

УДК 697.1

ВОДОГРЕЙНЫЕ КОТЛЫ В ТЕПЛОСНАБЖЕНИИ ЧАСТНЫХ ДОМОВ**Лашина Екатерина Николаевна,**

Старший преподаватель кафедры иностранных языков Санкт-Петербургского государственного университета промышленных технологий и дизайна. Высшая школа технологии и энергетики, Санкт-Петербург, ул. Ивана Черных, 4.
E-mail: lashinapiter@gmail.com

Солдатова Ирина Дмитриевна,

Студент кафедры ПТЭ Санкт-Петербургского государственного университета промышленных технологий и дизайна. Высшая школа технологии и энергетики, Санкт-Петербург, ул. Ивана Черных, 4.
E-mail: soldatova.irina.02@mail.ru

Аннотация

В статье рассмотрена система отопления частного дома с помощью водогрейных котлов. Приведены несколько способов расчета необходимой минимальной мощности котла.

Ключевые слова: водогрейный котел, теплоснабжение, частный дом, КПД, система отопления, тепловые потери.

WATER BOILERS IN THE HEAT SUPPLY OF PRIVATE HOUSES**Ekaterina N. Lashina,**

Senior Lecturer of the Department of Foreign Languages of St. Petersburg State University of Industrial Technology and Design. Higher School of Technology and Energy, St. Petersburg, Ivan Chernykh Street, 4.
E-mail: lashinapiter@gmail.com

Irina D. Soldatova,

Student of the Department of IHPE of St. Petersburg State University of Industrial Technology and Design. Higher School of Technology and Energy, St. Petersburg, Ivan Chernykh Street, 4.
E-mail: soldatova.irina.02@mail.ru

ABSTRACT

The heating system of a private house with the help of water boilers is considered in the article. Several methods for calculating the required minimum boiler power are given.

Keywords: boiler, heat supply, private house, efficiency, heating system, heat losses.

For many decades there has been a global urbanization. The population moved for permanent residence from villages and villages to megacities. There were various reasons for this, but the main reason was greater employment and earnings opportunities, as well as improved living conditions. This process continues in our time. But along with it, one can also observe the reverse process - deurbanization. This was due to the rapid development of technology, in particular wireless high-speed Internet, which allows people to work from various, including remote places. Deurbanization also contributes to the negative impact of the metropolis on health, which consists in noise pollution, which leads to various disorders, has a negative impact on every inhabitant. So, during the day, the average noise level in Mumbai and London can reach about 105 dB, while in Tokyo and Chicago - 95 dB. The results of a survey among residents of the European Union show that about 80% of residents believe that noise has a significant impact on their health to some extent (World Health Organization (WHO), 2018). Traffic, public transport, industrial and work premises, equipment, loud music and electronic devices can have a significant impact on human well-being. In fact, noise pollution is the cause of health problems such as stress, anxiety, and hearing loss. In particular, stress can lead to high blood pressure and increase the risk of heart disease. Living in a big city with constant noise affects our social behavior, which can lead to social isolation and negative feelings such as anger or dissatisfaction [1]. Therefore, most residents of big cities tend to go out of the city to the countryside at least for weekends and holidays in order to relax. And those who were able to switch to a remote work format tend to move to live in sparsely populated areas or in an area where there are not even communications, such as water supply, gas pipelines, electrical networks, or their availability is very limited. Due to the remoteness from communications, a person who seeks to settle away from noise has to think not only about building a house in the chosen area, but also about ways to heat it. As usual, the main parameters influencing the choice of one or another method of heating a house are its efficiency, economy, ease of maintenance and the availability of an energy carrier. All these parameters are met by a technical device designed to heat water under pressure by burning fuel or using electricity - a water boiler.

The most popular are electric and gas boilers. The advantage of the former is that the installation of any model can be done independently. No permission required to connect to networks. But there is also a significant drawback - the significant costs of paying for electricity in the winter. If using such a boiler to heat a cottage of a large area, resource supply companies will issue invoices for tens of thousands of rubles. There is another significant drawback of electric boilers when used in places that are difficult to access and remote from the main communication highways - interruptions and restrictions in the supply of electricity, which will lead to freezing of households in the winter and, as a result, to other negative consequences.

