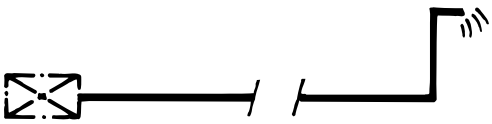
Flow Characteristics

Determining Pressure Loss in Piping Systems Using the INSTAFLEX Calculation Method

Pressure loss calculation is based on the determination of pipe diameters directly from the load units.

Approximate pipe diameters can be determined using section **2.1**



If pipe diameters are correctly calculated, pressure loss of 1.5 bar (150,000N/m^2) should not be exceeded for the entire installation, from the water meter or the pressure reducing valve to the last outlet.

If the pipe diameter is not sufficient, pressure losses must be determined for manifold distribution according to section **2.2** and for general distribution using section **2.3**. **& 2.4**

2.1 Determining the pipe diameter

The pipe diameter is determined using **Tables 1a** on page 7.03
The load units of the individual pipeline sections are the basis for determining pipe diameter.

The load unit «LU» corresponds to the flow rates of outlets and appliances specific to each country (see guidelines or technical regulations).
For the UK see
Table B4.21 p7.09

The total load unit of a pipeline section are the sum of individual load units in the section, without consideration of simultaneous use.

Table 1a: Load units (LU) and pipe diameters for INSTAFLEX polybutylene pipes and plastic fittings

max. number LU (LV)	**4**	**7**	**25**	**55**	**180**	**500**	**1100**
Pipe o.d. (mm)	16	20	25	32	40	50	63
Pipe ID (mm)	11.6	14.4	20.4	26.0	32.6	40.8	51.4

Manifold Pressure drop

	No. of Ports	K value	K
3/4"	2	6	5.08
	3	7.6	4.23

drop = $K \times 10^{-1} \times Q^{m}$
drop = mm H_2O
Q = l/h
m = 2.026

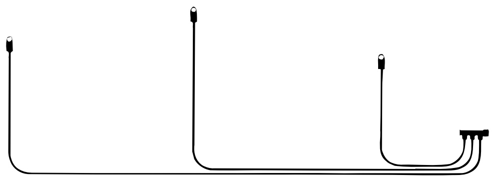
2.2 Manifold Distribution

Piping systems and pressure loss determination for manifold distribution in the pipe dimensions 16 and 20mm o.d. .

Pressure loss as a function of flow rate in manifold distribution systems, it can be determined using **Tables 2 and 3** on pages 7.04 and 7.05. Only the least favourable flow path, i.e. the index pipe with the greatest pressure loss, is considered when determining pressure loss.

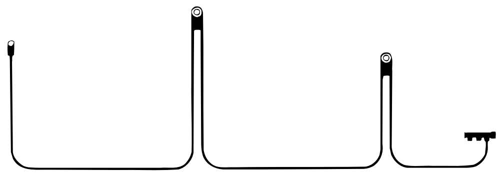
The load units (LU) for outlets and appliances are given in the relevant technical regulations or guidelines, see page 7.09

2.2.1 Individual lines



Individual lines supply only one outlet from the manifold. The pressure loss can be read directly from **Table 2 or 3** on pages 7.04 and 7.05.

2.2.2 Continuous line



Continuous lines supplying more than one outlet from each pipeline on the manifold. The fact that the tapping points are connected in series means that their pressure losses are cumulative.

By installing the outlet with the largest load units at the beginning of the pipeline, rather than at the end, considerably lower pressure losses can be obtained.

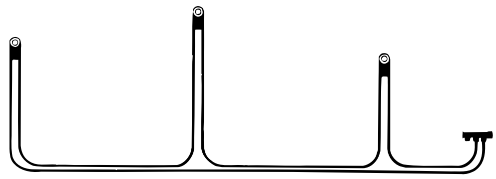
The pressure loss in continuous lines is calculated with peak flow. This reduced simultaneous use, which means that not all outlets on a flow path are used at the same time or for the same duration.

The peak flow (Vs) is determined from the total load units using the relevant diagrams and charts for simultaneous use or calculation formulae from the appropriate technical regulations see page 7.10.

If high pressure losses prevent the connection of all draw offs to a single line, then two or more pipelines may be necessary.

2.2.3 Ring mains

Ring mains supply more than one outlet from the manifold. The outlets are supplied by water from two directions.
This prevents water stagnation.



Pressure loss in a ring main is about 70 % less than in a **continuous line.** For calculating pressure loss, the ring main is treated as a **continuous line** with only one inlet. The pressure loss calculated is multiplied by **0.3**; the result is the pressure loss of the ring main.

2.2.4 Pressure losses in INSTAFLEX pipeline loops

The pressure losses in **Table 2 and 3** include the individual resistances caused by changes of direction, pipe joints and manifolds.

Table 2: Pressure losses in 16mm o.d. pipeline loops

V in l/s	V in m/s	Loop length l in meters																					
		1	1.5	2	2.5	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		Pressure loss in pipeline loop in mbar																					
0.07	0.7	17	21	24	28	31	38	45	52	57	66	72	79	86	93	100	107	114	121	128	135	141	148
0.10	0.9	32	38	45	51	57	70	83	96	109	121	134	147	160	173	185	198	211	224	237	249	262	275
0.13	1.2	54	64	74	84	94	114	134	154	174	194	214	234	254	274	294	314	334	354	374	394	414	434
0.15	1.4	72	85	98	111	124	150	177	203	229	255	281	307	333	359	385	411	438	464	490	516	542	568
0.20	1.9	129	150	172	194	216	259	303	346	390	433	477	520	564	607	651	694	738	781	825	868	912	955
0.22	2.1	156	182	208	234	259	311	363	415	467	518	570	622	674	726	777	829	881	933	985	1036	1088	1140
0.25	2.4	200	232	265	297	329	394	459	524	589	653	718	783	848	913	977	1042	1107	1172	1237	1301	1366	1431
0.30	2.8	274	319	364	409	454	544	634	723	813	903	993	1083	1173	1263	1353	1443	1533	1622	1712	1802	1892	1982
0.35	3.3	375	434	494	553	612	731	850	969	1088	1206	1325	1444	1563	1682	1800	1919						
0.40	3.8	490	566	642	717	793	944	1096	1247	1398	1549	1700	1852	2003									
0.50	4.7	746	860	973	1087	1200	1428	1655	1882														

