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The major characteristic parameters of the Estonian district heating networks and their efficiency increasing potential

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During the last years, essential changes have taken and are still taking place in both the economic and the engineering environments of the energy sector. In the Estonian energy market, prices of electricity and heat for all consumer groups have increased significantly. The poor condition of networks decreases the prospects of centralised heating, and consumers prefer local heating. Often, local heating is not an effective solution for a regional heat supply system and decreases the potential of combined heat and electricity production. The poor thermal insulation and over-dimensioning of pipes causes high heat losses. The present work gives examples of the economic optimisation of new pipelines. The Estonian old non-optimised district heating networks are compared with new optimised networks. The network efficiency increasing potential has been found. The results are practically useable in DH (district heating) pipeline design and in the renovation of old district heating networks.

Key words: district heating, Estonia, networks, efficiency, potential

1. INTRODUCTION

Over the last years, essential changes have taken and are still taking place both in the economic and the engineering environments of the energy sector. In the Estonian energy network, prices of electricity and heat for all consumer groups have increased significantly.

The structure and volumes of heat consumption have changed significantly. In many settlements, the district-heating (DH) network developed on the basis of the boiler house of the dominating industrial enterprise, and by now the network has been separated from the enterprise which often has either changed the production structure or is not in operation any more. District heating networks are over-dimensioned. The over-dimensioning and poor heat insulation causes high heat losses (around 18.5% [1]); for instance, in Finnish district heating networks, heat losses are in the range of 6–7% [1] and in Sweden 7–9% [2]. Relative heat losses in Russian DH networks are higher – 15–30% [3]. The Estonian district heating networks are 20–40 years old and need to be renovated in the near future to ensure an efficient and reliable heat supply.

The poor condition of DH networks and the unreliable heat supply can decrease the prospects of district heating, and consumers may prefer different heat supply alternatives. Often, decentralised heating is a not effective solution for regional heat supply strategy and decreases the potential of combined heat and power production.

An objective estimation of district heating networks and the technical-economic argumentation for their renovation should be carried out to increase the combined heat and electricity production.

The main characteristic parameters of the Estonian district heating networks and their difference from the optimal values are estimated for the first time and compared to one another and with the typical networks in Sweden. The network efficiency factors are considered. The current work presents the actual conditions of pipe thermal insulation in Tallinn and other Estonian towns. To evaluate it, was created a model based on heat losses determined from district heating network heat balances was compiled.

The aim of the current work was to estimate the main characteristic parameters of the Estonian district heating networks and their difference from the optimal values.

We give examples of new pipelines' economic optimisation. The Estonian old non-optimised district heating networks are compared with new optimised networks. The efficiency increasing potential of the old networks was found.

2. METHODS

2.1. The major characteristic parameters of the DH network

The major characteristic parameter for estimating the efficiency of the district heating networks is the heat loss factor q_{hlf}. The heat loss factor is a ratio between heat loss and the quantity of heat supplied to a district-heating network. The heat loss factor does not depend on the efficiency of the pipe insulation alone. It depends also on the following parameters:

- the overall heat transfer coefficient K_o, in W / (m$^2 \cdot$ K), which characterizes the efficiency of pipe insulation;

- the specific surface area of the distribution pipes A / L, in m^2/m, which characterizes the average size of district heating pipes;
- the degree-hours number $\int \Theta d\tau$, in °C · h, which indicates the level of water distribution temperature relative to the annual average of the outdoor temperature;
- the specific heat supply Q / L, in MW · h/m, which characterizes the concentration of the district heating demand,

where

A – surface area of the distribution pipes, m^2;

L – piping length, m;

Θ – difference between water average temperature and outdoor temperature, °C;

τ – water average temperature and outdoor temperature difference duration time, h;

Q – the annual quantity of heat supplied to the district-heating network, MW · h.

The overall heat transfer coefficient can be calculated on the basis of design data of the district networks or estimated from heat loss measurements. In the present work, the overall heat transfer coefficient is calculated on the basis of annual heat losses. Annual heat losses are calculated as a difference between the heat supplied to the district heating network and the heat measured at the consumers. The relative error of the heat-flow meters is within ± 2... ±5%, depending on the load.

The heat loss factor is

$$q_{hlf}=\frac{Q_{hlf}}{Q}=\frac{K_o\cdot A\cdot\int\Theta d\tau}{Q}=K_o\cdot\frac{(A/L)\cdot\int\Theta d\tau}{(Q/L)}, \quad (1)$$

where

Q_{hlf} – the annual distribution heat loss, MW · h.

