aalberts integrated piping systems

VSH XPress

pressure loss tables

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pressure loss

Every fluid that flows through a piping system experiences continuous and local flow resistances, the so-called pressure drops. There is a difference between the continuous and the local pressure drop. A continuous pressure drop is mainly caused by the flow resistance in straight tube sections, which essentially is a result of the friction between the fluid and the tube wall. Local pressure drops, on the contrary, are those flow resistances that are created by, for instance, a change in the internal tube diameter, a tube branch, an elbow, etc.

continuous pressure drop

To calculate the resistance of a fluid flow in a straight section of a piping system, first determine the resistance in a unit of length and then multiply the total length by this value. This value can be determined analytically using the Hazen-Williams formula.

$$p = \frac{6.05 \times 10^5}{C^{1.85} \times di^{4.87}} \times Q^{1.85}$$

p = pressure loss in the tube [bar/m]
Q = flow through the tube [l/min]
di = mean internal diameter of the tube [mm]
C = constant for type and condition of the tube
= 140 for VSH XPress stainless and carbon steel

local pressure drops

A local pressure drop is, as mentioned at the start of this section, the resistance to flow that results from changes in the flow direction and cross-sectional area, flow splitting over several channels, etc. In general, there are two ways of calculating such flow resistances: the direct analytical method and the method that uses ‘equivalent lengths’.

equivalent length method

This method assumes that the pressure drop at a particular point can be considered to be the same as an equivalent increase in the length of a straight piping system with the same internal diameter. The final result is a pressure drop that is equal to the real pressure drop. In other words, the actual length of the piping system is added to all the equivalent lengths of the individual joints. The actual length is then multiplied by the pressure drop per unit-length R in order to be able to calculate the total pressure drop of the system. This method is not as accurate as the direct method but has the advantage that the calculation can be carried out more quickly.

direct analytical method

The local pressure drop can be calculated using the following equation:

$$\Delta p_L = \Sigma\zeta \times v^2 \times \gamma/2 \times 10^{-5} \text{ [bar]}$$

v = flow velocity of the fluid [m/s]
γ = specific density of the fluid [kg/m³]
ζ = local flow resistance coefficient

The table gives the ζ values for each type of fitting. We can assume that ζ is velocity-independent for those velocities that occur in domestic installations or in other normal applications. This is supported by the fact that the change in ζ as a function of the Reynolds number in these velocity ranges is only minimal. Once the ζ value is known, you can read the corresponding local pressure drop off directly.

direct analytical method ζ / equivalent length method [m]

		W90		W45		TD[b]		TA[b]		K		RED		W90	
Ø	DN	ζ	[m]	ζ	[m]	ζ	[m]	ζ	[m]	ζ	[m]	ζ	[m]	ζ	[m]
12	10	1.29	0.38	0.61	0.18	0.30	0.09	0.90	0.27	0.26	0.08	0.09	0.09	-	-
15	12	1.02	0.49	0.69	0.33	0.40	0.19	1.13	0.55	0.36	0.17	0.52	0.25	0.64	0.31
18	15	0.93	0.58	0.77	0.48	0.50	0.32	1.41	0.89	0.46	0.29	1.06	0.67	0.96	0.60
22	20	0.44	0.35	0.38	0.30	0.15	0.12	1.05	0.84	0.11	0.08	0.73	0.59	1.29	1.04
28	25	0.35	0.38	0.28	0.32	0.13	0.28	0.93	1.01	0.05	0.06	0.65	0.72	0.82	0.92
35	32	0.31	0.43	0.29	0.40	0.08	0.11	0.93	1.34	0.03	0.04	0.53	0.79	1.47	2.19
42	40	0.25	0.48	0.22	0.42	0.11	0.20	1.20	2.27	0.06	0.11	0.46	0.85	-	-
54	50	0.30	0.79	0.19	0.49	0.09	0.24	1.15	3.06	0.06	0.14	0.36	1.43	-	-
76.1	65	0.25	1.04	0.15	0.62	0.08	0.31	1.07	4.42	0.04	0.17	0.32	1.68	-	-
88.9	80	0.24	1.22	0.13	0.66	0.07	0.36	1.06	5.38	0.04	0.20	0.27	2.10	-	-
108	100	0.23	1.51	0.12	0.76	0.07	0.43	1.05	6.90	0.03	0.20	-	-	-	-

equivalent lengths and values of local pressure drops

water 40°C, 12-22 mm

density: 992.2 kg/m³
viscosity: 0.0007 Pa.s
surface roughness: 0.01 mm

d [mm]	12			15			18			22		
di [mm]	9.6			12.6			15.6			19		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	23.8	0.09	4.2	50.9	0.11	6.5	92.0	0.13	9.0	158.6	0.16	12.2
30	26.5	0.10	5.2	56.7	0.13	8.0	102.4	0.15	11.2	176.3	0.17	15.0
35	29.1	0.11	6.3	62.0	0.14	9.6	112.0	0.16	13.4	192.7	0.19	18.0
40	31.5	0.12	7.4	67.1	0.15	11.3	121.1	0.18	15.6	208.2	0.20	21.0
45	33.8	0.13	8.5	71.9	0.16	12.9	129.7	0.19	17.9	222.9	0.22	24.0
50	36.0	0.14	9.6	76.5	0.17	14.6	137.9	0.20	20.2	236.8	0.23	27.1
55	38.0	0.15	10.7	80.9	0.18	16.4	145.7	0.21	22.6	250.2	0.25	30.3
60	40.1	0.15	11.9	85.1	0.19	18.1	153.2	0.22	25.0	263.0	0.26	33.5
65	42.0	0.16	13.1	89.2	0.20	19.9	160.5	0.23	27.4	275.4	0.27	36.7
70	43.9	0.17	14.3	93.1	0.21	21.7	167.5	0.24	29.9	287.3	0.28	39.9
75	45.7	0.18	15.5	96.9	0.22	23.5	174.3	0.25	32.3	298.9	0.29	43.2
80	47.4	0.18	16.7	100.6	0.22	25.3	180.9	0.26	34.8	310.2	0.30	46.5
85	49.2	0.19	17.9	104.2	0.23	27.2	187.3	0.27	37.3	321.1	0.31	49.9
90	50.8	0.19	19.2	107.7	0.24	29.0	193.6	0.28	39.9	331.7	0.32	53.2
95	52.5	0.20	20.4	111.1	0.25	30.9	199.7	0.29	42.4	342.1	0.34	56.6
100	54.1	0.21	21.7	114.5	0.26	32.8	205.7	0.30	45.0	352.3	0.35	60.0
110	57.2	0.22	24.3	121.0	0.27	36.6	217.2	0.32	50.2	372.0	0.36	66.9
120	60.2	0.23	26.9	127.2	0.28	40.5	228.3	0.33	55.5	390.8	0.38	73.9
130	63.0	0.24	29.5	133.2	0.30	44.4	239.0	0.35	60.8	409.0	0.40	80.9
140	65.8	0.25	32.1	139.0	0.31	48.3	249.4	0.36	66.2	426.6	0.42	88.0
150	68.5	0.26	34.8	144.7	0.32	52.3	259.4	0.38	71.6	443.6	0.43	95.2
160	71.1	0.27	37.5	150.1	0.33	56.4	269.1	0.39	77.1	460.2	0.45	102.4
170	73.7	0.28	40.3	155.4	0.35	60.4	278.6	0.40	82.6	476.2	0.47	109.7
180	76.2	0.29	43.0	160.6	0.36	64.5	287.8	0.42	88.1	491.9	0.48	117.0
190	78.6	0.30	45.8	165.7	0.37	68.7	296.8	0.43	93.7	507.1	0.50	124.4
200	80.9	0.31	48.6	170.6	0.38	72.8	305.5	0.44	99.4	522.0	0.51	131.8
220	85.5	0.33	54.3	180.2	0.40	81.2	322.5	0.47	110.7	550.9	0.54	146.8
240	89.9	0.35	60.0	189.4	0.42	89.7	338.8	0.49	122.2	578.6	0.57	161.9
260	94.2	0.36	65.8	198.2	0.44	98.3	354.5	0.52	133.8	605.2	0.59	177.2
280	98.3	0.38	71.7	206.8	0.46	106.9	369.7	0.54	145.5	631.0	0.62	192.6
300	102.3	0.39	77.6	215.0	0.48	115.6	384.4	0.56	157.3	655.9	0.64	208.1
350	111.7	0.43	92.6	234.7	0.52	137.8	419.3	0.61	187.2	715.1	0.70	247.3
400	120.6	0.46	107.9	253.2	0.56	160.3	452.1	0.66	217.5	770.5	0.75	287.2
450	129.0	0.50	123.4	270.6	0.60	183.1	483.0	0.70	248.3	822.9	0.81	327.5
500	136.9	0.53	139.2	287.2	0.64	206.3	512.4	0.74	279.4	872.7	0.85	368.3
550	144.6	0.55	155.1	303.0	0.68	229.7	540.4	0.79	310.9	920.2	0.90	409.6
600	151.9	0.58	171.3	318.2	0.71	253.3	567.4	0.82	342.6	965.8	0.95	451.2
650	159.0	0.61	187.5	332.9	0.74	277.1	593.3	0.86	374.7	1009.7	0.99	493.1
700	165.8	0.64	204.0	347.0	0.77	301.2	618.3	0.90	406.9	1052.0	1.03	535.3
750	172.4	0.66	220.5	360.7	0.80	325.4	642.6	0.93	439.5	1093.0	1.07	577.8
800	178.8	0.69	237.2	374.0	0.83	349.8	666.1	0.97	472.2	1132.7	1.11	620.6
850	185.0	0.71	254.0	386.9	0.86	374.4	688.9	1.00	505.1	1171.3	1.15	663.6
900	191.1	0.73	271.0	399.5	0.89	399.1	711.1	1.03	538.2	1208.8	1.18	706.8
950	197.0	0.76	288.0	411.7	0.92	423.9	732.7	1.06	571.5	1245.4	1.22	750.2
1000	202.8	0.78	305.1	423.7	0.94	448.9	753.9	1.10	604.9	1281.1	1.26	793.9
1100	213.9	0.82	339.6	446.8	1.00	499.2	794.7	1.15	672.2	1350.1	1.32	881.7
1200	224.6	0.86	374.5	468.9	1.04	550.0	833.9	1.21	740.1	1416.3	1.39	970.2
1300	234.9	0.90	409.7	490.3	1.09	601.1	871.6	1.27	808.5	1479.9	1.45	1059.4
1400	244.9	0.94	445.1	510.8	1.14	652.7	907.9	1.32	877.4	1541.3	1.51	1149.0
1500	254.5	0.98	480.8	530.8	1.18	704.5	943.1	1.37	946.7	1600.6	1.57	1239.2
1600	263.9	1.01	516.7	550.1	1.23	756.7	977.2	1.42	1016.3	1658.2	1.62	1329.9
1700	272.9	1.05	552.9	568.8	1.27	809.2	1010.3	1.47	1086.3	1714.0	1.68	1421.0
1800	281.8	1.08	589.3	587.1	1.31	862.0	1042.5	1.52	1156.7	1768.3	1.73	1512.5
1900	290.4	1.11	625.8	604.9	1.35	915.0	1073.9	1.56	1227.4	1821.3	1.78	1604.4
2000	298.8	1.15	662.6	622.2	1.39	968.2	1104.5	1.61	1298.4	1872.9	1.83	1696.7
2100	307.0	1.18	699.5	639.2	1.42	1021.7	1134.4	1.65	1369.6	1923.3	1.88	1789.3
2200	315.0	1.21	736.6	655.8	1.46	1075.4	1163.6	1.69	1441.1	1972.6	1.93	1882.2
2300	322.9	1.24	773.8	672.0	1.50	1129.3	1192.2	1.73	1512.9	2020.9	1.98	1975.4
2400	330.6	1.27	811.2	687.9	1.53	1183.4	1220.3	1.77	1584.9	2068.2	2.03	2068.9
2500	338.2	1.30	848.8	703.5	1.57	1237.7	1247.8	1.81	1657.2	2114.5	2.07	2162.7

