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Water supply of residential high-rise buildings in Saint-Petersburg

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ABSTRACT

The purpose of this article is to choose the most cost-effective water supply system for the high-rise building in St. Petersburg.

For this task the high-rise building was modelled. Two types of water supply systems were considered for this building: without zoning and with parallel zoning. The hydraulic calculation was made for the same work conditions.

The calculation shows that total losses at the network system with parallel zoning are less than in the system without a zoning As a result, author came to a conclusion that system with parallel zoning is the most cost-effective for the high-rise building.

Contents

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1. Introduction

Today the land in the city becomes more expensive. It makes high-rise construction more relevant. High-rise residential buildings become more urgent in today's St. Petersburg. To date, there are 1770 at least 35 meters height houses in Saint-Petersburg (the 12th largest city in the world). Providing high quality water in the required quantity to consumers is becoming one of the most important issues of construction. Raising the level of accomplishment of high-rise residential buildings depends on how designers solve the following basic requirements: providing a supply of predetermined amounts of water to the point of consumption at the required pressure, the creation of the necessary reserves of water to ensure the reliability or continuity of the process water supply facility.

2. Literature review

Water supplying of high-rise buildings has always been paid a great attention. Basic principles of design of water supply systems in high-rise buildings considered in the articles [1-7, 19]. The economic problem is solved in the works [7-8, 10-12, 20-24]. Energy efficiency is an important factor in the water system and its equipment [11-12, 14-15, 18]. Some examples of water supply systems in high-rise buildings in different cities of Russia and around the world [9, 13, 16-18, 21]. The model of high-rise building was made for Saint-Petersburg due to its necessity of economical land planning. There are not any similar calculations in works [1-24].

3. Research objective

The purpose of this research was the selection of the most cost-effective water supply system and the calculation of total losses in all parts of the network.

4. Research description

Problem of delivering water to consumers at different spot elevations is caused by the difference between layout of the consumer and lay of the land. The water supply of such facilities requires a division of the building into two or more "high-altitude zones" in various largest allowable pressures on networks. That can provide the most cost-effective way to meet the needs of water consumers.

Feasibility of zoning may be caused both by the nature relief and the difference of geodetic marks in the nodes of water intake and quantities required head and allowable pressure created in the sampling points of water consumers. At the same time, the implementation of the above requirements must be met along with the fact that the plumbing should be designed cost-effectively, providing the minimum cost for construction and operation of both the network and work of other systems' structures. These requirements are satisfied with the correct choice of network configuration and pipe diameter and material.

There are two main types of zone systems in Saint-Petersburg:

1. Systems of "parallel zoning," in which zones are connected in parallel and water is supplied from the headworks in each zone separately. System of parallel zoning in St. Petersburg is used for water supply in buildings of 12 or more stories. A separate district or a group of high-rise buildings has 2 zones in the internal water supply. The first zone covers the first 9 floors provided with the external water supply, and the second, upper zone with a special high-pressure network, where desired pressure is provided by booster pump station. The main disadvantage of "parallel zoning" system is a huge cost, which is increasing with the length of water pipelines.

2. Systems of "serial zoning", in which water is fed into the lower zone passes in transit through it and fed to the upper zone of the network with pumping. The disadvantage of this system is a need of freestanding pump station installation for each additional zone, which causes extreme increase of cost of construction and maintaining staff. The reliability of this system is lower than the parallel zoning system in which water is supplied to each zone via separate conduits.

In this article the water supply system without zoning and system with parallel zoning for high-rise building are compared. A sixteen-storey residential building in Saint-Petersburg was chosen as a research model. The purpose of the network calculation is to identify the most cost-effective pipe diameters of all its parts and corresponding pressure losses. The concept of economically the most advantageous diameter arose from a consideration of the conditions of the joint work of water lines and the water supply unit using energy to lift water. In the practice of designing for an approximate determination of the economically most advantageous diameters

parts of the network can be considered as independent operating lines. Then their diameters are determined by the formula:

$$d = ЭQ^3, \quad (1)$$

Э – economical factor,

Q - design flow.