The overall heat transfer coefficient K_o is calculated as

$$K_o=\frac{q_{hlf}}{\left[\dfrac{(A/L)\cdot\int\Theta\, d\tau}{(Q/L)}\right]}, \mathrm{W} / (\mathrm{m}^2\cdot K). \quad (2)$$

The average diameter of the district heating pipes d_a is

$$d_a=\frac{A/L}{2\cdot\pi}, \mathrm{m}. \quad (3)$$

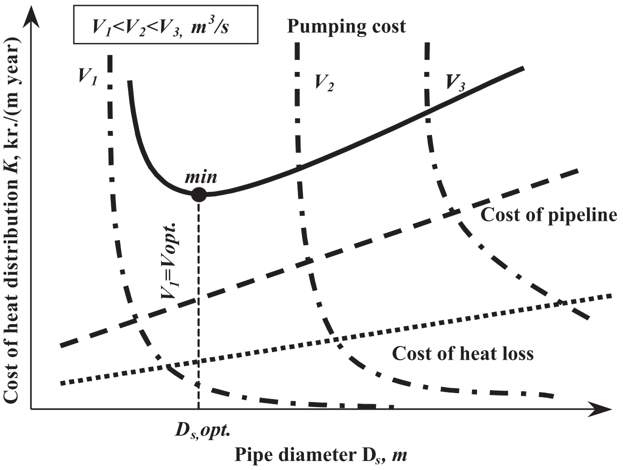

Fig. 1. Pipe diameter economic optimisation

For analysing district heating network efficiency, the heat loss factor can be divided into two parts: the overall heat transfer coefficient and the distribution parameter. The distribution parameter

$$q_{dp}=\frac{q_{hlf}}{K_o}=\frac{(A/L)\cdot\int\theta\, d\tau}{(Q/L)}, (\mathrm{m}^2\cdot \mathrm{K}) / \mathrm{W}. \quad (4)$$

2.2. Optimal selection of DH network pipe diameters

The question of how to select the optimal diameter of pipes in which a fluid is transported represents a classical optimisation problem [4–7]. Figure 1 shows qualitatively how an economic optimum can be found for the diameter of a district heating pipe. The total cost is the sum of costs for pipeline installation, for heat losses, and for the pumping power. Of these three cost elements, the costs of pipeline installation and heat losses increase their values strongly with the diameter, while the pumping power drops rapidly ($K_{pumping} \sim D_s^5$) with increasing the diameter.

Optimisation of this kind usually assumes that the flow rate is constant when the diameter is varied. This method was developed to be as simple as possible yet complete and accurate enough for design calculations.

Dynamic simulation models of district heating networks are also very popular today. One type of mathematical model involves a full physical modelling of the network [8], and in another type of model DH network is replaced by a simplified one [9].

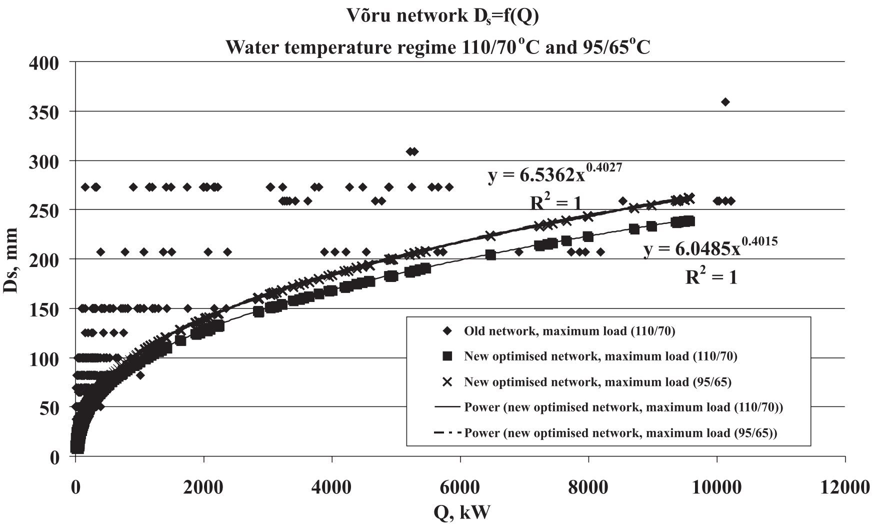

Fig. 2. Optimal diameter depending on heat load $D_s = f(Q)$ in Võru town DH network

In practice, if you design a network, the optimal values of pipe diameter, friction losses, water velocity and supplied heat load are presented by the power equations:

$$D_{s,opt} = C_1 \cdot Q^{n_1}\text{, m} \tag{5}$$

$$R_{l,opt.} = C_2 \cdot D_s^{n_2}\text{, Pa/m} \tag{6}$$

$$\omega_{opt.} = C_3 \cdot D_s^{n_3}\text{, m/s} \tag{7}$$

where the values of constants C_1, C_2, C_3, and powers n_1, n_2, n_3 depend on heat distribution cost.

