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Calculation of the Hydraulic Parameters afferent to Fluid Distribution through Closed-type Pipe Networks

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Abstract

This work deals with the possibilities of determining the flow rates and the nodal pressures afferent to loop-type gas distributing pipe networks. After recalling the equations of pressure variations and flow rates for simple pipes, pipes in series, pipes in parallel and branched-type pipes, two procedures of hydraulic design for the gas distributing pipe networks are described: the material balance and energy balance equations method, as well as the successive approximations method. The last method is illustrated with a case study which uses actual data from a complex loop-type gas distribution network.

Key words: *hydraulic parameters, gas distribution, pipe network, flow rate, pressure drop*

Introduction

Fluid transporting multiple-pipe systems containing common points, denoted as nodes, to which two or more pipes converge, are called as pipe networks. Pipe networks can be opened (or branched) and closed (or ring-shaped, also named loop-type) networks.

Using the energy conservation equation written for each network loop and the mass conservation equation formulated into each grid node, while knowing the friction loss modulus into each section of the multiple-pipe system, the flow rate distribution and, finally, the nodal pressures can be determined.

Determining Liquid Flow Rate Distribution in a Closed-type Pipe Network

Let us consider the pipe network in *figure 1*, consisting in two rings (A, B) and six pipes, with fluid inflow in node 1 and outflow in nodes 3 and 5 [1, 4, 6]. For determining the flow rate in each pipe of the network, $(n - 1)$ mass conservation equations and m energy conservation equations can be written, yielding a determined set of coupled algebraic equations which have $p = m + n - 1$ equations, where m is the number of rings, n – the number of nodes and p – the number of unknown flow rates Q_{ij}. Energy conservation equations consist in the relationships of annulation of the energy-loss algebraic sums for each ring. The terms in the energy equation have the plus or minus sign according to the clockwise or counterclockwise sense of the flow in each pipe of the ring. For some pipes in the network, the sense of the flow is arbitrarily established, following that the positive or negative value of the flow rate obtained confirm or infirm the sense previously chosen. If a recirculation pump is mounted into a node of the ring, then the sum of the hydraulic head losses on the respective ring equals pump's hydraulic head.

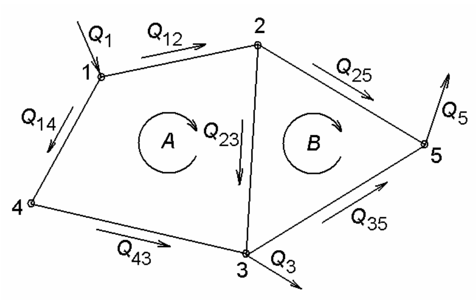

Fig. 1. Pipe network with two rings

For the example in *figure 1*, the energy and mass conservation equations have the form

$$M_{12} Q_{12}^2 + M_{23} Q_{23}^2 - M_{34} Q_{34}^2 - M_{14} Q_{14}^2 = 0 \,, \quad (1)$$

$$M_{25} Q_{25}^2 - M_{35} Q_{35}^2 - M_{23} Q_{23}^2 = 0 \,, \quad (2)$$

$$Q_1 = Q_{12} + Q_{14} \,, \quad (3)$$

$$Q_{12} = Q_{23} + Q_{25} \,, \quad (4)$$

$$Q_{23} + Q_{43} = Q_3 + Q_{35} \,, \quad (5)$$

$$Q_{25} + Q_{35} = Q_5 \,, \quad (6)$$

where M_{ij} is called as friction loss modulus and, if the minor head losses are neglected, has the expression

$$M_{ij} = \frac{8}{\pi^2 g} \frac{\lambda_{ij} l_{ij}}{d_{ij}^2} \,, \quad (7)$$

in which λ_{ij} denotes the friction factor in the sector *ij*, and l_{ij}, d_{ij} are the length and diameter of the mentioned sector respectively.