Gas boilers (single-circuit and double-circuit) are more expensive. If the house was not initially gasified, you will have to obtain permission to insert into the pipe. But there are also benefits. Gas is cheaper than electricity. The initial costs will pay off within 2-3 years. Do not forget that most of the models of modern heating boilers are double-circuit (Fig. 1). They are intended, including for receiving hot water. You can do without installing a boiler for direct or indirect heating (Fig. 2). The reliability of such equipment is at the proper level [2].

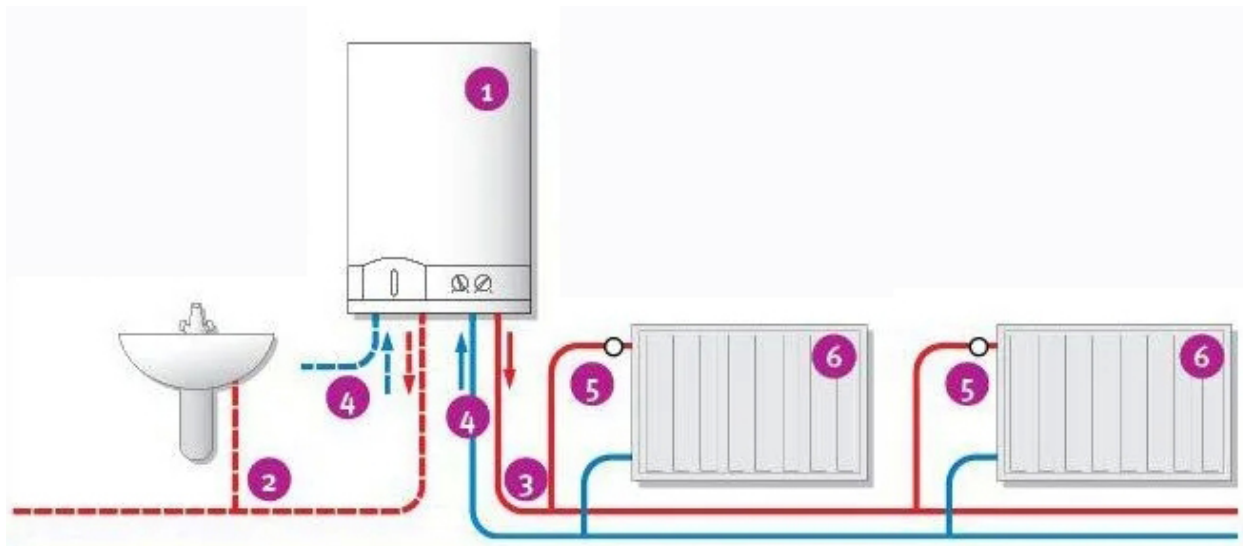


Figure 1. Double-circuit boiler. Heats water for domestic use and for heating. [Electronic resource]. <https://m-strana.ru/upload/sprint.editor/bb9/bb97b9dafe745dd77029deb36884e4f4.webp>

The diagram of a double-circuit boiler with a boiler shows:

1. Double-circuit boiler
2. Domestic hot water
3. Hot water for heating
4. Cold water supply
5. Temperature controller
6. Heating radiator