Table 3: Pressure losses in 20mm o.d. pipeline loops

V in l/s	V in m/s	Loop length l in metres																			
		1	1.5	2	2.5	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		Pressure loss in pipeline loop in mbar																					
0.07	0.4	6	8	9	10	11	14	16	19	21	24	26	29	31	34	36	39	41	44	46	49	51	54
0.10	0.6	12	14	17	19	21	26	31	35	40	44	49	54	58	63	67	72	77	81	86	90	95	100
0.13	0.8	20	24	27	31	35	42	49	57	64	71	78	86	93	100	108	115	122	130	137	144	151	159
0.15	0.9	26	31	36	40	45	54	64	73	82	91	101	110	119	129	138	147	157	166	175	184	194	203
0.20	1.2	46	53	61	69	76	92	107	123	138	153	169	184	200	215	230	246	261	277	292	307	323	338
0.22	1.4	55	64	73	82	91	110	128	146	165	183	201	220	238	256	274	293	311	329	348	366	384	403
0.25	1.5	70	81	93	104	116	138	161	184	207	230	252	275	298	321	344	366	389	412	435	458	480	503
0.30	1.8	100	115	131	147	163	194	226	258	289	321	352	384	416	447	479	510	542	574	605	637	668	700
0.35	2.1	134	155	176	196	217	259	300	342	384	425	467	508	550	592	633	675	716	758	800	841	883	924
0.40	2.5	174	200	226	253	279	332	385	438	491	544	597	650	703	755	808	861	914	967	1020	1073	1126	1179
0.50	3.1	268	307	347	386	426	505	584	663	742	821	900	980	1059	1138	1217	1296	1375	1454	1533	1612	1691	1771
0.60	3.7	384	439	494	549	604	714	824	934	1045	1155	1265	1375	1485	1705	1815	1925						
0.70	4.3	516	589	661	734	807	953	1099	1245	1391	1536	1682	1828	1974									
0.80	4.9	666	759	852	946	1039	1225	1411	1597	1783	1969												

7

2.3 Distribution mains

Determining pressure losses in distribution mains of polybutylene (PB) pipe dimensions 25, 32, 40, 50, 63, 75, 90, &110mm o.d.

The pressure loss ΔP_{VL} in the distribution mains is calculated by adding the pressure losses ΔP_{TS} of the individual sections of the index run.

In order to calculate pressure loss, peak flow V_S must be calculated from the total number of load units in each section of pipe, see page 7.09.

The pressure loss in the individual sections is determined by adding the fitting supplements (equivalent pipe lengths) from the information on page 7.14 to the given pipeline length. Multiplying the total length by the pressure loss per meter run of the corresponding pipe, as a function of peak flow volume V_S from Tables on pages 7.11 -13

2.4 Entire Installation

Pressure loss in the entire installation comprises manifold pressure loss ΔP_{ST} and distribution mains pressure loss ΔP_{VL} .

Only the manifold and distribution mains with the largest pressure loss are taken into account here, this is the index run.

The total pressure loss $\Delta P_{Inst.}$ is the maximum pressure loss in the index run from the water meter, pressure reducing valve or cistern to the last outlet.

To adjust the pressure reducing valve, the required flow pressure at the most distant outlet and the altitude difference between the pressure reducing valve and the highest outlet point must be added to the total pressure loss $\Delta P_{Inst.}$.

Job Reference ____ **Project Name** ____ **Date** ____ **Name** ____ **Sheet** __ of __

Information from the Drawing: | **Pressure Drop Calculations:**

1 Pipe References	2 Load Units	3 Flow Rate l/s	4 Pipe Length m	5 Pipe Size o.d.mm	6 Pressure Loss/metre (pascals/m) mbar/m	7 Fittings Equivalent Length m	8 Total Pipe Length m	9 Pressure Loss (pascals) mbar	10 Pressure Loss Total (pascals) mbar	11

Notes

Explaination

Column 2. summaries load units 7.09
Column 3. Using value in column 2 with information on either page 7.09
Column 5. Select size 7.11-13
Column 6. Note pressures 7.11-13
Column 7. All fittings per section 7.09
Column 8. Add column4 and column 7 together
Column 9. Multiply column 6 by column 8