28-54 mm

d [mm]	28			35			42			54		
di [mm]	25			32			39			51		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	336.8	0.19	18.3	660.6	0.23	26.2	1131.0	0.26	34.9	2338.0	0.32	50.9
30	374.0	0.21	22.6	733.0	0.25	32.3	1254.0	0.29	42.9	2591.0	0.35	62.5
35	408.6	0.23	26.9	800.3	0.28	38.5	1369.0	0.32	51.0	2825.0	0.38	74.4
40	441.1	0.25	31.4	863.4	0.30	44.8	1476.0	0.34	59.3	3045.0	0.41	86.4
45	471.8	0.27	35.9	923.0	0.32	51.2	1577.0	0.37	67.8	3252.0	0.44	98.6
50	501.0	0.28	40.5	979.8	0.34	57.7	1674.0	0.39	76.3	3450.0	0.47	110.9
55	529.0	0.30	45.2	1034.1	0.36	64.3	1766.0	0.41	85.0	3638.0	0.49	123.3
60	555.9	0.31	49.9	1086.2	0.38	70.9	1854.0	0.43	93.7	3819.0	0.52	135.9
65	581.8	0.33	54.6	1136.4	0.39	77.6	1940.0	0.45	102.5	3994.0	0.54	148.6
70	606.8	0.34	59.4	1185.0	0.41	84.4	2022.0	0.47	111.4	4162.0	0.57	161.4
75	631.0	0.36	64.3	1231.9	0.43	91.2	2102.0	0.49	120.3	4325.0	0.59	174.3
80	654.6	0.37	69.1	1277.5	0.44	98.1	2179.0	0.51	129.4	4483.0	0.61	187.2
85	677.5	0.38	74.1	1321.8	0.46	105.0	2254.0	0.52	138.4	4636.0	0.63	200.3
90	699.7	0.40	79.0	1365.0	0.47	112.0	2327.0	0.54	147.6	4786.0	0.65	213.4
95	721.5	0.41	84.0	1407.1	0.49	119.0	2399.0	0.56	156.8	4932.0	0.67	226.6
100	742.7	0.42	89.0	1448.2	0.50	126.1	2468.0	0.57	166.0	5074.0	0.69	239.9
110	783.8	0.44	99.1	1527.7	0.53	140.3	2603.0	0.61	184.6	5349.0	0.73	266.6
120	823.2	0.47	109.4	1604.0	0.55	154.7	2732.0	0.64	203.4	5613.0	0.76	293.5
130	861.2	0.49	119.7	1677.5	0.58	169.2	2857.0	0.66	222.4	5867.0	0.80	320.7
140	897.9	0.51	130.1	1748.5	0.60	183.8	2977.0	0.69	241.5	6112.0	0.83	348.1
150	933.4	0.53	140.6	1817.1	0.63	198.5	3093.0	0.72	260.7	6349.0	0.86	375.6
160	967.9	0.55	151.2	1883.8	0.65	213.3	3206.0	0.75	280.1	6579.0	0.89	403.3
170	1001.4	0.57	161.8	1948.5	0.67	228.2	3316.0	0.77	299.6	6802.0	0.92	431.2
180	1034.0	0.59	172.5	2011.6	0.69	243.2	3423.0	0.80	319.2	7020.0	0.95	459.2
190	1065.8	0.60	183.3	2073.0	0.72	258.3	3527.0	0.82	338.9	7232.0	0.98	487.3
200	1096.9	0.62	194.2	2133.0	0.74	273.5	3628.0	0.84	358.7	7439.0	1.01	515.6
220	1157.0	0.65	216.0	2249.0	0.78	304.1	3824.0	0.89	398.5	7838.0	1.07	572.5
240	1214.6	0.69	238.1	2360.3	0.82	334.9	4013.0	0.93	438.7	8221.0	1.12	629.8
260	1270.1	0.72	260.3	2467.4	0.85	366.0	4194.0	0.98	479.2	8590.0	1.17	687.5
280	1323.7	0.75	282.8	2570.8	0.89	397.3	4368.0	1.02	520.0	8946.0	1.22	745.6
300	1375.6	0.78	305.3	2670.8	0.92	428.8	4538.0	1.06	561.0	9290.0	1.26	804.1
350	1498.7	0.85	362.4	2908.1	1.00	508.4	4939.0	1.15	664.6	10105.0	1.37	951.5
400	1613.9	0.91	420.3	3130.3	1.08	589.1	5314.0	1.24	769.4	10868.0	1.48	1100.5
450	1722.7	0.97	478.9	3339.9	1.15	670.6	5668.0	1.32	875.3	11587.0	1.58	1251.0
500	1826.1	1.03	538.1	3538.9	1.22	752.9	6004.0	1.40	982.2	12270.0	1.67	1402.7
550	1924.8	1.09	597.8	3728.9	1.29	835.9	6325.0	1.47	1089.9	12921.0	1.76	1555.5
600	2019.4	1.14	658.1	3910.9	1.35	919.5	6632.0	1.54	1198.4	13544.0	1.84	1709.3
650	2110.4	1.19	718.7	4086.0	1.41	1003.7	6927.0	1.61	1307.5	14144.0	1.92	1863.9
700	2198.2	1.24	779.8	4254.9	1.47	1088.4	7212.0	1.68	1417.3	14722.0	2.00	2019.3
750	2283.1	1.29	841.2	4418.3	1.53	1173.5	7488.0	1.74	1527.6	15280.0	2.08	2175.5
800	2365.5	1.34	903.0	4576.6	1.58	1259.1	7755.0	1.80	1638.5	15822.0	2.15	2332.4
850	2445.5	1.38	965.0	4730.3	1.63	1345.1	8014.0	1.86	1749.9	16347.0	2.22	2489.9
900	2523.3	1.43	1027.4	4879.8	1.69	1431.5	8266.0	1.92	1861.7	16858.0	2.29	2647.9
950	2599.1	1.47	1090.1	5025.5	1.74	1518.2	8511.0	1.98	1973.9	17355.0	2.36	2806.6
1000	2673.0	1.51	1153.0	5167.5	1.78	1605.3	8751.0	2.03	2086.5	17841.0	2.43	2965.7
1100	2815.9	1.59	1279.6	5442.0	1.88	1780.3	9213.0	2.14	2312.9	18778.0	2.55	3285.4
1200	2952.8	1.67	1407.0	5704.9	1.97	1956.5	9656.0	2.25	2540.6	19675.0	2.68	3606.7
1300	3084.5	1.75	1535.3	5957.6	2.06	2133.7	10082.0	2.34	2769.6	20536.0	2.79	3929.7
1400	3211.4	1.82	1664.3	6201.3	2.14	2311.8	10492.0	2.44	2999.6	21367.0	2.91	4254.0
1500	3334.2	1.89	1793.9	6436.8	2.22	2490.7	10889.0	2.53	3230.6	22170.0	3.01	4579.6
1600	3453.1	1.95	1924.2	6664.9	2.30	2670.4	11273.0	2.62	3462.6	22947.0	3.12	4906.4
1700	3568.6	2.02	2055.0	6886.4	2.38	2850.8	11646.0	2.71	3695.4	23701.0	3.22	5234.2
1800	3680.8	2.08	2186.4	7101.8	2.45	3031.9	12008.0	2.79	3929.0	24434.0	3.32	5563.0
1900	3790.2	2.14	2318.2	7311.5	2.53	3213.6	12361.0	2.87	4163.3	25148.0	3.42	5892.8
2000	3896.9	2.21	2450.5	7516.0	2.60	3395.9	12705.0	2.95	4398.4	25844.0	3.51	6223.5
2100	4001.0	2.26	2583.3	7715.6	2.66	3578.7	13041.0	3.03	4634.1	26524.0	3.61	6554.9
2200	4102.9	2.32	2716.4	7910.8	2.73	3762.1	13370.0	3.11	4870.4	27187.0	3.70	6887.1
2300	4202.5	2.38	2850.0	8101.8	2.80	3945.9	13691.0	3.18	5107.2	27837.0	3.79	7220.1
2400	4300.1	2.43	2983.9	8288.8	2.86	4130.2	14005.0	3.26	5344.6	28473.0	3.87	7553.7
2500	4395.8	2.49	3118.2	8472.1	2.93	4314.9	14314.0	3.33	5582.6	29096.0	3.96	7888.0