In the next calculation examples, the optimal values of pipeline diameters, water velocities, friction losses and heat loads were obtained using the graphical method. Optimal values are compared with a network real operation data.

If we have an optimal diameter value, the heat loss cost is higher than the pumping cost. Heat loss costs have only an insignificant influence on the optimal diameter value. Changes in

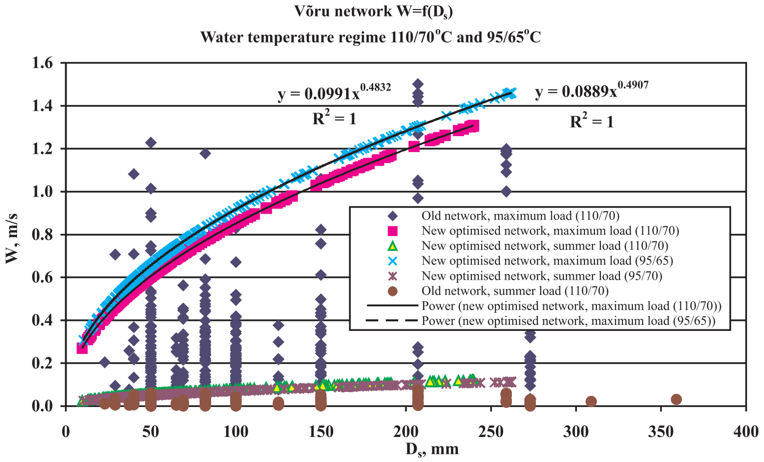

Fig. 3. Water velocity depending on pipe diameter $\omega = f(D_s)$ in Võru town DH network

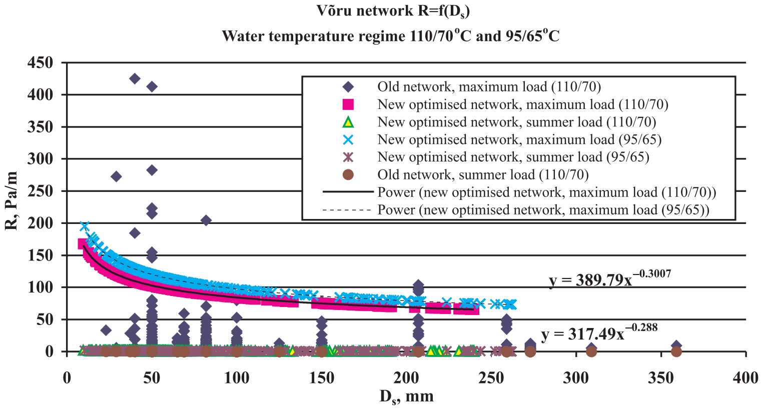

Fig. 4. Friction losses in Võru town DH network depending on pipe diameter $R_l = f(D_s)$

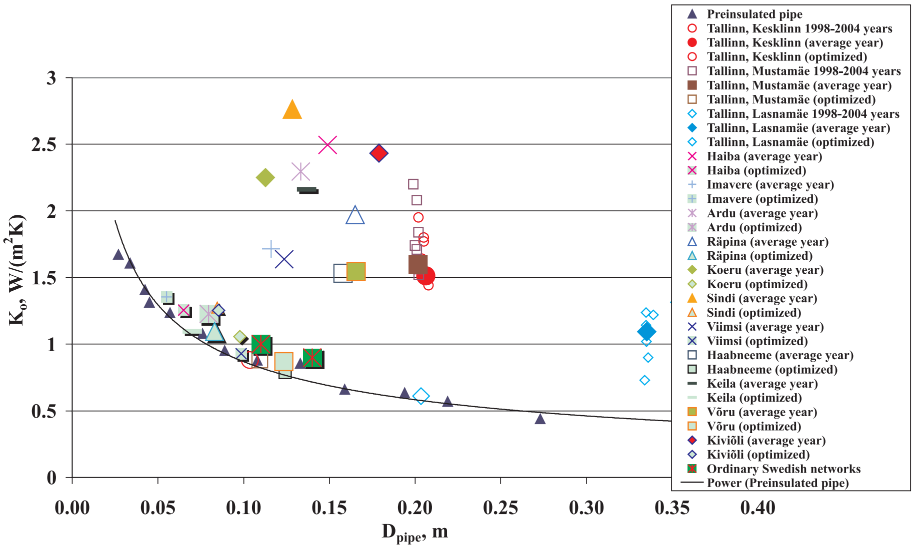

Fig. 5. Total overall heat transfer coefficient for old and new optimised Estonian district heating systems, depending on the average diameter of pipes (1998–2007)

heat losses practically did not influence the optimal diameter value, of course, invreasing the heat distribution costs. The total cost curve moves vertically up when heat losses are increasing, and it goes down when they are decreasing; at the same time, the value of the optimal diameter practically does not change.