Total Pressure Drop (Section No.) ________ △ **p =** ________ **mbar (pascals)**

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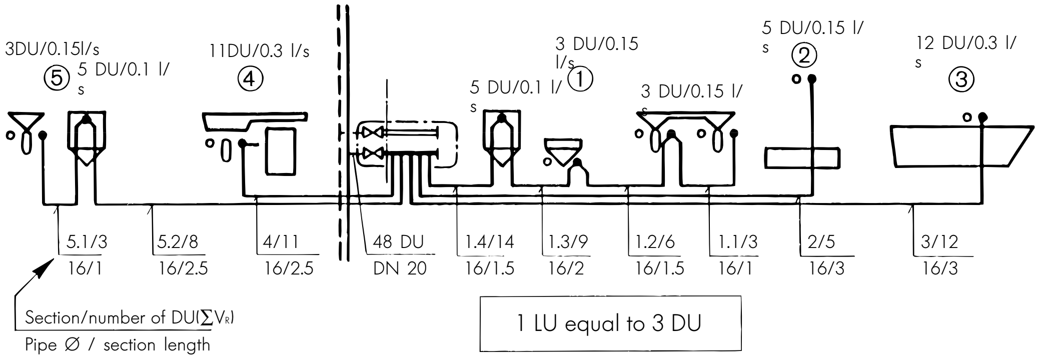
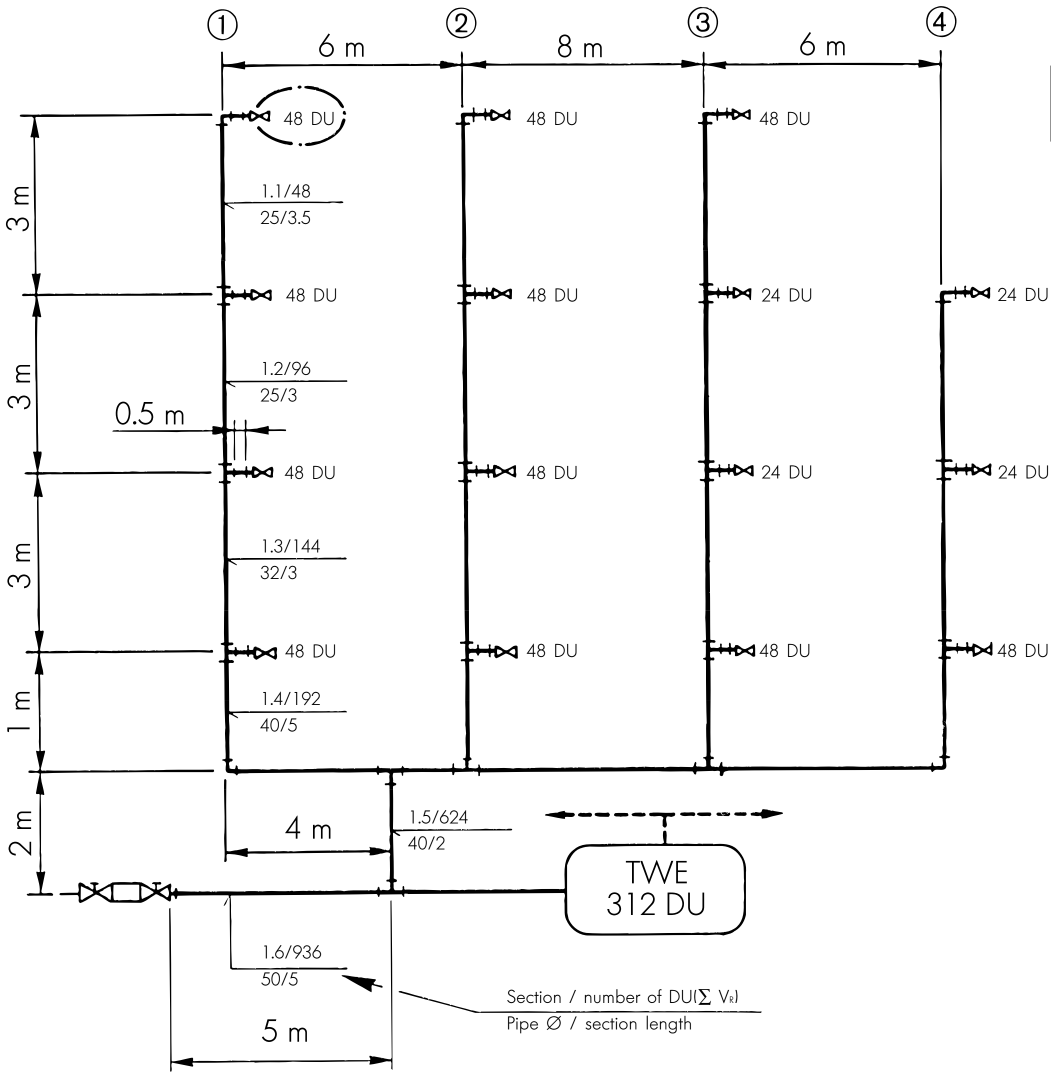
Calculation Example 3: based on the Chartered Institute of Building Services Engineers Guide B4

Apartment Distribution



Manifolds and Risers



7

Job Reference	**Project Name**	**Date**	**Name**	**Sheet**
Apartment Distribution	Example	XXXXX	XXXXX	1 of 2

Information from the Drawing: | **Pressure Drop Calculations:** | **Notes** | Explaination

1 Pipe References	2 Load Units	3 Flow Rate l/s	4 Pipe Length m	5 Pipe Size o.d.mm	6 Pressure Loss/metre (pascals/m) mbar/m	7 Fittings Equivalent Length m	8 Total Pipe Length m	9 Pressure Loss (pascals) mbar	10 Pressure Loss Total (pascals) mbar	11
1.1	3	0.15	1.0	16	-	-	-	72		
1.2	6	0.3	1.5	16	-	-	-	319		
1.3	9	0.3	2.0	16	-	-	-	364		
1.4	14	0.3	1.5	16	-	-	-	319		
								→	1074	
2	5	0.15	3.0	16	-	-	-	124	124	
3	12	0.3	3.0	16	-	-	-	454	454	
4	11	0.3	2.5	16	-	-	-	409	409	
5.1	3	0.15	1.0	16	-	-	-	72		
5.2	8	0.25	2.5	16	-	-	-	297		
								→	369	

↑ For low flow figures taken directly from Table B4:17 page 11.29

Notes

Column 2 Determining the demand units from C.I.B.S.E. Guide B4 Table B4:21 on page 11.29

Column 3. Determining the value of simultaneous demand from C.I.B.S.E. guide B4:17 on page 11.29 or from Table B4:20 on page 11.30 which ever is the lower value

Column 9. Determining the total pressure loss for the section, including all bends. From tables 2 & 3 on pages 11.04 & 11.05

Section 1
Section 2
Section 3
Section 4

Section 5

Explaination

Column 6. Note pressures 7.11-13
Column 7. All fittings per section 7.09
Column 8. Add column4 and column 7 together
Column 9. Multiply column 6 by column 8
Column 2. summaries load units 7.09
Column 3. Using value in column 2 with information on either page 7.09
Column 5. Select size 7.11-13

Total Pressure Drop (Section No.) 1 △ **p =** 1074mbar = 107400Pa ~~mbar~~ **(pascals)**

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C.I.B.S.E.

Job Reference	**Project Name**	**Date**	**Name**	**Sheet**
Manifold and Risers	Example	XXXX	XXXX	2 of 2

Information from the Drawing: | **Pressure Drop Calculations:** | **Notes** | Explaination

1 Pipe References	2 Load Units	3 Flow Rate l/s	4 Pipe Length m	5 Pipe Size o.d.mm	6 Pressure Loss/metre (pascals/m) ~~mbar/m~~	7 Fittings Equivalent Length m	8 Total Pipe Length m	9 Pressure Loss (pascals) ~~mbar~~	10 Pressure Loss Total (pascals) ~~mbar~~	11
Value	48	0.3	-	DN 20	-	-	-	8100	8100	
1.1	48	0.3	3.5	25	617	1.8	5.3	3270	11370	
1.2	96	0.5	3.0	25	1500	-	3.0	4500	15870	
1.3	144	0.6	3.0	32	640	-	3.0	1920	17790	
1.4	192	0.8	5.0	40	360	2.8	7.3	1228	20418	
1.5	624	1.8	2.0	40	1500	1.8	3.8	5700	26118	
1.6	936	2.5	5.0	50	920	1.6	6.6	6072	32190	

↑ For higher flows figures taken from Table B4:20 page 11.30

Notes

Value: INSTAFLEX DN 20-$^{3}/_{4}$" see valve chart on page 11.22

Column 2. Determining the demand units from C.I.B.S.E. Guide B4. Table B4.21 page 11.29

Column 3. Determining the value of simultaneous demand from C.I.B.S.E. Guide B4. Table B4.20 on page 11.30