66.7-108 mm

d [mm]	66.7			76.1			88.9			108		
di [mm]	63.7			72.1			84.9			104		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	4264.0	0.38	69.6	6165.0	0.41	83.9	9506.0	0.46	104.6	15861.0	0.52	135.6
30	4724.0	0.42	85.4	6825.0	0.45	102.8	10520.0	0.50	128.1	17544.0	0.57	165.9
35	5146.0	0.45	101.4	7437.0	0.49	122.1	11459.0	0.55	152.0	19103.0	0.62	196.6
40	5544.0	0.49	117.7	8010.0	0.53	141.6	12338.0	0.59	176.2	20563.0	0.67	227.8
45	5920.0	0.52	134.1	8551.0	0.57	161.4	13169.0	0.63	200.8	21941.0	0.72	259.4
50	6278.0	0.55	150.9	9065.0	0.60	181.4	13958.0	0.67	225.5	23250.0	0.76	291.3
55	6619.0	0.58	167.8	9557.0	0.63	201.6	14711.0	0.71	250.6	24500.0	0.80	323.4
60	6946.0	0.61	184.7	10028.0	0.66	222.0	15434.0	0.74	275.8	25699.0	0.84	355.9
65	7260.0	0.64	201.8	10482.0	0.69	242.5	16129.0	0.77	301.2	26852.0	0.88	388.5
70	7565.0	0.67	219.1	10919.0	0.72	263.2	16801.0	0.81	326.8	27965.0	0.91	421.4
75	7858.0	0.69	236.4	11343.0	0.75	284.0	17450.0	0.84	352.5	29041.0	0.95	454.4
80	8143.0	0.72	253.8	11754.0	0.78	305.0	18080.0	0.87	378.4	30085.0	0.98	487.7
85	8421.0	0.74	271.5	12153.0	0.80	326.1	18692.0	0.90	404.5	31098.0	1.02	521.1
90	8692.0	0.76	289.2	12542.0	0.83	347.2	19287.0	0.92	430.7	32085.0	1.05	554.7
95	8953.0	0.79	306.9	12920.0	0.86	368.5	19867.0	0.95	457.0	33046.0	1.08	588.4
100	9210.0	0.81	324.7	13290.0	0.88	389.9	20433.0	0.98	483.4	33984.0	1.11	622.3
110	9707.0	0.85	360.7	14004.0	0.93	432.9	21528.0	1.03	536.5	35796.0	1.17	690.4
120	10182.0	0.89	397.0	14689.0	0.97	476.3	22576.0	1.08	590.1	37533.0	1.23	759.1
130	10640.0	0.93	433.3	15348.0	1.02	520.0	23585.0	1.13	644.0	39203.0	1.28	828.1
140	11081.0	0.97	470.1	15983.0	1.06	564.0	24559.0	1.18	698.3	40814.0	1.33	897.6
150	11509.0	1.01	507.1	16598.0	1.10	608.2	25500.0	1.22	752.8	42372.0	1.39	967.4
160	11923.0	1.05	544.2	17194.0	1.14	652.7	26413.0	1.27	807.7	43882.0	1.43	1037.6
170	12324.0	1.08	581.5	17773.0	1.18	697.4	27299.0	1.31	862.8	45348.0	1.48	1108.1
180	12715.0	1.12	619.0	18337.0	1.21	742.3	28161.0	1.35	918.1	46775.0	1.53	1178.9
190	13096.0	1.15	656.6	18886.0	1.25	787.4	29001.0	1.39	973.7	48164.0	1.57	1250.0
200	13468.0	1.18	694.4	19421.0	1.29	832.7	29820.0	1.43	1029.5	49519.0	1.62	1321.3
220	14187.0	1.25	770.6	20456.0	1.35	923.7	31403.0	1.51	1141.7	52137.0	1.70	1464.7
240	14875.0	1.31	847.1	21447.0	1.42	1015.5	32920.0	1.58	1254.7	54645.0	1.79	1609.0
260	15538.0	1.37	924.4	22401.0	1.48	1107.8	34378.0	1.65	1368.3	57056.0	1.87	1754.1
280	16176.0	1.42	1001.8	23320.0	1.54	1200.6	35784.0	1.72	1482.5	59380.0	1.94	1899.9
300	16794.0	1.48	1079.8	24210.0	1.60	1293.9	37144.0	1.78	1597.3	61627.0	2.02	2046.4
350	18258.0	1.60	1276.2	26317.0	1.74	1529.0	40366.0	1.93	1886.4	66950.0	2.19	2415.2
400	19626.0	1.72	1474.7	28287.0	1.87	1766.4	43376.0	2.08	2178.3	71923.0	2.35	2787.3
450	20915.0	1.84	1674.7	30143.0	2.00	2005.8	46212.0	2.22	2472.5	76606.0	2.50	3162.1
500	22138.0	1.94	1876.2	31904.0	2.11	2247.0	48902.0	2.34	2768.6	81047.0	2.65	3539.4
550	23303.0	2.05	2079.0	33852.0	2.24	2489.7	51466.0	2.47	3066.6	85279.0	2.79	3918.7
600	24420.0	2.15	2282.9	35190.0	2.33	2733.7	53921.0	2.58	3366.1	89331.0	2.92	4299.9
650	25493.0	2.24	2488.2	36735.0	2.43	2979.0	56280.0	2.70	3667.1	93223.0	3.05	4682.8
700	26527.0	2.33	2694.0	38224.0	2.53	3225.4	58553.0	2.81	3969.3	96974.0	3.17	5067.2
750	27527.0	2.42	2900.9	39663.0	2.63	3472.8	60750.0	2.91	4272.8	100598.0	3.29	5453.0
800	28495.0	2.50	3108.4	41056.0	2.72	3721.2	62878.0	3.01	4577.3	104108.0	3.40	5840.1
850	29434.0	2.59	3316.9	42409.0	2.81	3970.4	64942.0	3.11	4882.8	107513.0	3.52	6228.3
900	30348.0	2.67	3526.0	43724.0	2.89	4220.4	66949.0	3.21	5189.2	110822.0	3.62	6617.7
950	31237.0	2.74	3735.6	45004.0	2.98	4471.2	68903.0	3.30	5496.5	114044.0	3.73	7008.1
1000	32104.0	2.82	3945.8	46253.0	3.06	4722.7	70808.0	3.39	5804.6	117185.0	3.83	7399.4
1100	33778.0	2.97	4368.2	48662.0	3.22	5227.6	74484.0	3.57	6423.1	123246.0	4.03	8184.7
1200	35381.0	3.11	4792.3	50969.0	3.37	5734.9	78003.0	3.74	7044.2	129046.0	4.22	8973.1
1300	36921.0	3.24	5218.5	53184.0	3.52	6244.2	81382.0	3.90	7667.8	134615.0	4.40	9764.3
1400	38403.0	3.37	5646.0	55319.0	3.66	6755.5	84637.0	4.06	8293.5	139980.0	4.58	10558.1
1500	39836.0	3.50	6075.3	57381.0	3.80	7268.5	87782.0	4.21	8921.2	145162.0	4.75	11354.2
1600	41223.0	3.62	6505.7	59377.0	3.93	7783.1	90826.0	4.35	9550.7	150178.0	4.91	12152.4
1700	42569.0	3.74	6937.5	61314.0	4.06	8299.2	93780.0	4.50	10181.9	155043.0	5.07	12952.6
1800	43877.0	3.85	7370.4	63196.0	4.18	8816.6	96649.0	4.63	10814.6	159771.0	5.22	13754.5
1900	45151.0	3.97	7804.6	65029.0	4.30	9335.3	99443.0	4.77	11448.8	164372.0	5.37	14558.2
2000	46391.0	4.08	8239.5	66815.0	4.42	9855.1	102166.0	4.90	12084.3	168856.0	5.52	15363.3
2100	47604.0	4.18	8675.7	68558.0	4.54	10376.0	104823.0	5.02	12721.1	173232.0	5.66	16170.0
2200	48788.0	4.29	9112.6	70261.0	4.65	10898.0	107419.0	5.15	13359.0	177507.0	5.80	16977.9
2300	49946.0	4.39	9550.2	71927.0	4.76	11420.9	109958.0	5.27	13998.0	181689.0	5.94	17787.2
2400	51079.0	4.49	9988.3	73558.0	4.87	11944.8	112444.0	5.39	14638.1	185782.0	6.07	18597.7
2500	52189.0	4.58	10427.6	75156.0	4.97	12469.5	114879.0	5.51	15279.1	189792.0	6.21	19409.3

water 60°C, 12-22 mm

density: 983.1 kg/m³
viscosity: 0.0005 Pa.s
surface roughness: 0.01 mm

d [mm]	12			15			18			22		
di [mm]	9.6			12.6			15.6			19		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	25.2	0.10	4.8	53.7	0.12	7.3	96.8	0.14	10.1	166.3	0.16	13.5
30	28.1	0.11	5.9	59.7	0.13	9.0	107.6	0.16	12.4	184.7	0.18	16.6
35	30.8	0.12	7.1	65.3	0.15	10.8	117.6	0.17	14.9	201.8	0.20	19.9
40	33.3	0.13	8.3	70.6	0.16	12.6	127.0	0.18	17.3	217.8	0.21	23.2
45	35.7	0.14	9.5	75.6	0.17	14.4	135.9	0.20	19.8	233.0	0.23	26.5
50	38.0	0.15	10.8	80.4	0.18	16.3	144.4	0.21	22.4	247.4	0.24	29.9
55	40.1	0.15	12.1	84.9	0.19	18.2	152.5	0.22	25.0	261.2	0.26	33.3
60	42.2	0.16	13.4	89.3	0.20	20.1	160.3	0.23	27.6	274.5	0.27	36.8
65	44.2	0.17	14.7	93.5	0.21	22.1	167.8	0.24	30.3	287.3	0.28	40.3
70	46.2	0.18	16.0	97.6	0.22	24.1	175.1	0.25	32.9	299.6	0.29	43.8
75	48.1	0.18	17.3	101.6	0.23	26.0	182.1	0.26	35.6	311.6	0.31	47.4
80	49.9	0.19	18.7	105.4	0.23	28.1	189.0	0.27	38.4	323.2	0.32	51.0
85	51.7	0.20	20.0	109.2	0.24	30.1	195.6	0.28	41.1	334.5	0.33	54.6
90	53.5	0.21	21.4	112.8	0.25	32.1	202.1	0.29	43.9	345.5	0.34	58.3
95	55.2	0.21	22.8	116.3	0.26	34.2	208.4	0.30	46.7	356.2	0.35	61.9
100	56.8	0.22	24.2	119.8	0.27	36.2	214.6	0.31	49.5	366.7	0.36	65.6
110	60.0	0.23	27.0	126.5	0.28	40.4	226.5	0.33	55.1	387.0	0.38	73.1
120	63.1	0.24	29.9	133.0	0.30	44.6	238.0	0.35	60.8	406.4	0.40	80.6
130	66.1	0.25	32.8	139.2	0.31	48.9	249.0	0.36	66.6	425.1	0.42	88.2
140	69.0	0.26	35.7	145.2	0.32	53.2	259.7	0.38	72.4	443.2	0.43	95.9
150	71.8	0.28	38.6	151.0	0.34	57.6	270.0	0.39	78.3	460.7	0.45	103.6
160	74.5	0.29	41.6	156.7	0.35	62.0	280.0	0.41	84.2	477.7	0.47	111.4
170	77.1	0.30	44.6	162.2	0.36	66.4	289.8	0.42	90.2	494.3	0.48	119.3
180	79.7	0.31	47.6	167.5	0.37	70.8	299.3	0.43	96.2	510.3	0.50	127.1
190	82.2	0.32	50.6	172.7	0.38	75.3	308.5	0.45	102.2	526.0	0.52	135.1
200	84.7	0.33	53.7	177.8	0.40	79.8	317.5	0.46	108.3	541.3	0.53	143.0
220	89.4	0.34	59.9	187.7	0.42	88.9	335.0	0.49	120.6	570.9	0.56	159.1
240	94.0	0.36	66.1	197.1	0.44	98.1	351.8	0.51	132.9	599.3	0.59	175.3
260	98.4	0.38	72.5	206.2	0.46	107.4	367.9	0.53	145.4	626.7	0.61	191.7
280	102.6	0.39	78.8	215.0	0.48	116.7	383.5	0.56	158.0	653.0	0.64	208.2
300	106.7	0.41	85.3	223.6	0.50	126.1	398.6	0.58	170.7	678.6	0.66	224.8
350	116.4	0.45	101.6	243.8	0.54	150.0	434.4	0.63	202.7	739.2	0.72	266.7
400	125.6	0.48	118.1	262.7	0.59	174.2	468.0	0.68	235.2	795.9	0.78	309.2
450	134.2	0.52	134.9	280.6	0.63	198.8	499.6	0.73	268.2	849.4	0.83	352.2
500	142.4	0.55	151.9	297.6	0.66	223.6	529.7	0.77	301.4	900.3	0.88	395.7
550	150.3	0.58	169.1	313.9	0.70	248.7	558.4	0.81	335.0	948.8	0.93	439.5
600	157.8	0.61	186.5	329.5	0.73	274.0	586.0	0.85	368.8	995.3	0.98	483.6
650	165.0	0.63	204.0	344.5	0.77	299.5	612.4	0.89	402.9	1040.0	1.02	528.0
700	172.0	0.66	221.7	358.9	0.80	325.2	638.0	0.93	437.3	1083.2	1.06	572.8
750	178.8	0.69	239.5	372.9	0.83	351.1	662.7	0.96	471.8	1124.9	1.10	617.7
800	185.4	0.71	257.4	386.5	0.86	377.1	686.7	1.00	506.5	1165.4	1.14	663.0
850	191.8	0.74	275.4	399.7	0.89	403.2	710.0	1.03	541.5	1204.6	1.18	708.4
900	198.0	0.76	293.6	412.5	0.92	429.6	732.6	1.06	576.6	1242.8	1.22	754.1
950	204.0	0.78	311.8	425.0	0.95	456.0	754.7	1.10	611.8	1280.1	1.25	799.9
1000	209.9	0.81	330.1	437.2	0.97	482.5	776.2	1.13	647.2	1316.4	1.29	845.9
1100	221.4	0.85	367.0	460.8	1.03	536.0	817.8	1.19	718.4	1386.5	1.36	938.5
1200	232.3	0.89	404.2	483.4	1.08	589.8	857.6	1.25	790.1	1453.7	1.42	1031.6
1300	242.8	0.93	441.7	505.1	1.13	644.1	896.0	1.30	862.3	1518.3	1.49	1125.3
1400	253.0	0.97	479.5	526.1	1.17	698.6	932.9	1.36	934.9	1580.5	1.55	1219.5
1500	262.8	1.01	517.4	546.4	1.22	753.5	968.6	1.41	1007.9	1640.7	1.61	1314.2
1600	272.4	1.05	555.6	566.0	1.26	808.7	1003.2	1.46	1081.2	1699.0	1.66	1409.2
1700	281.6	1.08	594.1	585.1	1.30	864.1	1036.8	1.51	1154.8	1755.6	1.72	1504.7
1800	290.6	1.12	632.7	603.7	1.34	919.8	1069.5	1.55	1228.8	1810.7	1.77	1600.5
1900	299.4	1.15	671.4	621.7	1.38	975.7	1101.3	1.60	1303.0	1864.3	1.83	1696.7
2000	308.0	1.18	710.4	639.4	1.42	1031.8	1132.4	1.65	1377.5	1916.5	1.88	1793.1
2100	316.3	1.21	749.5	656.6	1.46	1088.1	1088.1	1.58	1452.2	1967.6	1.93	1889.9
2200	324.5	1.25	788.7	673.4	1.50	1144.6	1144.6	1.66	1527.2	2017.5	1.98	1986.9
2300	332.5	1.28	828.1	689.9	1.54	1201.3	1201.3	1.75	1602.3	2066.3	2.02	2084.2
2400	340.3	1.31	867.6	706.0	1.57	1258.2	1258.2	1.83	1677.7	2114.1	2.07	2181.8
2500	348.0	1.34	907.3	721.8	1.61	1315.2	1315.2	1.91	1753.3	2160.9	2.12	2279.6