We can conclude that the value of pipe optimal diameter is mainly affected by the water difference temperatures. The water flow is determined by the heat load and depends on the difference of supply and return water temperatures. Other costs did not have such a great influence on the diameter optimum value, they mainly move the total cost curve in vertical direction up or down with a very small decrease or increase of the optimum value.

The growing of pipes and network building cost causes a moderate decrease of the pipes optimal diameter.

The pumping cost depends on the electricity cost. The pumping cost close to the optimal value of diameter is low as compared to the other costs (pipes and network building, heat losses). Even when the electricity prices double, pipe optimal diameter value grows only a little. The total cost curve moves somewhat right to the bigger diameters.

We can conclude that the optimal value of the diameter mainly depends on the ratio of pumping and network building costs. The pumping power drops rapidly ($K_{pumping} \sim D_s^5$) with the diameter increasing, and at the same time the costs of pipes and network building grow moderately.

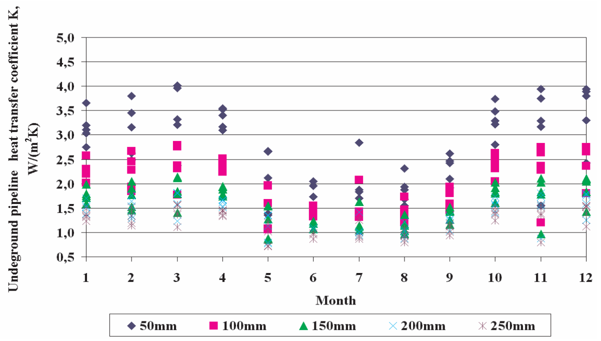

Fig. 6. Heat transfer coefficient for Võru town Võrusoo network pipes depending on climate condition differences (rainwater) during the year

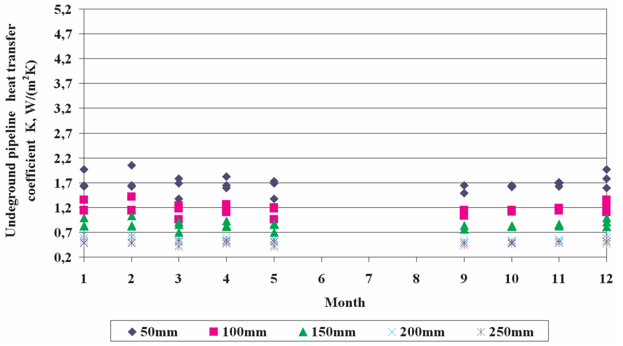

Fig. 7. Heat transfer coefficient for Orissare town network pipes depending on climate condition differences (rainwater) during the year

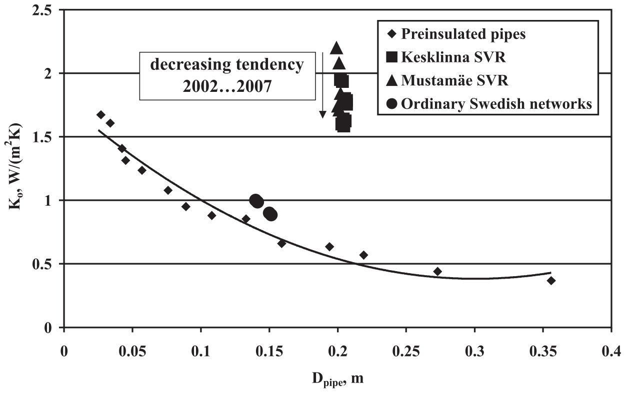

Fig. 8. The overall heat transfer coefficient reduction tendency in Tallinn DH networks (2002–2007)