Column 6. Selecting a suitable pipe size for fluid flow (usually under 3m/s velocity) Record pressure losses from tables on pages 11.31 -33

Column 7. Determining the total value for equivalent length for all items in the pipe section. From table 4a or 4b, page 11.33

Column 10. Summerise the pipe pressures pressures from the furthest point back to the pump

Explaination

Column 6. Note pressures 7.11-13
Column 7. All fittings per section 7.09
Column 8. Add column4 and column 7 together
Column 9. Multiply column 6 by column 8
Column 2. summaries load units 7.09
Column 3. Using value in column 2 with information on either page 7.09
Column 5. Select size 7.11-13

Total Pressure Drop (Section No.) 1 △ **p =** 32190 ~~mbar~~ **(pascals)**

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Total system pressure loss =107,400 + 32,190= 139,590pascals

△ **p** $_{\text{inst}}$ **1.4 bar** - Within anticipated working pressures

Excerpts from C.I.B.S.E. Guide, Section B4

The C.I.B.S.E. guides are the basis for selecting the size of the pipes and for determining the pressure losses, within the scope of the application shown.

Table B4.17. shows the guidelines for approximate water demand at each outlet.

Table B4.21. Shows the guidelines for demand units at each type of outlet

Table B4.17. Approximate demand required of water points (hot and cold).

Sanitary appliance	Flow rate (litre/second)
Basin (spray)	0.05
Basin (tap)	0.15
Bath (private)	0.3
Bath (public)	0.6
Flushing system	0.1
Shower (nozzle)	0.15
Shower (100mm rose)*	0.4
Sink (15mm tap)	0.2
Sink (20m tap)	0.3
Wash fountain	0.4

* The use of shower roses results in wasteful consumption of water, but emergency drench showers require high discharge rates.

Table B4.21. Practical demand units for use with data listed in Table B4.20

Fitting	Type of application		
	Congested	Public	Private
Basin*	10	5	3
Bath†	47	25	12
Sink	43	22	11
Urinal**	–	–	–
WC (13.5 litre)	35	15	8
WC (9 litre)	22	10	5

* These data apply to conventional taps only. If spray taps are used, demand may be continuous at 0.05 litre/s per tap

† If a shower spray nozzle is used over the bath, demand may be continuous at 0.1 litre/s per nozzle.

•• Demand will be continuous at 0.003 litre/s per stall

Table B4.20 on page 7.09 shows the anticipated flow rates for simultaneous usage as a result of the total demand units in each pipe section.

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Note: For approximate pipe sizes using tables 1a and 1b on page 7.03. 1 Load Unit (LU) equals 3 Demand Units from Table B4.21 above

Table B4.20. Simultaneous demand data for design

Demand units	Design demand (litre/s)																			
	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950
0	0.0	0.3	0.5	0.6	0.8	0.9	1.0	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0	2.1	2.2	2.3	2.4	2.5
1000	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5
2000	4.6	4.7	4.8	4.9	5.0	5.1	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4
3000	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2
4000	8.3	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.8	9.9
5000	10.0	10.1	10.2	10.3	10.4	10.5	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.2	11.2	11.3	11.4	11.5	11.6	11.7
6000	11.8	11.9	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.5	12.6	12.7	12.8	12.9	13.0	13.1	13.1	13.2	13.3	13.4
7000	13.5	13.6	13.7	13.7	13.8	13.9	14.0	14.1	14.2	14.3	14.3	14.4	14.5	14.6	14.7	14.8	14.9	14.9	15.0	15.1
8000	15.2	15.3	15.4	15.5	15.5	15.6	15.7	15.8	15.9	16.0	16.0	16.1	16.2	16.3	16.4	16.5	16.6	16.6	16.7	16.8
9000	16.9	17.0	17.1	17.2	17.2	17.3	17.4	17.5	17.6	17.7	17.7	17.8	17.9	18.0	18.1	18.2	18.2	18.3	18.4	18.5
10000	18.6	18.7	18.8	18.8	18.9	19.0	19.1	19.2	19.3	19.3	19.4	19.5	19.6	19.7	19.8	19.8	19.9	20.0	20.1	20.2
11000	20.3	20.3	20.4	20.5	20.6	20.7	20.8	20.8	20.9	21.0	21.1	21.2	21.3	21.3	21.4	21.5	21.6	21.7	21.8	21.8
12000	21.9	22.0	22.1	22.2	22.3	22.3	22.4	22.5	22.6	22.7	22.8	22.8	22.9	23.0	23.1	23.2	23.3	23.3	23.4	23.5
13000	23.6	23.7	23.8	23.8	23.9	24.0	24.1	24.2	24.3	24.4	24.5	24.5	24.6	24.7	24.7	24.8	24.9	25.0	25.1	25.2
14000	25.2	25.3	25.4	25.5	25.6	25.7	25.7	25.8	25.9	26.0	26.1	26.2	26.2	26.3	26.4	26..5	26.6	26.6	26.7	26.8
15000	26.9	27.0	27.1	27.1	27.2	27.3	27.4	27.5	27.6	27.6	27.7	27.8	27.9	28.0	28.0	28.1	28.2	28.3	28.4	28.5
16000	28.5	28.6	28.7	28.8	28.9	29.0	29.0	29.1	29.2	29.3	29.4	29.4	29.5	29.6	29.7	29.8	29.9	29.9	30.0	30.1
17000	30.2	30.3	30.3	30.4	30.5	30.6	30.7	30.8	30.8	30.9	31.0	31.1	31.2	31.2	31.3	31.4	31.5	31.6	31.7	31.7
18000	31.8	31.9	32.0	32.1	32.1	32.2	32.3	32.4	32.5	32.6	32.6	32.7	32.8	32.9	33.0	33.0	33.1	33.2	33.3	33.4
19000	33.5	33.5	33.6	33.7	33.8	33.9	33.9	34.0	34.1	34.2	34.3	34.3	34.4	34.5	34.6	34.7	34.8	34.8	34.9	35.0