In the case of complex closed-type pipe networks, solving the set of equations is a difficult task. Consequently, successive approximation methods can be used. One of these procedures, known as Lobacev method, consists in the following steps:

– admitting a set of values for the flow rates Q_{ij}, according to the continuity restrictions in nodes;

– calculating the sum of the head losses in each ring and comparing it with a value close to zero or to the recirculation pump's head;

– computing the flow rate change in each ring ΔQ_k, $k = A, B$, with relationships of the form

$$M_{25}(Q_{25} + \Delta Q_B)^2 - M_{35}(Q_{35} - \Delta Q_B)^2 - M_{23}(Q_{23} - \Delta Q_B)^2 = 0 \,, \quad (8)$$

if the prescribed tolerance for the corresponding ring is not achieved;

– recalculating the flow rates in each pipe with formulas like the following

$$Q_{25}' = Q_{25} + \Delta Q_B \,, \quad (9)$$

$$Q_{35}' = Q_{35} - \Delta Q_B \,, \quad (10)$$

$$Q_{23}' = Q_{23} + \Delta Q_A - \Delta Q_B \,, \quad (11)$$

where the positive sign of ΔQ_k corresponds to the clockwise sense of flow in the ring, and the double correction is set for the sector belonging to both rings;

– recalculating the head losses in all the rings.

The calculation procedure ends when the error condition is accomplished.

The terms including ΔQ_B^2 in equation (8) can be neglected, yielding

$$\Delta Q_B = -\frac{M_{25} Q_{25}^2 - M_{35} Q_{35}^2 - M_{23} Q_{23}^2}{2(M_{25} Q_{25} + M_{35} Q_{35} + M_{23} Q_{23})} \,, \quad (12)$$

or, in the general case,

$$\Delta Q_k = -\frac{\sum h_{d\,ij}}{2\sum\left|M_{ij}\,Q_{ij}\right|}\ ,\quad k = A, B\ , \tag{13}$$

where $h_{d\,ij}$ is the hydraulic energy dissipated in the pipe *ij*, expressed as a head loss.

Determining Gas Flow Rate Distribution in a Closed-type Pipe Network

Pressure variation and flow rates for the gas flow in single- and multiple-type pipes

Simple pipe. Admitting that the gas flow in a circular cross-section pipe, having a constant cross-sectional area and a straight axis, is steady and isothermal, the microscopic energy conservation equation can be written as

$$\frac{\mathrm{d}p}{\rho} + v\,\mathrm{d}v + \frac{\lambda}{d}\frac{v^2}{2}\mathrm{d}x = 0\ , \tag{14}$$

constituting, together with the mass conservation equation

$$M = \rho\, v\, A = const. \tag{15}$$

and the equation of state expressed as

$$\frac{p}{\rho} = \frac{p_1}{\rho_1}\ , \tag{16}$$

where λ is the friction factor, subscript 1 refers to pipe's initial cross-section, and A is the area of the cross-section of diameter d, the determined set of coupled equations for this flow.

By eliminating the density ρ, the velocity v and the mass flow rate M between equations (14)…(16), we get the following differential equation

$$\frac{p_1}{\rho_1}\frac{\mathrm{d}p}{p} - \left(\frac{M\,p_1}{A\rho_1}\right)^2 \frac{\mathrm{d}p}{p^3} + \frac{\lambda}{2d}\left(\frac{M\,p_1}{A\rho_1}\right)^2 \frac{1}{p^2}\mathrm{d}x = 0\ , \tag{17}$$

whose solution has the form

$$\left(\frac{A}{M}\right)^2 \frac{\rho_1}{2p_1} p^2 - \ln p + \frac{\lambda}{2d} x = a\ , \tag{18}$$

where the constant of integration a results from the boundary condition $p = p_1$ at $x = 0$ as

$$a = \left(\frac{A}{M}\right)^2 \frac{\rho_1}{2p_1} p_1^2 - \ln p_1\ , \tag{19}$$

According to equation (19), relationship (18) becomes

$$\left(\frac{A}{M}\right)^2 \frac{\rho_1\, p_1}{2}\left[1 - \left(\frac{p}{p_1}\right)^2\right] - \ln\frac{p_1}{p} = \frac{\lambda}{2d} x \tag{20}$$

and represents the pressure variation law for the short-length pipes, for which the kinetic energy term $\ln(p_1/p)$ has the same order of magnitude than the head loss. If the pipeline is long, the kinetic energy term is negligible, so that equation (20) reduces to the form

$$p_1^2 - p^2 = \left(\frac{M}{A}\right)^2 \frac{p_1}{\rho_1}\frac{\lambda}{d} x \ , \tag{21}$$

which, for the boundary condition $p = p_2$ at $x = l$, corresponding to the final cross-section of the pipe, leads to the following expression of the mass flow rate

$$M = A\sqrt{\frac{\rho_1 d^2\left(p_1^2 - p_2^2\right)}{p_1 \lambda l}} \ . \tag{22}$$