28-54 mm

d [mm]	28			35			42			54		
di [mm]	25			32			39			51		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	351.9	0.20	20.2	688.2	0.24	28.7	1176.0	0.27	38.0	2423.0	0.33	55.2
30	390.4	0.22	24.8	763.0	0.26	35.3	1303.0	0.30	46.7	2683.0	0.36	67.7
35	426.2	0.24	29.6	832.3	0.29	42.0	1420.0	0.33	55.5	2924.0	0.40	80.4
40	459.7	0.26	34.4	897.4	0.31	48.9	1531.0	0.36	64.4	3150.0	0.43	93.3
45	491.5	0.28	39.3	958.9	0.33	55.8	1635.0	0.38	73.5	3363.0	0.46	106.3
50	521.7	0.30	44.3	1017.3	0.35	62.8	1734.0	0.40	82.7	3565.0	0.48	119.5
55	550.5	0.31	49.4	1073.2	0.37	69.9	1829.0	0.43	92.0	3758.0	0.51	132.8
60	578.3	0.33	54.5	1126.9	0.39	77.0	1920.0	0.45	101.3	3944.0	0.54	146.3
65	604.9	0.34	59.6	1178.5	0.41	84.3	2007.0	0.47	110.8	4122.0	0.56	159.8
70	630.7	0.36	64.8	1228.4	0.42	91.5	2092.0	0.49	120.3	4295.0	0.58	173.5
75	655.7	0.37	70.0	1276.6	0.44	98.9	2173.0	0.51	129.9	4461.0	0.61	187.2
80	679.9	0.38	75.3	1323.5	0.46	106.3	2253.0	0.52	139.6	4623.0	0.63	201.0
85	703.5	0.40	80.6	1369.0	0.47	113.7	2330.0	0.54	149.3	4780.0	0.65	214.9
90	726.4	0.41	85.9	1413.3	0.49	121.2	2405.0	0.56	159.0	4933.0	0.67	228.8
95	748.8	0.42	91.3	1456.5	0.50	128.7	2478.0	0.58	168.9	5082.0	0.69	242.9
100	770.6	0.44	96.7	1498.6	0.52	136.3	2549.0	0.59	178.7	5227.0	0.71	257.0
110	812.8	0.46	107.6	1580.2	0.55	151.5	2687.0	0.62	198.6	5508.0	0.75	285.3
120	853.3	0.48	118.6	1658.4	0.57	166.9	2820.0	0.66	218.6	5778.0	0.79	313.9
130	892.3	0.50	129.7	1733.7	0.60	182.4	2947.0	0.69	238.8	6037.0	0.82	342.7
140	930.0	0.53	140.9	1806.4	0.62	198.0	3070.0	0.71	259.1	6287.0	0.85	371.7
150	966.4	0.55	152.1	1876.7	0.65	213.7	3189.0	0.74	279.6	6529.0	0.89	400.8
160	1001.8	0.57	163.5	1944.8	0.67	229.5	3304.0	0.77	300.2	6763.0	0.92	430.1
170	1036.2	0.59	174.9	2011.1	0.69	245.4	3416.0	0.79	320.9	6991.0	0.95	459.6
180	1069.6	0.61	186.3	2075.6	0.72	261.4	3525.0	0.82	341.7	7212.0	0.98	489.2
190	1102.2	0.62	197.9	2138.4	0.74	277.4	3631.0	0.84	362.6	7428.0	1.01	518.9
200	1134.0	0.64	209.4	2199.7	0.76	293.6	3735.0	0.87	383.5	7639.0	1.04	548.7
220	1195.5	0.68	232.8	2318.2	0.80	326.1	3935.0	0.92	425.8	8045.0	1.09	608.7
240	1254.5	0.71	256.3	2431.8	0.84	358.8	4127.0	0.96	468.3	8435.0	1.15	669.1
260	1311.3	0.74	280.0	2541.1	0.88	391.8	4311.0	1.00	511.1	8810.0	1.20	729.9
280	1366.0	0.77	303.9	2646.6	0.91	425.0	4489.0	1.04	554.2	9171.0	1.25	791.0
300	1419.0	0.80	328.0	2748.6	0.95	458.3	4661.0	1.08	597.5	9521.0	1.29	852.4
350	1544.8	0.87	388.6	2990.4	1.03	542.6	5069.0	1.18	706.7	10349.0	1.41	1007.1
400	1662.4	0.94	450.1	3216.6	1.11	627.7	5451.0	1.27	817.0	11122.0	1.51	1163.3
450	1773.3	1.00	512.1	3429.8	1.18	713.7	5810.0	1.35	928.4	11851.0	1.61	1320.7
500	1878.6	1.06	574.8	3632.2	1.25	800.4	6151.0	1.43	1040.6	12542.0	1.71	1479.3
550	1979.1	1.12	637.9	3825.2	1.32	887.8	6477.0	1.51	1153.5	13201.0	1.80	1638.8
600	2075.4	1.17	701.5	4010.1	1.39	975.6	6788.0	1.58	1267.1	13832.0	1.88	1799.2
650	2167.9	1.23	765.5	4187.8	1.45	1064.0	7087.0	1.65	1381.4	14438.0	1.96	1960.4
700	2257.2	1.28	829.8	4359.1	1.51	1152.9	7376.0	1.72	1496.2	15023.0	2.04	2122.3
750	2343.5	1.33	894.5	4524.8	1.56	1242.2	7655.0	1.78	1611.5	15587.0	2.12	2284.8
800	2427.2	1.37	959.5	4685.2	1.62	1331.8	7925.0	1.84	1727.2	16134.0	2.19	2447.9
850	2508.4	1.42	1024.7	4841.0	1.67	1421.9	8187.0	1.90	1843.4	16665.0	2.27	2611.5
900	2587.3	1.46	1090.3	4992.5	1.72	1512.2	8442.0	1.96	1960.0	17180.0	2.34	2775.7
950	2664.2	1.51	1156.0	5140.0	1.78	1602.9	8691.0	2.02	2076.9	17682.0	2.40	2940.3
1000	2739.3	1.55	1222.1	5283.8	1.82	1693.9	8933.0	2.08	2194.3	18172.0	2.47	3105.4
1100	2884.1	1.63	1354.8	5561.5	1.92	1876.6	9400.0	2.19	2429.8	19117.0	2.60	3436.7
1200	3022.9	1.71	1488.2	5827.4	2.01	2060.3	9847.0	2.29	2666.6	20021.0	2.72	3769.5
1300	3156.2	1.79	1622.4	6082.8	2.10	2244.9	10277.0	2.39	2904.4	20890.0	2.84	4103.6
1400	3284.7	1.86	1757.2	6329.0	2.19	2430.3	10691.0	2.49	3143.1	21726.0	2.95	4438.9
1500	3408.9	1.93	1892.6	6566.9	2.27	2616.4	11091.0	2.58	3382.7	22534.0	3.06	4775.2
1600	3529.2	2.00	2028.5	6797.3	2.35	2803.2	11478.0	2.67	3623.0	23317.0	3.17	5112.5
1700	3645.9	2.06	2165.0	7020.8	2.42	2990.6	11854.0	2.76	3864.1	24075.0	3.27	5450.7
1800	3759.4	2.13	2301.8	7238.0	2.50	3178.5	12219.0	2.84	4105.9	24813.0	3.37	5789.8
1900	3869.9	2.19	2439.1	7449.5	2.57	3367.0	12575.0	2.92	4348.2	25531.0	3.47	6129.6
2000	3977.7	2.25	2576.9	7655.7	2.64	3556.0	12921.0	3.00	4591.2	26230.0	3.57	6470.2
2100	4082.9	2.31	2714.9	7857.0	2.71	3745.4	13259.0	3.08	4834.7	26913.0	3.66	6811.4
2200	4185.7	2.37	2853.4	8053.7	2.78	3935.3	13590.0	3.16	5078.7	27580.0	3.75	7153.2
2300	4286.2	2.43	2992.1	8246.1	2.85	4125.6	13913.0	3.24	5323.2	28233.0	3.84	7495.7
2400	4384.7	2.48	3131.2	8434.5	2.91	4316.2	14230.0	3.31	5568.1	28871.0	3.93	7838.7
2500	4481.3	2.54	3270.6	8619.1	2.98	4507.3	14540.0	3.38	5813.5	29497.0	4.01	8182.2