Table: Pressure Loss per meter run of INSTAFLEX PB Pipe

Pressure Drop (pascals)	Velocity (m/s)	Pipe Size Volumetric Flow L/S 16mm	20mm	25mm	32mm	40mm	50mm	63mm	75mm	90mm	110mm	Velocity (m/s)	Pressure Drop (pascals)
5.0		0.003	0.006	0.013	0.030	0.065	0.13	0.34	0.42	0.70	1.10		5.0
5.5		0.004	0.007	0.014	0.033	0.070	0.14	0.36	0.44	0.74	1.16		5.5
6.0		0.004	0.007	0.015	0.036	0.075	0.15	0.38	0.46	0.78	1.21		6.0
6.5		0.004	0.008	0.016	0.039	0.079	0.16	0.40	0.48	0.82	1.27		6.5
7.0		0.004	0.008	0.017	0.042	0.082	0.17	0.41	0.50	0.85	1.33		7.0
7.5		0.005	0.008	0.017	0.045	0.085	0.17	0.43	0.52	0.88	1.38		7.5
8.0		0.005	0.009	0.018	0.047	0.088	0.18	0.44	0.54	0.95	1.43		8.0
8.5		0.005	0.009	0.018	0.049	0.091	0.18	0.46	0.56	0.98	1.48		8.5
9.0		0.005	0.010	0.019	0.051	0.094	0.19	0.48	0.58	1.01	1.53		9.0
9.5		0.006	0.010	0.019	0.053	0.097	0.19	0.49	0.60	1.04	1.54		9.5
10.0		0.006	0.010	0.020	0.055	0.100	0.20	0.50	0.62	1.14	1.62		10.0
12.5		0.006	0.011	0.023	0.060	0.110	0.22	0.52	0.70	1.24	1.84		12.5
15.0		0.007	0.012	0.025	0.066	0.120	0.24	0.55	0.78	1.24	2.04		15.0
17.5		0.007	0.014	0.028	0.074	0.130	0.26	0.57	0.86	1.34	2.22		17.5
20.0		0.008	0.015	0.030	0.080	0.140	0.28	0.60	0.92	1.44	2.39		20.0
22.5		0.008	0.016	0.033	0.085	0.150	0.30	0.62	0.97	1.53	2.55		22.5
25.0		0.009	0.018	0.035	0.090	0.160	0.31	0.65	1.02	1.62	2.70		25.0
27.5		0.009	0.019	0.038	0.095	0.170	0.33	0.67	1.07	1.71	2.85		27.5
30.0		0.010	0.020	0.040	0.100	0.180	0.34	0.70	1.12	1.80	2.99		30.0
32.5		0.010	0.021	0.043	0.105	0.190	0.36	0.72	1.18	1.88	3.12	0.5	32.5
35.0		0.011	0.022	0.045	0.110	0.200	0.37	0.75	1.23	1.96	3.25		35.0
37.5		0.011	0.023	0.048	0.115	0.210	0.39	0.77	1.28	2.04	3.37		37.5
40.0		0.012	0.024	0.050	0.120	0.220	0.40	0.80	1.32	2.12	3.50		40.0
42.5		0.012	0.025	0.053	0.125	0.229	0.41	0.82	1.37	2.19	3.62		42.5
45.0		0.013	0.026	0.055	0.130	0.238	0.42	0.85	1.41	2.26	3.75		45.0
47.5		0.013	0.027	0.058	0.135	0.247	0.44	0.87	1.45	2.33	3.87		47.5
50.0		0.014	0.028	0.060	0.140	0.256	0.45	0.89	1.49	2.40	4.00		50.0
52.5		0.014	0.029	0.063	0.144	0.264	0.47	0.92	1.53	2.47	4.12		52.5
55.0		0.015	0.030	0.065	0.148	0.272	0.48	0.94	1.56	2.53	4.25		55.0
57.5		0.015	0.031	0.068	0.152	0.280	0.50	0.96	1.59	2.60	4.37		57.0
60.0		0.016	0.031	0.070	0.156	0.287	0.51	0.99	1.62	2.66	4.50		60.0
62.5		0.016	0.032	0.073	0.160	0.294	0.53	1.01	1.66	2.72	4.62		62.5
65.0		0.017	0.033	0.075	0.164	0.301	0.54	1.03	1.69	2.78	4.75		65.0
67.5		0.017	0.034	0.078	0.168	0.308	0.55	1.06	1.72	2.84	4.87		67.0
70.0		0.018	0.034	0.080	0.172	0.315	0.57	1.08	1.75	2.90	5.00		70.0
72.5		0.018	0.035	0.083	0.176	0.322	0.58	1.10	1.79	2.95	5.12		72.0
75.0		0.019	0.036	0.085	0.180	0.329	0.59	1.13	1.82	3.00	5.25		75.0
77.5		0.019	0.037	0.088	0.184	0.336	0.61	1.15	1.85	3.50	5.37		77.5
80.0		0.020	0.037	0.090	0.188	0.342	0.62	1.17	1.88	3.10	5.50		80.0
82.5		0.020	0.038	0.093	0.192	.0348	0.64	1.20	1.91	3.15	5.62		82.5
85.0		0.021	0.039	0.095	0.196	0.364	0.65	1.22	1.94	3.20	5.75		85.0
87.5		0.021	0.039	0.098	0.200	0.370	0.66	1.24	1.97	3.25	5.87		87.5
90.0		0.022	0.040	0.100	0.204	0.376	0.67	1.26	2.00	3.30	6.00		90.0
92.5		0.022	0.040	0.103	0.208	0.382	0.69	1.28	2.03	3.35	6.12		92.5
95.0		0.023	0.041	0.105	0.212	0.388	0.70	1.30	2.06	3.40	6.25	1.0	95.0
97.5		0.023	0.041	0.108	0.216	0.394	0.71	1.32	2.09	3.45	6.37		97.0
100.0		0.024	0.042	0.110	0.220	0.40	0.72	1.34	2.12	3.50	6.50		100.0
120.0		0.027	0.046	0.120	0.240	0.44	0.80	1.48	2.35	3.85	7.00		120.0
140.0		0.030	0.050	0.130	0.260	0.48	0.87	1.61	2.57	4.20	8.00		140.0
160.0		0.032	0.054	0.140	0.285	0.51	0.94	1.74	2.79	4.55	9.00		160.0

