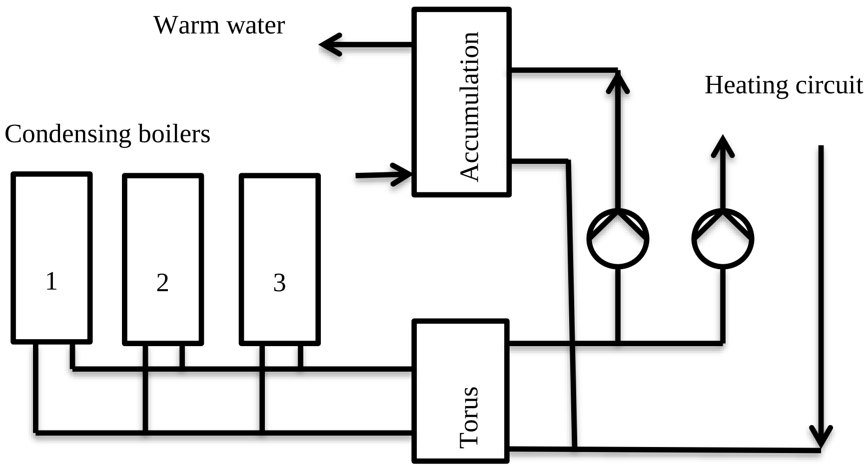

Fig. 1 Simplified scheme of engagement from the year 2009

An example of an incorrect project is a house boiler room built in 2009 in an older residential building. There are three condensing boilers installed in a cascade with preferred hot water heating. The boilers are connected via a torus to the heating system with a separate heating circulator pump. The individual risers of the house are regulated by differential pressure regulators. Radiators have thermostatic valves. The hot water heating into two tanks is driven by a control unit. For the hot water supply a separate charging pump is used. The hot water for the tanks heating is withdrawn behind a torus. Figures Fig. 1. and Fig. 2 represents a state after the project. From the left is

Fig. 2 Boiler room after construction in 2009

the torus on the ground, behind which two pumps are connected to the outlet pipe. The first smaller is the charge pump for the other, the larger the heating system pump. The third pipe is equipped with a shut-off valve only, i.e. a return pipe of the heating system, to which a small return pipe is connected across the wall from the hot water reservoirs. There are three condensing boiler units in front of the torus in the next section. According to the project, when the hot water supply is depleted, the heating system pump is switched off and the hot water pump switched on. Water heating is performed by all three boiler units. Their power is greater than that of the hot water heat exchanger. The heating time varies according to current consumption. The trays have a capacity of 500 liters; the average daily consumption of hot water is about 4 m^3. The heating does not start until the hot water supply has been depleted but it is due to the position of the thermometer in the tank and the setting of the minimum temperature. In fact, due to circulation losses the double amount of hot water is heated (equivalent to the consumption of gas for hot water). The hot water supply system has a separate circulating pump that interrupts circulating during the night hours. During the day circulation occurs every 15 minutes with a duration of about 5 minutes. The duration of hot water heating throughout the day can be estimated in a length of 15 extremely up to 25 minutes. When heating is complete, the heating system is started. If we consider a minimum of 12 heating cycles per day (in fact, it is more) for 15 minutes, it is a three-hour interruption of the heating water supply over a day, which is logically replaced by the high temperature in the heating system and a larger amount of heating water. Additionally, the pump (in Adaptive Auto mode) looks for the optimum setting, but restarts every time it is turned off. Although the control unit allows control of the mixing valve and simultaneous operation of hot water heating and heating, the designer in 2009 described this option as expensive and unnecessary with the installation of the mixing valve. In this connection, the Grundfos Magna 50-120 pump often operated at 60% of the delivered volume, exceptionally at 40%, and increased the output to 100% at the start of the heating cycle. Label of the pump has a minimum rating of 35W and max 800W.

2 RECONSTRUCTION

After the heating season of 2016 was completed, a boiler room was reconstructed. A mixing valve was installed in the heating circuit. In Fig 3. Fig. 4 a mixing valve embodiment prior to suction of the heating circulator pump is presented. The pump was set to constant output pressure with a displacement height of 3 meters and was not set in the auto-adaptive mode. The house has twelve floors above ground so the effect of natural circulation cannot be neglected.