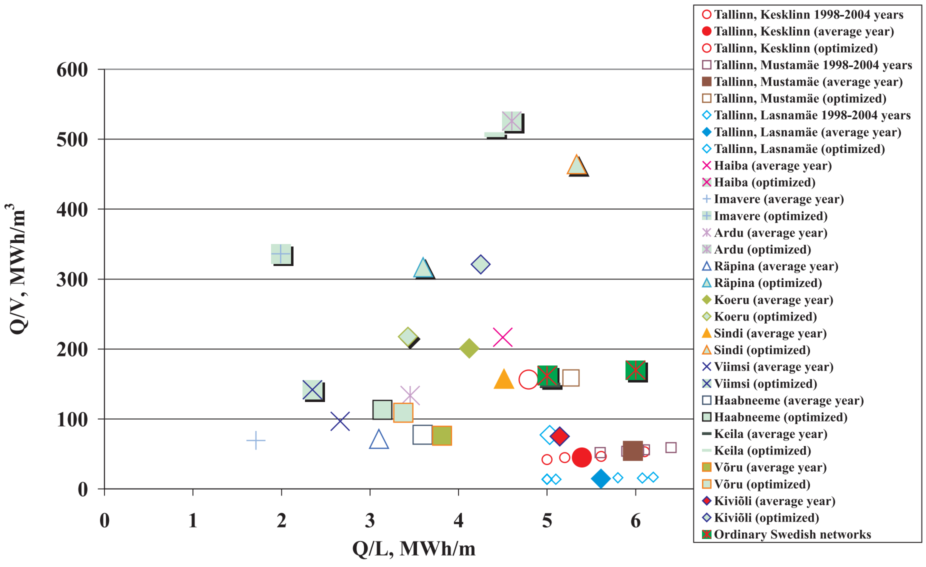

Fig. 9. The specific volume heat supply for old and new optimised Estonian district heating networks depending on the specific length heat supply (1998–2007)

Table 1. **The major characteristic parameters of the Estonian district heating networks before and after prospective optimisation**

DH network	Degree-hours, 10^5 °Ch	q_{hlf}	*L*, m	d_a, m	*A* / *L*, m^2/m	*V* / *L*, m^3/m	*Q* / *L*, MWh/m	*Q* / *V*, MWh/m^3	Q_{hl} / *L*, MWh/m	K_o, W / (m^2K)	Q_{dp}, (m^2K) / W
a) Supplied heat 5000 mWh / year											
Haiba											
old network	5.0	0.26	597	0.149	0.94	0.02	4.5	217	1.2	2.5	0.10
new optimized network	5.0	0.05	405	0.065	0.41	0.01	6.7	684	0.2	1.3	0.04
Imavere											
old network	3.3	0.24	1905	0.116	0.73	0.03	1.71	69	0.4	1.7	0.14
new optimized network	5.1	0.13	1599	0.055	0.35	0.01	1.99	336	0.2	1.4	0.09
Ardu											
old network	2.0	0.11	982	0.133	0.84	0.03	3.5	134	0.4	2.3	0.05
new optimized network	4.0	0.05	1212	0.080	0.50	0.01	4.6	526	0.2	1.2	0.04
b) Supplied heat 5000–10000 MWh / year											
Räpina											
old network	3.1	0.20	1732	0.165	1.04	0.04	3.1	72	0.6	2.0	0.10
new optimized network	5.1	0.08	1374	0.083	0.52	0.01	3.6	317	0.3	1.1	0.07
Koeru											
old network	4.0	0.15	2390	0.113	0.71	0.02	4.1	201	0.6	2.2	0.07
new optimized network	4.0	0.08	2630	0.098	0.61	0.02	3.4	218	0.3	1.1	0.07
Sindi											
old network	2.4	0.12	2139	0.128	0.81	0.03	4.5	157	0.5	2.8	0.04
new optimized network	3.9	0.05	1889	0.085	0.53	0.01	5.3	464	0.2	1.3	0.04
c) Supplied heat 10000–50000 MWh / year											
Viimsi											
old network	4.5	0.22	3921	0.124	0.78	0.03	2.7	97	0.6	1.6	0.13
new optimized network	4.5	0.11	3921	0.099	0.62	0.02	2.4	142	0.3	0.9	0.12
Haabneeme											
old network	5.0	0.21	4800	0.158	0.99	0.05	3.6	77	0.8	1.5	0.14
new optimized network	5.0	0.10	4800	0.124	0.78	0.03	3.1	113	0.3	0.8	0.12
d) Supplied heat 50000–100000 MWh / year											
Keila											
old network	4.6	0.17	11916	0.137	0.86	0.03	5.0	149	0.8	2.2	0.08
new optimized network	4.6	0.05	11916	0.070	0.44	0.01	4.4	507	0.2	1.1	0.05
Võru											
old network	4.7	0.20	20083	0.166	1.04	0.05	3.8	76	0.7	1.5	0.13
new optimized network	4.7	0.09	20083	0.123	0.78	0.03	3.4	109	0.3	0.9	0.11
Kiviõli											
old network	4.9	0.26	1104	0.179	1.12	0.07	5.1	75	1.3	2.4	0.11
new optimized network	4.9	0.08	1104	0.085	0.54	0.01	4.3	321	0.3	1.3	0.06
f) Supplied heat over 100000 MWh / year											
Tallinn, Kesklinna SVR											
old network	4.9	0.18	84366	0.206	1.29	0.12	5.4	45	1.0	1.5	0.12
new optimized network	5.0	0.06	82902	0.104	0.65	0.03	4.8	156	0.3	0.9	0.07