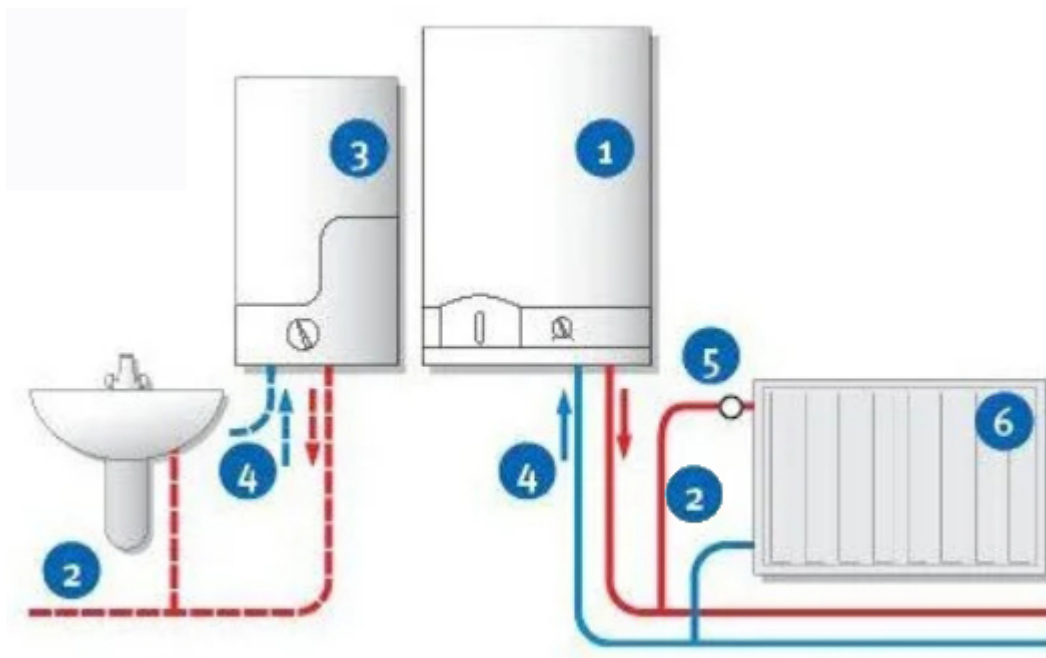


Figure 2. Single-circuit boiler with an additional boiler. In the connection diagram, the boiler and the additional boiler are independent from each other. [Electronic resource]. <https://m-strana.ru/upload/sprint.editor/bb9/bb97b9dafe745dd77029deb36884e4f4.webp>

The diagram of a single-circuit boiler with a boiler shows:

1. Single-circuit boiler

2. Domestic hot water. Hot water for heating
3. Additional boiler
4. Cold water supply
5. Temperature controller
6. Heating radiator

It should be noted that it is very important to calculate the appropriate power, that is, no less and no more. In the first case, the building simply will not warm up sufficiently. In the second, the heating system starts to work unevenly, which leads to excessive wear. The result is frequent repairs and premature replacement of the boiler. In addition, the gas consumption increases [3].

In order to maintain a comfortable temperature in each room, the heat output of the heating system (respectively, the boiler) must ensure the heat loss of the house, which is also measured in kW. That is, the heat output of the boiler unit is equal to the total heat loss of the house through the walls, floor, ceiling, foundation windows and doors + margin in case of severe frosts (Fig. 3).