By introducing the expression (22) into the equation (21) we get the pressure variation law in a long pipe as

$$p = \sqrt{p_1^2 - \frac{p_1^2 - p_2^2}{l} x} \ . \tag{23}$$

Invoking the equation of state for viscid gases written as

$$\frac{p_1}{\rho_1} = Z R T \tag{24}$$

and put into the particular form

$$\frac{p_0}{\rho_0} = R T_0 \ , \tag{25}$$

the volume flow rate in normal pressure and temperature conditions can be written, on the basis of relationship (22), as

$$Q_0 = A\sqrt{\frac{T_0\left(p_1^2 - p_2^2\right)d}{Z T \lambda \rho_0 p_0 l}} \ . \tag{26}$$

On the other hand, from equation (24) written for air, in normal state conditions, we have

$$\frac{p_0}{\rho_a} = R_a T_0 \ , \tag{27}$$

equation which can be divided by relationship (25) to give

$$\frac{\rho_0}{\rho_a} = \rho_r = \frac{R_a}{R} \tag{28}$$

and, consequently, equation (26) becomes

$$Q_0 = \frac{A T_0 \sqrt{R_a}}{p_0}\sqrt{\frac{\left(p_1^2 - p_2^2\right)d}{Z \lambda \rho_r T l}} \ , \tag{29}$$

where λ can be expressed by Weymouth equation written as

$$\lambda = \frac{0{,}009407}{\sqrt[3]{d}} \ . \tag{30}$$

Pipes in series. When gas flows through a pipeline consisting in n pipes with diameters d_j and lengths l_j, with $j = 1, 2, \ldots, n$, connected in series, the gas flow rate in each pipe is expressed by equation (29) written as [5, 7]

$$Q_0 = K_j\sqrt{\frac{p_j^2 - p_{j+1}^2}{l_j}} \ , \tag{31}$$

where the flow rate modulus K_j has the expression

$$K_j = \frac{\pi T_0 \sqrt{R_a}}{4 p_0} \sqrt{\frac{d_j^5}{Z \lambda_j \rho_r T}} \; . \tag{32}$$

Consequently, relationship (31) yields

$$p_j^2 - p_{j+1}^2 = Q_0^2 \frac{l_j}{K_j^2} \; , \tag{33}$$

which, by summation member by member for the *n* pipes of the pipeline, leads to the equation

$$p_j^2 - p_{n+1}^2 = Q_0^2 \sum_{j=1}^{n} \frac{l_j}{K_j^2} \; . \tag{34}$$

Using the notations

$$\frac{1}{K_e^2} = \sum_{j=1}^{n} \frac{l_j}{K_j^2} \; , \quad l = \sum_{j=1}^{n} l_j \; , \tag{35}$$

we get the relationship

$$Q_0 = K_e \sqrt{\frac{p_j^2 - p_{n+1}^2}{l}} \; , \tag{36}$$

where K_e is the equivalent flow rate modulus.

Pipes in parallel. In this case, the flow rate of the pipe-system characterized by the same initial and final ends for all the individual pipes, has the expression

$$Q_0 = \sum_{j=1}^{n} Q_j \; , \tag{37}$$

where Q_j has an expression similar to (36), namely

$$Q_j = K_j \sqrt{\frac{p_1^2 - p_2^2}{l_j}} \; , \tag{38}$$

and the flow rate modulus is given by equation (32).