The configuration, lengths of parts and water withdrawals in knots are known in the current calculation of network. The equation of the first law of Kirchhoff expressing the balance of expenditure at the sites was used to find the water consumption qi-k in p parts of the network:

$$\sum q_{i-k} + Q_i = 0, \quad (2)$$

q_{i-k}– pressure losses in every part of network,

Q_i – total pressure losses in network.

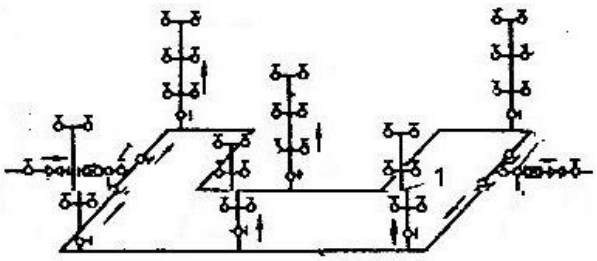

Figure1. System without zoning

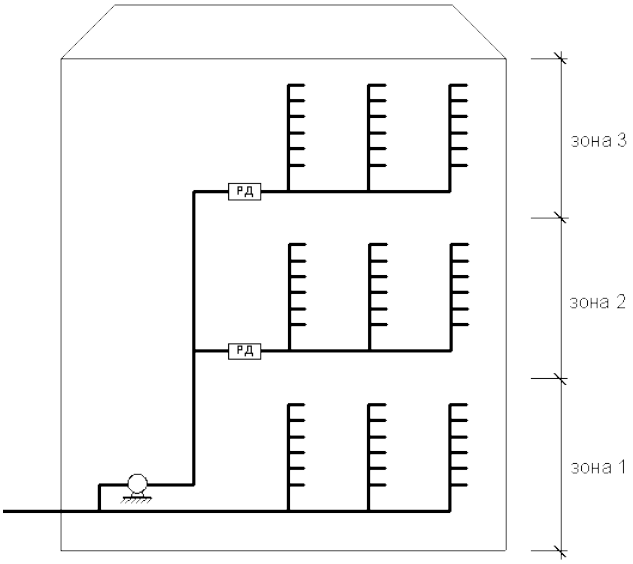

Figure 2. System with parallel zoning

Pipes with the same diameter were used in the calculation of both water supply systems. The losses in every part of network are determined by the formula:

$$H_l = 1{,}3il, \quad (3)$$

i - specific losses of a pressure on friction,

l – length of network part.

For calculation of losses in all network losses in all parts are summarized. The calculation of the losses in all network in the system without zoning turned $\sum \mathrm{H_l} = 32{,}71\ \mathrm{m}$; similar value in the system with parallel zoning turned $\sum \mathrm{H_l} = 18{,}28\ \mathrm{m}$, which is less on 44%. Therefore, a system with parallel zoning is more cost-effective than the system without zoning because it requires a water supplier uses less energy to create the necessary pressure on the network.

5. Conclusion

As a conclusion of this work it should be noticed that:

1. The water supply system of high-rise buildings must be separated to the "high-altitude zone". There are two types of zonal systems used: serial and parallel.

2. The calculation in the current study shows that total losses at all parts of the network system with parallel zoning turned 18,28 m which is 44% less than in the system without a zoning – 32,71 m.

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Водоснабжение жилых домов повышенной этажности в Санкт-Петербурге

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ИНФОРМАЦИЯ О СТАТЬЕ	**История**	**Ключевые слова**
УДК 696.115	Подана в редакцию 28 января 2014 Оформлена 26 февраля 2014 Согласована 28 февраля 2014	система водоснабжения зонирование высотное здание жилое здание экономическая эффективность

АННОТАЦИЯ

В статье поставлена задача – подобрать наиболее экономически эффективную систему водоснабжения для высотного здания в Санкт-Петербурге.

Для этого было смоделировано здание повышенной этажности. Для него были рассмотрены 2 вида систем водоснабжения: без зонирования и с параллельным зонированием. Был проведен их гидравлический расчет потерь напора в трубопроводе для одних и тех же условий работы.

В результате расчета потери напора для системы с параллельным зонированием получились меньше, чем в системе без зонирования. Автор сделал вывод, что для высотного здания наиболее экономически выгодной получилась система с параллельным зонированием, так как в ней потери в трубопроводе меньше.

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