66.7-108 mm

d [mm]	66.7			76.1			88.9			108		
di [mm]	63.7			72.1			84.9			104		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	4411.0	0.39	75.2	6370.0	0.42	90.4	9808.0	0.47	112.4	16339.0	0.53	145.2
30	4881.0	0.43	92.0	7046.0	0.47	110.6	10846.0	0.52	137.4	18060.0	0.59	177.4
35	5316.0	0.47	109.2	7673.0	0.51	131.2	11806.0	0.57	162.9	19653.0	0.64	210.0
40	5724.0	0.51	126.6	8260.0	0.55	152.0	12706.0	0.61	188.6	21144.0	0.69	243.1
45	6109.0	0.54	144.1	8813.0	0.58	173.1	13554.0	0.65	214.7	22550.0	0.74	276.5
50	6473.0	0.57	161.9	9339.0	0.62	194.3	14360.0	0.69	241.0	23885.0	0.78	310.2
55	6823.0	0.60	179.8	9841.0	0.65	215.8	15130.0	0.73	267.5	25159.0	0.82	344.2
60	7157.0	0.63	197.9	10323.0	0.68	237.4	15867.0	0.76	294.2	26380.0	0.86	378.5
65	7478.0	0.66	216.1	10786.0	0.71	259.2	16576.0	0.79	321.1	27555.0	0.90	412.9
70	7789.0	0.69	234.4	11233.0	0.74	281.1	17261.0	0.83	348.1	28688.0	0.94	447.6
75	8090.0	0.72	252.9	11665.0	0.77	303.2	17923.0	0.86	375.3	29783.0	0.97	482.4
80	8380.0	0.74	271.3	12084.0	0.80	325.4	18564.0	0.89	402.7	30845.0	1.01	517.4
85	8663.0	0.77	290.0	12492.0	0.83	347.7	19187.0	0.92	430.2	31876.0	1.04	552.6
90	8937.0	0.79	308.6	12888.0	0.85	370.1	19794.0	0.95	457.8	32879.0	1.08	587.9
95	9206.0	0.82	327.5	13274.0	0.88	392.5	20384.0	0.98	485.5	33856.0	1.11	623.3
100	9467.0	0.84	346.3	13650.0	0.90	415.1	20960.0	1.00	513.3	34809.0	1.14	658.9
110	9973.0	0.88	384.3	14378.0	0.95	460.6	22073.0	1.06	569.3	36650.0	1.20	720.5
120	10457.0	0.93	422.5	15075.0	1.00	506.3	23140.0	1.11	625.7	38414.0	1.26	802.5
130	10923.0	0.97	461.0	15745.0	1.04	552.4	24165.0	1.16	682.3	40109.0	1.31	874.9
140	11372.0	1.01	499.6	16392.0	1.08	598.7	25154.0	1.21	739.3	41743.0	1.36	947.6
150	11806.0	1.05	538.6	17017.0	1.13	645.2	26110.0	1.25	796.6	43324.0	1.42	1020.7
160	12226.0	1.08	577.6	17623.0	1.17	692.0	27037.0	1.30	854.1	44854.0	1.47	1094.1
170	12636.0	1.12	616.9	18211.0	1.21	738.9	27936.0	1.34	911.9	46340.0	1.52	1167.8
180	13033.0	1.16	656.3	18784.0	1.24	786.1	28811.0	1.38	969.9	47785.0	1.56	1241.8
190	13420.0	1.19	695.8	19341.0	1.28	833.4	29663.0	1.42	1028.1	49193.0	1.61	1316.0
200	13798.0	1.22	735.5	19885.0	1.32	880.9	30493.0	1.46	1086.5	50565.0	1.65	1390.4
220	14527.0	1.29	815.4	20935.0	1.39	976.4	32098.0	1.54	1203.8	53215.0	1.74	1540.0
240	15226.0	1.35	895.6	21940.0	1.45	1072.5	33634.0	1.61	1321.9	55752.0	1.82	1690.3
260	15898.0	1.41	976.4	22907.0	1.52	1169.1	35111.0	1.68	1440.5	58190.0	1.90	1841.4
280	16545.0	1.47	1057.6	23839.0	1.58	1266.1	36534.0	1.75	1559.6	60539.0	1.98	1993.1
300	17171.0	1.52	1139.1	24739.0	1.64	1363.6	37910.0	1.82	1679.3	62810.0	2.05	2145.4
350	18652.0	1.65	1344.2	26873.0	1.78	1609.0	41168.0	1.97	1980.3	68186.0	2.23	2528.4
400	20037.0	1.78	1551.1	28866.0	1.91	1856.4	44210.0	2.12	2283.8	73204.0	2.39	2914.2
450	21341.0	1.89	1759.6	30742.0	2.03	2105.6	47074.0	2.26	2589.3	77928.0	2.55	3302.5
500	22576.0	2.00	1969.0	32521.0	2.15	2356.3	49788.0	2.39	2896.5	82404.0	2.69	3692.7
550	23753.0	2.11	2179.9	34216.0	2.26	2608.4	52375.0	2.51	3205.2	86668.0	2.83	4084.8
600	24881.0	2.21	2391.7	35838.0	2.37	2861.6	54850.0	2.63	3515.3	90748.0	2.97	4478.5
650	26964.0	2.30	2604.4	37397.0	2.48	3115.9	57227.0	2.74	3826.6	94666.0	3.10	4873.5
700	27007.0	2.39	2818.0	38898.0	2.57	3371.1	59517.0	2.85	4139.1	98441.0	3.22	5269.9
750	28015.0	2.48	3032.1	40349.0	2.67	3627.3	61730.0	2.96	4452.5	102086.0	3.34	5667.4
800	28991.0	2.57	3247.1	41753.0	2.76	3884.2	63871.0	3.06	4766.8	105615.0	3.45	6066.1
850	29938.0	2.66	3462.7	43116.0	2.85	4141.8	65949.0	3.16	5082.0	109038.0	3.57	6465.6
900	30858.0	2.74	3678.9	44440.0	2.94	4400.2	67968.0	3.26	5397.9	112365.0	3.67	6866.1
950	31754.0	2.82	3895.6	45729.0	3.03	4659.1	69934.0	3.35	5714.6	115602.0	3.78	7267.5
1000	32627.0	2.89	4112.8	46986.0	3.11	4918.7	71849.0	3.44	6031.9	118757.0	3.88	7669.6
1100	34313.0	3.04	4548.7	49410.0	3.27	5439.5	75545.0	3.62	6668.5	124844.0	4.08	8476.0
1200	35926.0	3.18	4986.3	51730.0	3.42	5962.2	79081.0	3.79	7307.3	130666.0	4.27	9285.0
1300	37473.0	3.32	5425.2	53957.0	3.57	6486.6	82475.0	3.95	7948.0	136255.0	4.46	10096.2
1400	38965.0	3.45	5865.6	56103.0	3.71	7012.7	85744.0	4.11	8590.6	141637.0	4.63	10909.6
1500	40405.0	3.58	6307.3	58174.0	3.85	7540.2	88901.0	4.26	9234.8	146834.0	4.80	11724.8
1600	41799.0	3.71	6750.1	60180.0	3.98	8068.9	91956.0	4.41	9880.4	151863.0	4.97	12541.7
1700	43152.0	3.83	7194.1	62124.0	4.11	8598.9	94919.0	4.55	10527.4	156740.0	5.13	13360.2
1800	44466.0	3.94	7638.8	64014.0	4.24	9130.0	97798.0	4.69	11175.6	161478.0	5.28	14180.2
1900	45744.0	4.06	8084.6	65853.0	4.36	9662.1	100599.0	4.82	11825.0	166088.0	5.43	15001.4
2000	46991.0	4.17	8531.1	67645.0	4.48	10195.1	103329.0	4.95	12475.5	170581.0	5.58	15823.9
2100	48207.0	4.27	8978.5	69394.0	4.59	10729.1	105993.0	5.08	13127.0	174964.0	5.72	16647.6
2200	49396.0	4.38	9426.5	71102.0	4.71	11263.8	108595.0	5.21	13779.4	179245.0	5.86	17472.3
2300	50557.0	4.48	9875.1	72773.0	4.82	11799.4	111139.0	5.33	14432.7	183432.0	6.00	18298.0
2400	51694.0	4.58	10324.3	74408.0	4.92	12335.7	113630.0	5.45	15086.8	187530.0	6.13	19124.7
2500	52809.0	4.68	10774.4	76011.0	5.03	12872.6	116070.0	5.56	15741.7	191545.0	6.26	19952.3

water 80°C, 12-22 mm

density: 971.9 kg/m³
viscosity: 0.0004 Pa.s
surface roughness: 0.01 mm

d [mm]	12			15			18			22		
di [mm]	9.6			12.6			15.6			19		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	26.3	0.10	5.3	55.8	0.12	8.0	100.3	0.15	10.9	172.0	0.17	14.6
30	29.3	0.11	6.5	62.0	0.14	9.8	111.4	0.16	13.5	190.9	0.19	18.0
35	32.1	0.12	7.8	67.8	0.15	11.7	121.7	0.18	16.1	208.4	0.20	21.4
40	34.7	0.13	9.1	73.2	0.16	13.7	131.4	0.19	18.8	224.8	0.22	25.0
45	37.1	0.14	10.4	78.4	0.17	15.7	140.5	0.20	21.5	240.4	0.24	28.5
50	39.5	0.15	11.8	83.3	0.19	17.7	149.2	0.22	24.2	255.1	0.25	32.2
55	41.7	0.16	13.2	87.9	0.20	19.8	157.5	0.23	27.0	269.3	0.26	35.8
60	43.8	0.17	14.6	92.4	0.21	21.8	165.5	0.24	29.8	282.8	0.28	39.5
65	45.9	0.18	16.0	96.8	0.22	23.9	173.2	0.25	32.6	295.9	0.29	43.3
70	47.9	0.18	17.4	101.0	0.23	26.0	180.7	0.26	35.5	308.5	0.30	47.0
75	49.9	0.19	18.9	105.0	0.23	28.2	187.9	0.27	38.4	320.7	0.31	50.8
80	51.8	0.20	20.3	108.9	0.24	30.3	194.9	0.28	41.3	332.6	0.33	54.6
85	53.6	0.21	21.8	112.8	0.25	32.5	201.7	0.29	44.2	344.1	0.34	58.5
90	55.4	0.21	23.3	116.5	0.26	34.7	208.3	0.30	47.1	355.4	0.35	62.4
95	57.1	0.22	24.7	120.1	0.27	36.9	214.7	0.31	50.1	366.3	0.36	66.3
100	58.8	0.23	26.2	123.7	0.28	39.1	221.0	0.32	53.1	377.0	0.37	70.2
110	62.2	0.24	29.3	130.6	0.29	43.5	233.2	0.34	59.1	397.7	0.39	78.1
120	65.3	0.25	32.3	137.2	0.31	48.0	244.9	0.36	65.2	417.5	0.41	86.1
130	68.4	0.26	35.4	143.5	0.32	52.6	256.2	0.37	71.3	436.6	0.43	94.1
140	71.3	0.27	38.6	149.7	0.33	57.2	267.1	0.39	77.5	455.0	0.45	102.3
150	74.2	0.28	41.7	155.6	0.35	61.8	277.6	0.40	83.8	472.8	0.46	110.4
160	77.0	0.30	44.9	161.4	0.36	66.5	287.8	0.42	90.0	490.1	0.48	118.7
170	79.7	0.31	48.1	167.0	0.37	71.2	297.7	0.43	96.4	506.9	0.50	126.9
180	82.3	0.32	51.3	172.4	0.38	75.9	307.4	0.45	102.7	523.3	0.51	135.3
190	84.9	0.33	54.6	177.7	0.40	80.7	316.8	0.46	109.1	539.2	0.53	143.6
200	87.4	0.34	57.9	182.9	0.41	85.5	326.0	0.47	115.5	554.8	0.54	152.0
220	92.2	0.35	64.4	193.0	0.43	95.1	343.8	0.50	128.5	584.9	0.57	169.0
240	96.9	0.37	71.1	202.6	0.45	104.9	360.9	0.52	141.6	613.7	0.60	186.1
260	101.3	0.39	77.8	211.9	0.47	114.7	377.3	0.55	154.7	641.5	0.63	203.3
280	105.7	0.41	84.6	220.9	0.49	124.6	393.1	0.57	168.0	668.3	0.65	220.6
300	109.9	0.42	91.5	229.5	0.51	134.6	408.5	0.59	181.4	694.2	0.68	238.0
350	119.8	0.46	108.8	250.1	0.56	159.8	444.9	0.65	215.1	755.6	0.74	282.0
400	129.1	0.50	126.3	269.4	0.60	185.4	478.9	0.70	249.3	813.1	0.80	326.6
450	137.9	0.53	144.1	287.6	0.64	211.2	511.0	0.74	283.8	867.3	0.85	371.6
500	146.3	0.56	162.1	304.9	0.68	237.4	541.5	0.79	318.7	918.8	0.90	416.9
550	154.2	0.59	180.3	321.3	0.72	263.7	570.6	0.83	353.9	967.8	0.95	462.7
600	161.9	0.62	198.6	337.1	0.75	290.3	598.5	0.87	389.3	1014.9	0.99	508.7
650	169.3	0.65	217.1	352.3	0.78	317.1	625.3	0.91	424.9	1060.1	1.04	555.1
700	176.4	0.68	235.7	367.0	0.82	344.0	651.1	0.95	460.8	1103.7	1.08	601.7
750	183.2	0.70	254.5	381.2	0.85	371.1	676.1	0.98	496.9	1145.8	1.12	648.5
800	189.9	0.73	273.3	394.9	0.88	398.3	700.3	1.02	533.1	1186.6	1.16	695.5
850	196.4	0.75	292.3	408.3	0.91	425.7	723.9	1.05	569.5	1226.3	1.20	742.8
900	202.7	0.78	311.3	421.3	0.94	453.2	746.7	1.09	606.1	1264.8	1.24	790.2
950	208.8	0.80	330.4	433.9	0.97	480.8	769.0	1.12	642.8	1302.3	1.28	837.8
1000	214.8	0.82	349.7	446.2	0.99	508.6	790.8	1.15	679.7	1338.9	1.31	885.5
1100	226.4	0.87	388.3	470.1	1.05	564.4	832.7	1.21	753.7	1409.6	1.38	981.5
1200	237.4	0.91	427.3	492.9	1.10	620.5	872.9	1.27	828.3	1477.3	1.45	1078.0
1300	248.1	0.95	466.5	514.9	1.15	677.0	911.6	1.32	903.2	1542.4	1.51	1175.0
1400	258.4	0.99	506.0	536.0	1.19	733.8	948.8	1.38	978.5	1605.0	1.57	1272.5
1500	268.3	1.03	545.7	556.5	1.24	790.9	984.8	1.43	1054.1	1665.6	1.63	1370.3
1600	278.0	1.07	585.6	576.3	1.28	848.2	1019.7	1.48	1130.1	1724.3	1.69	1468.6
1700	287.3	1.10	625.7	595.5	1.33	905.8	1053.5	1.53	1206.3	1781.2	1.75	1567.1
1800	296.4	1.14	665.9	614.2	1.37	963.6	1086.4	1.58	1282.8	1836.5	1.80	1666.0
1900	305.3	1.17	706.3	632.4	1.41	1021.5	1118.4	1.63	1359.6	1890.4	1.85	1765.2
2000	313.9	1.20	746.9	650.2	1.45	1079.7	1149.7	1.67	1436.6	1942.9	1.90	1864.6
2100	322.4	1.24	787.5	667.5	1.49	1138.1	1180.1	1.72	1513.8	1994.2	1.95	1964.3
2200	330.6	1.27	828.4	684.5	1.52	1196.6	1209.9	1.76	1591.2	2044.3	2.00	2064.3
2300	338.7	1.30	869.3	701.1	1.56	1255.3	1239.1	1.80	1668.8	2093.3	2.05	2164.4
2400	346.6	1.33	910.4	717.3	1.60	1314.2	1267.6	1.84	1746.6	2141.3	2.10	2264.8
2500	354.3	1.36	951.6	733.3	1.63	1373.2	1295.6	1.88	1824.5	2188.3	2.14	2365.4