Later on, equation (37) becomes

$$Q_0 = \sqrt{p_1^2 - p_2^2} \sum_{j=1}^{n} \frac{K_j}{\sqrt{l_j}} \tag{39}$$

and, using the equivalent quantities K_e and l_e defined together as

$$\frac{K_e}{\sqrt{l_e}} = \sum_{j=1}^{n} \frac{K_j}{\sqrt{l_j}} \tag{40}$$

we obtain the relationship

$$Q_0 = \frac{K_e}{\sqrt{l_e}} \sqrt{p_1^2 - p_2^2} \; . \tag{41}$$

Branched pipe systems. A branched pipe system involves nodal gas inflows and outflows defined by known flow rate values for the given pressures p_1, p_{n+1} at the initial and final pipe-system ends, for the problem of dimensioning the main (distribution) pipe which has a constant diameter either across its full length or for each consecutive inter-nodal section.

In the first case, we start from the fact that the flow rate on the inter-nodal section j is given by equation (31) written as

$$Q_j = K_j \sqrt{\frac{p_j^2 - p_{j+1}^2}{l_j}} \ , \tag{42}$$

where K_j = K has the expression (32). Then, by separating $p_j^2 - p_{n+1}^2$ from this equation and summing these terms for the whole distribution pipe, we get the formula

$$p_1^2 - p_{n+1}^2 = \frac{1}{K^2} \sum_{j=1}^{n} Q_j^2 \, l_j \ , \tag{43}$$

from which yields, using equation (32) written under the form

$$K = \frac{\pi T_0 \sqrt{R_a}}{4 \, p_0} \sqrt{\frac{d^5}{Z \lambda_j \rho_r T}} \ , \tag{44}$$

for

$$K = \sqrt{\frac{\sum_{j=1}^{n} Q_j^2 \, l_j}{p_1^2 - p_{n+1}^2}} \ , \tag{45}$$

the diameter of the distribution pipe.

In the case of a constant diameter for each inter-nodal section, we admit a linear variation for the pressure drop between two consecutive nodes, according to the relationship

$$p_j - p_{j+1} = \frac{l_j}{l} \left(p_1 - p_{n+1} \right) , \tag{46}$$

where l is given by the second equation (35) and, consequently, the flow rate modulus obtained from formula (42) written as

$$K_j = Q_j \sqrt{\frac{l_j}{p_j^2 - p_{j+1}^2}} \ , \tag{47}$$

allows us, using equation (32), to get the diameter d_j of the section studied.

Calculating gas flow rate distribution and nodal pressures

As in the case of liquid distribution through a closed-type pipe network, which was treated in the second paragraph of this work, the determination of gas flow rate distributed through such a network can be done either by a) formulating and solving the energy balance and material balance equations, or b) using the successive approximation method.

The procedure of using the energy balance and material balance equations is known, in the case of gas distribution through closed-type pipe networks, as the network un-looping method.

Considering two neighbored rings of the network, as in *figure 2*, by un-looping we get the equivalent open network in *figure 3*.

The algorithm specific to this portion of the closed-type network consists in the following steps:

– choosing a flow rate distribution (in normal pressure and temperature conditions) so that, in node 1, the incoming flow rate has the distribution

$$Q = 0.4 Q_{12} + 0.6 Q_{16} \ , \tag{48}$$

using the calculation flow rate

$$Q_c = Q\sqrt{N} \ , \tag{49}$$

where

$$N = 1 - \frac{q}{Q} + \left(\frac{1}{3} + \frac{1}{6n}\right)\left(\frac{q}{Q}\right)^2 \ , \tag{50}$$

where q is the component of the transit flow rate defined as $(Q - q)$ and $n = 1, 2, 3, \dots$ indicates the iteration number;

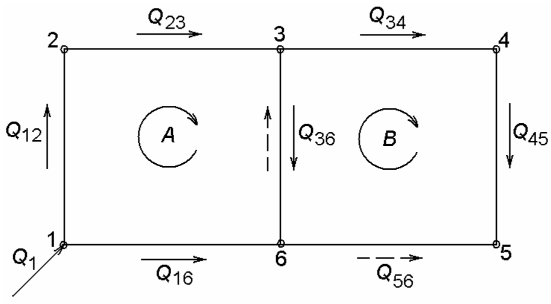

Fig. 2. Two adjacent rings of a pipe network

– calculating the pressure value in node 3 with the relationships

$$p_3 = p_1 - \frac{Q_{c123}^2 \sqrt{N}}{K^2} l_{123} \ , \tag{51}$$

$$2\, p_3 = p_1 - \frac{Q_{c163}^2 \sqrt{N}}{K^2} l_{163} \ , \tag{52}$$

where K is given by equation (32).