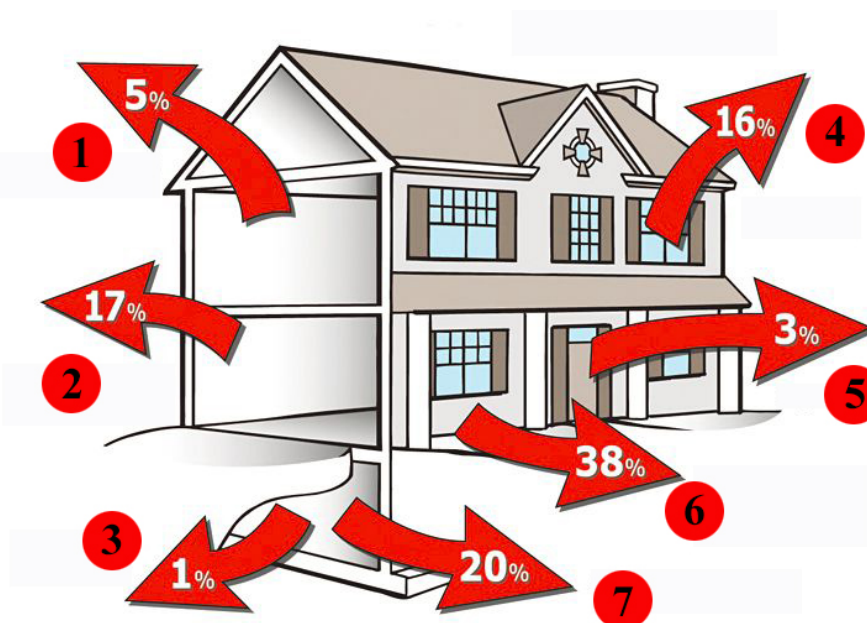


Figure 3. Heat loss of the house. [Electronic resource]. <https://gradusplus.com/wp-content/uploads/2019/01/Teplovye-poteri-chastnogo-doma.jpg>

Heat loss of the house occurs:

1. Through the ceilings
2. Through the frame walls
3. Through the basement floor
4. Through the windows
5. Through the doors
6. Through the cracks in the walls, windows and doors
7. Through the walls of the basement.

There are several ways to calculate the required minimum boiler power, and the most common of them are by the area of the room, by the volume of the room, and also more accurate, taking into account various factors.

For an average house with an area of 100 m² with two-brick walls and a ceiling height of 2.7 m, which is located in the Moscow region, 1 kW of heat output is needed for every 10 m² (average heat loss). The power of the boiler, taking into account the power reserve of 20 %, will be:

$$100 / 10 * 1.2 = 12 \text{ kW}$$

If the house has insulation (thermal insulation layer up to 150 mm or walls made of timber), then heat losses are reduced to 0.5-0.7 kW per 10 m² and, accordingly, the minimum required boiler power is reduced.

The second method is based on SNiP 23-02-2003 "Thermal Protection of Buildings" [4] and is usually used for apartments. All accounting for heat loss is reduced to average values and thermal conductivity of walls made of various materials. This means that it is rational to use it if the external walls are not insulated, the apartment has no more than 4 standard windows, the radiators are connected in the most efficient way, and the neighboring apartments are heated. Calculation of the minimum power of the boiler using this method, taking into account a 20% margin for power, since the house is detached and there are no heated apartments nearby:

$100 * 2.7 * 0.034 * 1.2 = 11 \text{ kW}$, where 0.034 kW/m³ is the rate of specific heat energy consumption for a brick apartment building [5].

When calculating with these two methods, a power difference of 9.1 % is obtained. This makes it possible to use both methods for a quick preliminary assessment of the power of the selected boiler.

A more accurate calculation is based on the area calculation method, but it is broken down into individual rooms, but it also takes into account all possible heat losses (Fig. 4), the way radiators are connected, which affects the efficiency of the heating system, climatic conditions and even the location relative to the wind rose [6].