28-54 mm

d [mm]	28			35			42			54		
di [mm]	25			32			39			51		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	362.9	0.21	21.7	708.2	0.24	30.8	1208.0	0.28	40.6	2485.0	0.34	58.7
30	402.4	0.23	26.7	784.6	0.27	37.8	1337.0	0.31	49.8	2749.0	0.37	71.9
35	439.0	0.25	31.8	855.5	0.30	44.9	1457.0	0.34	59.1	2994.0	0.41	85.3
40	473.3	0.27	36.9	921.9	0.32	52.2	1570.0	0.37	68.6	3224.0	0.44	98.9
45	505.7	0.29	42.1	984.6	0.34	59.5	1676.0	0.39	78.2	3440.0	0.47	112.6
50	536.6	0.30	47.4	1044.2	0.36	66.9	1777.0	0.41	87.9	3646.0	0.50	126.5
55	566.0	0.32	52.8	1101.1	0.38	74.4	1873.0	0.44	97.7	3842.0	0.52	140.5
60	594.3	0.34	58.2	1155.7	0.40	82.0	1966.0	0.46	107.5	4031.0	0.55	154.6
65	621.5	0.35	63.7	1208.3	0.42	89.6	2055.0	0.48	117.5	4212.0	0.57	168.8
70	647.8	0.37	69.2	1259.0	0.43	97.3	2141.0	0.50	127.5	4387.0	0.60	183.1
75	673.3	0.38	74.7	1308.2	0.45	105.1	2224.0	0.52	137.6	4556.0	0.62	197.5
80	698.0	0.39	80.3	1355.8	0.47	112.8	2304.0	0.54	147.7	4720.0	0.64	211.9
85	722.0	0.41	85.9	1402.1	0.48	120.7	2382.0	0.55	157.9	4879.0	0.66	226.5
90	745.3	0.42	91.5	1447.1	0.50	128.6	2459.0	0.57	168.2	5034.0	0.68	241.1
95	768.1	0.43	97.2	1491.0	0.51	136.5	2533.0	0.59	178.5	5185.0	0.71	255.8
100	790.3	0.45	102.9	1533.9	0.53	144.4	2605.0	0.61	188.9	5332.0	0.73	270.5
110	833.3	0.47	114.4	1616.7	0.56	160.5	2745.0	0.64	209.7	5616.0	0.76	300.1
120	874.5	0.49	126.0	1696.1	0.59	176.6	2879.0	0.67	230.7	5889.0	0.80	330.0
130	914.1	0.52	137.7	1772.5	0.61	192.9	3008.0	0.70	251.8	6151.0	0.84	360.0
140	952.4	0.54	149.5	1846.2	0.64	209.3	3133.0	0.73	273.1	6404.0	0.87	390.2
150	989.4	0.56	161.3	1917.5	0.66	225.7	3253.0	0.76	294.5	6648.0	0.90	420.6
160	1025.4	0.58	173.3	1986.7	0.69	242.3	3370.0	0.78	316.0	6885.0	0.94	451.1
170	1060.2	0.60	185.2	2053.8	0.71	259.0	3483.0	0.81	337.6	7115.0	0.97	481.7
180	1094.2	0.62	197.3	2119.1	0.73	275.7	3594.0	0.84	359.3	7339.0	1.00	512.5
190	1127.3	0.64	209.4	2182.8	0.75	292.5	3701.0	0.86	381.1	7557.0	1.03	543.4
200	1159.5	0.66	221.6	2244.9	0.78	309.4	3806.0	0.89	403.0	7770.0	1.06	574.4
220	1221.9	0.69	246.1	2364.9	0.82	343.3	4008.0	0.93	447.0	8180.0	1.11	636.7
240	1281.7	0.73	270.7	2479.9	0.86	377.5	4202.0	0.98	491.3	8573.0	1.17	699.4
260	1339.2	0.76	295.6	2590.4	0.89	411.9	4388.0	1.02	535.9	8951.0	1.22	762.4
280	1394.7	0.79	320.6	2697.0	0.93	446.5	4568.0	1.06	580.6	9315.0	1.27	825.7
300	1448.4	0.82	345.7	2800.1	0.97	481.3	4742.0	1.10	625.7	9668.0	1.31	889.3
350	1575.6	0.89	409.1	3044.5	1.05	569.0	5154.0	1.20	739.0	10502.0	1.43	1049.4
400	1694.6	0.96	473.2	3272.8	1.13	657.6	5538.0	1.29	853.4	11280.0	1.53	1210.8
450	1806.7	1.02	537.9	3487.9	1.20	746.9	5900.0	1.37	968.8	12014.0	1.63	1373.3
500	1913.0	1.08	603.1	3692.0	1.28	836.8	6244.0	1.45	1084.8	12709.0	1.73	1536.8
550	2014.5	1.14	668.7	3886.5	1.34	927.3	6571.0	1.53	1201.6	13371.0	1.82	1701.2
600	2111.6	1.19	734.8	4072.8	1.41	1018.3	6885.0	1.60	1319.0	14005.0	1.90	1866.3
650	2205.0	1.25	801.2	4251.8	1.47	1109.8	7186.0	1.67	1436.9	14614.0	1.99	2032.1
700	2295.0	1.30	868.0	4424.3	1.53	1201.7	7476.0	1.74	1555.3	15201.0	2.07	2198.6
750	2382.0	1.35	935.0	4591.0	1.59	1293.9	7757.0	1.80	1674.1	15767.0	2.14	2365.5
800	2466.3	1.40	1002.3	4752.4	1.64	1386.5	8028.0	1.87	1793.3	16316.0	2.22	2533.0
850	2548.1	1.44	1069.9	4909.1	1.70	1479.4	8292.0	1.93	1913.0	16848.0	2.29	2701.0
900	2627.6	1.49	1137.8	5061.3	1.75	1572.6	8548.0	1.99	2023.9	17366.0	2.36	2869.4
950	2705.0	1.53	1205.8	5209.6	1.80	1666.1	8797.0	2.05	2153.2	17869.0	2.43	3038.2
1000	2780.5	1.57	1274.1	5354.2	1.85	1759.9	9040.0	2.10	2273.9	18360.0	2.50	3207.4
1100	2926.3	1.66	1411.1	5633.2	1.95	1948.1	9509.0	2.21	2515.9	19307.0	2.63	3546.8
1200	3065.8	1.73	1548.9	5900.2	2.04	2137.1	9958.0	2.32	2758.9	20213.0	2.75	3887.5
1300	3199.8	1.81	1687.3	6156.6	2.13	2326.9	10388.0	2.42	3002.9	21083.0	2.87	4229.2
1400	3329.0	1.88	1826.3	6403.7	2.21	2517.5	10804.0	2.51	3247.6	21920.0	2.98	4572.0
1500	3453.8	1.95	1965.7	6642.4	2.29	2708.6	11204.0	2.61	3493.1	22729.0	3.09	4915.7
1600	3574.6	2.02	2105.7	6873.4	2.37	2900.3	11592.0	2.70	3739.3	23512.0	3.20	5260.2
1700	3691.8	2.09	2246.0	7097.5	2.45	3092.5	11969.0	2.78	3986.1	24272.0	3.30	5605.5
1800	3805.7	2.15	2386.8	7315.3	2.53	3285.2	12335.0	2.87	4233.4	25009.0	3.40	5951.4
1900	3916.6	2.22	2527.9	7527.3	2.60	3478.4	12691.0	2.95	4481.3	25727.0	3.50	6298.0
2000	4024.7	2.28	2669.4	7733.9	2.67	3672.0	13038.0	3.03	4729.6	26427.0	3.59	6645.3
2100	4130.2	2.34	2811.2	7935.6	2.74	3866.0	13376.0	3.11	4978.5	27110.0	3.69	6993.0
2200	4233.3	2.40	2953.3	8132.6	2.81	4060.3	13707.0	3.19	5227.7	27777.0	3.78	7341.3
2300	4334.2	2.45	3095.6	8325.3	2.88	4255.0	14030.0	3.26	5477.4	28429.0	3.87	7690.1
2400	4432.9	2.51	3238.3	8514.0	2.94	4450.0	14347.0	3.34	5727.4	29067.0	3.95	8039.4
2500	4529.7	2.56	3381.2	8698.8	3.00	4645.3	14657.0	3.41	5977.8	29693.0	4.04	8389.1