Table 1 (continued)

DH network	Degree-hours, 10^5 °Ch	q_{hlf}	*L*, m	d_a, m	*A* / *L*, m²/m	*V* / *L*, m³/m	*Q* / *L*, MWh/m	*Q* / *V*, MWh/m³	Q_{hl} / *L*, MWh/m	K_o, W / (m²K)	Q_{dp}, (m²K) / W
Tallinn, Lasnamäe SVR											
old network	5.1	0.21	146002	0.335	2.11	0.38	5.6	15	1.2	1.1	0.19
new optimized network	5.1	0.08	138794	0.204	1.28	0.07	5.0	77	0.4	0.6	0.13
Tallinn, Mustamäe SVR											
old network	4.8	0.16	143299	0.202	1.27	0.11	6.0	54	1.0	1.6	0.10
new optimized network	4.8	0.05	144036	0.109	0.69	0.03	5.3	159	0.3	0.9	0.06

Table 2. **The major characteristic parameters for the ordinary Swedish district heating networks [2]**

Network	q_{hlf}	d_a, m	*A* / *L*, m²/m	*V* / *L*, m³/m	Degree-hours, 10^5 °Ch	*Q* / *L*, MWh/m	*Q* / *V*, MWh/m³	Q_{hl} / *L*, MWh/m	K_o, W / (m²K)
Ordinary Swedish networks	0.07–0.085	0.0140–0.15	0.880–0.942	0.031–0.035	5.6	5–6	162–170	0.35–0.43	0.9–1.1
Swedish one-family house networks	0.15–0.21	0.025–0.065	0.158–0.408	0.001–0.004	4.8–5.5	0.5–2.0	302–510	0.105–0.3	2.5–4.0

The water velocities and friction losses in pipes of Estonian old district heating networks, as a rule, are much lower than the optimum values. This situation exists because old networks were designed for much a bigger load and take into account the growing potential. At present, the heat load of consumers is 15–30% less than designed (in some cases two times less).

Pumping costs in old networks with over-dimensioned pipes are much lower than in new optimised networks. At the same time, heat losses in old networks with over-dimensioned and badly insulated pipes are several times higher. The saving in heat losses gives a great increase of the total DH distribution cost.

As a rule, many district heating networks in Denmark and in other European countries have been designed by applying a friction loss of 100 Pa/m [4, 7]. Estonian old networks are designed also by applying a similar friction loss of about ~80 Pa/m [10], but real friction losses are much less.

In Fig. 2, the optimal diameter depending to the heat load is presented. Figures 3 and 4 present the real and the optimised values of water velocity and friction loss depending on pipe diameter. An example is given for a typical Estonian network situated in the Võru town. Calculation results for water velocity and friction losses are presented for the full heat load for the outdoor temperature –22 °C and also for summer load.

The obtained results may be used, in DH pipelines design and in the renovation of old district heating networks.

As Fig. 4 shows, real friction losses in pipes are mainly less than optimal values and in some old pipes, mainly with small diameters (about 50 mm), are higher. The friction loss optimal value is not constant for all diameters, as the rule of thumb says. For the smaller diameters, the optimal values of friction losses are higher than for bigger diameters. A similar tendency was presented by G. Phetteplace in [7].

3. RESULTS

Using the described method, the total overall heat transfer coefficients for the different district heating networks in Tallinn and small Estonian towns were calculated and analysis was carried out. The total overall heat transfer coefficients before and after prospective optimisation of the Estonian district heating networks are presented in Fig. 5. For comparison, in Fig. 5 relevant data on Swedish district heating networks are provided. As shown in Fig. 5, the total overall heat transfer coefficients for different underground ducts of the district heating pipes in Tallinn and small Estonian towns are much higher (up to 3 times) than the same coefficients for the pre-insulated district heating pipes with the same diameters.

Variation of the heat transfer coefficient values depend on the climate condition differences. Old pipelines, which are located in the underground concrete ducts, are very sensitive to rainfalls. Moisture from rain and melted snow, which infiltrates the duct, significantly increases the heat transfer coefficient (Fig. 6). An example is given for a typical Estonian network situated in the Võru town. Also, Fig. 7 presents the heat transfer coefficient for the totally renovated Orissaare network, and we can see that moisture from rain and melted snow did not increase so much the heat transfer coefficient of pipes.