0.5 — 1.0 — 1.5

7

0.5 — 1.0 — 1.5

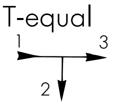
Pressure Drop (pascals)	Velocity (m/s)	Pipe Size / Volumetric Flow L/S 16mm	20mm	25mm	32mm	40mm	50mm	63mm	75mm	90mm	110mm	Velocity (m/s)	Pressure Drop (pascals)
180.0		0.034	0.058	0.150	0.300	0.54	1.00	1.86	3.00	4.90	9.50	1.5	180.0
200.0		0.036	0.061	0.160	0.315	0.57	1.06	1.98	3.15	5.20	9.90		200.0
220.0		0.037	0.064	0.168	0.330	0.59	1.12	2.09	3.30	5.50	10.50		220.0
240.0		0.039	0.067	0.176	0.345	0.62	1.18	2.20	3.45	5.75	10.85		240.0
260.0		0.041	0.070	0.184	0.360	0.65	1.23	2.30	3.60	6.00	11.20		260.0
280.0		0.042	0.074	0.192	0.375	0.68	1.29	2.40	3.74	6.25	11.50		280.0
300.0		0.043	0.078	0.200	0.390	0.71	1.32	2.49	3.88	6.50	11.70		300.0
320.0		0.045	0.089	0.207	0.405	0.74	1.38	2.58	4.02	6.75	12.00		320.0
340.0		0.046	0.084	0.214	0.420	0.77	1.43	2.67	4.16	7.00	12.35		340.0
360.0		0.047	0.087	0.221	0.435	0.80	1.48	2.76	4.30	7.20	12.65	2.0	360.0
380.0		0.049	0.090	0.228	0.450	0.82	1.52	2.85	4.44	7.40	13.00		380.0
400.0		0.050	0.093	0.235	0.465	0.84	1.56	2.94	4.58	7.60	13.30		400.0
420.0		0.051	0.096	0.241	0.480	0.86	1.60	3.02	4.72	7.80	13.65		420.0
440.0	0.5	0.053	0.098	0.247	0.495	0.88	1.64	3.10	4.86	8.00	14.00		440.0
460.0		0.054	0.100	0.253	0.51	0.90	1.68	3.18	5.00	8.20	14.25		460.0
480.0		0.055	0.103	0.259	0.52	0.92	1.72	3.25	5.13	8.40	14.50		480.0
500.0		0.057	0.105	0.265	0.53	0.94	1.76	3.32	5.26	8.60	14.75		500.0
520.0		0.058	0.107	0.271	0.54	0.96	1.80	3.39	5.37	8.80	15.00		520.0
540.0		0.059	0.109	0.277	0.55	0.98	1.84	3.46	5.48	8.98	15.35		540.0
560.0		0.061	0.111	0.283	0.56	1.00	1.88	3.52	5.59	9.15	15.70	2.5	560.0
580.0		0.062	0.113	0.289	0.57	1.02	1.92	3.58	5.70	9.32	16.00		580.0
600.0		0.063	0.115	0.295	0.58	1.04	1.96	3.64	5.80	9.50	16.30		600.0
620.0		0.065	0.117	0.301	0.59	1.06	2.00	3.70	5.90	9.67	16.60		620.0
640.0		0.066	0.199	0.307	0.60	1.08	2.04	3.76	6.00	9.84	16.90		640.0
660.0		0.067	0.121	0.313	0.61	1.10	2.07	3.82	6.10	10.01	17.20		660.0
680.0		0.069	0.123	0.319	0.62	1.12	2.10	3.88	6.20	10.18	17.50		680.0
700.0		0.070	0.125	0.325	0.63	1.14	2.14	3.95	6.30	10.35	17.75		700.0
720.0		0.071	0.127	0.331	0.64	1.16	2.17	4.02	6.40	10.51	18.00		720.0
740.0		0.073	0.129	0.337	0.65	1.18	2.20	4.08	6.50	10.67	18.25		740.0
760.0		0.074	0.131	0.343	0.65	1.20	2.24	4.14	6.60	10.83	18.50		760.0
780.0		0.075	0.133	0.349	0.67	1.22	2.27	4.20	6.70	10.99	18.75		780.0
800.0		0.077	0.135	0.355	0.68	1.24	2.30	4.26	6.80	11.15	19.00	3.0	800.0
820.0		0.078	0.137	0.360	0.69	1.26	2.34	4.32	6.90	11.30	19.30		820.0
840.0		0.079	0.139	0.365	0.70	1.28	2.37	4.38	7.00	11.45	19.60		840.0
860.0		0.080	0.141	0.370	0.71	1.30	2.40	4.44	7.10	11.60	19.85		860.0
880.0		0.082	0.143	0.375	0.72	1.32	2.44	4.50	7.20	11.75	20.10		880.0
900.0		0.083	0.145	0.380	0.73	1.34	2.47	4.56	7.30	11.90	30.35		900.0
920.0		0.084	0.147	0.384	0.74	1.36	2.50	4.62	7.38	12.05	20.60		920.0
940.0		0.085	0.149	0.388	0.75	1.38	2.53	4.68	7.46	12.19	20.90		90.0
960.0		0.087	0.151	0.392	0.76	1.40	2.56	4.73	7.54	12.33	21.20		960.0
980.0		0.088	0.153	0.396	0.77	1.42	2.59	4.78	7.62	12.47	21.50		980.0
1000.0		0.089	0.155	0.400	0.78	1.44	2.62	4.83	7.70	12.60	21.75	3.5	1000.0
1100.0		0.094	0.164	0.420	0.82	1.52	2.75	5.09	8.10	13.30	23.00		1100.0
1200.0		0.098	0.173	0.440	0.86	1.60	2.88	5.34	8.50	13.90	24.20		1200.0
1300.0		0.102	0.181	0.460	0.90	1.67	3.01	5.58	8.90	14.50	24.90	4.0	1300.0
1400.0	1.0	0.106	0.189	0.480	0.94	1.73	3.14	5.81	9.30	15.10	25.80		1400.0
1500.0		0.110	0.197	0.500	0.97	1.80	3.26	6.03	9.60	15.70	26.90		1500.0
1600.0		0.114	0.204	0.520	1.01	1.86	3.38	6.25	9.90	16.25	27.75		1600.0
1700.0		0.118	0.211	0.540	1.04	1.92	3.50	6.46	10.30	16.80	28.50	4.5	1700.0
1800.0		0.122	0.218	0.560	1.08	1.98	3.61	6.66	10.60	17.30	29.10		1800.0