66.7-108 mm

d [mm]	66.7			76.1			88.9			108		
di [mm]	63.7			72.1			84.9			104		
Δp [Pa/m]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]	m [kg/h]	v [m/s]	p_{dyn} [Pa]
25	4514.0	0.40	79.7	6514.0	0.43	95.6	10019.0	0.48	118.7	16669.0	0.55	152.9
30	4993.0	0.45	97.4	7201.0	0.48	116.9	11072.0	0.53	144.9	18414.0	0.60	186.6
35	5434.0	0.49	115.4	7837.0	0.52	138.5	12046.0	0.58	171.6	20028.0	0.65	220.7
40	5846.0	0.52	133.6	8432.0	0.56	160.3	12958.0	0.62	198.5	21537.0	0.70	255.2
45	6237.0	0.56	152.1	8994.0	0.60	182.4	13817.0	0.66	225.7	22960.0	0.75	290.1
50	6608.0	0.59	170.7	9527.0	0.63	204.6	14634.0	0.70	253.2	24311.0	0.79	325.2
55	6962.0	0.62	189.4	10036.0	0.66	227.1	15412.0	0.74	280.8	25599.0	0.84	360.6
60	7300.0	0.65	208.3	10524.0	0.70	249.7	16159.0	0.77	308.7	26833.0	0.88	396.2
65	7626.0	0.68	227.3	10993.0	0.73	272.4	16876.0	0.81	336.7	28020.0	0.92	432.0
70	7941.0	0.71	246.5	11445.0	0.76	295.3	17568.0	0.84	364.9	29164.0	0.95	468.0
75	8244.0	0.74	265.6	11882.0	0.79	318.3	18237.0	0.87	393.2	30270.0	0.99	504.2
80	8538.0	0.77	285.0	12306.0	0.81	341.4	18886.0	0.91	421.7	31342.0	1.02	540.5
85	8880.0	0.80	308.3	12718.0	0.84	364.6	19515.0	0.94	450.3	32383.0	1.06	577.0
90	9103.0	0.82	323.9	13118.0	0.87	388.0	20127.0	0.96	479.0	33394.0	1.09	613.6
95	9374.0	0.84	343.5	13508.0	0.89	411.4	20724.0	0.99	507.8	34380.0	1.12	650.4
100	9638.0	0.86	363.1	13889.0	0.92	434.9	21305.0	1.02	536.7	35341.0	1.16	687.3
110	10149.0	0.91	402.6	14624.0	0.97	482.1	22429.0	1.08	594.8	37197.0	1.22	761.3
120	10637.0	0.95	442.3	15328.0	1.01	529.7	23505.0	1.13	653.2	38974.0	1.27	835.8
130	11108.0	1.00	482.2	16005.0	1.06	577.5	24539.0	1.18	711.9	40682.0	1.33	910.7
140	11561.0	1.04	522.4	16657.0	1.10	625.5	25536.0	1.22	770.9	42328.0	1.38	985.9
150	11999.0	1.08	562.8	17288.0	1.14	673.8	26499.0	1.27	830.2	43919.0	1.44	1061.4
160	12424.0	1.11	603.3	17899.0	1.18	722.3	27433.0	1.31	889.7	45460.0	1.49	1137.1
170	12836.0	1.15	643.9	18492.0	1.22	770.9	28339.0	1.36	949.5	46955.0	1.54	1213.2
180	13236.0	1.19	684.8	19069.0	1.26	819.7	29219.0	1.40	1009.4	48408.0	1.58	1289.5
190	13627.0	1.22	725.8	19631.0	1.30	868.7	30077.0	1.44	1069.5	49824.0	1.63	1366.0
200	14007.0	1.26	766.9	20178.0	1.34	917.9	30913.0	1.48	1129.8	51204.0	1.67	1442.7
220	14741.0	1.32	849.5	21236.0	1.41	1016.6	32528.0	1.56	1250.9	53867.0	1.76	1596.7
240	15445.0	1.39	932.4	22248.0	1.47	1115.9	34073.0	1.63	1372.6	56417.0	1.84	1751.4
260	16120.0	1.45	1015.8	23221.0	1.54	1215.6	35558.0	1.70	1494.9	58865.0	1.92	1906.7
280	16772.0	1.50	1099.6	24158.0	1.60	1315.7	36989.0	1.77	1617.6	61225.0	2.00	2062.6
300	17401.0	1.56	1183.6	25064.0	1.66	1416.2	38371.0	1.84	1740.7	63504.0	2.08	2219.0
350	18891.0	1.69	1395.0	27209.0	1.80	1669.0	41644.0	2.00	2050.3	68899.0	2.25	2612.1
400	20283.0	1.82	1608.1	29211.0	1.93	1923.6	44697.0	2.14	2362.0	73931.0	2.42	3007.6
450	21592.0	1.94	1822.3	31095.0	2.06	2179.8	47570.0	2.28	2675.4	78666.0	2.57	3405.2
500	22833.0	2.05	2037.8	32880.0	2.18	2437.2	50292.0	2.41	2990.4	83151.0	2.72	3804.5
550	24015.0	2.15	2254.3	34581.0	2.29	2695.9	52885.0	2.53	3306.7	87422.0	2.86	4205.4
600	25145.0	2.26	2471.5	36208.0	2.40	2955.5	55366.0	2.65	3624.1	91508.0	2.99	4607.6
650	26232.0	2.35	2689.8	37770.0	2.50	3216.1	57747.0	2.77	3942.6	95430.0	3.12	5011.1
700	27278.0	2.45	2908.5	39275.0	2.60	3477.5	60041.0	2.88	4262.1	99207.0	3.24	5415.6
750	28287.0	2.54	3127.7	40729.0	2.70	3739.7	62256.0	2.98	4582.4	102854.0	3.36	5821.2
800	29267.0	2.63	3348.2	42136.0	2.79	4002.5	64400.0	3.09	4903.4	106384.0	3.48	6227.6
850	30215.0	2.71	3568.6	43500.0	2.88	4266.0	66480.0	3.19	5225.2	109808.0	3.59	6634.9
900	31138.0	2.79	3789.8	44827.0	2.97	4530.0	68500.0	3.28	5547.6	113134.0	3.70	7042.9
950	32035.0	2.87	4011.3	46117.0	3.05	4794.6	70466.0	3.38	5870.7	116370.0	3.81	7451.6
1000	32909.0	2.95	4233.4	47375.0	3.14	5059.7	72382.0	3.47	6194.3	119524.0	3.91	7861.0
1100	34596.0	3.10	4678.6	49801.0	3.30	5591.2	76079.0	3.65	6843.1	125607.0	4.11	8681.5
1200	36209.0	3.25	5125.1	52122.0	3.45	6124.4	79613.0	3.82	7493.7	131424.0	4.30	9504.2
1300	37759.0	3.39	5573.2	54349.0	3.60	6659.1	83006.0	3.98	8146.0	137007.0	4.48	10328.8
1400	39252.0	3.52	6022.6	56494.0	3.74	7195.1	86273.0	4.14	8799.8	142382.0	4.66	11155.1
1500	40692.0	3.65	6472.6	58565.0	3.88	7732.2	89427.0	4.29	9454.9	147571.0	4.83	11982.9
1600	42086.0	3.77	6923.3	60569.0	4.01	8270.5	92478.0	4.43	10111.3	152591.0	4.99	12812.2
1700	43438.0	3.90	7375.8	62513.0	4.14	8809.7	95438.0	4.57	10768.7	157459.0	5.15	13642.7
1800	44753.0	4.01	7828.6	64401.0	4.26	9349.9	98312.0	4.71	11427.2	162188.0	5.30	14474.4
1900	46030.0	4.13	8282.0	66238.0	4.38	9890.9	101109.0	4.85	12086.7	166788.0	5.45	15307.2
2000	47276.0	4.24	8736.6	68027.0	4.50	10432.7	103834.0	4.98	12747.0	171271.0	5.60	16141.0
2100	48492.0	4.35	9191.5	69774.0	4.62	10975.2	106493.0	5.10	13408.1	175643.0	5.74	16975.7
2200	49679.0	4.46	9646.7	71480.0	4.73	11518.4	109090.0	5.23	14070.0	179914.0	5.88	17811.3
2300	50840.0	4.56	10103.2	73148.0	4.84	12062.3	111629.0	5.35	14732.7	184090.0	6.02	18647.8
2400	51976.0	4.66	10559.8	74780.0	4.95	12606.7	114114.0	5.47	15396.0	188177.0	6.15	19484.9
2500	53090.0	4.76	11016.8	76380.0	5.06	13151.8	116549.0	5.59	16059.9	192181.0	6.28	20322.9

compressed air 3 bar, depending on the volume flow, 12-35 mm

temperature: 20°C
density: 3.612 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.01 mm

d [mm]	12		15		18		22		28		35	
di [mm]	9.6		12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	1.0	0.09	0.6	0.02	0.4	0.01	0.2	0.00	0.1	0.00	0.1	0.00
0.5	1.9	0.29	1.1	0.08	0.7	0.03	0.5	0.01	0.3	0.00	0.2	0.00
0.75	2.9	0.58	1.7	0.16	1.1	0.06	0.7	0.02	0.4	0.01	0.3	0.00
1	3.8	0.95	2.2	0.26	1.5	0.09	1.0	0.04	0.6	0.01	0.3	0.00
1.25	4.8	1.41	2.8	0.38	1.8	0.14	1.2	0.05	0.7	0.01	0.4	0.00
1.5	5.8	1.95	3.3	0.53	2.2	0.19	1.5	0.07	0.8	0.02	0.5	0.01
1.75	6.7	2.57	3.9	0.69	2.5	0.25	1.7	0.10	1.0	0.03	0.6	0.01
2	7.7	3.26	4.5	0.88	2.9	0.31	2.0	0.12	1.1	0.03	0.7	0.01
2.25	8.6	4.03	5.0	1.08	3.3	0.39	2.2	0.15	1.3	0.04	0.8	0.01
2.5	9.6	4.88	5.6	1.30	3.6	0.47	2.4	0.18	1.4	0.05	0.9	0.02
2.75	10.6	5.80	6.1	1.55	4.0	0.55	2.7	0.21	1.6	0.06	0.9	0.02
3	11.5	6.79	6.7	1.81	4.4	0.64	2.9	0.25	1.7	0.07	1.0	0.02
3.25			7.2	2.08	4.7	0.74	3.2	0.29	1.8	0.08	1.1	0.02
3.5			7.8	2.38	5.1	0.85	3.4	0.33	2.0	0.09	1.2	0.03
3.75			8.4	2.70	5.4	0.96	3.7	0.37	2.1	0.10	1.3	0.03
4			8.9	3.03	5.8	1.08	3.9	0.42	2.3	0.11	1.4	0.03
4.5			10.0	3.75	6.5	1.33	4.4	0.51	2.5	0.14	1.6	0.04
5			11.1	4.54	7.3	1.60	4.9	0.62	2.8	0.17	1.7	0.05
5.5					8.0	1.91	5.4	0.73	3.1	0.20	1.9	0.06
6					8.7	2.23	5.9	0.86	3.4	0.23	2.1	0.07
6.5					9.4	2.58	6.4	0.99	3.7	0.26	2.2	0.08
7					10.2	2.95	6.9	1.13	4.0	0.30	2.4	0.09
7.5					10.9	3.34	7.3	1.28	4.2	0.34	2.6	0.10
8							7.8	1.44	4.5	0.38	2.8	0.12
8.5							8.3	1.60	4.8	0.42	2.9	0.13
9							8.8	1.78	5.1	0.47	3.1	0.14
9.5							9.3	1.96	5.4	0.52	3.3	0.16
10							9.8	2.15	5.7	0.57	3.5	0.17
10.5							10.3	2.35	5.9	0.62	3.6	0.19
11							10.8	2.56	6.2	0.67	3.8	0.20
11.5									6.5	0.73	4.0	0.22
12									6.8	0.79	4.1	0.24
12.5									7.1	0.85	4.3	0.26
13									7.4	0.91	4.5	0.28
13.5									7.6	0.98	4.7	0.30
14									7.9	1.04	4.8	0.32
14.5									8.2	1.11	5.0	0.34
15									8.5	1.18	5.2	0.36
16									9.1	1.33	5.5	0.40
17									9.6	1.48	5.9	0.45
18									10.2	1.65	6.2	0.50
19									10.8	1.82	6.6	0.55
20									11.3	2.00	6.9	0.60
21											7.3	0.65
22											7.6	0.71
23											7.9	0.77
24											8.3	0.83
25											8.6	0.90
30											10.4	1.25

