RIGA TECHNICAL UNIVERSITY

Faculty of Civil Engineering
Heat, Gas, and Water Technology Institute

Ināra LAUBE

PhD student of Heat, Gas, and Water Technology Institute

CALCULATING METHODOLOGY FOR PARAMETERS OF GAS DISTRIBUTION SYSTEMS

Summary of Promotion Thesis

Scientific supervisor
Dr.sc.ing., associate professor
I. PLATAIS

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OFFICIAL OPPONENTS:

Prof., Dr.habil.sc.ing. Egīls Dzelzītis
Riga Technical university

Dr. sc.ing. Andra Ješinska
JSC „Latvijas Gāze”

Dr. sc.ing. Ivars Kudreņickis
Institute of Physical Energetics

CONFIRMATION

I confirm that the given doctoral thesis has been worked out by myself and submitted for nomination for scientific degree of the doctor of engineering sciences in Riga Technical University. The doctoral thesis has not been submitted in any other university for obtaining the scientific degree.

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The Promotional Work is written in Latvian with 94 pages, it contains Annotation, 5 Sections, Conclusion, Refenences with 85 units.

ANOTATION

The objective of this Promotion Paper is development of the methods for calculating correct consumption of natural gas and optimum parameters of gas supply distribution systems. To ensure construction of technically as well as economically substantiated systems, it is necessary to develop gas supply layouts – technical solutions with application of correct natural gas consumption measures for estimation of gas supply system parameters (diameter, material, loss of pressure).

The drafting of this Paper included study of methods for calculation of natural gas consumption and distribution gas supply systems in gas management facilities in Latvia, Lithuania, Germany, and Russia, as well as analysis of actual load on gas supply systems in Latvia, focusing in particular on analysis of the factors that influence the consumption of natural gas. It has been established that in case of high and medium pressure distribution gas-pipes built in the cities of Latvia before late 90s (basic load pipes) the diameters exceed by 20 – 30% the figures required for present load of natural gas – the maximum hourly consumption (m^3/h). It has been demonstrated that increased maximum hourly consumption is used in the relevant calculations without taking into consideration either simultaneous operation of devices of the users of natural gas or the seasonal principle. Diameters of distribution gas-pipes are estimated with minimum loss of pressure, thus the diameter of gas-pipes is notably increased. It is therefore concluded that consumption of natural gas by industrial and agricultural sector is reduced, including consumption by households reduced by 16%, due to increased efficiency factor and power efficiency, as well as demand for consumption of electric power.

The Paper includes methods developed for calculation of natural gas distribution system parameters. Procedure for technically economical calculations has been improved due to application of geographic information system (GIS), and calculation of the maximum number of customers on the residential territories has been simplified. Proposals have been drafted for simplification of calculation model of gas supply systems, optimization of the loss of pressure, and the key principles applicable to hydraulic calculations of pipelines have been improved to enable reduction of estimated diameters of high-pressure gas-pipes from 7 to 10%, thus making it possible to save on construction costs of new distribution gas supply systems up to 15%.

The results of promotion are used in the standard LVS 417:2011 “Gas distribution and user systems. External gas-pipes and adjustment facilities. Design”, and in the industrial standard LV NS GS 26:2012 “Development of prospective gas supply layout”, as well as for the Bachelor and MA studies in the subject ‘Gas supply systems’ at RTU Heat, Gas and Water Technologies program.

Reports on the results of work have been presented at 8 international conferences and reflected in 10 publications.

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INTRODUCTION

Projects for connecting of new consumers of natural gas, involving the extension of natural gas distribution systems and construction of new gas pipelines, are investment-consuming.

Efficient usage of energy resources, development possibilities of natural gas system, as well as the potential increase of consumption and the effect on the designed systems have been studied by A.Krēsliņš, E.Dzelzītis, A. Dāvis, N.Zeltiņš, V.Zēbergs, A.Ješinska, I.Kudreņickis, I.Platais, A.Joņins, J.Karpjuks. However, there is still lack of methods for designing and construction of new distribution systems, namely, for correct calculation of natural gas consumption and defining of optimum distribution gas-pipe parameters.

The **objective of this Promotion Paper** is development of the methods for calculating correct consumption of natural gas and optimum parameters of gas distribution systems.

The work involves the following tasks:

1. To assess the dynamics of natural gas consumption, calculation methods and regulatory documents applicable to the calculation of natural gas consumption;
2. To conduct research for identification of the actual consumption of natural gas;
3. To draft proposals aimed at increasing the stability of operation of gas suply systems and reduction of construction costs;
4. To draft proposals for adjustment of calculations of natural gas consumption in the National Standard LVS 417:2011 “Gas distribution and user systems. External gas-pipes and adjustment facilities. Design” for adjustment of natural gas consumption.;
5. To draft proposals for development of industrial standard LV NS GS 26:2012 “Development of prospective gas supply layout”.

The results of calculation of gas supply system parameters (diameter of gas pipes, material, loss of pressure) depend on the maximum hourly gas consumption (m^3/h). Technical and economical substantiations – estimations of return on investments – identify the amount of capital investments required for construction of specific gas supply system, the number of user connections during the accounting period in each given year, and the prospective total annual consumption of natural gas (m^3/a) calculated on the basis of heat consumption load of a used of natural gas, with application of factors for transition to natural gas.

Methods and Tools of Study - the sources used in the study include data from information systems of the Joint-Stock company "Latvijas Gāze" - customer database (LOGS) and payment database (PUNS) – regarding the existing users, installed equipment and payments, as well as geographic information system (GIS) – regarding the existing transmission and distribution gas-pipe system. According to the collected data, the method of mathematical statistics was applied to estimate the average statistical annual consumption of natural gas per household, including comparison by different territories of Latvia. Methods for calculation of the maximum hourly consumption were compared, using the factor of hourly maximum and the factor of simultaneous operation of equipment. Hydraulic calculations of gas-pipes have been performed using licensed software "OptiPlan", modeling systems with different load and pressure categories. Technical and economical advantages of each scenario have been identified. The principle of statistic simultaneity has been applied in calculations regarding the groups of natural gas consumers presenting similar regime of operation. Technical and economical substantiation has been developed using Microsoft Excel application to estimate the period of return on investments.