Recently, a considerable tendency of the overall heat transfer coefficient reduction in the district heating networks in Tallinn (Kesklinna and Mustamäe networks) has been observed (Fig. 8). This reduction is caused by replacement of district heating network sections with new pre-insulated pipes. Several "wet" sections of the network can significantly increase the value of the heat transfer coefficient. Replacement of these sections will significantly decrease the overall heat transfer coefficient.

The distribution parameter expresses the potential of the network to have a certain relative distribution loss. The overall heat transfer coefficient is a constant of proportionality, which expresses the heat loss reduction ability of the insulation. In

Tallinn, the distribution parameters of the district heating networks are in the range 0.136–0.176 ($m^2 \cdot K$) / W. In small local district heating networks, the distribution parameters are in the range 0.057–0.086 ($m^2 \cdot K$) / W.

Analysing the district heating networks' efficiency, we can also use a specific volume heat supply (Q / V) in MW · h/m^3, where V is the total volume of district heating network pipes. Figure 8 presents a specific volume heat supply for different district heating networks depending on the specific heat supply Q / L, MW · h/m.

As shown in Fig. 9, in Tallinn, the specific volume heat supply of the district heating networks is in the range 14–63 MW · h/m^3 and for the local networks 150–202 MW · h/m^3. For comparison, the specific volume heat supply of typical Swedish district heating networks are in the range 160–170 MW · h/m^3 and for the areas with one-family houses in the range 300–500 MW · h/m^3. As shown in Fig. 9, in small Estonian towns, the specific volume heat supply of the district heating networks is in a higher range (59–233 MW · h/m^3) than in Tallinn, but lower than in ordinary Swedish networks.

The results of calculations have shown that in Tallinn and also in the local district heating networks the pipe diameters are over-dimensioned. The reason for the over-dimensioning is that the networks were designed taking into account the growth potential of the consumers in the future. Actually, the heat consumption has decreased. The number of industrial customers has decreased, consumers started to save energy, and some consumers disconnected from the district heating network and use local heating.

In Table 1, examples of major characteristic parameters are presented for Estonian old non-optimised district heating networks. Also, for observed networks, we made optimisation calculations and determined how much these values can change in a better direction.

The relevant data on the Swedish district heating networks are provided in Table 2.

4. CONCLUSIONS

The main characteristic parameters of the Estonian district heating networks have been estimated for the first time according to the presented methodology and compared to one another and with the typical networks in Sweden.

As investigations show, the heat transfer coefficient for pipes in old underground concrete ducts may significantly increase in the rainy season – up to 2–3 times as compared with the dry season.

Relative heat losses in typical Estonian small town old networks are about 15–25%. Extremely high relative heat losses were found in the Türi town Terme network – about 30–40%, due to a low heat demand density and a high heat transfer coefficient of pipes. In the Tallinn networks, relative heat losses are lower than in the small towns due to a higher concentration of the district heating demand, and reach 16–23%. In Swedish typical networks, relative heat losses are 7–9%, and there they have a similar heat demand concentration as in Tallinn (5–6 MWh/m), but a much better heat insulation of pipes: the overall heat transfer coefficient is 0.9–1.1 W / (m^2K), more than two times less than in Tallinn networks.

The efficiency of heat insulation for typical Estonian networks, which is estimated by the overall heat transfer coefficient, is 2–3 times lower than the same value for ordinary Swedish networks. For example, in the Võru network, the overall heat transfer coefficient during last years ranged within 1.6–1.9 W / (m^2K), and this value is 1.6–1.9 times higher than in Swedish networks. In Orissares totally renovated network, the overall heat transfer coefficient is about 0.9–1.0 W / (m^2K), i. e. in the same range as in Swedish networks.

The total overall heat transfer coefficients before and after prospective optimisation for Estonian district heating networks are presented in Fig. 5.

The network pipelines are over-dimensioned. The pumping energy consumption for over-dimensioned pipes can be less than for optimally designed pipelines due to a lower hydraulic resistance, but heat losses are much bigger as compared with optimally designed and well insulated pipelines.

The water velocities and friction losses in pipes of Estonian old district heating networks, as a rule, are much lower than the optimum values (~0.6–1.2 m/s and ~100–70 Pa/m for 50–250 mm pipes).

This situation exists because old networks were designed for a much bigger load and take into account the growing potential.

