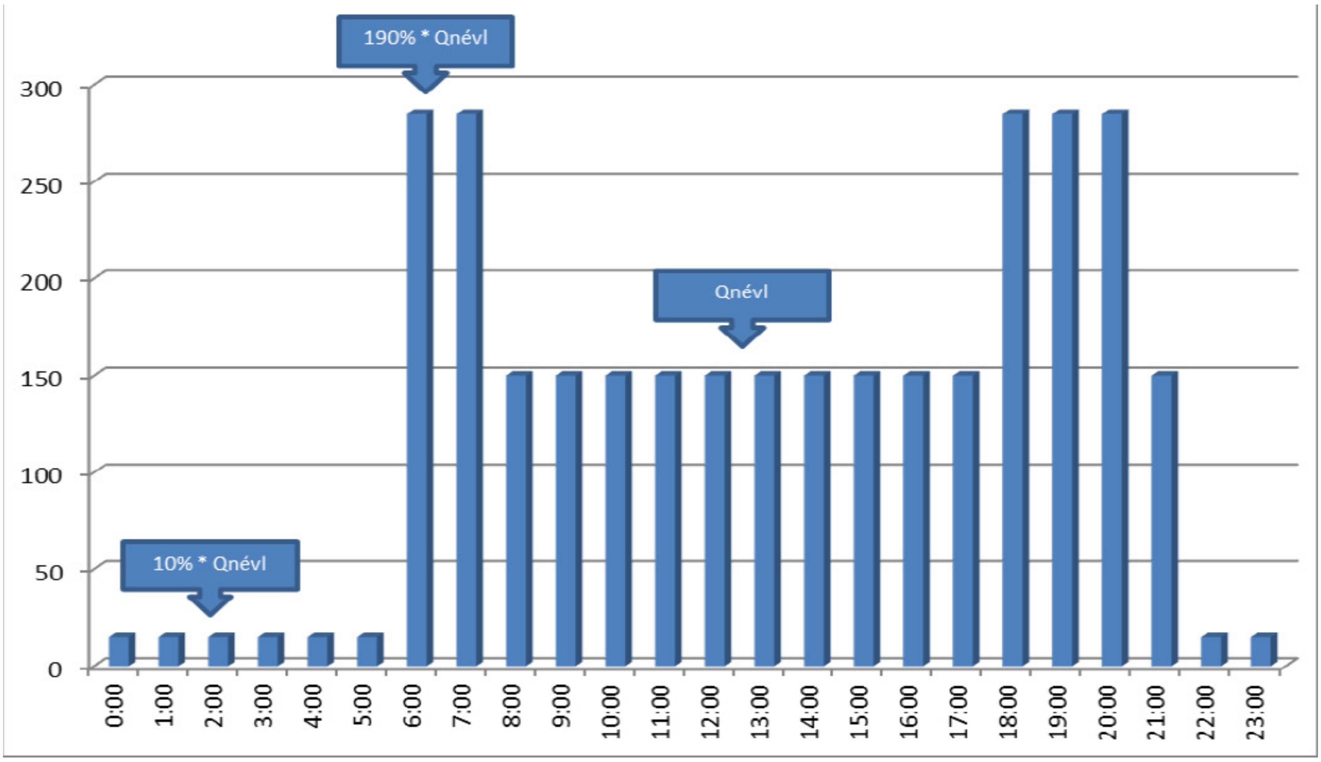
Tutorial

Stationary computation problems for pipe network systems

The steps of the problem solving

1. The definition of the geometry and topology of the network for the staci program without the pumps in the network.
2. Series running with the previously given consumptions of the network, where in the place of the pump 10 different supply is applied (as negative consumption) from 0 to 2 x $Q_{nominal}$.
3. Draw the characteristic curve of the system from the 10 solutions (with given consumptions it is possible to draw it.)
4. Choose a pump for the flow rate $Q_{nominal}$, and the necessary system height, and place it into the system.
5. Rerun of the system with the previously given consumptions (100%), and with 10% (according to nights) and 190% (according to the peak time) consumptions.



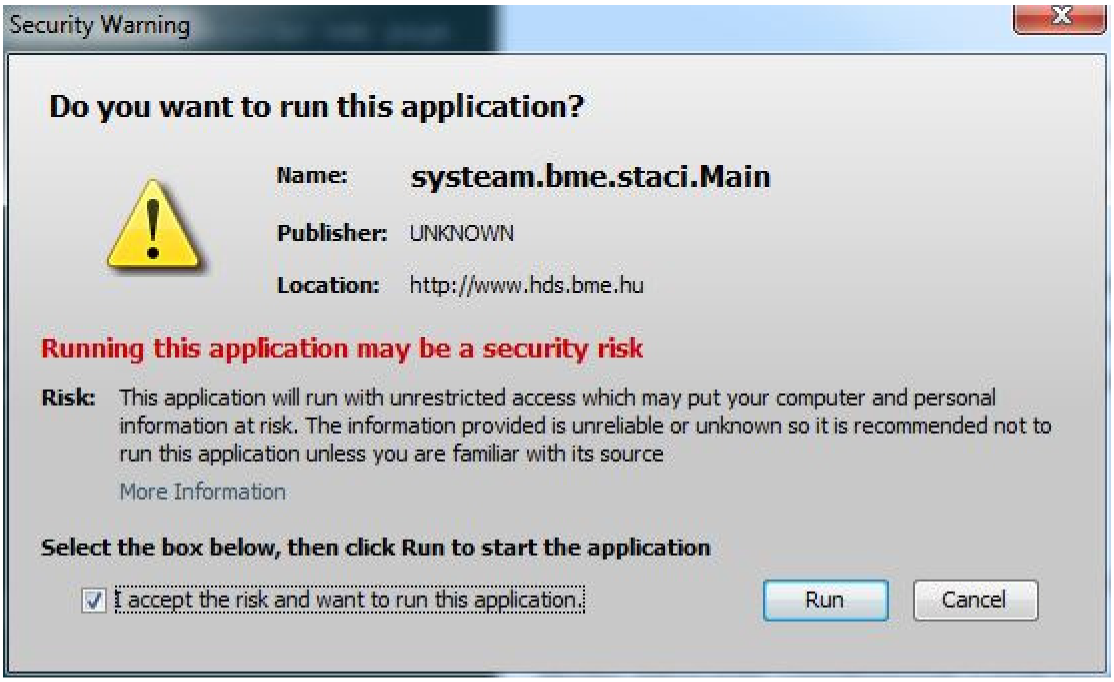
0:00-6:00	6:00-8:00	8:00-18:00	18:00-21:00	21:00-22:00	22:00-24:00

0:00-6:00	6:00-8:00	8:00-18:00	18:00-21:00	21:00-22:00	22:00-24:00	
10% Q_n	190% Q_n	100% Q_n	190% Q_n	100% Q_n	10% Q_n	

6. Calculate the needed end reservoir (pool) area, so that the total water level in this reservoir stays in between 2-4 meters with the obtained daily water consumption.
7. Write a documentation about the solution in a detailed description of the above listed steps, with an attachment of a 'spr' staci project file which can be found on the server.

Starting the program

On the Staci web page click on 'staci program indítása hálózatos módban', then opening the Java application the network computing program will start. After accepting the terms the program can be started. (If it does not work adjust the Java security level to 'medium'.)



Every user will receive a personal email with the login name and password.

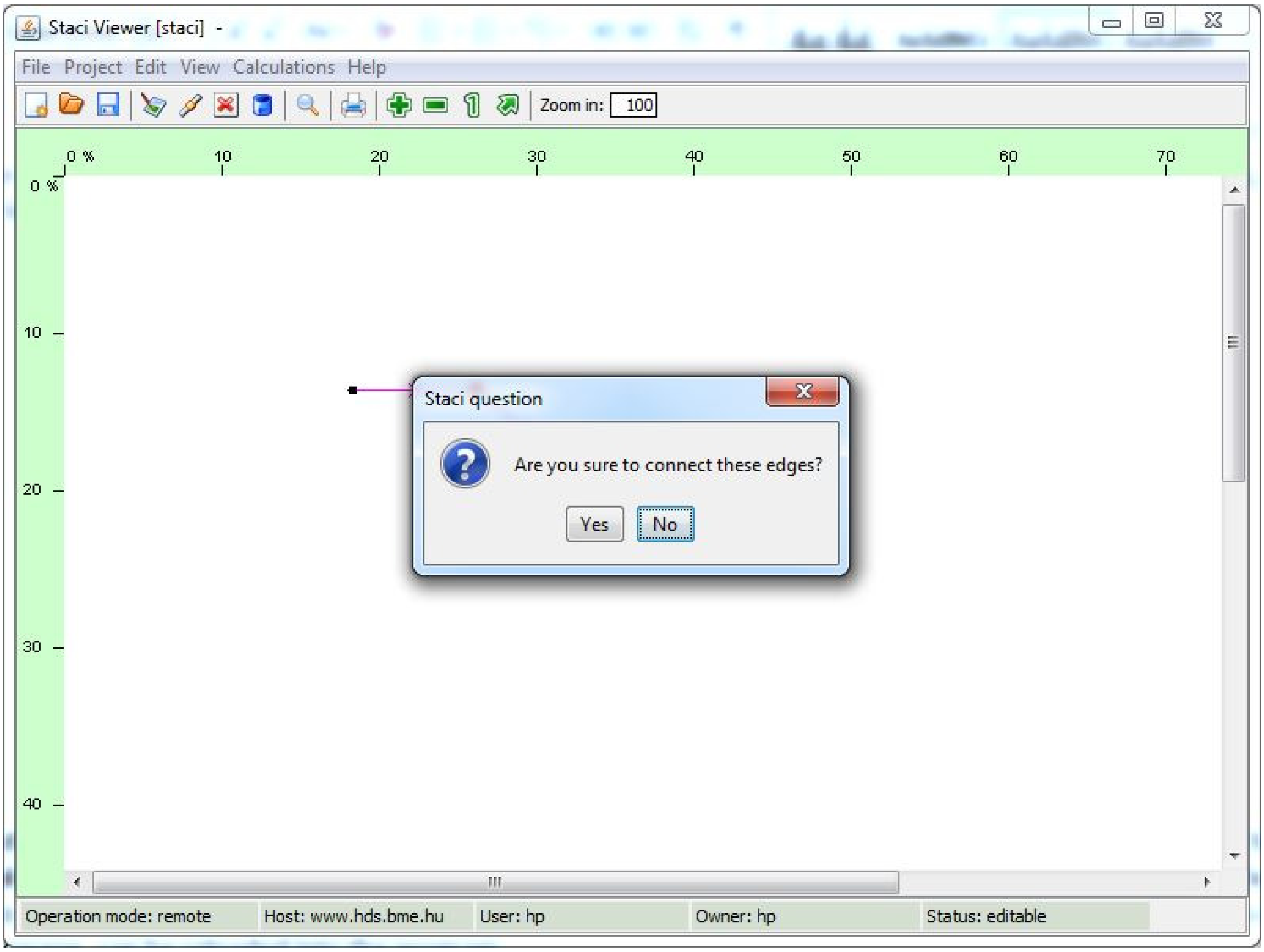
New project

A new project can be created with the program or one of the previously saved projects can be opened. (Attention! Every user can only see the projects saved under their own login name. We kindly ask everyone to save their projects under the name 'group_serialnumber_versionnumber.spr' – eg. 'group_1_ver2.spr', and at the end the documentation should contain the very last and final version number.)