Scientific Novelty and Key Results of the Work - the work included development of methods for optimization of the parameters of distribution systems in order to reduce construction costs of future gas supply systems: correct calculation of natural has consumption taking into consideration simultaneous operation of facilities, season-based irregularity, efficiency factors and power efficiency. The relevant systems were modeled by means of OptiPlan software using the technological properties of pipes that have the effect of reducing the internal roughness of pipes, and the threshold of increasing of natural gas pressure loss was identified. Increased flow of natural has at the calculated stage enabled the reduction of pipe diameters and, correspondingly, the reduction of construction costs.

Practical application of the Work - the developed model for calculation of natural gas consumption and parameters of distributions systems can be used by designers of gas supply systems for construction of optimum technically and economically substantiated gas supply infrastructure, with the possibility to reduce the costs of construction.

1. THE PLANING OF GAS DISTRIBUTION SYSTEM

The purpose of developing the design of prospective gas supply – development of the scheme – is to provide correct technical solution for the prospective construction of gas supply system. Connection providing process is showed in the Figure 1.1. (connection to the existing system – 1, connection to new distribution system construction -2). Development of prospective gas supply design is aimed at the prospective period of 20 years, with due regard to mutually coordinated territorial planning on national as well as regional and local municipal levels, taking into account the existing gas supply distribution and transmission system in the given municipality.

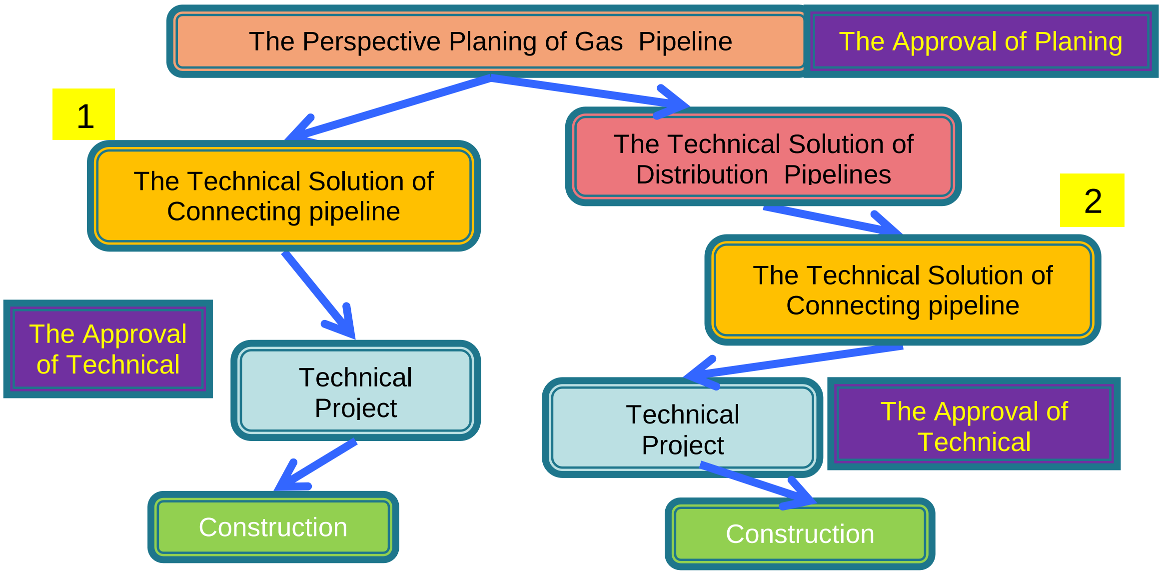


Fig. 1.1 Scheme of gas supply to the users of natural gas

Territorial planning is aimed at facilitating the availability of infrastructure services, including the gas supply system. When developing the design of gas supply, the territory made available by municipalities for construction zoning) and the permitted density has to be taken into account, and consumption of natural gas has to be estimated by each group of users on the given territory. Development of the prospective gas supply schemes for the largest cities of Latvia was based on long-term planning documents regarding the building coverage of territories, intensive industrial development and stable growth of population. Annual consumption of natural gas was calculated on the basis of then applicable construction norms and regulations established in 60s and applied throughout the former Soviet Union, while the maximum hourly consumption was calculated with application of the hourly maximum factor corresponding with the number of population according to long-term estimates.

The work includes analysis of the gas supply schemes developed by various design entities during the period from 1967 to 2002, including the estimated the hourly and annual consumption and the methods for consumption. The maximum hourly rate (m^3/h) of natural gas consumption applied in such schemes was compared to the actual maximum hourly consumption during the most recent five years fixed by means of using the data of remote measure-reading system; summary of the results is presented in figure 1.2.

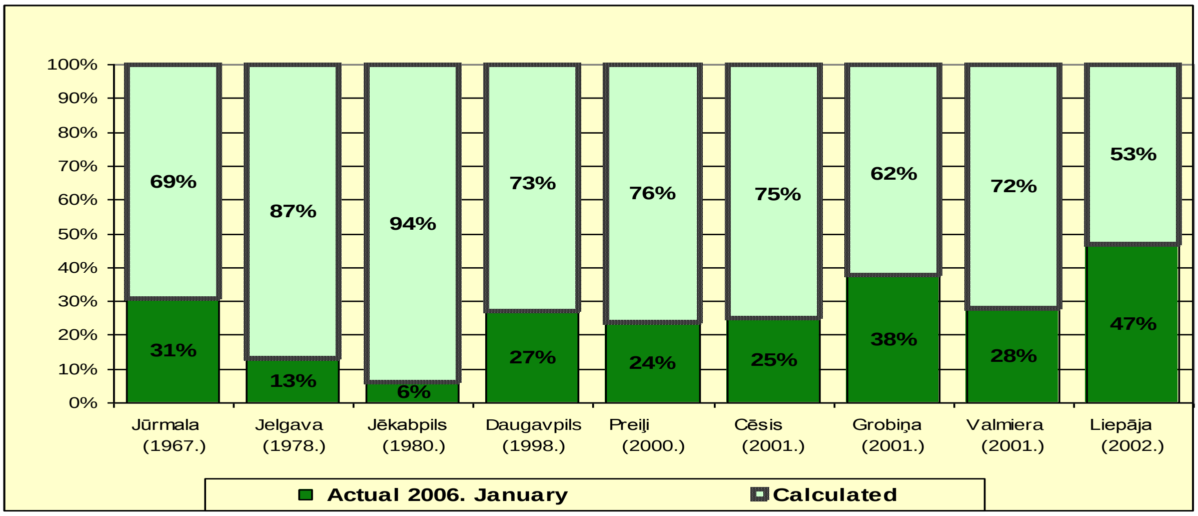


Fig. 1.2. Comparison of the calculated and actual maximum hourly consumption (m3/h) in the gas supply systems of cities (%)