As Fig. 4 shows, real friction losses in pipes are mainly below the optimal values and in some old pipes, mainly with small diameters (about 50 mm), are higher. The friction loss optimal value is not constant for all diameters, as the rule of thumb says. For smaller diameters, the optimal values of friction losses are higher than for bigger diameters. The optimal friction losses decrease slowly (Fig. 4) with increasing the diameter, for example, from 150 Pa/m (DN 25) to 75 Pa/m (DN 200), and the water temperature regime is 110 / 70 °C. The optimal value of friction losses for a lower temperature difference (temperature regime 95 / 65 °C) will be somewhat higher.

After the optimal selection of network pipe diameters and with a total renovation of pipes, relative heat losses decrease. Several "wet" sections of the network can significantly increase the value of the heat transfer coefficient. Replacement of these sections will significantly decrease the overall heat transfer coefficient.

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References

1. Kütuse- ja energiamajanduse pikaajaline riiklik arengukava aastani 2015. Riigiteataja, RT I, 23 12 2004, 88, 601.
2. Fredriksen S., Werner S., Fjärrvärme. Teori, teknik och funktion. Lund, 1993.
3. Никкинен Р. Энергетическое сравнение систем централизованного теплоснабжения России и Финляндии // Теплоэнергетика. 1999. № 4.
4. Bøhm B. Energy-economy of Danish District Heating Systems. A Technical and Economic Analysis. Technical University of Denmark, Copenhagen, 1988.
5. Frederiksen S. A Thermodynamic Analysis of District Heating. Lund Institute of Technology, Lund, 1982.

6. Koskelainen L. A Model for Optimal Design of District Heating Networks. Lappeenranta University of Technology, Lappeenranta, 1978.
7. Phetteplace G. Optimal Design of Piping Systems for District Heating. CRREL Report 95–17, U. S. Army Corps of Engineers. Cold Regions Research and Engineering Laboratory. Hanover, 1995.
8. Benonysson A. Dynamic Modelling and Operational Optimization of District Heating Systems. PhD Thesis. Laboratory of Heating and Air Conditioning, Technical University of Denmark, September 1991.
9. Larsen H., Pallson H., Bøhm B., Ravn H. Aggregated dynamic simulation model of district heating networks. Energy Conversion and Management. 2002. N 43.
10. Козин В. Е. и др. Теплоснабжение. Москва: Высшая школа, 1980.

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ESTIJOS CENTRINIO ŠILDYMO TINKLŲ PAGRINDINIAI PARAMETRAI IR JŲ EFEKTYVUMO DIDINIMO GALIMYBĖS

Santrauka

Per pastaruosius metus iš esmės kinta energetikos sektorius ekonomikos ir technikos srityse. Estijos energetikos rinkoje ženkliai išaugo elektros ir šilumos kainos visoms vartotojų grupėms. Prasta tinklų būklė blogina centralizuoto šildymo perspektyvas, todėl vartotojai renkasi vietinį šildymą. Dažnai vietinis šildymas nėra efektyvi galimybė regioninei šilumos tiekimo sistemai, taip pat mažina kombinuotos šilumos ir elektros gamybos potencialą. Bloga vamzdžių šilumos izoliacija ir per didelės jų apimtys lemia didelius šilumos nuostolius. Šis darbas pateikia naujų vamzdžių ekonominio optimizavimo pavyzdžių. Seni estiški neoptimizuoti centrinio šildymo tinklai yra lyginami su naujais optimizuotais tinklais. Buvo nustatytas tinklų efektyvumo didinimo potencialas. Gauti rezultatai yra praktiškai pritaikomi centrinio šildymo vamzdžių projektavimui ir pasenusių centrinio šildymo tinklų renovacijai.

Raktažodžiai: centrinis šildymas, efektyvumas, optimizavimas

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ОСНОВНЫЕ ПАРАМЕТРЫ СЕТЕЙ ЦЕНТРАЛЬНОГО ОТОПЛЕНИЯ ЭСТОНИИ И ПОТЕНЦИАЛ ПОВЫШЕНИЯ ИХ ЭФФЕКТИВНОСТИ

Резюме

В течение последних лет на энергетическом рынке Эстонии значительно возросли цены на электроэнергию и тепло. Плохое состояние сетей усугубляет перспективы развития централизованного отопления, поэтому потребители переходят на местное отопление, которое часто не является эффективным для региональной системы теплоснабжения и уменьшает потенциал комбинированного производства тепла и электроэнергии. Плохая термоизоляция труб и другие факторы в основном определяют большие теплопотери. В этой работе представлены методы оптимизации систем новых труб. Старые неоптимизированные системы центрального теплоснабжения сопоставлены с новыми оптимизированными сетями. Определен потенциал повышения эффективности сетей. Полученные результаты применяются для проектирования труб центрального теплоснабжения, а также для реновации устаревших сетей.

Ключевые слова: центральное теплоснабжение, эффективность, оптимизация.