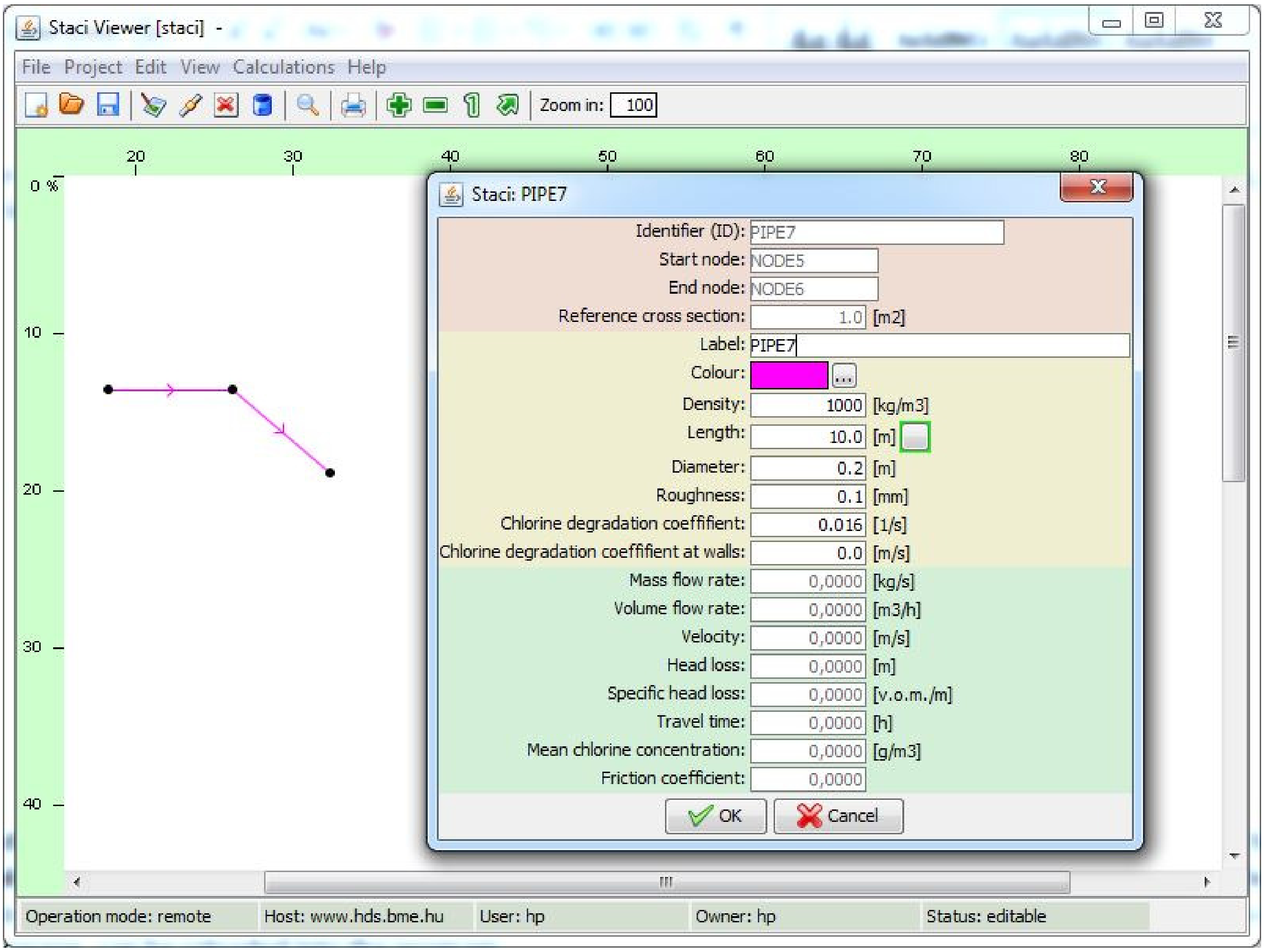
Elements

Creating a hydraulic model involves the insertion of the elements, the connection of elements and defining their properties.
By inserting a new element a new pipe, pool, pump… etc. can be created. These are automatically created with the right number of nodes (at the beginning and end points).

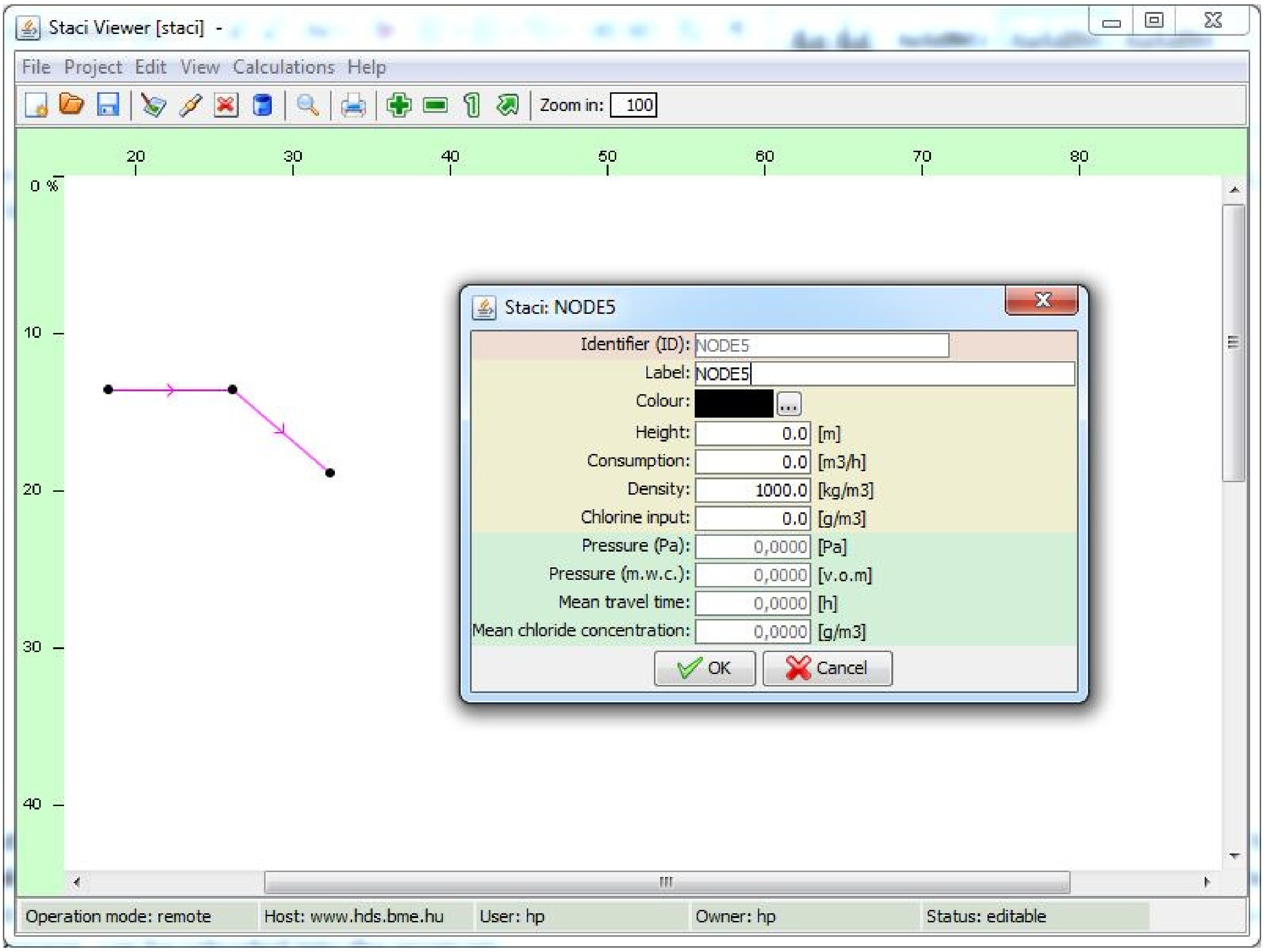
Elements can be connected by clicking on the node – the marker of the node should change to a red rectangle - and pulling it to the node we want to connect it with. The nodes will be connected only if clicking on 'Yes' when the question 'Are you sure to connect these edges?' pops up. (The nodes will not be connected if they are only on each other!!!)



The properties of the created edges (denoted by a, b, c, and d) and nodes (denoted by p and r) also have to be defined. We can give the properties of an element by right clicking on it. The identifier (ID) of an element or node cannot be changed, but by the Label name we can refer to its name in our model. Moreover, here we can give the needed parameters such as diameter, length, roughness in the case of pipes (here negative λ has to be given!), water level and bottom level in the case of pools, performance curve in the case of pumps, etc.



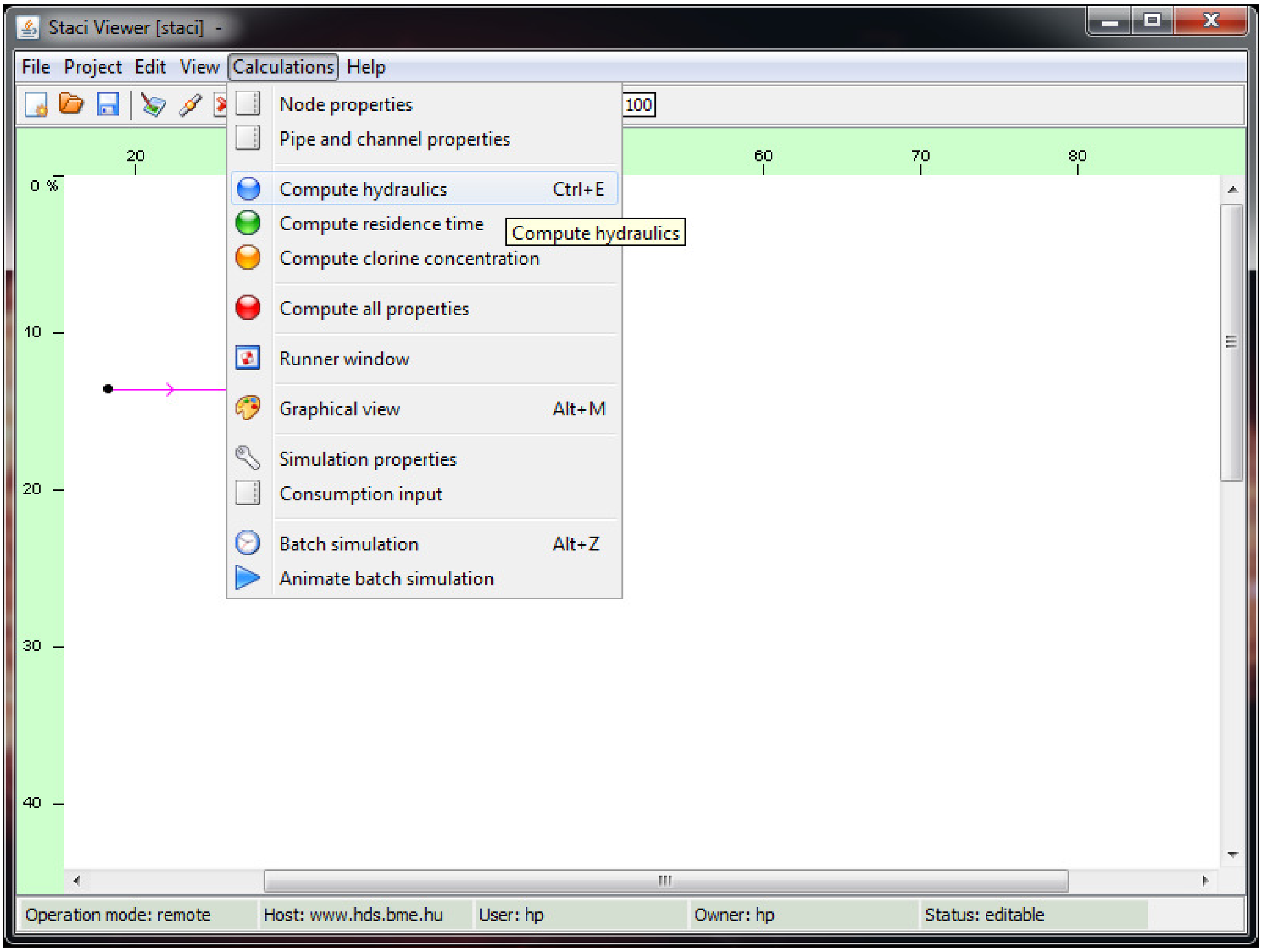
We also have to define the nodes, their label, height and their consumption. (Attention! The picture of the model only shows the topology of the system, it does not contain the height above the sea level, it can only be given by the height of the nodes.)



For the calculations to be performed first the changes have to be saved! The parameters can be checked in the list of nods and elements.
(Remark: Even if one or more parameters are not given, the calculations will be carried out, since the program will run with the default values. Most of the times these differ from the parameters of the given problem, therefore it won' t give the expected results!)