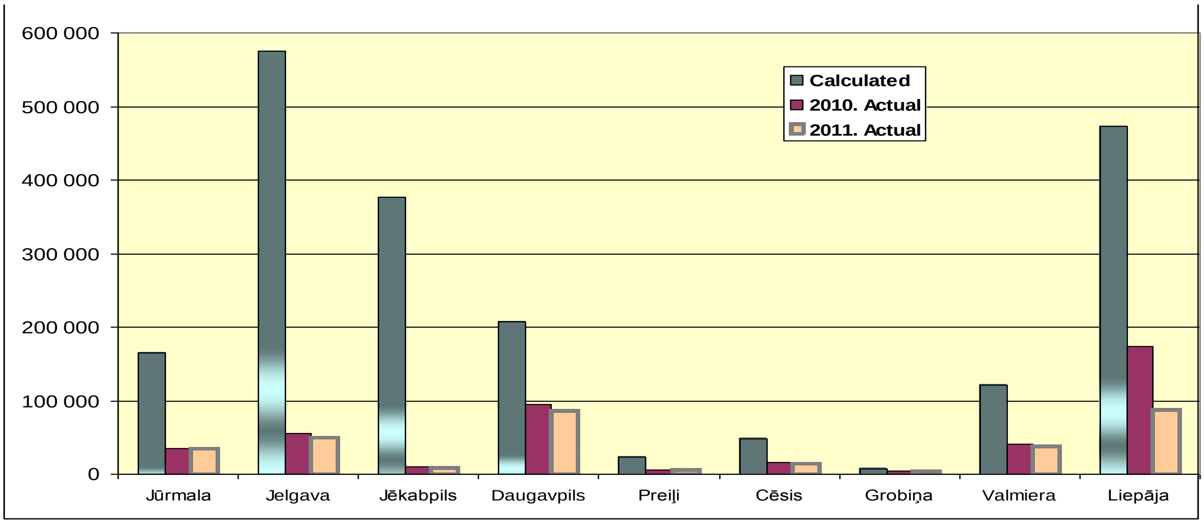


Fig. 1.3. Comparison of the calculated and actual maximum natural gas consumption in 2010, 2011 (m3/a) in the gas supply systems of cities (%)

The comparison between the actual natural gas users in the biggest cities (Jūrmala, Jelgava, Jēkabpils, Daugavpils, Preiļi, Cēsis, Grobiņa, Valmiera and Liepāja) in years 2010 and 2011, and the calculated consumption in gas supply schemas is showed in Figure 1.3.

Analysis of the obtained results lead to conclusion that diameter of the high and medium pressure gas supply distribution systems built in 60s – 90s (basic load pipeline networks) exceed by 20% - 30% the diameters required for present load of natural gas – the maximum hourly consumption (m^3/h). Incommensurably high consumption of natural gas was estimated because no methods had been established for calculation of natural gas consumption. Application of increased maximum hourly consumption of natural has in hydraulic estimates of gas-pipes resulted in requirement for increased diameter of gas-pipes. Gas supply systems were based on calculations with minimum loss of pressure, and it has been established that historically the built systems were not reasonably loaded and therefore excessive consumption of steel pipes was taking place.

2. THE DETERMINING OF NATURAL GAS CONSUMPTIONS FOR GAS SUPPLY SYSTEM DESIGNING

The natural gas consumption is described by the volume of gas supplied for use per time unit. In order to secure technically and economically justified construction of systems of gas pipelines, it is necessary to calculate natural gas consumption. There are the following types of natural gas consumption - annual consumption - $\mathbf{Q_a}$ (m^3/a), monthly consumption- $\mathbf{Q_m}$ (m^3/monthly), daily consumption - $\mathbf{Q_d}$ (m^3/daily), peak hour consumption - $\mathbf{Q_h}$ (m^3/h).

The volume of natural gas consumption is impacted by the types of use of gas, economic situation, political decisions and documents, ambient temperature, household needs and habits. Natural gas consumption is estimated for the following needs - development of the plans of the perspective gas supply system, design of transmission, distribution and users' gas pipelines and facilities construction, reconstruction and replacement of gas pipelines systems and facilities. Annual and monthly consumption of natural gas is calculated and applied for the assessment of the eventual investment in planned gas supply systems of cities or settlements and for the purpose of assessing the profitability of a construction project. However, for the purpose of developing technically and economically justified distribution gas supply systems by selecting optimum diameters or gas pipelines, it is necessary to calculate maximum hourly consumption indices, in compliance with the Latvian standards, regulatory documents. For the purpose of calculating natural gas supply transmission systems, the calculated daily consumption of natural gas is applied.

Users of natural gas (consumers) are split into the following groups:

- households – for cooking, heating, hot water production and power generation in future,

- business, catering, consumer services providing companies - for heating, ventilation, hot water production, cooling, technologies, power generation,
- industry and agricultural companies, for heating, ventilation, hot water production, cooling, technologies, power generation.

Two methods for calculating the maximal hourly consumption in households and commercial companies were used in the Standards of Latvia LVS 417:2002 till the year 2011. Method No. 1 - by application of the maximum hourly consumption coefficient, which is applied for the transition from the annual consumption (m3/a) to the maximum hourly natural gas consumption (m3/h), depending on the number of residents:

$$Q_d^h = K_{\max}^h \times Q_a , \quad (2.1)$$

where $K_{\max}^h$ - the hourly maximum coefficient,

Q_a - annual gas consumption, m^3/a.