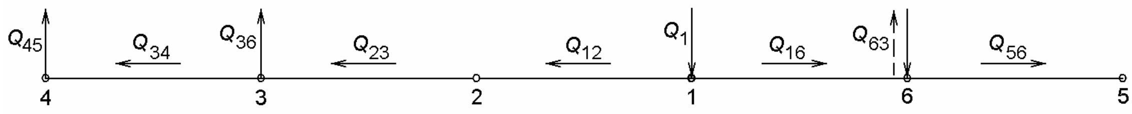

Fig. 3. Opened network equivalent to the closed network in figure 2

If the values of pressure p_3 obtained from equations (51) and (52) are not equal, within an acceptable tolerance, another flow rate distribution is chosen and the calculus will continue until the equality is achieved. Then, we proceed by calculating pressure p_4 with the relationships

$$p_4 = p_1 - \frac{Q_{c1234}^2 \sqrt{N}}{K^2} l_{1234} \ , \tag{53}$$

$$p_4 = p_1 - \frac{Q_{c1654}^2 \sqrt{N}}{K^2} l_{1654} \ . \tag{54}$$

b) The successive approximation method, which was presented in the second paragraph for the case of liquid distribution through a closed-type pipe network, can be directly adapted to the case of gas distribution according to the following algorithm:

– admitting a flow gas rate distribution which satisfies the mass balance equation in each node;

– establishing an actual or arbitrary flow sense in each section of the pipe network;

– writing the energy conservation equation, similar to relationship (1), in each network node, as

$$\sum_{j=1}^{n} \left(\frac{Q_0^2}{K^2}\right)_j = 0 \ , \tag{55}$$

where, according to equation (31), we have

$$\left(\frac{Q_0^2}{K^2}\right)_j = \left(\frac{p_1^2 - p_2^2}{l}\right)_j \ . \tag{56}$$

If the condition (55) is not satisfied, the flow rate distribution is modified with ΔQ_k for each segment of every ring, where $k = A, B$ is the ring index, as in relationships (9), (10), (11).

Finally, from equation (56) written for each ring yields, for the flow rate corrections, the solution

$$\Delta Q_k = \frac{\sum \frac{Q_0^2}{K^2}}{2\left|\sum \frac{Q_0}{K^2}\right|}, \tag{58}$$

similar to relationship (13).

Case Study

The target of this study [10] is the determination of gas flow rates distributed by each section and the calculation of nodal pressures in the case of gas supply, using polyethylene pipes, into a urban center having household, socio-cultural and industrial consumers. Input data include: network framework presented in figure 4, lengths of the inter-nodal sections, and calculation (consumption) flow rates, the system also including a regulating-measuring station at the delivery point (SRMP) as well as repartition pipes at medium pressure (ranging between 600 kPa and 200 kPa) which feed, at preset flow rates, two sector regulating stations (SRS), outputting in the gas distribution network of low pressure (ranging from 200 kPa to 5 kPa).