Hydraulic calculations

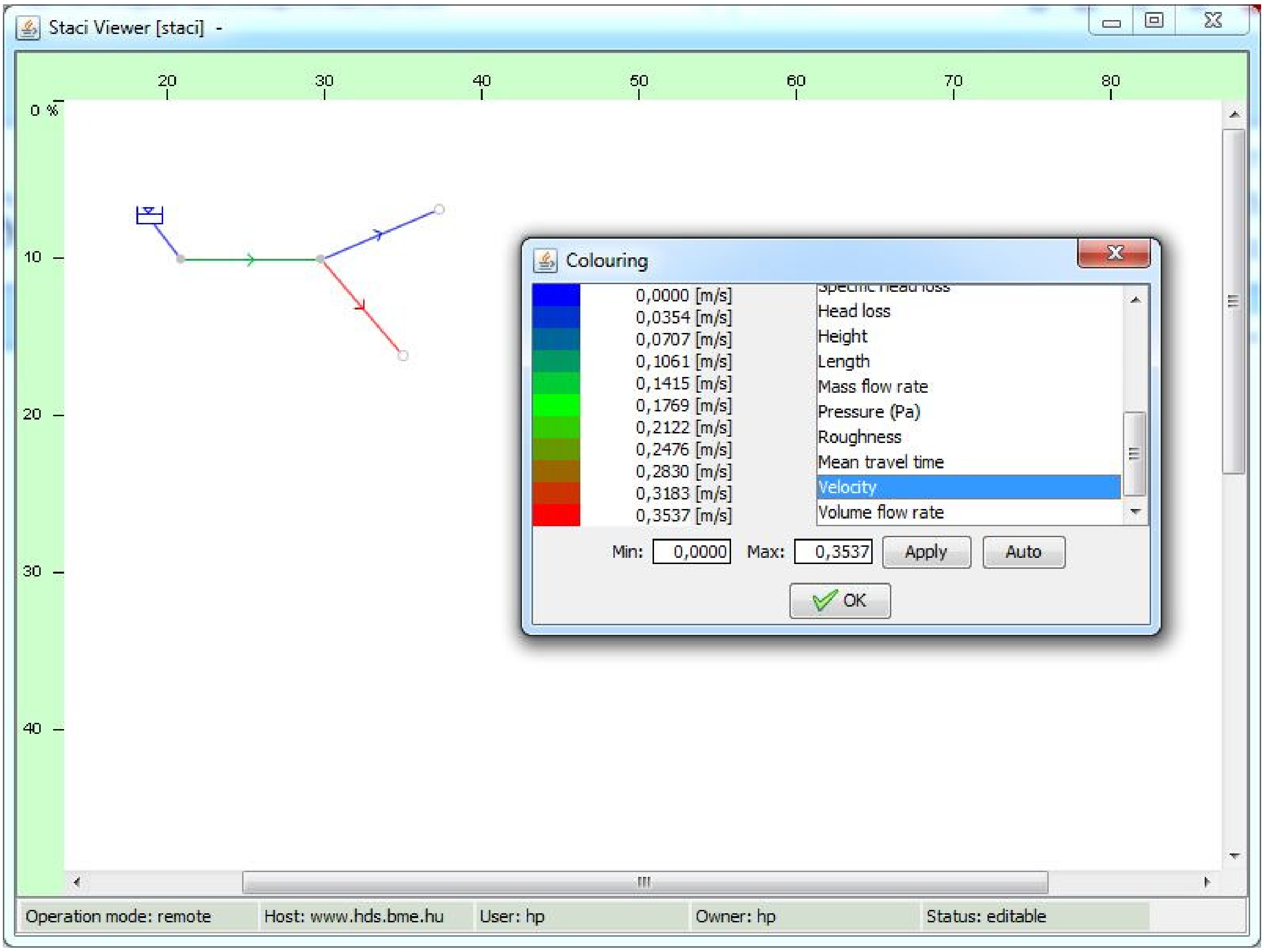
By clicking on Calculations/Compute hydraulics the program will carry out the stationary computations on the hydraulic model defined by the given parameters. This takes a few seconds, we will notice when it is done.



With the program we can also carry out multiplications. At the end of our problem solving, with this we can check for example if the water level in our pools (with given areas) are valid.

Results

After the calculations, the visualization of the results are possible, where the resulting values of pressure, velocity, etc. can be checked in graphical form.



In Project\Project properties we can get the list of all the iterations from the result file if we set the Debug level to 2.
In the Calculations menu point we can obtain the list of all the data (properties) of the nodes or elements, then the list can be copied to clipboard and pasted into, for example, an excel file, making the drawing of the performance curves easier. The data, of course, can be reloaded into the program.
We can also export the data. The exported file can be saved onto the computer as an .xml file, and from there can be reloaded into the program. (Attention! The final, and actual program version must be on the server! Saving the results to our own computer might be useful to look for mistakes.)
The data of the network elements

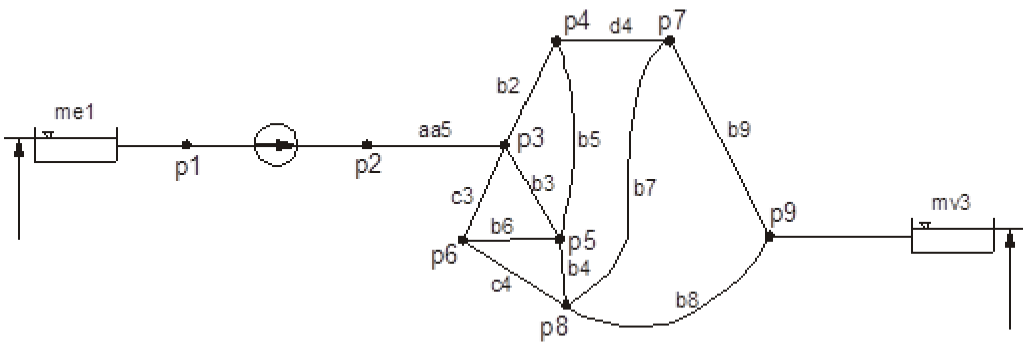
	D [m]	λ **[-]**	**L [m]**
a*1	0,25	0,025	200
a*2	0,25	0,025	400
a*3	0,25	0,025	600
a*4	0,25	0,025	800
a*5	0,25	0,020	5000

	D [m]	λ [-]	L [m]
aa5	0,35	0,020	4500
a*6	0,25	0,025	200
a*7	0,25	0,025	400
a*8	0,25	0,025	600
aa8	0,40	0,020	500
a*9	0,25	0,025	800
a0	0,35	0,020	1000
b1	0,20	0,028	200
b2	0,20	0,028	400
b3	0,20	0,028	600
b4	0,20	0,028	800
b5	0,20	0,020	8000
b6	0,20	0,020	8200
b7	0,20	0,020	8400
b8	0,20	0,020	8600
b9	0,20	0,020	8800
c1	0,15	0,030	200
c2	0,15	0,030	400
c3	0,15	0,030	600
c4	0,15	0,030	800
c5	0,15	0,030	1000
c6	0,15	0,030	200
c7	0,15	0,030	400
c8	0,15	0,030	600
c9	0,15	0,030	800
d1	0,10	0,035	200

	D [m]	λ [-]	L [m]
d2	0,10	0,035	400
d3	0,10	0,035	600
d4	0,10	0,035	800
d5	0,10	0,030	5000
d6	0,10	0,035	200
d7	0,10	0,030	5400
d8	0,10	0,030	5600
d9	0,10	0,030	5800

In the following examples:
z [m]: Height
f [m^3/h]: Consumption
H [m]: Bottom level
h [m]: Water level

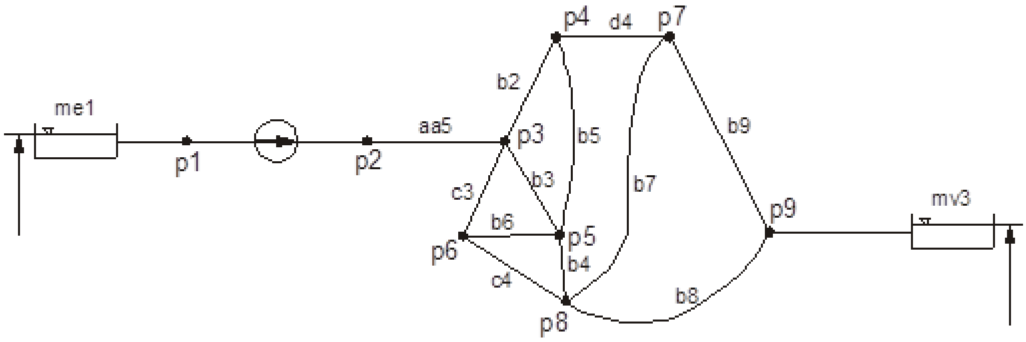
A11



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
p1	110	-	p2	110	-
p3	126	21	p4	125	21
p5	123	8	p6	126	6
p7	134	18	p8	123	1
p9	122	13			

	H(m)	h(m)
me1	113	2
mv3	158	2

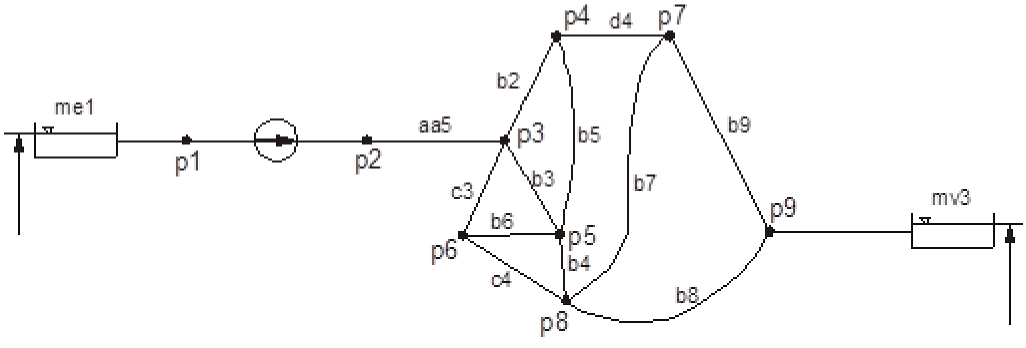
A12



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
p1	140	-	p2	140	-
p3	156	11	p4	157	15
p5	153	18	p6	153	6
p7	167	22	p8	156	4
p9	154	9			

	H(m)	h(m)
me1	133	2
mv3	188	2

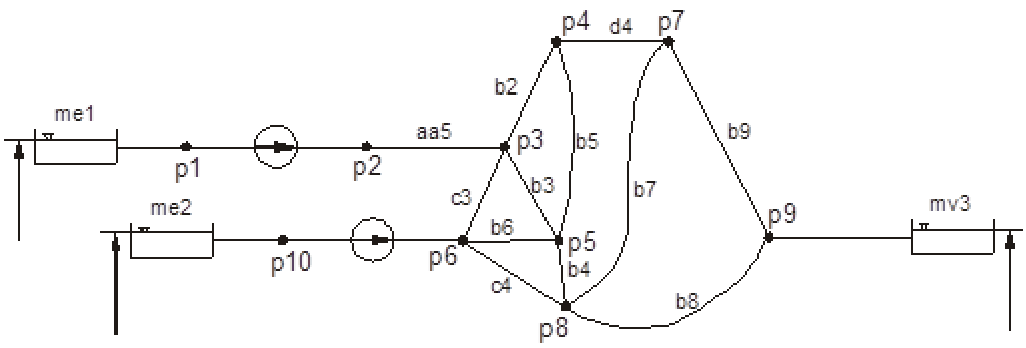
A13



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
p1	211	-	p2	211	-
p3	227	15	p4	225	2
p5	224	11	p6	226	6
p7	235	1	p8	223	1
p9	223	2			

	H(m)	h(m)
me1	214	2
mv3	258	2

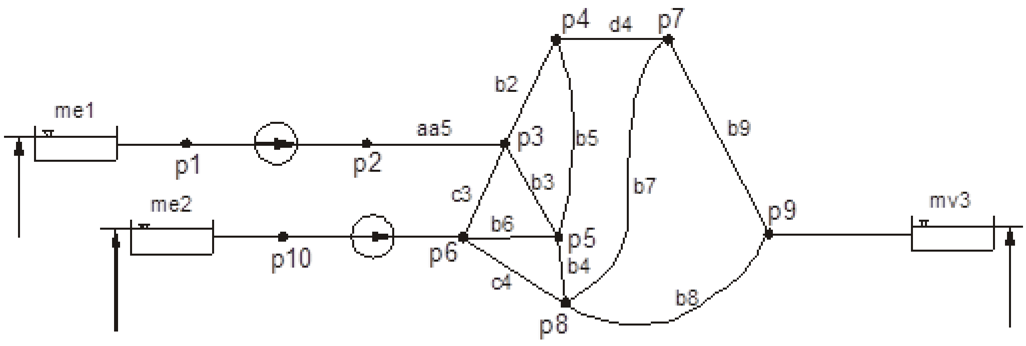
A21



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
p1	200	-	p2	200	-
p3	206	8	p4	215	9
p5	213	12	p6	201	1
p7	214	15	p8	209	5
p9	206	12	p10	201	-