This method was used for calculating the maximum hourly gas consumption for all groups of consumers - for residents, for consumer services, industrial, and agricultural companies. The numerical values of the maximum hourly gas consumption are provided for in construction standards and regulations.

Method No. 2 - by application of the simultaneous operation coefficient for individual residential houses and public buildings the calculated hourly natural gas consumption Q_d^h (m3/h) is determined based upon the formula (2.2), by summing the rated gas consumption which is consumed by gas devices and taking into account their simultaneous operation coefficient.

$$Q_d^h = \sum_{i=1}^{m} K_{sim} \times q_{nom} \times n_i , \quad (2.2)$$

where $Q_d^h = \sum_{i=1}^{m}$ - indices $K_{sim} q_{nom} n_i$ multiplication sum from i to m;

K_{sim} - the simultaneousness coefficient,

q_{nom} - the nominal gas consumption of a device or a group of devices as specified in the device documents or the technical description, m3/h;

n_i - the number of the devices of the same type or a group of devices, pcs;

m - the number of types of devices or groups of devices, pcs.

According to the currently valid Standard of Latvia LVS 417:2011, similarly to the regulatory documents referred to above, the hourly gas consumption of detached houses, apartment houses, business companies, consumer services and catering companies Q_d^h (m3/h) is calculated according to the formula (2), by means of adding the rated gas consumption of gas devices and taking into account the coefficient of their simultaneous operation. When the maximum hourly natural gas consumption indices are calculated, the type of installed devices (a gas cooker with four or two rings), their number which is installed in detached residential houses and apartment houses in the particular territory has to be taken into account.

Group of scientists from the Institute of Physical Power Industry of Latvian Academy of Science managed by N.Zeltiņš, V.Zēbergs, I.Kudreņickis carried out research to establish the norm of heat consumption and corresponding application of the respective norms of gas consumption to estimates related to gas supply networks. It was established as a result of such research that the actual consumption of natural gas was by 20% to 40% smaller than estimated in regulatory documents. The results of research were not taken into consideration for the purposes of drafting the Standard LVS 417:2002. The sources used in the Promotion Paper include statistic data collected by the Information System (PUNS) in 2010 regarding the total consumption of natural gas by households. Mathematical statistic method has been applied to estimate the average consumption of natural gas by groups of users, and dynamics of consumption in different cities has been analyzed. Research data regarding the average actual consumption of natural gas by households in multi-residential buildings in Latvia where natural has is used for household needs are summarized in Table 2.1 and presented in Fig. 2.1.

Table 2.1

Annual natural gas consumption (m3/h) per user per apartment
in Daugavpils, Cēsis and Liepāja district areas

Territory	Number of gas cookers (Pcs)	Annual consumption (thous. m^3/a)	Average annual consumption per apartment (m^3/h)
Daugavpils division			
Daugavpils city	27,907	1,677 326	60.10
Preiļi city	2,380	129,814	54. 54
Total in Daugavpils division	30,287	1,807,140	59.67
Cēsis division			
Cēsis city, Priekuļi, Līgatne, Amata districts	3971	237,070	59. 70
Sigulda city, Sigulda district	3857	316,920	82.16
Valmiera city, Valmiera, Burtnieki, Kocēni, Smiltene districts	5986	350,251	58.51
Total in Cēsis division	13,814	904,241	65. 46
Liepāja division			
Liepāja city, Liepāja district	24,219	1,530,745	63.20
Grobiņa city	882	52,304	59.30
Saldus city, Saldus district	2087	151,485	72.59
Total in Liepāja division	27,188	1,734, 534	63.80

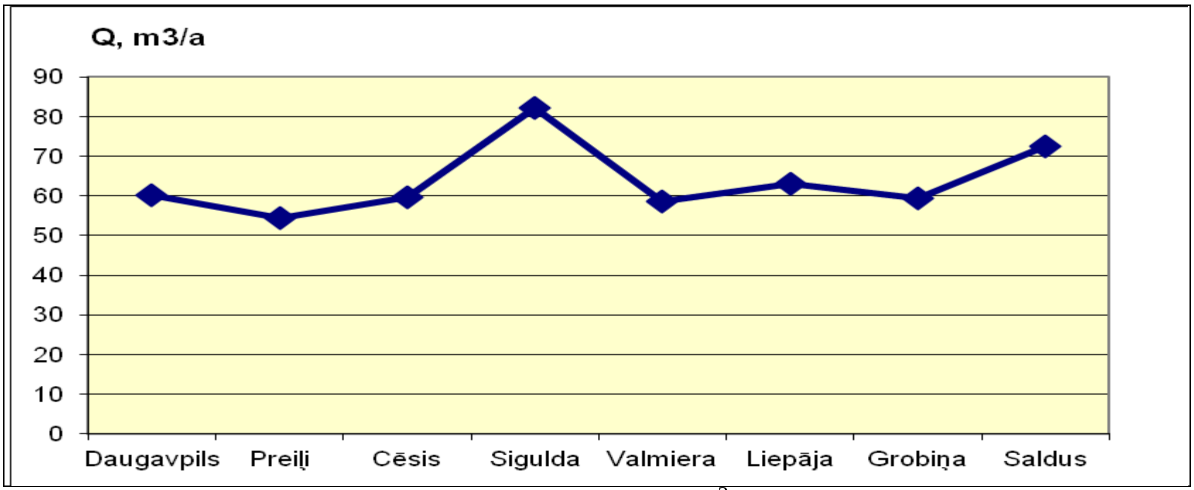


Fig. 2.1. Average annual natural gas consumption (m^3/a) for users in a single apartment in the areas of Daugavpils, Cēsis and Liepāja divisions

The promotion work included study of the consumption of natural gas on different territories of Latvia, namely, in the regions of Liepāja, Cēsis, Daugavpils, and Riga, to establish correct methods of estimating natural gas consumption for the calculation of future parameters of distribution systems. Consumption of natural gas at multi-residential buildings has notably decreased along with the increased number of electrically driven household appliances. Statistic data regarding the monthly and annual consumption of natural gas have been used to estimate the actual monthly and annual consumption of natural gas per household, based on the assumption of three members of each household (the average number according to the data of Central Statistics Board). Comparison of the actual consumption and annual consumption calculated for gas supply schemes is presented in Figure 2.2.