1.5 — 2.0 — 2.5 — 3.0 — 3.5 — 4.0 — 4.5 — 5.0

1.5 — 2.0 — 2.5 — 3.0 — 3.5 — 4.0 — 4.5 — 5.0

Pressure Drop (pascals)	Velocity (m/s)	Pipe Size Volumetric Flow L/S 16mm	20mm	25mm	32mm	40mm	50mm	63mm	75mm	90mm	110mm	Velocity (m/s)	Pressure Drop (pascals)
1900.0		0.126	0.224	0.580	1.11	2.04	3.72	6.86	10.90	17.80	29.65		19.00.0
2000.0		0.130	0.230	0.600	1.15	2.10	3.83	7.06	11.25	18.30	30.15	5.0	2000.0
2250.0		0.140	0.245	0.640	1.23	2.25	4.07	7.53	12.00	19.55			2250.0
2500.0		0.150	0.260	0.680	1.30	2.40	4.31	7.98	12.70	20.70			2500.0
2750.0	1.5	0.157	0.275	0.715	1.37	2.52	4.54	8.41	13.35	21.75			2750.0
3000.0		0.164	0.290	0.750	1.43	2.64	4.76	8.82	14.00	22.70			3000.0
3250.0		0.173	0.305	0.780	1.49	2.76	4.97	9.21	14.60	23.55			3250.0
3500.0		0.180	0.320	0.810	1.55	2.88	5.18	9.58	15.15				3500.0
3750.0		0.187	0.335	0.840	1.61	3.00	5.38	10.03					3750.0
4000.0		0.193	0.350	0.870	1.67	3.09	5.55	10.36					4000.0
4250.0		0.200	0.360	0.900	1.73	3.18	5.75	10.66					4250.0
4500.0		0.206	0.370	0.930	1.79	3.27	5.93						4500.0
4750.0	2.0	0.212	0.380	0.960	1.85	3.36	6.11						4750.0
5000.0		0.218	0.390	0.990	1.90	3.45	6.29						5000.0
5250.0		0.224	0.400	1.020	1.95	3.54	6.45						5250.0
5500.0		0.230	0.410	1.050	2.00	3.63	6.61						5500.0
5750.0		0.235	0.420	1.075	2.05	3.72	6.76						5750.0
6000.0		0.240	0.430	1.100	2.10	3.81	6.90						6000.0
6250.0		0.245	0.440	1.125	2.15	3.90	7.03						6250.0
6500.0		0.250	0.450	1.150	2.20	3.98	7.15					5.5	6500.0
6750.0		0.255	0.458	1.170	2.24	4.06	7.26						6750.0
7000.0		0.260	0.466	1.190	2.28	4.14	7.36						7000.0
7250.0	2.5	0.265	0.474	1.210	2.32	4.22							7250.0
7500.0		0.270	0.482	1.230	2.36	4.30							7500.0
7750.0		0.275	0.490	1.250	2.40	4.38							7750.0
8000.0		0.280	0.500	1.270	2.44	4.46							8000.0
8250.0		0.285	0.508	1.300	2.48	4.54							8250.0
8500.0		0.290	0.516	1.310	2.52								8500.0
8750.0		0.295	0.524	1.330	2.56								8750.0
9000.0		0.300	0.532	1.360	2.60								9000.0
9250.0		0.305	0.540	1.380	2.64								9250.0
9500.0		0.310	0.550	1.400	2.68								9500.0
9750.0	3.0	0.315	0.560	1.420	2.72								9750.0
10000.0		0.320	0.570	1.440	2.76								10000.0
12000.0	3.5	0.355	0.630	1.600									12000.0
14000.0		0.380	0.680	1.750									14000.0
16000.0	4.0	0.405	0.730	1.900								6.0	16000.0
18000.0		0.430	0.780										18000.0
20000.0	4.5	0.455	0.820										20000.0
22000.0		0.480	0.870										22000.0
24000.0		0.505	0.910										24000.0
26000.0	5.0	0.530	0.950										26000.0
28000.0		0.555	0.990										28000.0
30000.0	5.5	0.580	1.030										30000.0
32000.0		0.600	1.070										32000.0
34000.0	6.0	0.620	1.110										34000.0
36000.0		0.640											36000.0
38000.0		0.660											38000.0
40000.0		0.680											40000.0

Table 4b: Equivalent pipe lengths for socket fusion & electro fusion fittings

	PB pipe dimension o.d. mm									
	16	20	25	32	40	50	63	75	90	110
Item	Equivalent pipe lengths m									
Elbow 90°	0.3	0.4	0.6	0.8	1.0	1.2	1.7	2.1	2.6	3.2
Elbow 45°	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.5	1.9	2.4
T-equal  1 – 3	0.6	0.8	1.1	1.5	1.8	2.3	3.2	4.2	5.4	6.6
1 – 2	0.7	0.9	1.2	1.7	2.1	2.7	3.7	4.8	5.9	7.0
Stop cock	4.0	7.0	10.0	13.0	16.0	22.0		34.0		
Non return valve	2.5	4.3	5.6	6.0	7.9	11.5				
Tap	3.7	11.8	22.0							
T-reduced	Always consider the loss factor of the outlet in flow direction (1–2 or 1–3) from T-equal.									

Straight-through tees, sockets, reducers, unions are not included because their equivalent pipe length values are to low

Mechanical and physical properties

Properties	Value	Unit	Standard
Density	0.93	g/cm^3	DIN 53479
Melt temperature	122–128	° C	DTA
Vicat softening point	113	° C	DIN 53735
Glass transition point	– 18	° C	ASTM D-746
Fusion heat	~ 100	kJ/kg	DSC
Thermal conductivity	0.22	W/mK	DIN 52612
Thermal expansion coefficient	0.13	mm/mK	DIN 53752
Modulus of elasticity	350	MPa	DIN 53457
Shore hardness	53	D-Scale	ISO 8608
Impact resistance	40	(0 °C) kJ/m^2	DIN 53453
Ultimate elongation	>125	%	DIN 53457
Tensile strength	33	MPa	DIN 53455
Yield stress	17	MPa	DIN 53455

Flushing times for dead legs

Medium content «V» per m INSTAFLEX PB pipe

16 mm o.d. = 0.10 l/m
20 mm o.d. = 0.16 l/m
25 mm o.d. = 0.33 l/m
32 mm o.d. = 0.53 l/m
40 mm o.d. = 0.83 l/m
50 mm o.d. = 1.31 l/m
63 mm o.d. = 2.07 l/m

Calculation of flushing time «t»

$$t = \frac{V \cdot L}{\dot{V}}$$

V = pipe content l/m
L = pipeline length m
$\dot{V}$ = flow l/s
t = flushing time s