	H(m)	h(m)
me1	203	2
me2	207	2
mv3	253	2

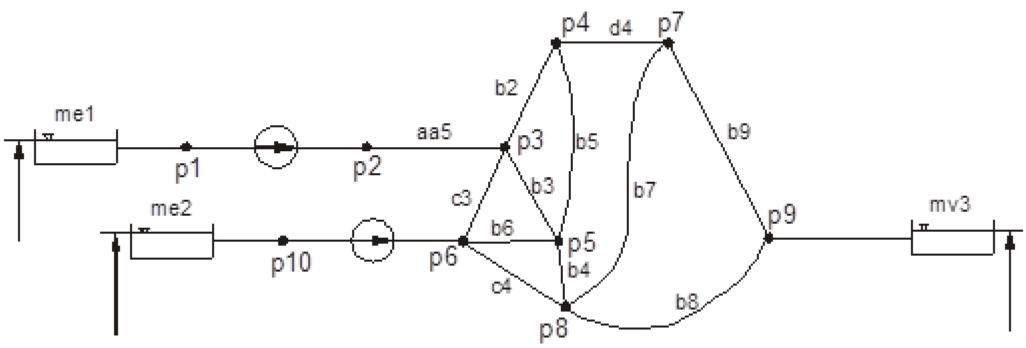
A22



	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
p1	130	-	p2	130	-
p3	136	48	p4	145	28
p5	143	42	p6	152	30
p7	144	15	p8	139	24
p9	136	32	p10	152	-

	H(m)	h(m)
me1	132	2
me2	152	2
mv3	181	2

A23

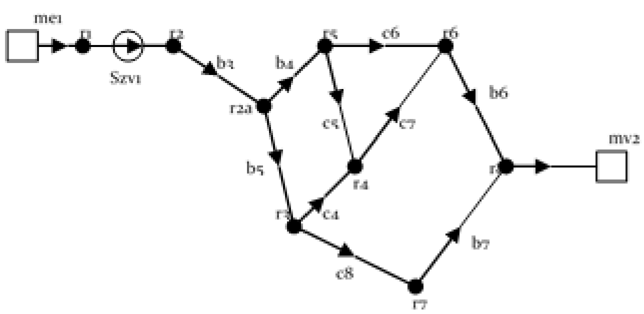


	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
p1	100	-	p2	100	-
p3	107	2	p4	115	18

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
p5	114	12	p6	101	10
p7	114	15	p8	109	17
p9	106	22	p10	101	-

	H(m)	h(m)
me1	101	2
me2	106	2
mv3	153	2

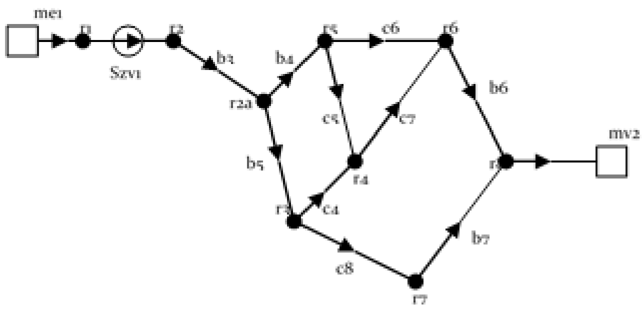
B11



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	110	-	r5	123	70
r2	110	-	r6	125	12
r2a	122	-	r7	127	31
r3	134	23	r8	120	13
r4	132	44			

	H(m)	h(m)
me1	113	2
me2	163	2

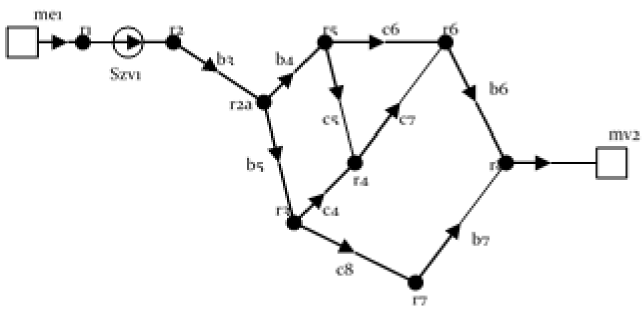
B12



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	160	-	r5	172	7
r2	160	-	r6	174	21
r2a	170	-	r7	177	9
r3	182	7	r8	170	7
r4	183	10			

	H(m)	h(m)
me1	103	2
me2	203	2

B13

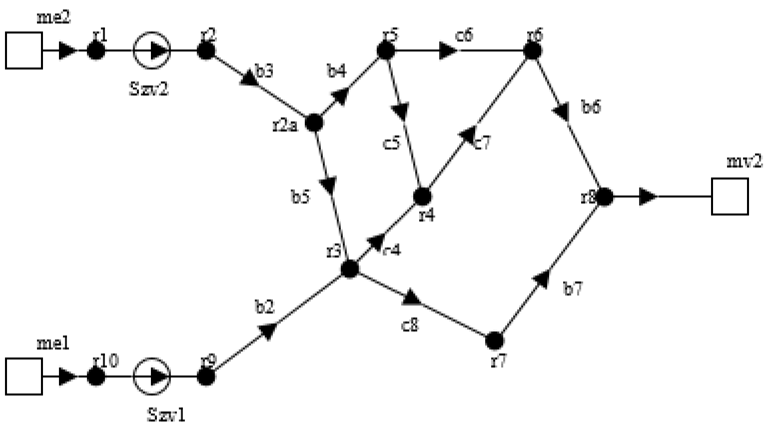


	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	200	-	r5	212	70
r2	200	-	r6	214	20
r2a	211	-	r7	217	16
r3	222	31	r8	211	17

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r4	225	55			

	H(m)	h(m)
me1	203	2
me2	273	2

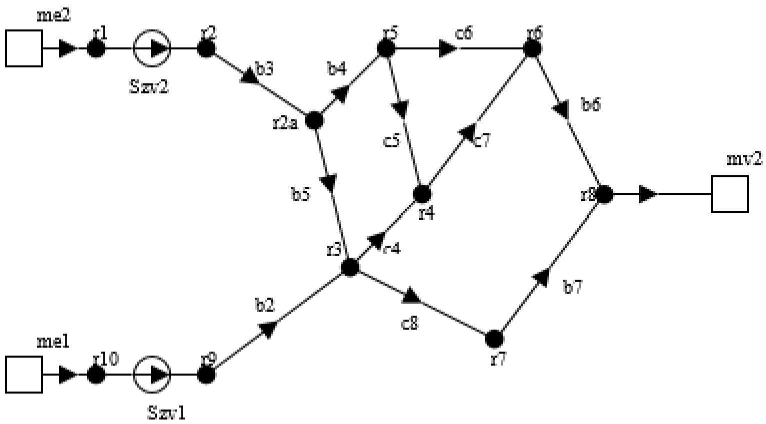
B21



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	200	-	r6	224	40
r2	200	-	r7	217	33
r2a	210	-	r8	210	35
r3	212	26	r9	202	-
r4	213	70	r10	202	-
r5	222	75			

	H(m)	h(m)
me1	203	2
me2	198	2
mv2	258	2

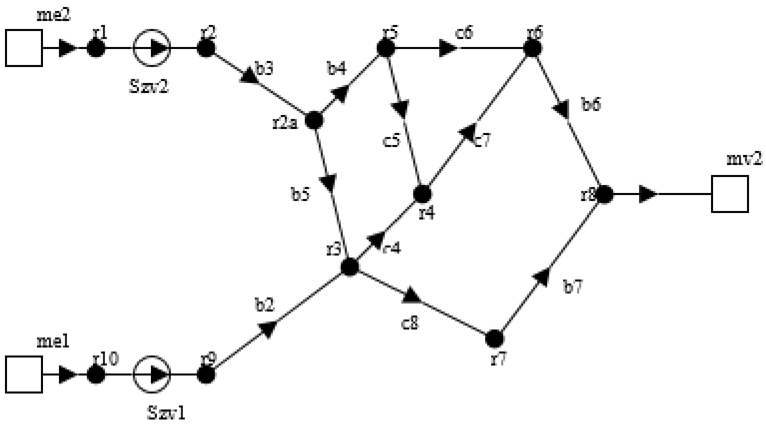
B22



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	150	-	r6	174	30
r2	150	-	r7	167	23
r2a	150	-	r8	160	25
r3	162	12	r9	152	-
r4	163	43	r10	152	-
r5	172	75			

	H(m)	h(m)
me1	153	2
me2	148	2
mv2	197	2

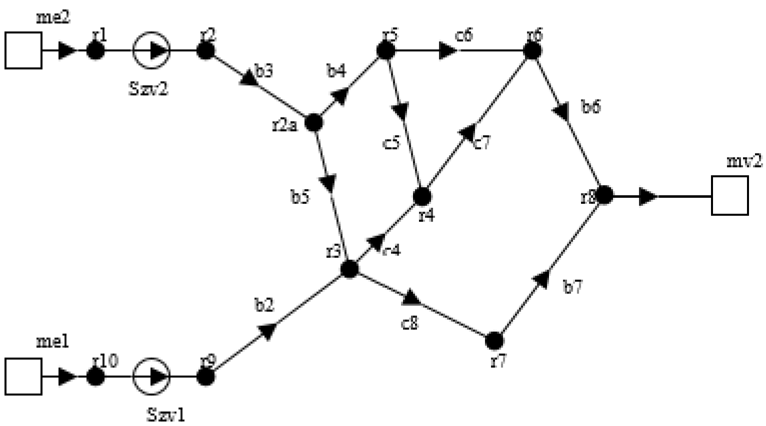
B23



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	100	-	r6	124	22
r2	100	-	r7	117	3
r2a	110	-	r8	110	15
r3	112	12	r9	102	-
r4	113	5	r10	102	-
r5	122	10			

	H(m)	h(m)
me1	106	2
me2	98	2
mv2	158	2

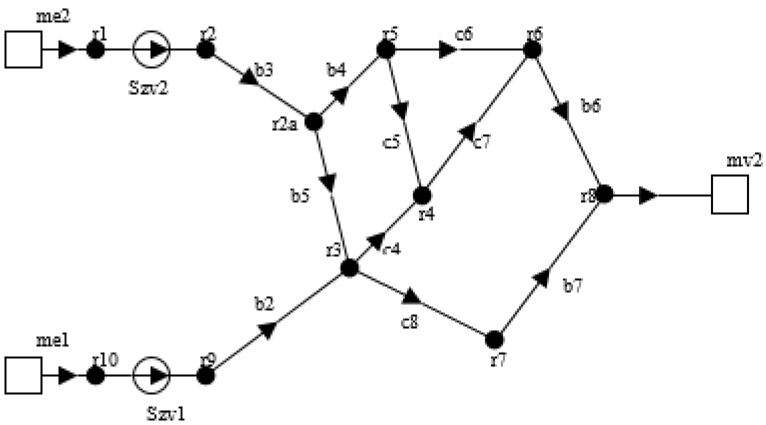
C21



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	200	-	r6	212	35
r2	200	-	r7	203	22
r2a	215	22	r8	218	25
r3	204	45	r9	205	-
r4	223	12	r10	205	-
r5	210	16			

	H(m)	h(m)
me1	213	2
me2	210	2
mv2	262	2

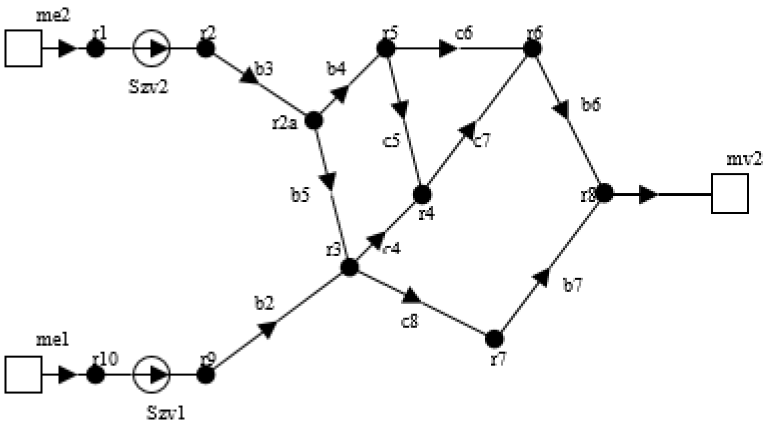
C22



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	100	-	r6	112	25
r2	100	-	r7	107	32
r2a	112	20	r8	118	25
r3	106	35	r9	103	-
r4	123	11	r10	103	-
r5	111	10			