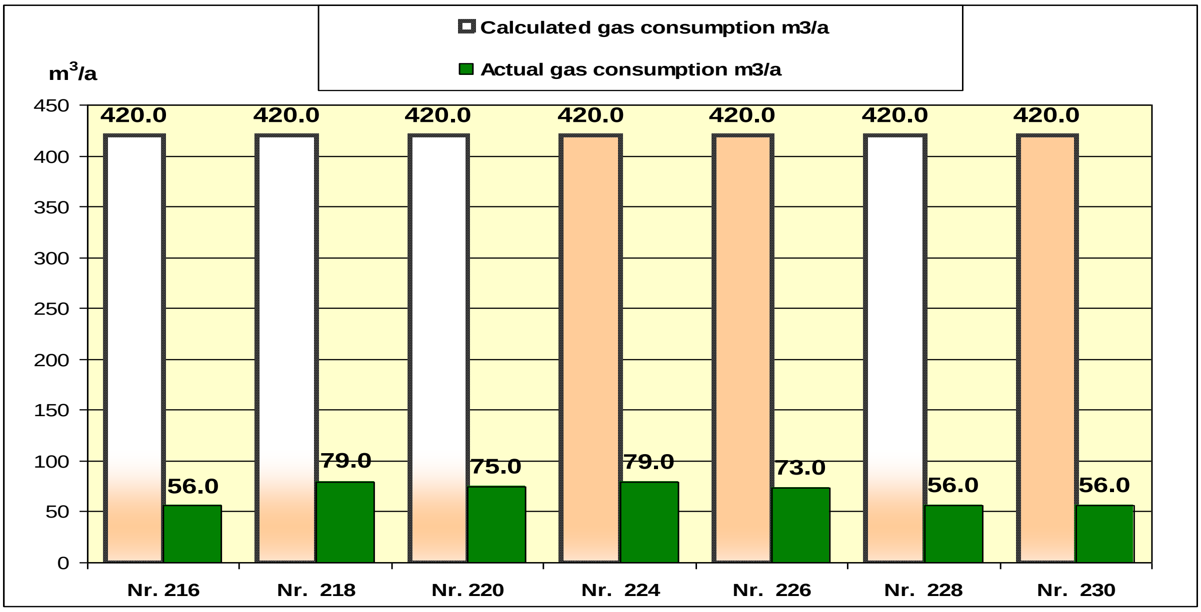


Fig. 2.2. Comparison of the calculated and actual natural gas consumption for an apartment in apartment houses at Biķernieku street No.216, 218, 220, 224, 226, 228, 230 in Riga.

Statistical analysis performed in the most recent five years shows that increase of efficiency and power efficiency of devices and increased demand for electric power leads to decrease of annual consumption of natural gas for industrial and agricultural purposes, including consumption by households has decreased by 16%. The average actual annual consumption in case of apartment buildings 70 m^3/a, and in case of family houses 2700 m^3/a.

3. THE OPTIMIZATION OF DISTRIBUTION GAS SUPPLY SYSTEM PARAMETERS

To ensure uninterrupted gas supply to all users of natural gas in the conditions of maximum hourly gas consumption (m^3/h), the optimum parameters of gas supply systems need to be defined (diameters, loss of pressure, and the speed of natural gas flow). The promotion work includes assessment and comparison of calculation principles applied to gas supply systems according to the regulatory documents in Latvia, Germany, Lithuania, Estonia, the former USSR, and Russian Federation, respectively. Loss of pressure in medium and high pressure networks is calculated according to the formula:

$$P_s^2 - P_b^2 = \frac{P_0}{81 \times \pi^2} \times \lambda \times \frac{Q_0^2}{d^5} \times \rho_0 \times l = 1{,}2687 \times 10^{-4} \times \lambda \times \frac{Q_0^2}{d^5} \times \rho_0 \times l, \qquad (3.1.)$$

Formula applicable to calculation in case of low pressure networks:

$$P_s^2 - P_b^2 = \frac{10^6}{162 \times \pi^2} \times \lambda \times \frac{Q_0^2}{d^5} \times \rho_0 \times l = 626{,}1 \times 10^{-4} \times \lambda \times \frac{Q_0^2}{d^5} \times \rho_0 \times l, \qquad (3.2.)$$

where P_s - absolute pressure at the input of gas-pipe, MPa;

P_b - absolute pressure at the output of gas-pipe, MPa;

P_0 - =0.101325 (MPa);

λ - hydraulic friction factor;

l - length of gas-pipe with constant diameter, m;

d - internal diameter of gas-pipe, cm;

ρ_0 - density of gas in standard conditions, kg/m^3;

Q_0 - consumption of gas in standard conditions, m^3/h.

Hydraulic friction factor λ is determined depending on the flow regime (laminar, turbulent) of gas movement in the pipeline, and it is described by Reynolds Number (Re):

$$\mathrm{Re} = \frac{Q_0}{9 \times \pi \times d \times \upsilon} = 0{,}0354 \frac{Q_0}{d \times \upsilon}, \qquad (3.3.)$$

$$\mathrm{Re}\left(\frac{n}{d}\right) < 23, \qquad (3.4.)$$

where υ - kinematic viscosity factor of gas in standard conditions;

d - internal diameter of gas supply, cm;

Q_0 - consumption of gas in standard conditions, m^3/h ;

n - equivalent absolute roughness of internal wall of the pipe,

Hydraulic calculations of gas-pipes are made according to the formula described in (3.1-3.4.) above. Methods for calculation of pipe networks have experiences significant changes in the most recent 20 years, with the introduction of software such as Caddy, OptiPlan. Models for calculation of gas supply systems are also drafted digitally in frames of reference, using geographic information system (GIS) where data are stored regarding the parameters of piping system, such as design pressure and operational pressure, material of pipes (steel, polyethylene), their length and pressure of gas flow. Calculation of pipeline network starts from developing by mans of software a mathematic network model which presents a mathematical and possibly feasible layout of gas supply system. The use of software is flexible, and the data are available for exporting to Microsoft Access. A model calculation developed by software OptiPlan is presented in Figure 3.1.