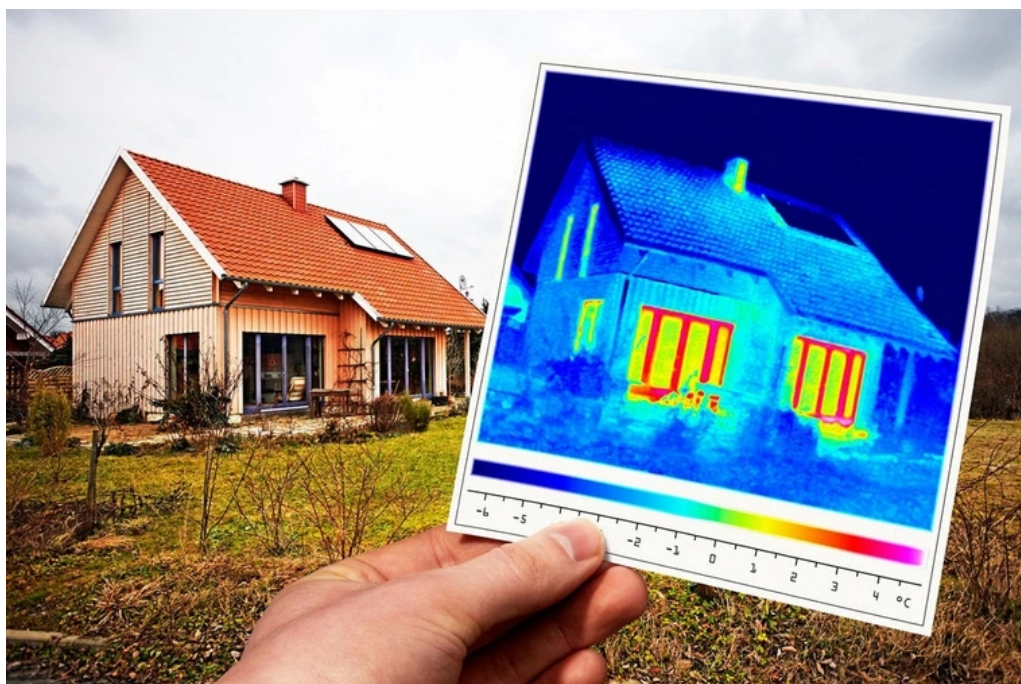


Figure 4. Thermal imaging of the house to identify cold bridges for accurate calculation of heat loss. [Electronic resource]. https://club.dns-shop.ru/api/v1/image/getOriginal/q93_25132ae98e7363d8b5d234eb0aa8c0a421805a55d9f65ea68fd6ddda15856b6e.jpg/

In summary, moving out of town to a detached house can be a great idea and a way to deal with the stress and pollution of today's metropolitan areas. But, at the same time, it is important to correctly approach the project of this building. In particular, if the house heating system is considered, it is necessary to analyze and evaluate all the characteristics of the house from this point of view and select the boiler with the optimal power.

Список литературы:

1. Что такое шумовое загрязнение и как его сократить? <https://www.rockfon.ru/>
2. ТОП 15 лучших газовых котлов <https://www.teplomatica.ru/stati/top-15-luchshikh-gazovykh-kotlov-rejting-gazovykh-kotlov-dlya-otopleniya-chastnogo-doma-2021.html>
3. Как выбрать газовый котёл для частного дома – разновидности и особенности <https://m-strana.ru/articles/kak-vybrat-gazovyy-kotyel-dlya-chastnogo-doma-raznovidnosti-i-osobennosti/>
4. СНиП 23-02-2003. Тепловая защита зданий <http://sniprf.ru/razdel-2/23-02-2003>
5. Как рассчитать необходимую мощность котла для отопления частного дома <https://gradusplus.com/kotly/raschet-moshhnosti-kotla-dlya-otopleniya-chastnogo-doma/>
6. Как рассчитать мощность отопительного котла <https://club.dns-shop.ru/blog/t-354-otopitelnoe-oborudovanie/70407-kak-rasschitat-moschnost-otopitelnogo-kotla>

References:

1. What is noise pollution and how can it be reduced? <https://www.rockfon.ru/>
2. TOP 15 best gas boilers <https://www.teplomatica.ru/stati/top-15-luchshikh-gazovykh-kotlov-rejting-gazovykh-kotlov-dlya-otopleniya-chastnogo-doma-2021.html>
3. How to choose a gas boiler for a private house – varieties and features <https://m-strana.ru/articles/kak-vybrat-gazovyy-kotyel-dlya-chastnogo-doma-raznovidnosti-i-osobennosti/>
4. SNiP 23-02-2003. Thermal protection of buildings <http://sniprf.ru/razdel-2/23-02-2003>
5. How to calculate the required boiler power for heating a private house <https://gradusplus.com/kotly/raschet-moshhnosti-kotla-dlya-otopleniya-chastnogo-doma/>
6. How to calculate the power of a heating boiler <https://club.dns-shop.ru/blog/t-354-otopitelnoe-oborudovanie/70407-kak-rasschitat-moschnost-otopitelnogo-kotla>