	H(m)	h(m)
me1	111	2
me2	110	2
mv2	143	2

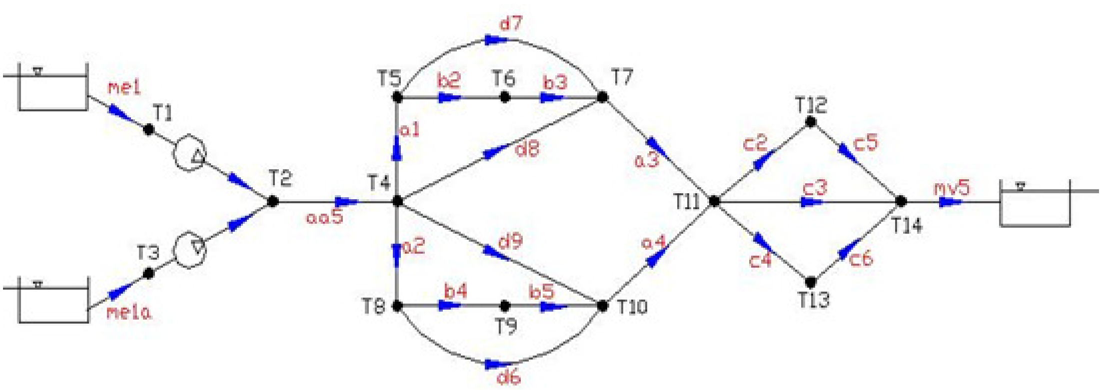
C23



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	300	-	r6	310	19
r2	103000	-	r7	305	14
r2a	312	7	r8	318	20
r3	304	15	r9	301	-
r4	323	5	r10	103013	-
r5	310	7			

	H(m)	h(m)
me1	313	2
me2	309	2
mv2	375	2

D21

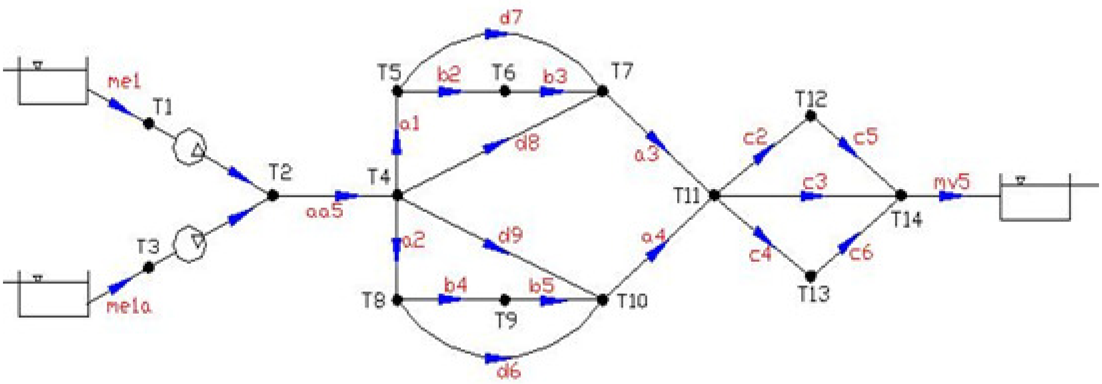


	z [m]	f [m^3/h]		z [m]	f [m^3/h]

	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
T1	104	-	T8	104	15
T2	104	-	T9	105	33
T3	104	-	T10	108	30
T4	101	28	T11	109	34
T5	103	12	T12	111	20
T6	105	22	T13	112	25
T7	108	41	T14	119	-

	H(m)	h(m)
me1	104	2
me1a	105	2
mv5	158	2

D22

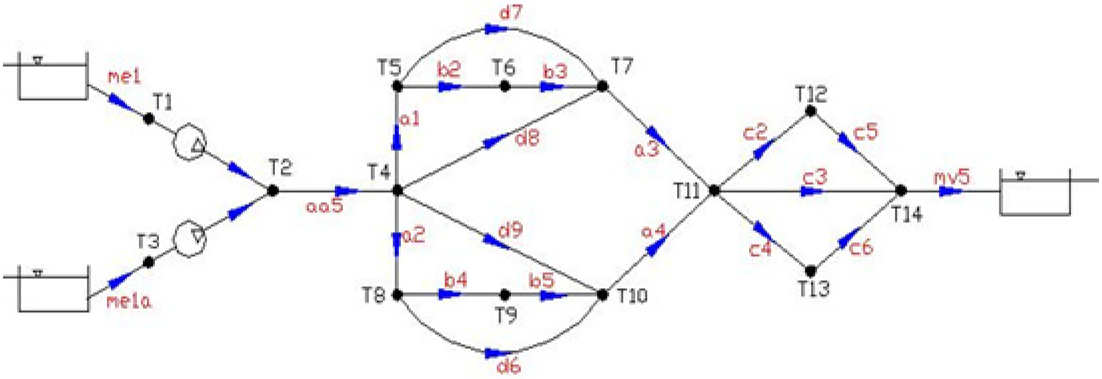


	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
T1	203	-	T8	214	35
T2	203	-	T9	215	53
T3	203	-	T10	228	20
T4	214	33	T11	219	31
T5	214	32	T12	231	20
T6	215	17	T13	222	22

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
T7	208	41	T14	219	-

	H(m)	h(m)
me1	212	2
me1a	213	2
mv5	271	2

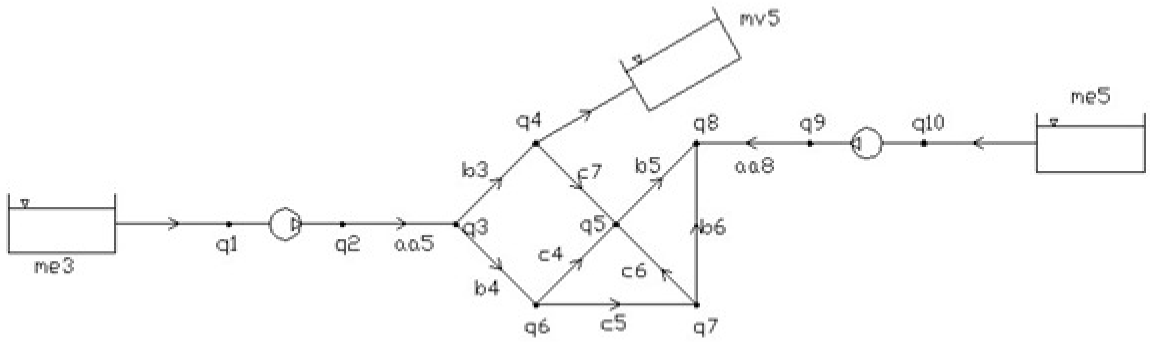
D23



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
T1	153	-	T8	164	29
T2	153	-	T9	165	43
T3	153	-	T10	178	30
T4	164	23	T11	169	31
T5	164	32	T12	176	21
T6	165	37	T13	177	22
T7	158	31	T14	169	-

	H(m)	h(m)
me1	163	2
me1a	163	2
mv5	202	2

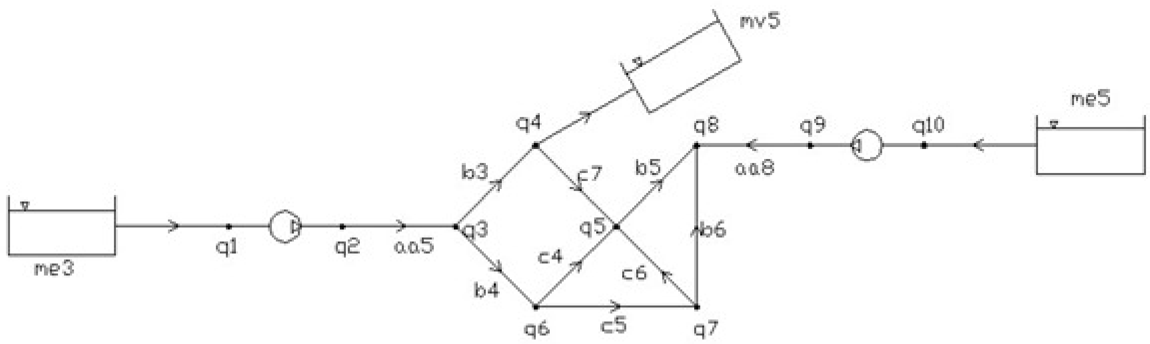
E21



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
q1	118	-	q6	124	20
q2	118	-	q7	117	15
q3	125	40	q8	112	15
q4	133	30	q9	111	10
q5	123	25	q10	111	-

	H(m)	h(m)
me1	121	2
me5	115	2
mv5	160	2

E22

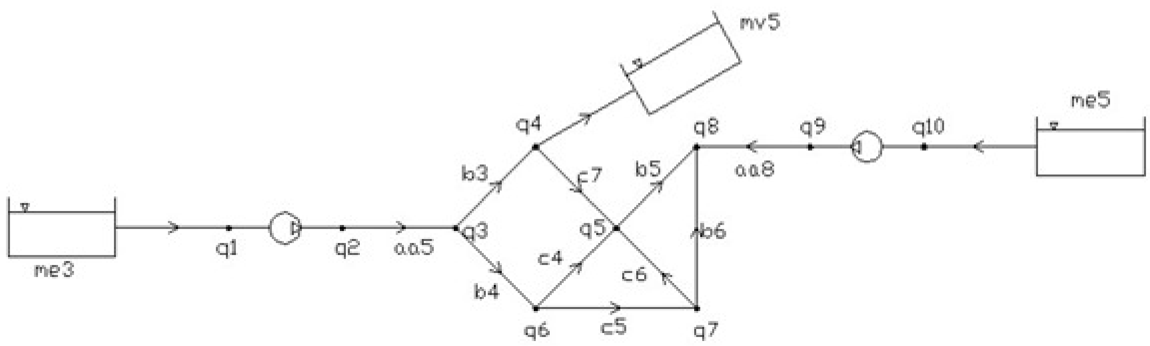


	z [m]	f [m^3/h]		z [m]	f [m^3/h]

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
q1	142	-	q6	175	23
q2	142	-	q7	170	11
q3	162	40	q8	168	40
q4	185	90	q9	150	40
q5	175	10	q10	150	-

	H(m)	h(m)
me1	150	2
me5	148	2
mv5	208	2

E23

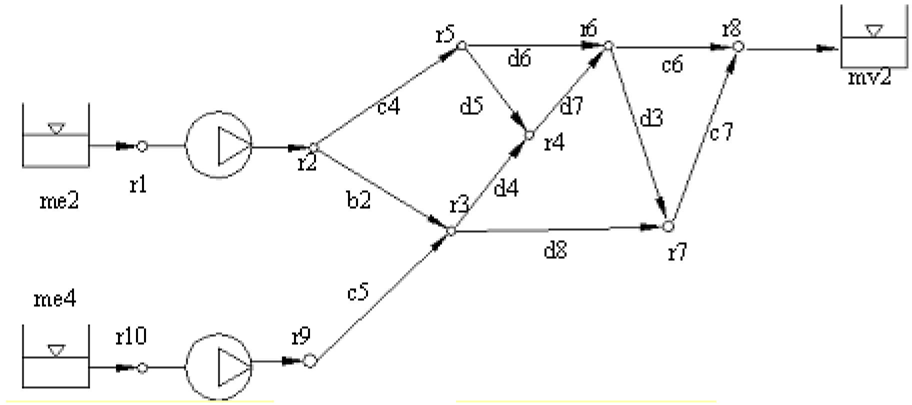


	z [m]	f [m^3/h]		z [m]	f [m^3/h]
q1	245	-	q6	279	32
q2	245	-	q7	272	22
q3	265	40	q8	267	45
q4	285	77	q9	250	15
q5	275	22	q10	250	-

	H(m)	h(m)
me1	253	2

	H(m)	h(m)
me5	248	2
mv5	303	2

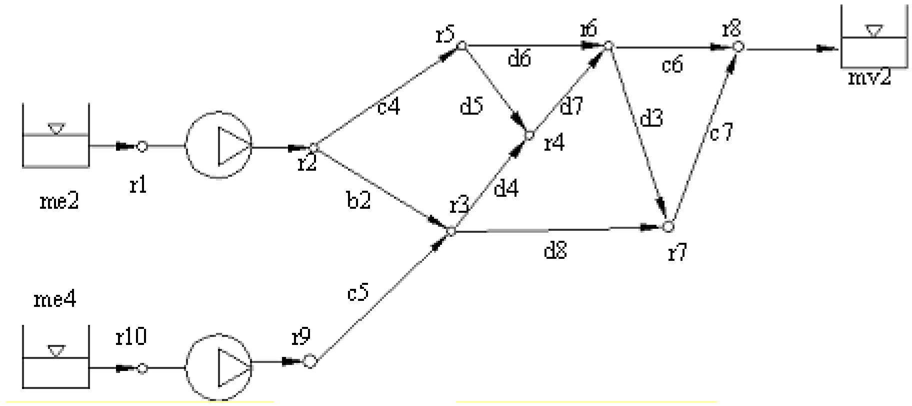
F21



	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
r1	101	-	r6	104	20
r2	101	-	r7	105	25
r3	103	11	r8	110	15
r4	103	23	r9	100	-
r5	102	35	r10	100	-