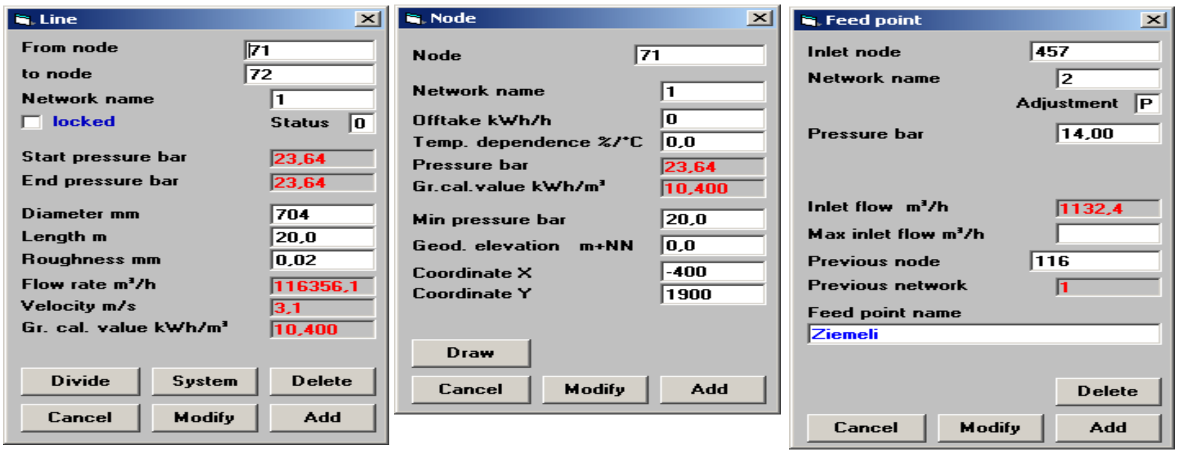


Figure 3.1 Tables of parameters (line, focal point, gas supply point) OptiPlan

To reduce the possibility of errors eventually occurring upon entering the calculated consumption of natural gas (m3/h) to the focal load points of the model net, the possibility was analyzed in course of drafting the Promotion Paper to use the data collected in PUNS database about the devices installed by the existing users of natural gas and proposals were developed for consequent matching of such data with the model calculation in OptiPlan software. When calculating hydraulic estimates of gas-pipes by means of software, the calculated gas-pipe parameters (diameter, material, length of spans of gas-pipes) are imported to Access database, and construction volumes may then be identified using Excel.

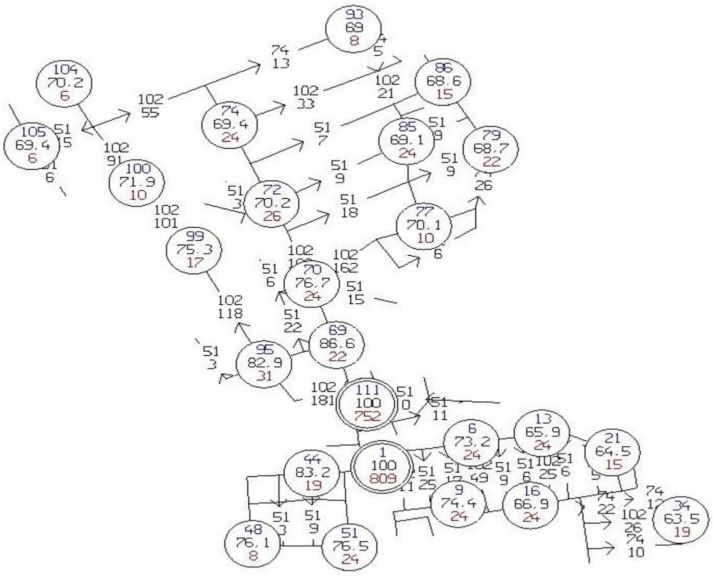


Figure 3.2 Example of model calculation

Analysis of hydraulic calculation methods has been performed to assess and compare the results of manual calculations with those obtained using OptiPlan and Caddy.

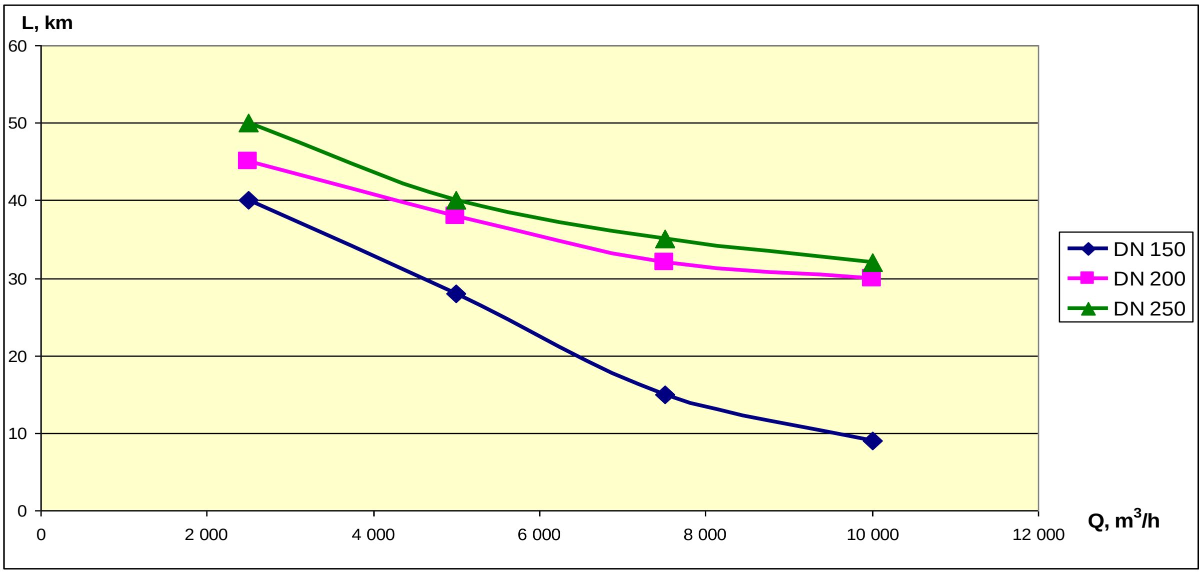


Figure 3.3 Operation distance of high pressure PN≤1.6 MPa gas supply distribution system

The work includes estimates of gas-pipes for high pressure gas supply systems PN≤0.6 MPa, PN≤1.2 MPa, PN≤1.6 MPa, and the optimum operational distances (range) of gas supply systems have been estimated for eventual specific consumption of gas Q (2500 m^3/h, 5000 m^3/h, 7500 m^3/h, 10 000 m^3/h), see figures 3.3 and 3.4.