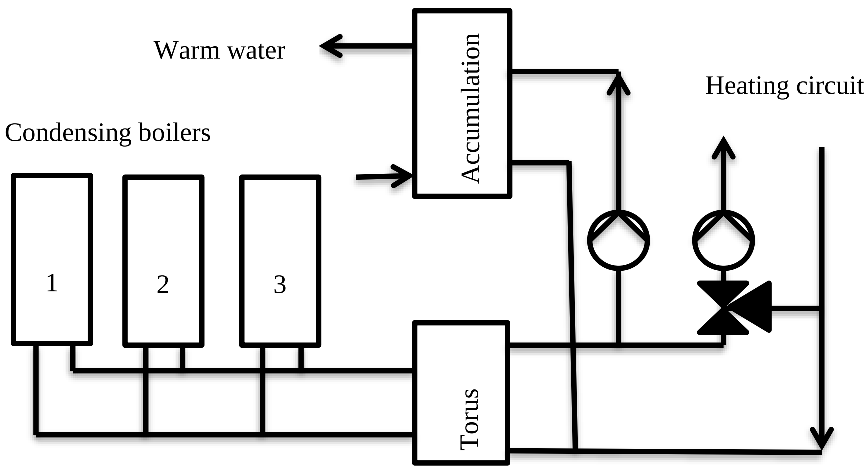

Fig.3 Simplified diagram of 2016

Fig.4 Reconstruction of the heating circuit

The target supply temperature was set two degrees of Celsius lower than in apartments. The lower supply water temperature represents a saving in heating system consumption. However, our main interests is the consumption of electricity for the operation of the boiler room. Currently, after the reconstruction, when the water temperature drops below the set value, the DHW charging pump starts. At the same time, if all the boiler units are not working, they start and gradually increase the power. The boiler output temperature is 80°C. Three-way valve regulates the flow temperature of the heating circuit according to the outside temperature. It responds to the delay so that the temperature increases during heating of hot water by several degrees. The control unit gradually eliminates this temperature increase, but only when the hot water is over. In heating season 2016/17 during boiler room inspections the pump worked exceptionally at 40% of the quantity delivered, especially in frosts, mostly at 20%.

2.1 Used data

The boiler room data was obtained from boiler room operational records from 2010 to 2014 for the months of January, February, March, April marked with the number 4 and October November December marked with the number 3. These months were chosen because they were regularly heated (except for one exception). Fixed heating periods differ from actual weather, heating is not interrupted. Data on average monthly temperatures were obtained from the CHMI (Czech Hydro meteorological Institute) portal (2) historical data for the Liberec region and were compared with the data on the TZB portal degree days calculator for Liberec. On TZB on the way; Heating, tables and calculations, degree days calculator, where historical data from the Liberec airport, which is situated on the outskirts of the city at an altitude of 400 m above sea level, are stored. It should also be noted that if the monthly data for the Liberec Region were also based on measurements at the Liberec airport, there were differences between the temperature of different boroughs of the city and the airport. The town is situated in a hilly terrain with various buildings and vegetation. Differences in temperatures vary. They are not constant, but they are not critical for our measurement and analysis. I became acquainted with this fact during work with the city's heating system. The same can be said for airports and data for the Liberec region, fig. 5. Differences in average monthly temperatures are insignificant. Monthly power consumption data is subject to error, unequal recording of operational data in the boiler room.