	H(m)	h(m)
me3	99	2
me5	97	2
mv5	159	2

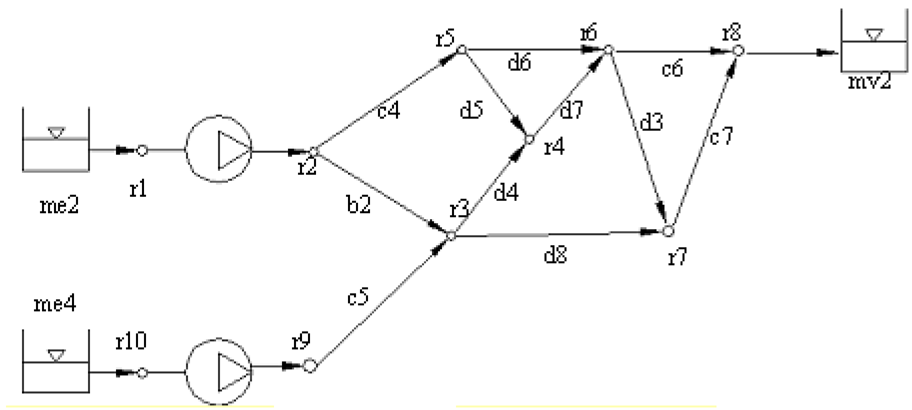
F22



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	205	-	r6	222	10
r2	205	-	r7	207	25
r3	212	31	r8	211	25
r4	215	31	r9	200	-
r5	212	32	r10	200	-

	H(m)	h(m)
me3	208	2
me5	208	2
mv5	243	2

F23

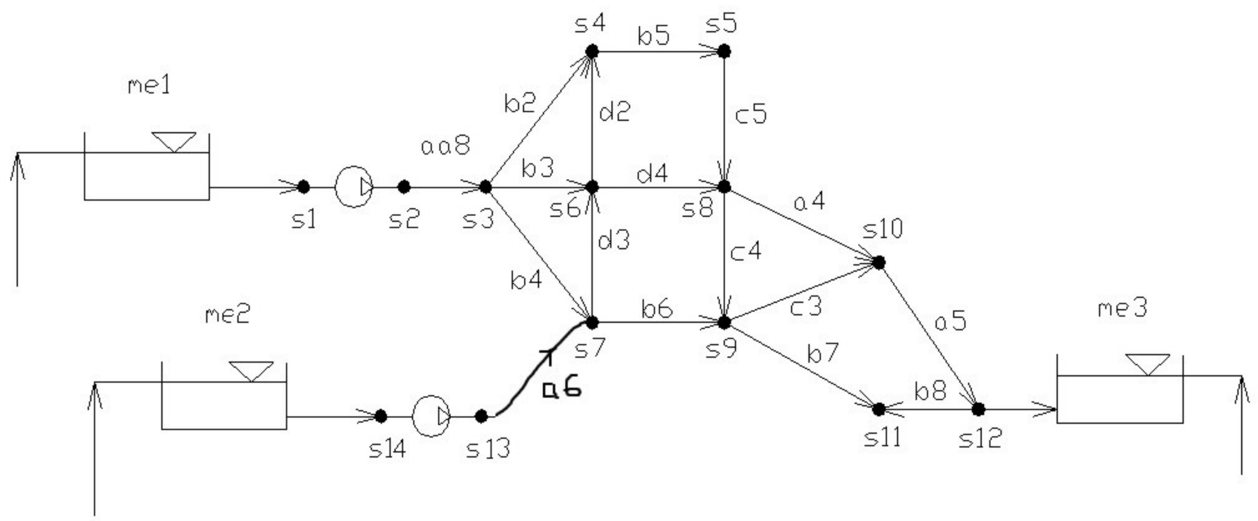


	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r1	100	-	r6	124	41

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
r2	100	-	r7	107	15
r3	113	35	r8	110	-
r4	115	30	r9	100	-
r5	112	12	r10	100	-

	H(m)	h(m)
me3	108	2
me5	107	2
mv5	163	2

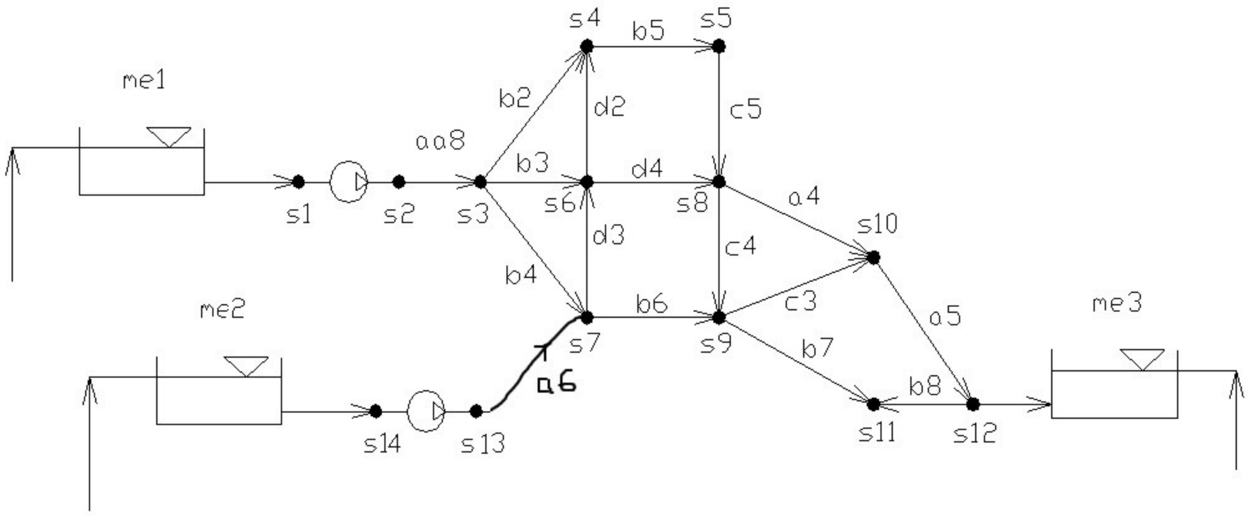
G21



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
s1	101	-	s8	110	24
s2	101	-	s9	110	27
s3	105	25	s10	108	11
s4	107	11	s11	109	-
s5	110	33	s12	112	-
s6	106	21	s13	105	-
s7	112	11	s14	105	-

	H(m)	h(m)
me1	106	2
me2	105	2
me3	138	2

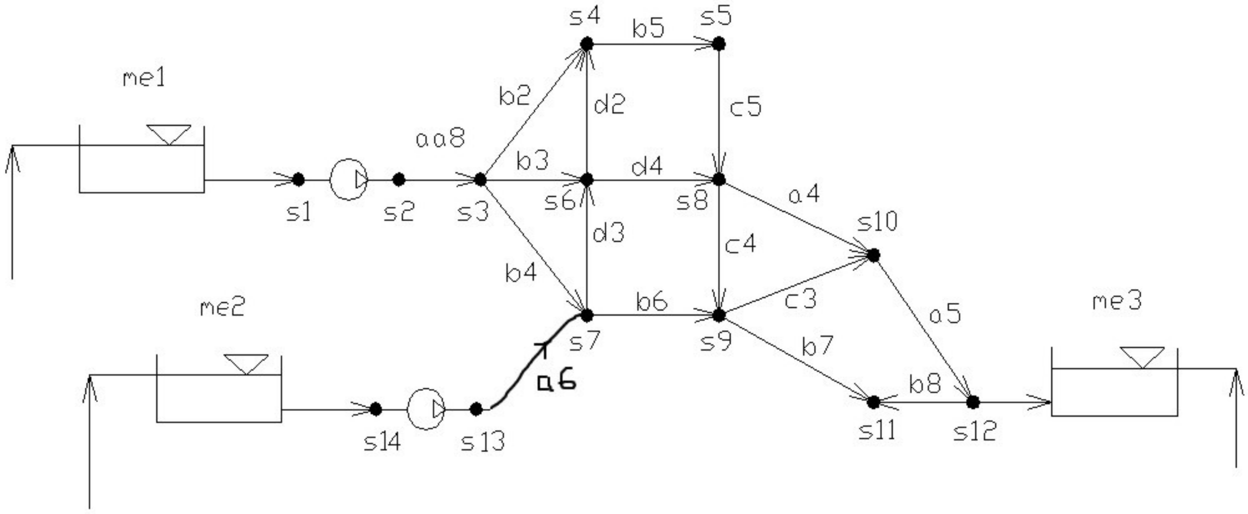
G22



	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
s1	102	-	s8	130	24
s2	102	-	s9	120	23
s3	125	15	s10	118	21
s4	137	18	s11	129	11
s5	110	23	s12	132	-
s6	136	25	s13	125	-
s7	132	22	s14	125	-

	H(m)	h(m)
me1	106	2
me2	105	2
me3	138	2

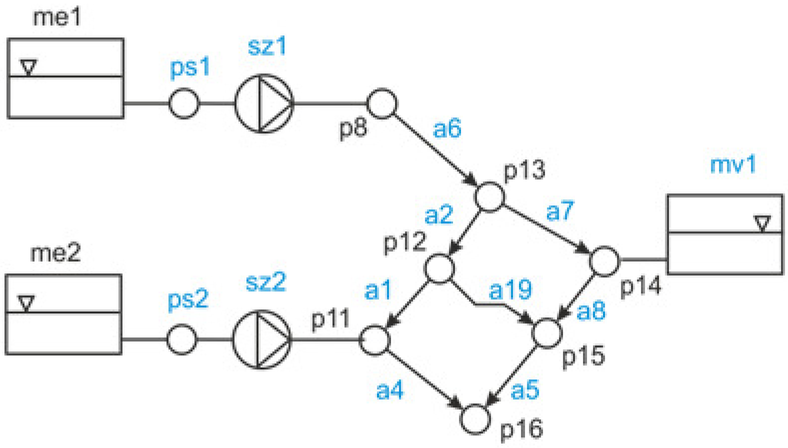
G23



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
s1	202	-	s8	230	24
s2	202	-	s9	220	27
s3	225	15	s10	218	21
s4	237	18	s11	229	1
s5	210	23	s12	232	-
s6	236	35	s13	225	-
s7	232	29	s14	225	-

	H(m)	h(m)
me1	214	2
me2	226	2
me3	269	2

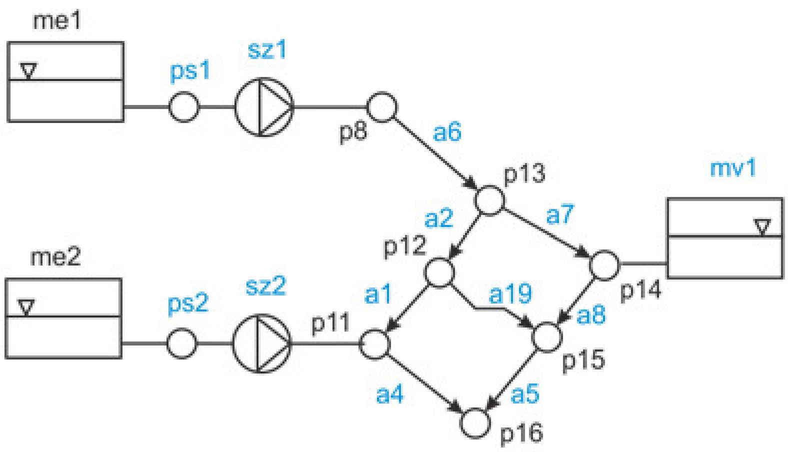
H21



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	104	-	P13	114	35
Ps2	103	-	P14	124	45
P8	104	30	P15	116	19
P11	103	31	P16	123	21
P12	113	13			