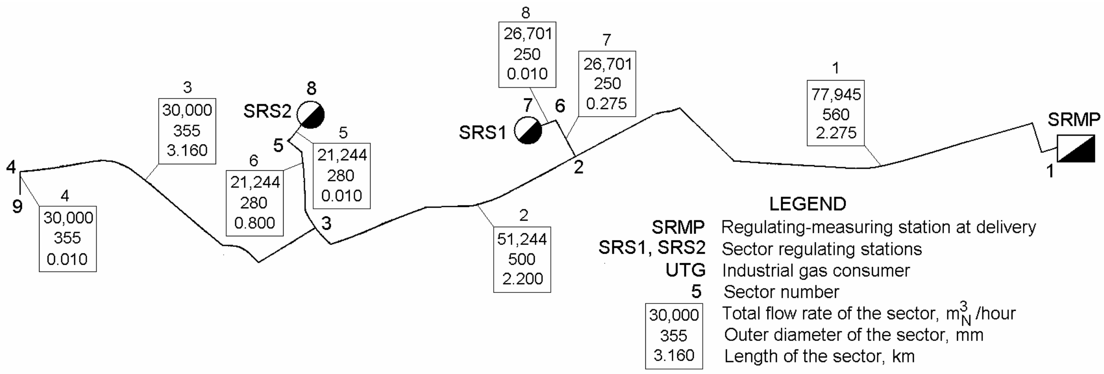

Fig. 4. Case study network framework

The calculations afferent to this study are based on the use of the successive approximation method previously presented, by means of a specialized software which has as input data the lengths of the inter-nodal sectors and the flow rates afferent to these sectors and produces as outputs the zonal flow rates, the pressures in the network nodes, the diameter of each inter-nodal sector and the actual velocity in the network pipes, for all the 974 sectors.

The results of the calculus are presented, as an illustration, for the inter-nodal sectors between 1 and 50, in *table 1*, where the negative flow rates signify a flow sense opposite to the one considered when applying the procedure, while the null flow rate corresponds to the immobility of gas into that sector.

Conclusions

- The pipe networks dedicated to fluid (liquid (water) or natural gas) distribution can be divided into open-type or branched networks and closed-type networks.
- The determination of fluid (liquid or gas) flow rate distribution through a closed-type pipe network can be done by using either the method of formulating and solving the energy

balance and mass balance equations, known, for gas distribution, as the network un-looping method, or the successive approximation procedure, which is called, in a specific variant, the Lobacev method.

Table 1. Parameters of the pipe network

Sector number	Initial node	Final node	Sector length, m	Sector flow rate, m_N^3/h	Total flow rate, m_N^3/h	λ	Re, $\cdot 10^6$	Pressure in initial node, 10^5 Pa	Pressure in final node, 10^5 Pa	Inner dia-meter, mm	Actual velocity, m/s
1	2	3	0.465	92	–92	0.0259	5.10	1.725	1.959	50	11.00
2	3	4	0.905	19	–100	0.0248	4.30	1.959	1.974	63	6.87
3	4	5	0.050	10	–125	0.0243	5.40	1.974	1.986	63	8.51
4	5	7	0.410	95	–73	0.0258	4.10	1.986	2.108	50	7.93
5	7	8	0.120	84	84	0.0265	5.80	2.108	1.973	40	13.90
6	3	9	0.070	10	l'10	0.0369	0.71	1.959	1.960	40	1.79
7	4	10	0.125	19	15	0.0324	1.00	1.974	1.968	40	2.53
8	5	6	0.100	12	–158	0.0241	6.90	1.986	2.024	63	10.69
9	6	7	0.260	37	–239	0.0231	8.70	2.024	2.108	75	10.96
10	6	11	0.060	4	43	0.0232	3.00	2.024	2.008	40	7.20
11	11	12	0.065	4	37	0.0350	2.50	2.008	1.992	40	6.21
12	14	13	0.150	3	3	0.0531	0.18	2.008	2.007	40	0.43
13	15	15	0.870	115	–115	0.0250	5.00	1.820	2.008	63	8.15
14	19	19	0.100	20	–166	0.0240	7.20	2.008	2.049	63	11.06
15	20	20	0.030	13	–198	0.0234	7.20	2.049	2.056	75	9.13
16	21	21	0.025	5	–211	0.0232	7.70	2.056	2.062	75	9.73
17	22	22	0.080	16	–263	0.0227	9.50	2.062	2.093	75	11.98
18	23	23	0.045	10	–296	0.0226	11.00	2.093	2.115	75	13.33
19	29	29	0.380	267	–960	0.0197	21.00	2.115	2.241	125	15.07
20	30	30	0.090	63	132	0.0272	9.10	2.241	2.011	40	20.92
21	31	31	0.115	164	–86	0.0253	5.90	2.011	2.141	40	13.88
22	32	32	0.140	80	–243	0.0230	11.00	2.141	2.251	63	14.98
23	33	33	0.065	6	81	0.0421	5.60	2.251	2.188	40	12.31
24	34	34	0.145	12	32	0.0352	2.20	2.188	2.163	40	5.00
25	35	35	0.285	25	–45	0.0309	3.10	2.163	2.254	40	6.91
26	36	36	0.145	12	–19	0.0352	1.30	2.254	2.263	40	2.86
27	37	37	0.120	10	–52	0.0320	3.50	2.263	2.311	40	7.60
28	38	38	0.070	6	–52	0.0421	3.50	2.311	2.338	40	7.47
29	39	39	0.130	11	–85	0.0302	5.80	2.338	2.465	40	11.95
30	15	16	0.030	0	30	0.0298	2.10	2.008	2.003	40	5.11
31	16	17	0.365	18	18	0.0326	1.20	2.003	1.980	40	3.03
32	16	18	0.165	12	12	0.0351	0.85	2.003	1.998	40	2.09
33	19	24	0.050	18	18	0.0325	1.30	2.049	2.046	40	3.02
34	20	25	0.100	9	9	0.0381	0.60	2.056	2.054	40	1.43
35	21	26	0.240	36	36	0.0292	2.40	2.062	2.009	40	5.91
36	22	27	0.300	39	–16	0.0288	1.10	2.093	2.108	40	2.58
37	27	28	0.150	20	20	0.0320	1.40	2.108	2.097	40	3.21
38	29	40	0.055	6	–1.098	0.0196	24.00	2.241	2.264	125	16.68
39	40	41	0.075	8	–1.191	0.0192	23.00	2.264	2.285	140	14.24
40	41	42	0.045	8	201	0.0234	8.70	2.285	2.261	63	11.96
41	42	47	0.050	9	183	0.0235	7.90	2.261	2.239	63	11.00
42	47	43	0.330	60	89	0.0264	6.10	2.239	1.830	40	14.62
43	43	44	0.060	11	25	0.0308	1.70	1.830	1.822	40	4.62
44	44	45	0.060	11	11	0.0363	0.73	1.822	1.820	40	1.97
45	44	49	0.070	4	4	0.0476	0.25	1.822	1.822	40	0.69
46	43	48	0.100	4	4	0.0472	0.26	1.830	1.829	40	0.70
47	47	27	0.355	49	85	0.0254	4.70	2.239	2.108	50	8.64
48	42	46	0.100	10	10	0.0368	0.69	2.261	2.259	40	1.51
49	41	50	0.080	12	12	0.0365	0.83	2.285	2.282	40	1.79
50	30	51	0.135	26	–35	0.0307	2.40	2.011	2.039	40	5.80