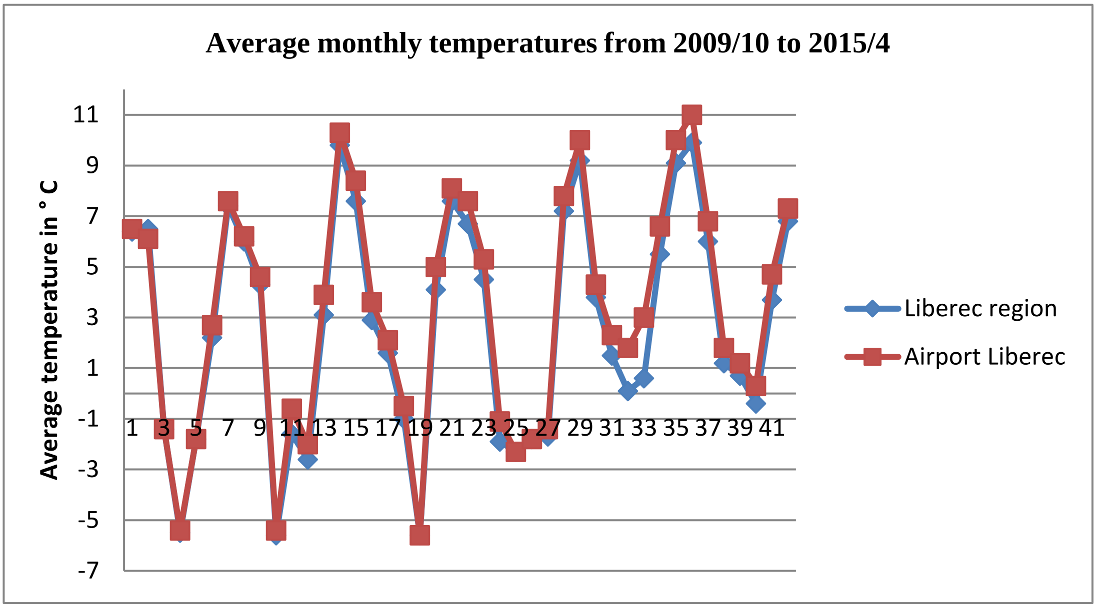

Fig.5 Average monhly temperatures

This error was more than one day. Figure 6 illustrates a graphically simple linear regression for all monthly energy consumption readings over the period from 2010 to 2015. The confidence factor is 0.8197. If you exclude from the data set months that are not from 30 and 31 days, we obtain a coefficient of determination $R^2 = 0.9359$ (Fig.7). Different lengths of reading were due to, for example, absence, omission of the operator, or it was only February.