	H(m)	h(m)
me1	105	2
me2	106	2
mv1	137	2

H22

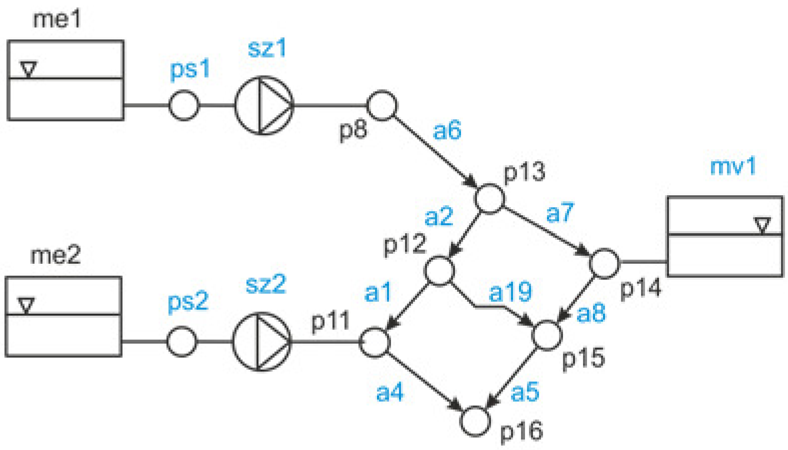


	z [m]	f [m^3/h]		z [m]	f [m^3/h]

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	98	-	P13	116	40
Ps2	103	-	P14	124	45
P8	98	11	P15	127	10
P11	103	13	P16	122	33
P12	114	21			

	H(m)	h(m)
me1	104	2
me2	104	2
mv1	153	2

H23

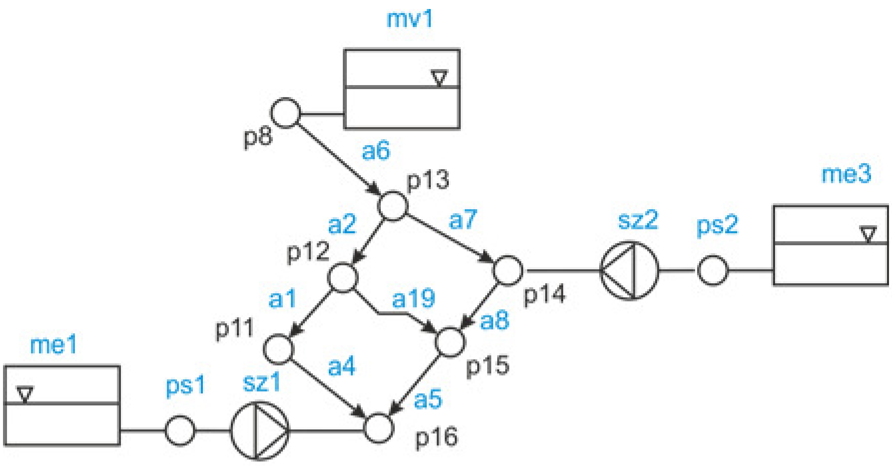


	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	104	-	P13	116	3
Ps2	101	-	P14	121	3
P8	104	11	P15	122	10
P11	101	3	P16	118	11
P12	116	7			

	H(m)	h(m)
me1	107	2

	H(m)	h(m)
me2	107	2
mv1	139	2

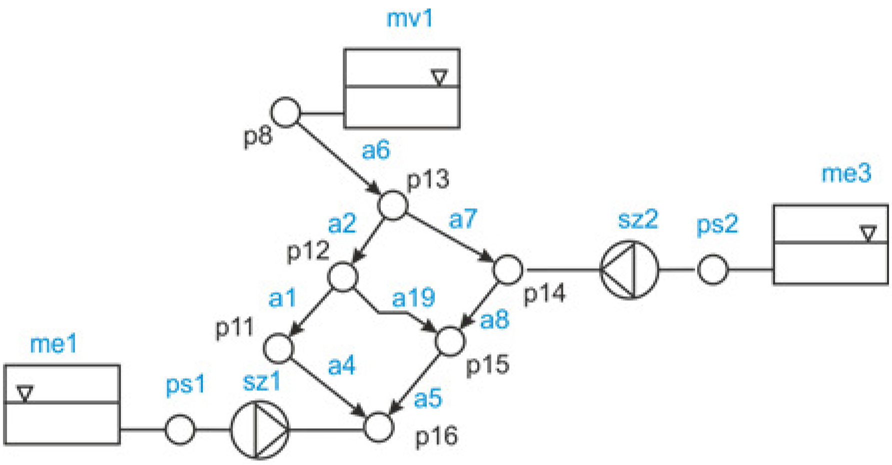
I21



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	121	-	P13	150	11
Ps2	123	-	P14	123	8
P8	141	8	P15	167	7
P11	137	12	P16	121	9
P12	142	8			

	H(m)	h(m)
me1	126	2
me3	126	2
mv1	167	2

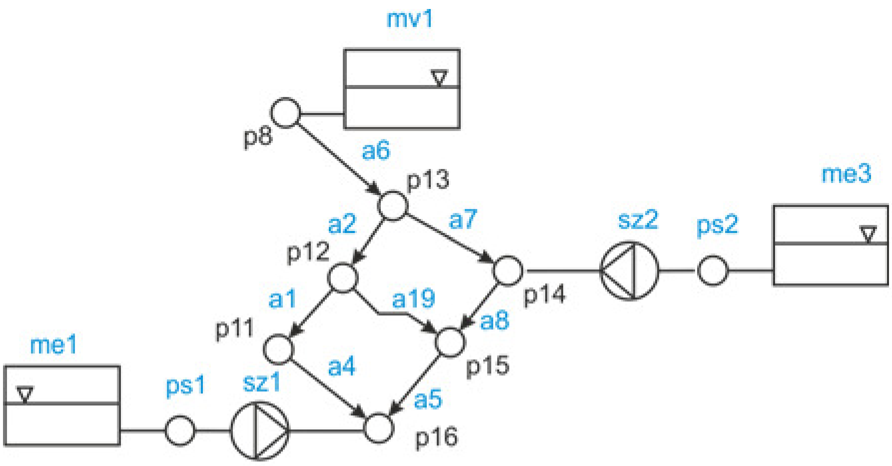
I22



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	255	-	P13	280	1
Ps2	249	-	P14	249	32
P8	241	20	P15	267	31
P11	278	18	P16	255	25
P12	281	15			

	H(m)	h(m)
me1	258	2
me3	253	2
mv1	299	2

I23

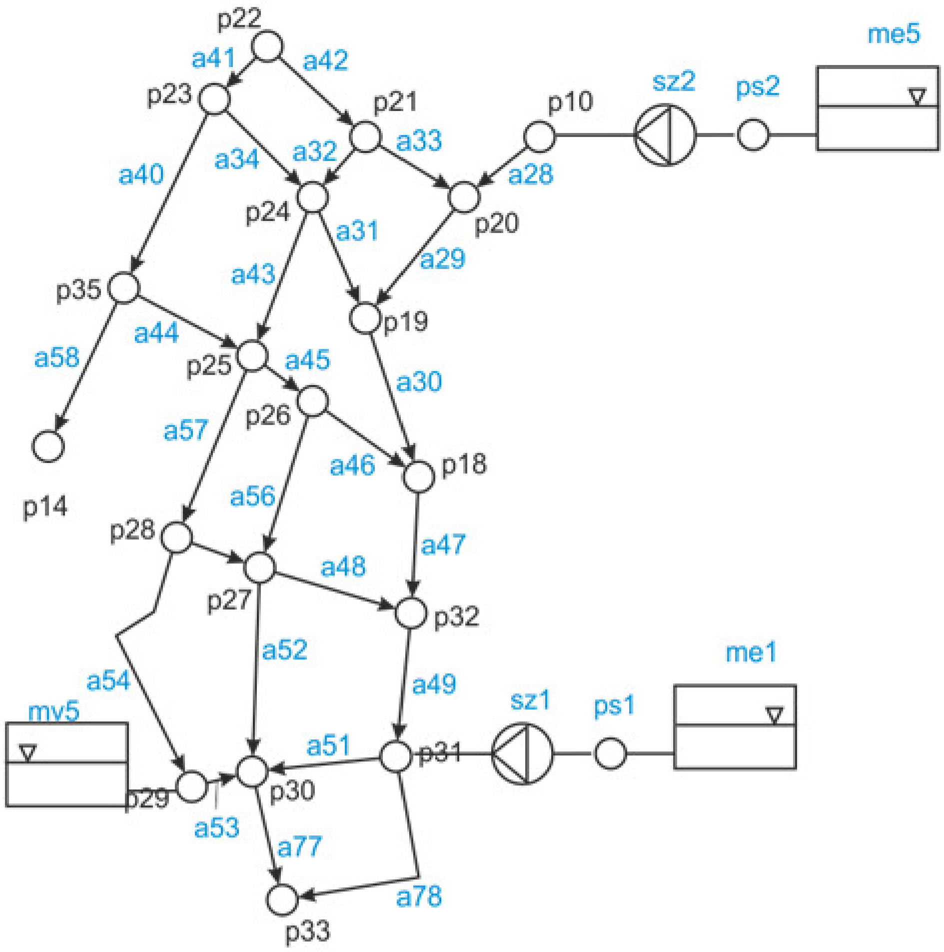


	z [m]	f [m^3/h]		z [m]	f [m^3/h]

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	155	-	P13	180	12
Ps2	149	-	P14	149	15
P8	141	5	P15	170	15
P11	173	12	P16	155	25
P12	183	9			

	H(m)	h(m)
me1	158	2
me3	157	2
mv1	213	2

K21

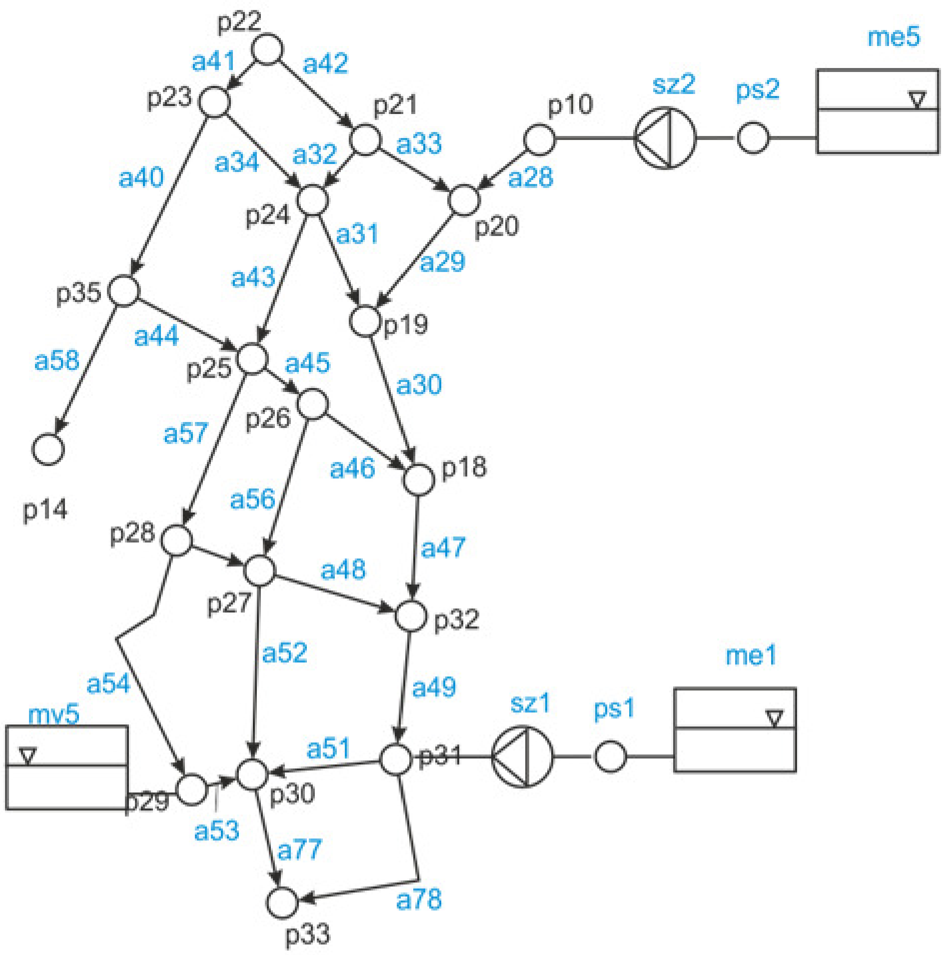


generated by haroopad

	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
Ps1	95	-	P25	122	6
Ps2	97	-	P26	131	8
P10	97	9	P27	140	8
P14	113	7	P28	141	-
P18	131	12	P29	148	11
P19	120	16	P30	134	9
P20	133	13	P31	95	-
P21	131	-	P32	129	-
P22	126	9	P33	135	15
P23	127	10	P35	129	6
P24	131	5			