Pipeline 16 mm o.d.						**Water content per m of pipeline 0.10 l**			
	Flow in l/s								
		0.07	0.10	0.15	0.20	0.25	0.30	0.50		
	Flushing times in seconds								
Pipeline length in m	2	2.8	2.0	1.3	1.0					
	4	5.7	4.0	2.7	2.0	1.6	1.3			
	6	8.6	6.0	4.0	3.0	2.4	2.0	1.2		
	8	11.4	8.0	5.3	4.0	3.2	2.7	1.6		
	10	14.3	10.0	6.7	5.0	4.0	3.3	2.0		
	12	17.1	12.0	8.0	6.0	4.8	4.0	2.4		
	14	20.0	14.0	9.3	7.0	5.6	4.7	2.8		
	16	22.8	16.0	10.7	8.0	6.4	5.6	3.2		
	18	25.7	18.0	12.0	9.0	7.2	6.0	3.6		
	20	28.6	20.0	13.3	10.0	8.0	6.7	4.0		
	22	31.4	22.0	14.7	11.0	8.8	7.3	4.4		
	24	34.3	24.0	16.0	12.0	9.6	8.0	4.8		
	26	37.1	26.0	17.3	13.0	10.4	8.7	5.2		
	28	40.0	28.0	18.7	14.0	11.2	9.3	5.6		
	30	42.8	30.0	20.0	15.0	12.0	10.0	6.0		

Pipeline 20mm o.d.						**Water content per m of pipeline 0.16 l**				
	Flow in l/s									
		0.07	0.10	0.15	0.20	0.25	0.30	0.50	0.60	1.00
	Flushing times in seconds									
Pipeline length in m	2	4.6	3.2	2.1	1.6	1.3	1.1			
	4	9.1	6.4	4.3	3.2	3.6	2.1	1.3	1.1	
	6	13.7	9.6	6.4	4.8	3.8	3.2	1.9	1.6	1.0
	8	18.3	12.8	8.5	6.4	5.1	4.3	2.6	2.2	1.3
	10	22.8	16.0	10.7	8.0	6.4	5.3	3.2	2.7	1.6
	12	27.4	19.2	12.8	9.6	7.7	6.4	3.8	3.2	1.9
	14	32.0	22.4	15.0	11.2	9.0	7.5	4.5	3.7	2.2
	16	36.6	25.6	17.1	12.8	10.2	8.5	5.1	4.3	2.6
	18	41.1	28.8	19.2	14.4	11.5	9.6	5.8	4.8	2.9
	20	45.7	32.0	21.3	16.0	12.8	10.7	6.4	5.3	3.2
	22	50.3	35.2	23.5	17.6	14.1	11.7	7.0	5.9	3.5
	24	54.8	38.4	25.6	19.2	15.4	12.8	7.7	6.4	3.8
	26	59.4	41.6	27.7	20.8	16.8	13.8	8.4	6.9	4.2
	28	64.0	44.8	29.9	22.4	18.0	15.0	9.0	7.5	4.5
	30	68.6	48.0	32.0	24.0	19.2	16.1	9.6	8.0	4.8

Terms, Symbols and Units

Term	Symbol	Unit	Definition
Calculated flow velocity	ν	m/s	Average flow velocity at peak flow
Volume	$\dot{V}$	m^3	–
Flow area	A	m_2	Cross sectional internal area of pipe
Flow, Volume flow	$\dot{V}$	l/s m^3/h	Quantity of water volume, which flows through a certain flow area, in a specific amount of time
Outlet flow	$\dot{V}_E$	l/s	Flow through an open tap including outlets (jet regulator, shower, etc.) at the actual flow pressure
Highest outlet flow	$\dot{V}_0$	l/s	Outlet flow for a specific flow pressure according to DIN 52 218 Part2
Least outlet flow	$\dot{V}_{min}$	l/s	The smallest outlet flow which suffices for use of the tap
Calculated flow	$\dot{V}_R$	l/s	The presumed outlet flow for the calculation: $\dot{V}_R = \frac{\dot{V}_{min} + \dot{V}_0}{2}$
Total flow	$\Sigma\dot{V}_R$	l/s	The sum of all calculated flows of the supplied water consumption devices in an open cross-section
Peak flow	$\dot{V}_s$	l/s	The flow which is decisive in hydraulic calculations taking into consideration the probable simultaneous use of water outlet during operation.
Stationary pressure	p_R	bar, mbar, Pa	Static atmospheric pressure at a measurement point in the system, when water is not flowing
Flow pressure	p_{Fl}	bar, mbar, Pa	Static atmospheric pressure at a measurement point in the potable water system, when water is flowing
Minimum flow pressure	$p_{min\ Fl}$	bar, mbar, Pa	Required static atmospheric pressure at the connecting point of a water outlet at the least outlet flow
Minimum supply pressure	$p_{min\ V}$	bar mbar Pa	Minimum static atmospheric pressure at the connecting point of the connecting line to the supply line according to the specifications of the respective water supply company (WVU)
Pressure difference, pressure loss	Δp	bar mbar Pa	Difference between two pressures in a potable water system (see also table 2)
Pressure loss from geodetic height difference	Δp_{geo}	bar mbar Pa	$\Delta \rho_{geo} \propto h_{geo} = g \cdot \rho$

Term	Symbol	Unit	Definition
Available pressure difference	Δp_{verf}	bar, mbar, Pa	The available pressure difference for pipe friction and fittings
Pipe friction pressure drop	R	bar/m, mbar/m, Pa/m	Pressure loss per unit length from pipe friction $R = \frac{\Delta p}{l}$
Pressure loss from pipe friction	$l \cdot R$	bar, mbar, Pa	Pressure loss from pipe friction in a calculated section
Available pipe friction pressure drop	R_{verf}	bar/m, mbar/m, Pa/m	The approximated value used in the calculation for pipe friction pressure drop
Pressure loss from fitting	Z	bar, mbar, Pa	$Z = \zeta \cdot \frac{\upsilon^2 \cdot \rho}{2}$
Pipe length	l	m	–
Pipe inner diameter	d_i	mm	–
Resistance value, pipe friction value	λ	1	–
Pipe roughness PB roughness factor	Ω	rf = 0.007	The presumed absolute roughness of the pipe inner wall in use (empiric probability)
Loss value	ζ	1	Characteristic flow parameter (constant) for a fitting; required for calculation of the local pressure loss
Density	ρ	kg/m^3	Ratio of mass and volume
Reynolds number	R_e	1	$Re = \frac{di \cdot \upsilon}{\upsilon}$
Kinematic viscosity	υ	m^2/s	–
Pump flow	$\dot{V}_P$	m^3/h	The usable volume flow conveyed by the pump (from: DIN 4046/09.83)
Pump pressure pump	Δp_P	mbar, bar, Pa	Difference between ultimate pressure side of the circulation and the pressure before the pump with a pump flow of $\dot{V}_P$