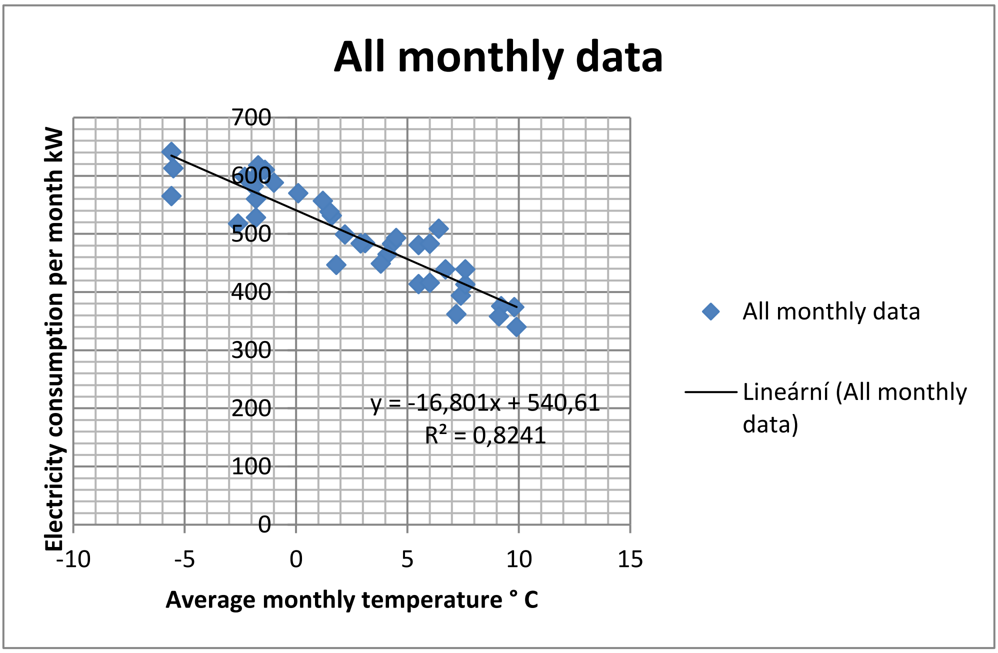

Fig.6 All monthly data

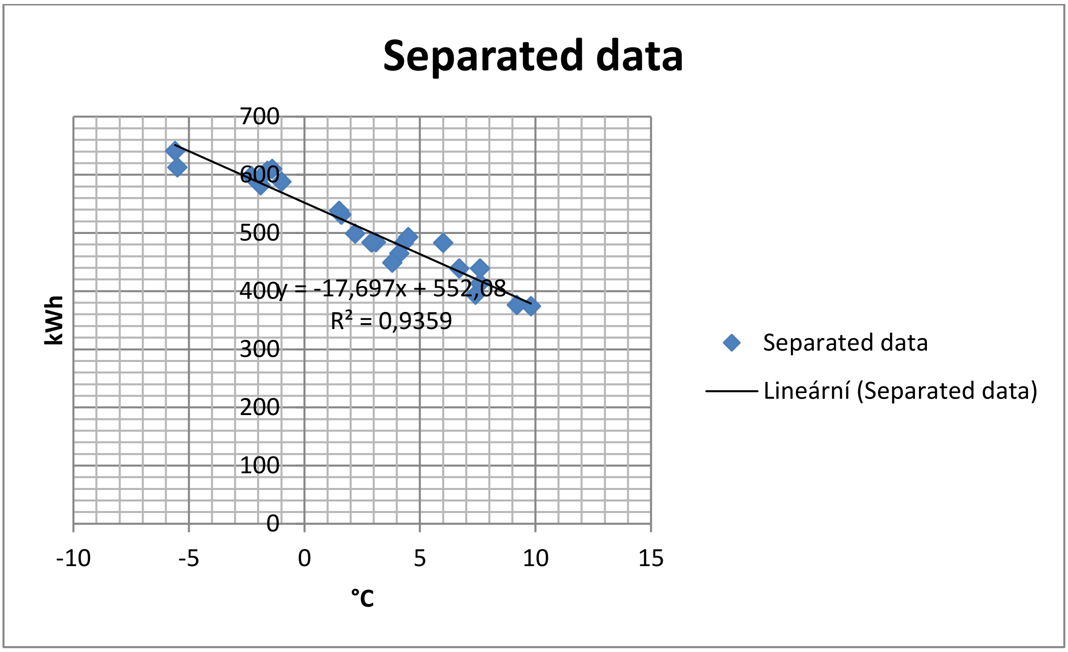

Fig.7 Separated data

2.2 Editing the measurement data

Inaccuracies of writing data in one day's difference can be reduced. If we consider a longer time interval, for example 3 months in the fall (October, November, December) or 4 months in the spring (January, February, March, April), see Table 1 and 2, partially inaccurate manual inactivity Boiler

Year	2010-3	2011-3	2012-3	2013-3	2014-3	2016-3
Averange temperature °C	1,56	4	3,1	4,8	5,7	2,9
Electricity kWh	1607	1428	1516	1363	1313	1342

Table 1. Autumn

Year	2010-4	2011-4	2012-4	2013-4	2014-4	2017-4
Averange temperature °C	0,6	2,2	1,3	0,4	4,1	1,5
Electricity kWh	2066	1983	2057	2106	1756	1739

Table 2. Spring

room to obtain the linear regression equation. From the data of the average monthly temperatures, the average temperature of given period was calculated for the three-month autumn and the 4-month spring, which was rounded to decimal numbers. The rounding of temperatures to the decimal places for Liberec is irrelevant. The electricity consumption is large enough to consume more than 90 days, and the effect of one day's reading inaccuracy is small. The line equation then shows a confidence value, which is close to one in Figure 8. If we were to count the data for years, the result of a linear regression would have worsened because data is only available for 4 years and also because the house behaves differently in the autumn and spring It is not possible to combine the average monthly temperatures and the consumed energy into one equation. The electricity consumption in the boiler room is linearly dependent on the average temperature.

In the heating season 2016/17, the adjustments made were reflected in the electricity consumption. Although both pumps were operated at the same time and the mixing valve actuator was operating, there is a saving in electricity consumption. Linear equations obtained by simple regression can be considered to be sufficiently accurate to estimate the savings in electricity consumption. In autumn 2016 after reconstruction, when the average temperature in three months (autumn) was 2.9 C, see Table 1, consumption was 1,342 kWh boiler room. If the reconstruction was not carried out, the linear model consumption would be approximately 1514 kWh. The saving is about 11% of the electricity. In the spring of 2017, at an average temperature of 1.5 °C, see Table 2, and a consumption of 1739 kWh, savings of approximately 274.7 kWh were calculated, is 13% of electricity.