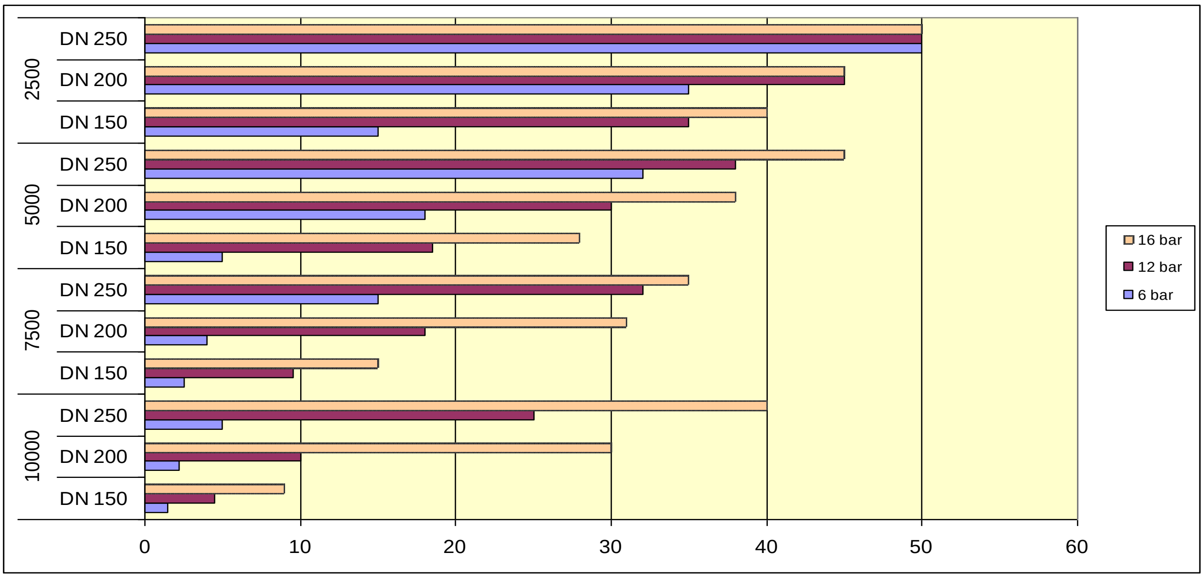


Figure 3.4 Comparison of operation distance (km) of high pressure gas supply systems (DN 150, 200, 250 mm, gas consumption 2500, 5000, 7500, 10 000 m^3/h)

Regulations effective before 2011 stipulated the following permissible loss of natural gas pressure: for high pressure gas-pipes – 0.15 to 0.2 MPa, for medium pressure gas-pipes under 0.1 MPa above the lower limit of the category of medium pressure. Improved –technology for production of pipes enables significant reduction of internal roughness in pipes made of polyethylene and steel, and friction factor is also decreased. Technical parameters of gas adjustment equipment are improved, and the difference between input and output gas pressure does not need to exceed 0.05 MPa. It is possible to increase the amount of flow in the calculation stage. Pipeline hydraulic calculations for high pressure P<0,6 MPa gas supply system were carried out, modelling variety of loading - 2000 (m^3/h), 4000 (m^3/h), 6000 (m^3/h), 8000 (m^3/h); using software OptiPlan the diameters of pipelines and the loss of pressure (ΔP) were calculated, as well the optimal technical solutions were evaluated, system parameters designed. As a result of calculations, it is possible to reduce the diameters of high pressure gas pipelines from 7% to 10%.

4. THE RECOMMENDATION FOR DECREASING THE COSTS FOR NEW GAS SUPPLY SYSTEMS

Specific gasification procedure is established to provide gas supply to each prospective user of natural gas and to develop safe and stable gas supply system: layout (scheme) of gas supply – technical solution – detail design – construction - launching. Financial conditions of gas-pipe construction are approved with due regard to the tariff structure and capital investment efficiency rate estimated by supplier of natural gas. Exact distribution of costs between the supplier and user of natural gas may only be specified when the specific detail design and economic substantiation is drafted. Economical estimates of new gas-pipe construction are made using model algorithms and specific forms reflecting the expected/actual structure of costs: topography, design and construction costs as well as costs related to compensation for land and other costs. Project pay-of period is defined as the projected number of years required for full compensation of investments. The internal return rate (IRR) is the discount rate application of which makes the future benefits and costs of the project equal to the original investments. Cost-benefit ratio index (RI) means the ratio of discounted project value against the amount of investments, Return rate of the project enables comparison of investment projects with different costs and income flows.