	H(m)	h(m)
me1	100	2
me5	102	2
mv5	147	2

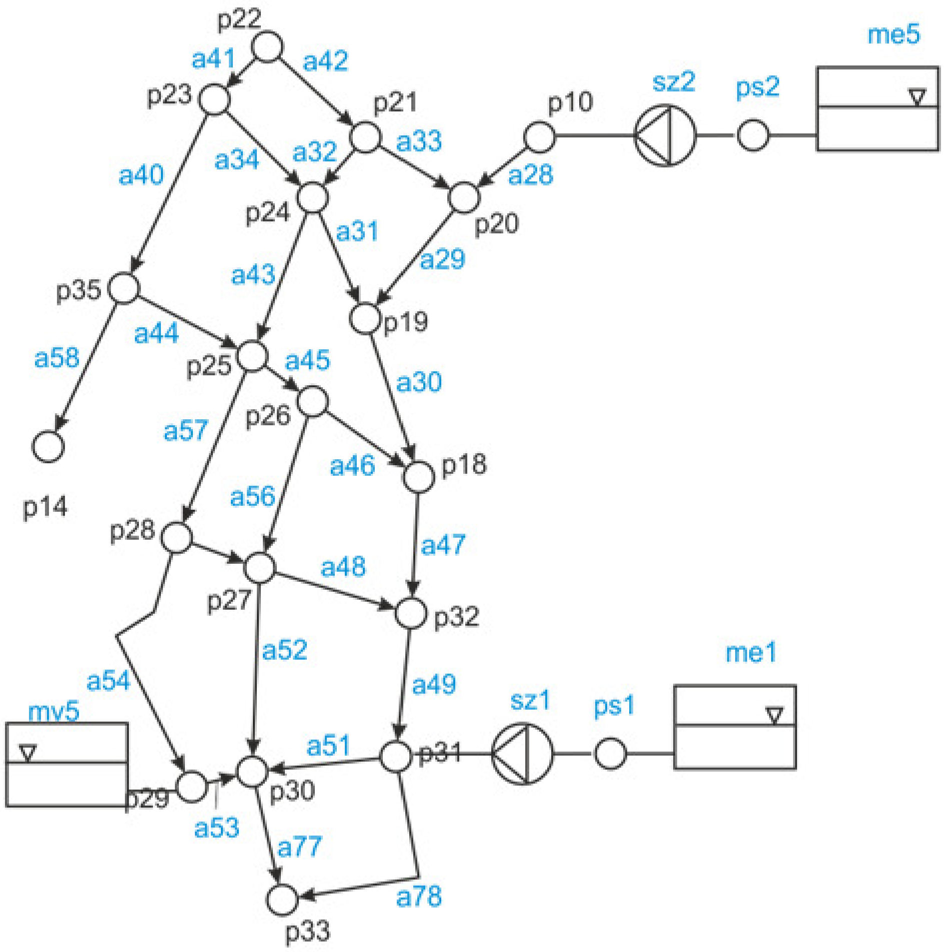
K22



	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
Ps1	95	-	P25	122	6
Ps2	97	-	P26	131	28
P10	97	7	P27	140	11
P14	113	9	P28	141	-
P18	132	12	P29	148	14
P19	120	23	P30	134	13
P20	132	1	P31	95	-
P21	137	-	P32	136	-
P22	123	12	P33	135	25
P23	127	10	P35	129	16
P24	131	7			

	H(m)	h(m)
me1	99	2
me5	105	2
mv5	153	2

K23

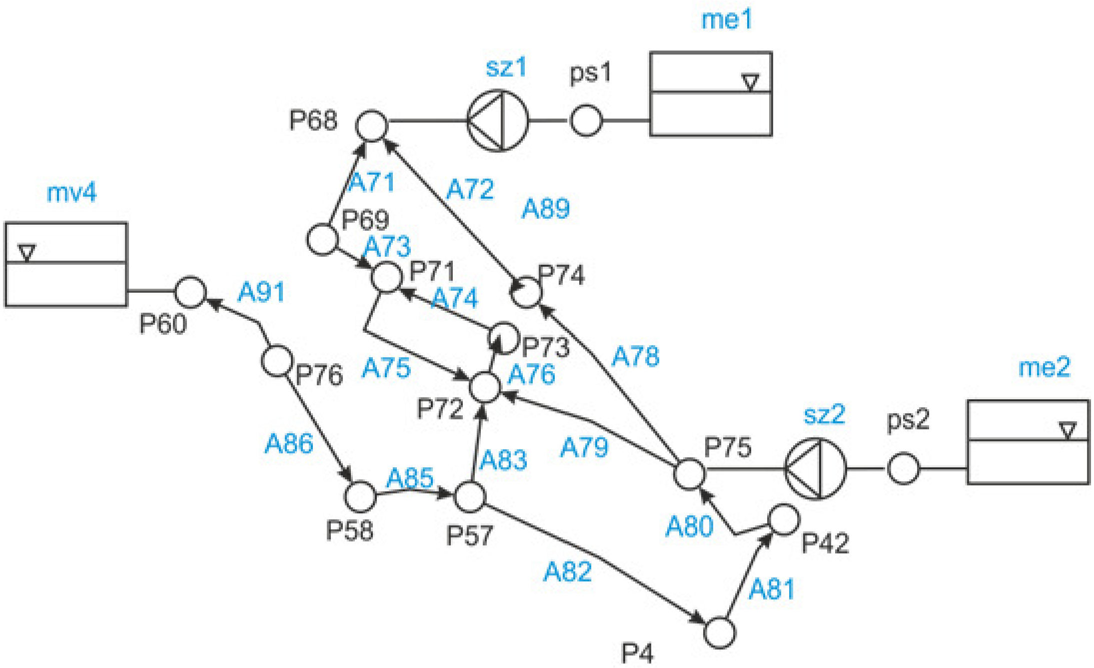


	z $[m]$	f $[m^3/h]$		z $[m]$	f $[m^3/h]$
Ps1	295	-	P25	322	6
Ps2	297	-	P26	331	8
P10	297	21	P27	340	12
P14	313	11	P28	341	-
P18	331	16	P29	348	12
P19	320	21	P30	334	11

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
P20	333	2	P31	295	-
P21	331	-	P32	336	-
P22	326	4	P33	335	15
P23	327	10	P35	329	1
P24	331	7			

	H(m)	h(m)
me1	297	2
me5	302	2
mv5	360	2

L21

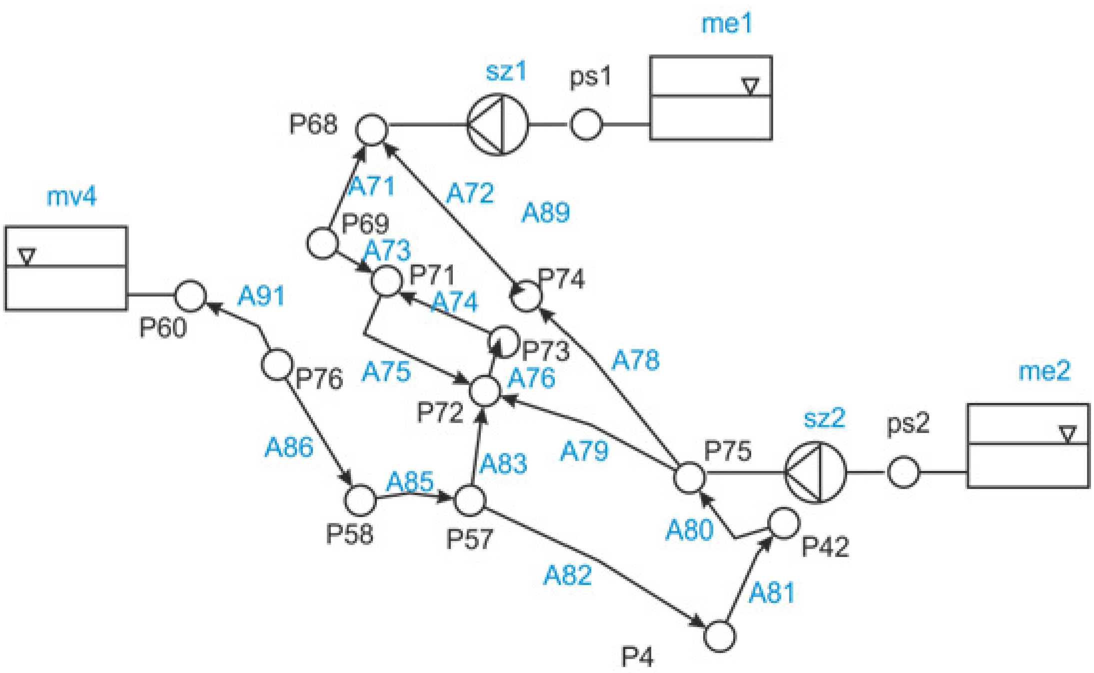


	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	97	-	P69	122	5
Ps2	98	-	P71	133	6
P4	111	9	P72	130	21
P42	108	7	P73	121	12

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
P57	113	14	P74	123	11
P58	124	-	P75	98	6
P60	133	9	P76	131	9
P68	97	13			

	H(m)	h(m)
me1	102	2
me2	101	2
mv4	139	2

L22

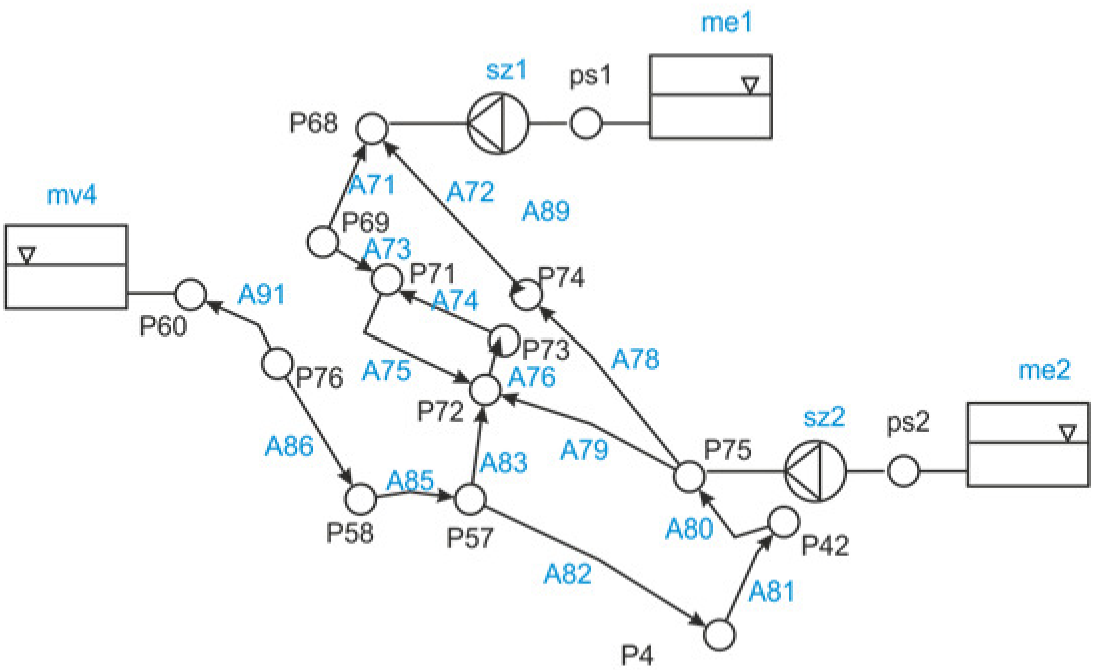


	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	212	-	P69	240	17
Ps2	213	-	P71	244	16
P4	231	21	P72	227	7
P42	230	6	P73	233	4
P57	233	13	P74	229	14

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
P58	240	31	P75	213	21
P60	226	-	P76	249	12
P68	212	11			

	H(m)	h(m)
me1	219	2
me2	217	2
mv4	252	2

L23



	z [m]	f [m^3/h]		z [m]	f [m^3/h]
Ps1	313	-	P69	340	11
Ps2	318	-	P71	344	21
P4	331	12	P72	337	20
P42	329	11	P73	333	14
P57	333	15	P74	329	5
P58	335	21	P75	318	13

	z [m]	f [m^3/h]		z [m]	f [m^3/h]
P60	326	-	P76	351	14
P68	313	20			

	H(m)	h(m)
me1	319	2
me2	320	2
mv4	358	2

generated by haroopad