- Because this work attributes a primordial interest to the determination of the total gas flow rate distribution through a closed-type pipe network, the establishment of pressure variation law and gas flow rates formulas when gas flows through single-type pipes, pipes in series, pipes in parallel and branched-type pipes was considered and proven to be necessary.
- The great usefulness of the detailed approach of the branched-type gas transporting pipes case is revealed mainly by the treatment of the problem of calculating the gas flow rate distributed and the nodal pressures, by using the network un-looping method, knowing that we can transform two adjacent closed loops of the pipe network into a sequence of branched pipes, for which the problem of establishing the diameter of each inter-nodal segment can also be easily solved.
- The case study, dedicated to the determination of gas flow rates distribution through pipe sectors and nodal pressure values, afferent to the gas supply into an urban center involving household, socio-cultural and industrial consumers, for a closed-type pipe network having 974 sectors, in presence of gas furniture for two sector regulating stations (SRS), permitted, by using a specialized software, the calculation of the network gas-dynamic parameters as well as the values of the diameters of all the sectors afferent to the pipe-system considered.

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Calcularea parametrilor hidraulici aferenți distribuției fluidelor prin rețele de conducte de tip închis

Rezumat

Lucrarea studiază posibilitățile de determinare a debitelor şi presiunilor nodale aferente rețelelor de conducte de tip închis pentru distribuția gazelor. După ce sunt expuse ecuațiile variației presiunii şi debitului de gaze aferente conductelor simple, în serie, în paralel şi ramificate, în lucrare sunt descrise două proceduri de calcul hidraulic al rețelelor de conducte pentru distribuția gazelor: metoda ecuațiilor de bilanț material şi energetic, precum şi metoda aproximațiilor succesive. Ultima procedură este ilustrată cu un studiu de caz care foloseşte date reale dintr-o rețea complexă de distribuție a gazelor naturale de tip închis.