Selection of the optimum project is based on efficiency estimate of a cost unit or cost-benefit ratio calculated according to the formula (4.1):

$$RI = \frac{NPV}{PC} \times 100\% \quad , \tag{4.1}$$

where RI – cost-benefit ratio index,

NPV – cash income (LVL),

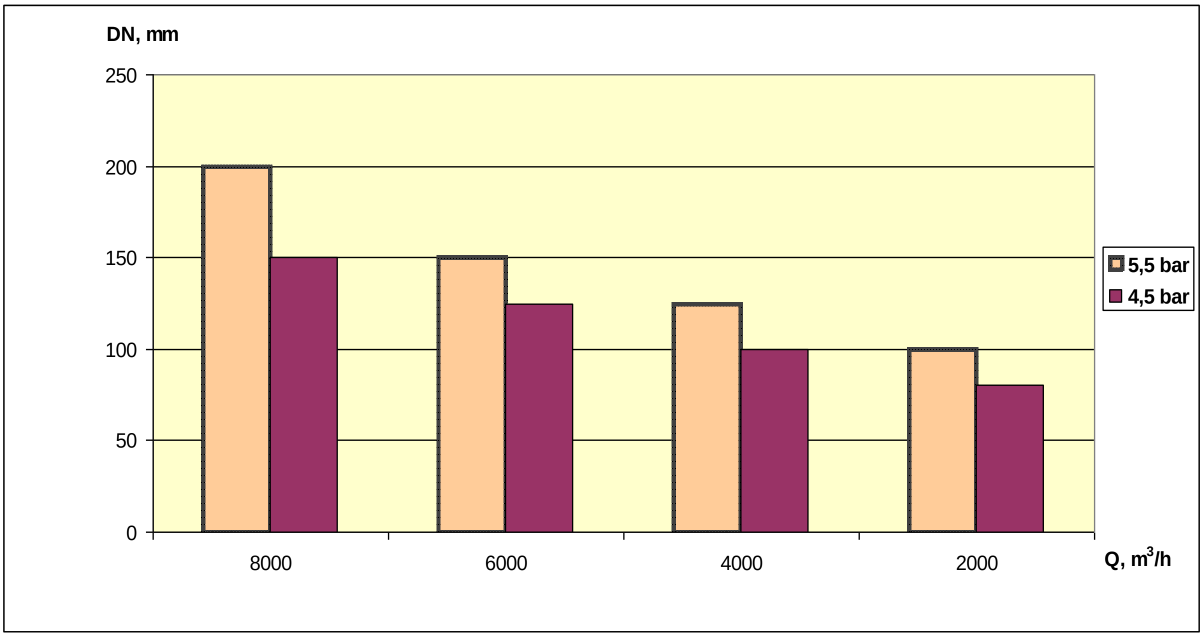
PC – amount of investment (LVL).

Construction of new distribution mains is launched in construction areas, cities and villages with cost-benefit ratio index RI ≥1. With reference to research conducted regarding the actual load on the existing gas supply system and pay-off conditions of investments, the Promotion Paper recommends the prospective volume of natural gas consumption to the prospective users of system connected to the new gas-pipe. On the basis of researches for the optimization of pipeline parameters (diameter, pressure, flow amount) carried out during the elaboration of promotion paper, it is concluded that the saving on construction costs for new distribution system construction is possible up to 15%, see Table 4.1. and Figure 4.1.

Table 4.1

Decrease of costs

Pressure of natural gas (bar)	Consumption of natural gas (m^3/h)	Decrease of diameters (mm)	Decrease of costs (LVL/1000 m)
5,5 / 4,5	2000	100 / 80	8 7300
5,5 / 4,5	4000	125 / 100	1 6900
5,5 / 4,5	6000	150 / 125	9 0900
5,5 / 4,5	8000	200 / 150	16 5800



4.1. fig. Pipeline diameter calculation depending of pressure loss in the calculation stage

In order to improve gas supply planning developments, the procedure of performing tecnically economical calculations, as well as optimizing the gasification process of construction sites, the following proposals are developed regarding the procedure for gas supply distribution system project designing:

- On the basis of territory planningd by municipalities, natural gas user groups - individual, multi-storey, mixed building, industrial and agriculture territory, must be defined;
- Calculation of the maximum number of customers in family-house communities within the given construction site can be made on site basis using the geographic information system (GIS) where the expected gas supply system is reflected as well as the relevant cadastral information,
- Identification of correct maximum hourly and annual consumption of natural gas,
- Modeling of optimum gas supply systems with the use of OptiPlan software, including assessment of the loss of pressure,
- When calculating hydraulic estimates of gas-pipes by means of software, the calculated gas-pipe parameters (diameter, material, length of spans of gas-pipes) are imported to Access database, and construction volumes may then be identified using Excel.
- Drafting of economical calculations.

CONCLUSIONS

1. It has been established that in case of high and medium pressure distribution gas-pipes built in the cities of Latvia before late 90s (both transit and basic load pipes) the diameters exceed by 20 – 30% the figures required for present load of natural gas – the maximum hourly consumption (m^3/h):

- It has been demonstrated that increased maximum hourly consumption is used in the relevant calculations without taking into consideration either simultaneous operation of devices of the users of natural gas or the seasonal principle;
- Diameters of distribution gas-pipes are estimated with minimum loss of pressure, thus the diameter of gas-pipes is notably increased.

2. Statistic analysis conducted in the most recent five years shows that consumption of natural gas by industrial and agricultural sector is reduced, including consumption by households reduced by 16%, due to increased efficiency factor and power efficiency, as well as demand for consumption of electric power (increased by 180% in 20 years).
3. The average actual annual consumption by households in Latvia makes: apartment buildings - 65 m^3/a, family houses - 2700 m^3/a.
4. The Paper presents methodology for calculation of natural gas distribution system parameters and improved procedure for making technical and economical calculations:

- Calculation of the maximum number of customers in family-house communities within the given construction site can be made on site basis using the geographic information system (GIS),
- When calculating hydraulic estimates of gas-pipes by means of software, the calculated gas-pipe parameters (diameter, material, length of gas pipelines) are imported to Access database, and construction volumes may then be identified using Excel.

5. Improved technologies developed in the last twenty years for production of pipes enables significant reduction of internal roughness in pipes made of polyethylene and steel, and friction factor is also decreased. Technical parameters of gas adjustment equipment are improved (and the difference between input and output gas pressure does not need to exceed 0.05 MPa and it is possible to increase the loss of pressure and to reduce the estimated diameter of high pressure gas supply
6. The following proposals are developed regarding the procedure for new gas supply distribution system projects, thus saving on construction costs of new gas supply distribution systems up to 15 %.
7. The results of promotion are used in the standard LVS 417:2011 "Gas distribution and user systems. External gas-pipes and adjustment facilities. Design", and in the industrial standard LV NS GS 26:2012 "Development of perspective gas supply layout"

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