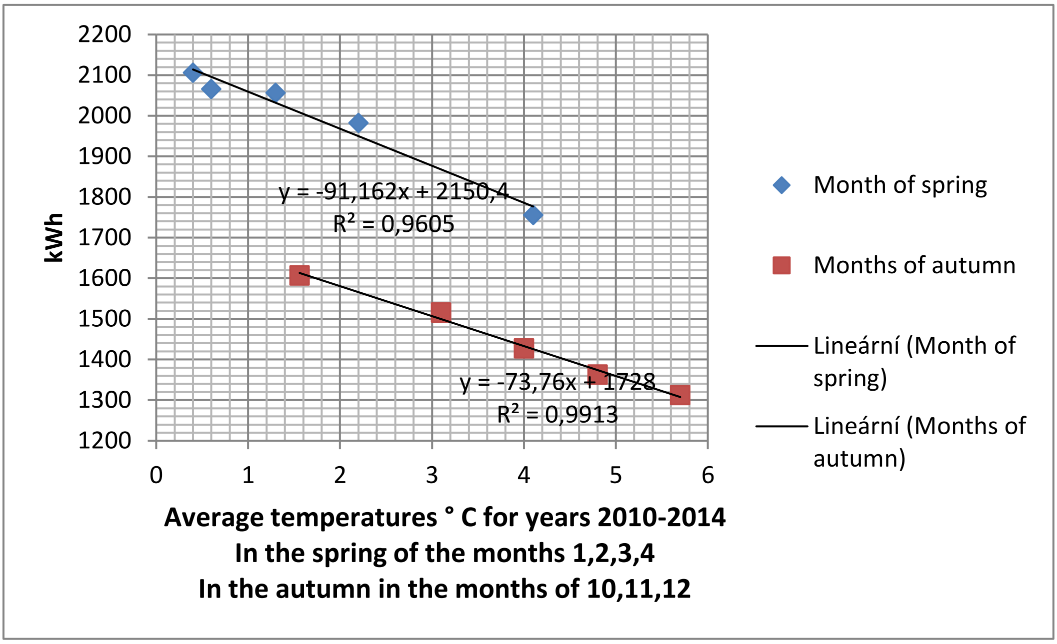

Fig.8 Average temperatures for years

3 CONCLUSIONS

It has been confirmed that the electricity consumption for this house is changing linearly proportional to the average temperature. This is a dependence on the measured temperature in the evaluated period. Whether this dependency applies to temperatures up to -15 °C is not confirmed. Boiler room performance was not downgraded or refurbished during the night hours due to the fact that the house has small apartments and is inhabited by a wide range of people from old citizens to families with small children (not the exception of a four-person family in a 1+1 apartment). Every apartment occupant adjusted the temperature according to his own needs by adjusting the thermostatic valve. Uninterrupted heating increased satisfaction of the residents and removed noise caused by dilatations, which could not be eliminated for years.

Return on investment of about 50,000 crowns will not be satisfied. The total reconstruction of the boiler room, which will be after fifteen years of boilers operation, remains only seven years. However, there has been an increase in the quality of housing and the reduction of electricity consumption for heating. Savings are also in gas consumption as the heating water has been reduced by approx. 6 ° C. In this respect, we can speculate how much efficiency of condensing boilers has increased during the heating season. The cost of installing the mixing valve would be lower if it was implemented during the boiler room construction in 2009. When the boiler room is about 15 years old, the valve would be paid. Savings arose, even if adaptive pump operation has not been used. There is a reserve. The result is decided by the quality of the project, the knowledge of the designer and the state-of-the-art technology. The technique itself is not enough.

This publication was written at the Technical University of Liberec as part of the project SGS 21182 with the support of the Specific University Research Grant, as provided by the Ministry of Education, Youth and Sports of the Czech Republic in the year 2017.

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