42-108 mm

d [mm]	42		54		66.7		76.1		88.9		108	
di [mm]	39		51		63.7		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.00	0.0	0.00								
0.5	0.1	0.00	0.1	0.00								
0.75	0.2	0.00	0.1	0.00								
1	0.2	0.00	0.1	0.00								
1.25	0.3	0.00	0.2	0.00								
1.5	0.3	0.00	0.2	0.00								
1.75	0.4	0.00	0.2	0.00								
2	0.5	0.00	0.3	0.00								
2.25	0.5	0.00	0.3	0.00								
2.5	0.6	0.01	0.3	0.00								
2.75	0.6	0.01	0.4	0.00								
3	0.7	0.01	0.4	0.00								
3.25	0.8	0.01	0.4	0.00								
3.5	0.8	0.01	0.5	0.00								
3.75	0.9	0.01	0.5	0.00								
4	0.9	0.01	0.5	0.00								
4.5	1.0	0.02	0.6	0.00	0.4	0.00						
5	1.2	0.02	0.7	0.01	0.4	0.00						
5.5	1.3	0.02	0.7	0.01	0.5	0.00						
6	1.4	0.03	0.8	0.01	0.5	0.00						
6.5	1.5	0.03	0.9	0.01	0.6	0.00						
7	1.6	0.04	1.0	0.01	0.6	0.00						
7.5	1.7	0.04	1.0	0.01	0.7	0.00						
8	1.9	0.05	1.1	0.01	0.7	0.00						
8.5	2.0	0.05	1.2	0.01	0.7	0.01						
9	2.1	0.06	1.2	0.02	0.8	0.01						
9.5	2.2	0.06	1.3	0.02	0.8	0.01						
10	2.3	0.07	1.4	0.02	0.9	0.01	0.7	0.00	0.5	0.00	0.3	0.00
10.5	2.4	0.07	1.4	0.02	0.9	0.01	0.7	0.00	0.5	0.00	0.3	0.00
11	2.6	0.08	1.5	0.02	1.0	0.01	0.7	0.00	0.5	0.00	0.4	0.00
11.5	2.7	0.09	1.6	0.02	1.0	0.01	0.8	0.00	0.6	0.00	0.4	0.00
12	2.8	0.09	1.6	0.03	1.0	0.01	0.8	0.00	0.6	0.00	0.4	0.00
12.5	2.9	0.10	1.7	0.03	1.1	0.01	0.8	0.00	0.6	0.00	0.4	0.00
13	3.0	0.11	1.8	0.03	1.1	0.01	0.9	0.01	0.6	0.00	0.4	0.00
13.5	3.1	0.11	1.8	0.03	1.2	0.01	0.9	0.01	0.6	0.00	0.4	0.00
14	3.3	0.12	1.9	0.03	1.2	0.01	0.9	0.01	0.7	0.00	0.5	0.00
14.5	3.4	0.13	2.0	0.04	1.3	0.01	1.0	0.01	0.7	0.00	0.5	0.00
15	3.5	0.14	2.0	0.04	1.3	0.01	1.0	0.01	0.7	0.00	0.5	0.00
16	3.7	0.15	2.2	0.04	1.4	0.02	1.1	0.01	0.8	0.00	0.5	0.00
17	4.0	0.17	2.3	0.05	1.5	0.02	1.1	0.01	0.8	0.00	0.6	0.00
18	4.2	0.19	2.4	0.05	1.6	0.02	1.2	0.01	0.9	0.00	0.6	0.00
19	4.4	0.21	2.6	0.06	1.7	0.02	1.3	0.01	0.9	0.00	0.6	0.00
20	4.7	0.23	2.7	0.06	1.7	0.02	1.3	0.01	1.0	0.01	0.7	0.00
21	4.9	0.25	2.9	0.07	1.8	0.02	1.4	0.01	1.0	0.01	0.7	0.00
22	5.1	0.27	3.0	0.07	1.9	0.03	1.5	0.01	1.1	0.01	0.7	0.00
23	5.3	0.30	3.1	0.08	2.0	0.03	1.5	0.01	1.1	0.01	0.8	0.00
24	5.6	0.32	3.3	0.09	2.1	0.03	1.6	0.02	1.2	0.01	0.8	0.00
25	5.8	0.34	3.4	0.09	2.2	0.03	1.7	0.02	1.2	0.01	0.8	0.00
30	7.0	0.48	4.1	0.13	2.6	0.05	2.0	0.02	1.4	0.01	1.0	0.00
35	8.1	0.63	4.8	0.17	3.1	0.06	2.3	0.03	1.7	0.01	1.1	0.01
40	9.3	0.81	5.4	0.22	3.5	0.07	2.6	0.04	1.9	0.02	1.3	0.01
45	10.5	1.00	6.1	0.27	3.9	0.09	3.0	0.05	2.2	0.02	1.5	0.01
50			6.8	0.33	4.4	0.11	3.3	0.06	2.4	0.03	1.6	0.01
55			7.5	0.39	4.8	0.13	3.6	0.07	2.6	0.03	1.8	0.01
60			8.2	0.46	5.2	0.16	4.0	0.08	2.9	0.04	2.0	0.01
65			8.8	0.53	5.7	0.18	4.3	0.09	3.1	0.04	2.1	0.02
70			9.5	0.61	6.1	0.21	4.6	0.11	3.4	0.05	2.3	0.02
75			10.2	0.69	6.5	0.23	5.0	0.12	3.6	0.05	2.5	0.02
80			10.9	0.77	7.0	0.26	5.3	0.13	3.8	0.06	2.6	0.02
85					7.4	0.29	5.6	0.15	4.1	0.07	2.8	0.03
90					7.8	0.33	6.0	0.17	4.3	0.08	2.9	0.03
95					8.3	0.36	6.3	0.18	4.6	0.08	3.1	0.03
100					8.7	0.39	6.6	0.20	4.8	0.09	3.3	0.04
105					9.2	0.43	6.9	0.22	5.0	0.10	3.4	0.04
110					9.6	0.47	7.3	0.24	5.3	0.11	3.6	0.04

42-108 mm

d [mm]	42		54		66.7		76.1		88.9		108	
di [mm]	39		51		63.7		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
115					10.0	0.51	7.6	0.26	5.5	0.12	3.8	0.05
120					10.5	0.55	7.9	0.28	5.8	0.13	3.9	0.05
125							8.3	0.30	6.0	0.14	4.1	0.05
130							8.6	0.33	6.2	0.15	4.3	0.06
135							8.9	0.35	6.5	0.16	4.4	0.06
140							9.3	0.37	6.7	0.17	4.6	0.07
145							9.6	0.40	7.0	0.18	4.7	0.07
150							9.9	0.42	7.2	0.19	4.9	0.08
160							10.6	0.48	7.7	0.22	5.2	0.09
170									8.1	0.24	5.6	0.10
180									8.6	0.27	5.9	0.11
190									9.1	0.30	6.2	0.12
200									9.6	0.33	6.5	0.13
210									10.1	0.36	6.9	0.14
220									10.5	0.39	7.2	0.15
230											7.5	0.17
240											7.8	0.18
250											8.2	0.19
300											9.8	0.27
315											10.3	0.30
325											10.6	0.31

compressed air 6 bar, depending on the volume flow, 12-35 mm

temperature: 20°C
density: 7.224 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.01 mm

d [mm]	12		15		18		22		28		35	
di [mm]	9.6		12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	1.0	0.14	0.6	0.04	0.4	0.01	0.2	0.01	0.1	0.00	0.1	0.00
0.5	1.9	0.48	1.1	0.13	0.7	0.05	0.5	0.02	0.3	0.01	0.2	0.00
0.75	2.9	0.98	1.7	0.26	1.1	0.10	0.7	0.04	0.4	0.01	0.3	0.00
1	3.8	1.63	2.2	0.44	1.5	0.16	1.0	0.06	0.6	0.02	0.3	0.01
1.25	4.8	2.44	2.8	0.65	1.8	0.23	1.2	0.09	0.7	0.02	0.4	0.01
1.5	5.8	3.39	3.3	0.90	2.2	0.32	1.5	0.12	0.8	0.03	0.5	0.01
1.75	6.7	4.50	3.9	1.19	2.5	0.42	1.7	0.16	1.0	0.04	0.6	0.01
2	7.7	5.74	4.5	1.52	2.9	0.54	2.0	0.21	1.1	0.06	0.7	0.02
2.25	8.6	7.13	5.0	1.88	3.3	0.66	2.2	0.26	1.3	0.07	0.8	0.02
2.5	9.6	8.66	5.6	2.27	3.6	0.80	2.4	0.31	1.4	0.08	0.9	0.03
2.75	10.6	10.33	6.1	2.70	4.0	0.95	2.7	0.37	1.6	0.10	0.9	0.03
3	11.5	12.15	6.7	3.17	4.4	1.11	2.9	0.43	1.7	0.11	1.0	0.03
3.25			7.2	3.67	4.7	1.29	3.2	0.49	1.8	0.13	1.1	0.04
3.5			7.8	4.20	5.1	1.47	3.4	0.56	2.0	0.15	1.2	0.05
3.75			8.4	4.77	5.4	1.67	3.7	0.64	2.1	0.17	1.3	0.05
4			8.9	5.38	5.8	1.88	3.9	0.72	2.3	0.19	1.4	0.06
4.5			10.0	6.69	6.5	2.33	4.4	0.89	2.5	0.24	1.6	0.07
5			11.1	8.13	7.3	2.83	4.9	1.08	2.8	0.28	1.7	0.09
5.5					8.0	3.37	5.4	1.28	3.1	0.34	1.9	0.10
6					8.7	3.96	5.9	1.50	3.4	0.39	2.1	0.12
6.5					9.4	4.59	6.4	1.74	3.7	0.46	2.2	0.14
7					10.2	5.27	6.9	1.99	4.0	0.52	2.4	0.16
7.5					10.9	5.99	7.3	2.26	4.2	0.59	2.6	0.18
8							7.8	2.55	4.5	0.66	2.8	0.20
8.5							8.3	2.85	4.8	0.74	2.9	0.22
9							8.8	3.17	5.1	0.82	3.1	0.25
9.5							9.3	3.50	5.4	0.91	3.3	0.27
10							9.8	3.85	5.7	1.00	3.5	0.30
10.5							10.3	4.22	5.9	1.09	3.6	0.33
11							10.8	4.60	6.2	1.19	3.8	0.36
11.5									6.5	1.29	4.0	0.39
12									6.8	1.39	4.1	0.42
12.5									7.1	1.50	4.3	0.45
13									7.4	1.62	4.5	0.48
13.5									7.6	1.73	4.7	0.52
14									7.9	1.85	4.8	0.55
14.5									8.2	1.98	5.0	0.59
15									8.5	2.11	5.2	0.63
16									9.1	2.37	5.5	0.71
17									9.6	2.66	5.9	0.79
18									10.2	2.95	6.2	0.88
19									10.8	3.27	6.6	0.97
20									11.3	3.59	6.9	1.06
21											7.3	1.16
22											7.6	1.27
23											7.9	1.38
24											8.3	1.49
25											8.6	1.61
30											10.4	2.25

42-108 mm

d [mm]	42		54		66.7		76.1		88.9		108	
di [mm]	39		51		63.7		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.00	0.0	0.00								
0.5	0.1	0.00	0.1	0.00								
0.75	0.2	0.00	0.1	0.00								
1	0.2	0.00	0.1	0.00								
1.25	0.3	0.00	0.2	0.00								
1.5	0.3	0.00	0.2	0.00								
1.75	0.4	0.01	0.2	0.00								
2	0.5	0.01	0.3	0.00								
2.25	0.5	0.01	0.3	0.00								
2.5	0.6	0.01	0.3	0.00								
2.75	0.6	0.01	0.4	0.00								
3	0.7	0.01	0.4	0.00								
3.25	0.8	0.02	0.4	0.00								
3.5	0.8	0.02	0.5	0.00								
3.75	0.9	0.02	0.5	0.01								
4	0.9	0.02	0.5	0.01								
4.5	1.0	0.03	0.6	0.01	0.4	0.00						
5	1.2	0.03	0.7	0.01	0.4	0.00						
5.5	1.3	0.04	0.7	0.01	0.5	0.00						
6	1.4	0.05	0.8	0.01	0.5	0.00						
6.5	1.5	0.05	0.9	0.01	0.6	0.01						
7	1.6	0.06	1.0	0.02	0.6	0.01						
7.5	1.7	0.07	1.0	0.02	0.7	0.01						
8	1.9	0.08	1.1	0.02	0.7	0.01						
8.5	2.0	0.09	1.2	0.02	0.7	0.01						
9	2.1	0.10	1.2	0.03	0.8	0.01						
9.5	2.2	0.10	1.3	0.03	0.8	0.01						
10	2.3	0.11	1.4	0.03	0.9	0.01	0.7	0.01	0.5	0.00	0.3	0.00
10.5	2.4	0.13	1.4	0.03	0.9	0.01	0.7	0.01	0.5	0.00	0.3	0.00
11	2.6	0.14	1.5	0.04	1.0	0.01	0.7	0.01	0.5	0.00	0.4	0.00
11.5	2.7	0.15	1.6	0.04	1.0	0.01	0.8	0.01	0.6	0.00	0.4	0.00
12	2.8	0.16	1.6	0.04	1.0	0.02	0.8	0.01	0.6	0.00	0.4	0.00
12.5	2.9	0.17	1.7	0.05	1.1	0.02	0.8	0.01	0.6	0.00	0.4	0.00
13	3.0	0.18	1.8	0.05	1.1	0.02	0.9	0.01	0.6	0.00	0.4	0.00
13.5	3.1	0.20	1.8	0.05	1.2	0.02	0.9	0.01	0.6	0.00	0.4	0.00
14	3.3	0.21	1.9	0.06	1.2	0.02	0.9	0.01	0.7	0.00	0.5	0.00
14.5	3.4	0.22	2.0	0.06	1.3	0.02	1.0	0.01	0.7	0.01	0.5	0.00
15	3.5	0.24	2.0	0.07	1.3	0.02	1.0	0.01	0.7	0.01	0.5	0.00
16	3.7	0.27	2.2	0.07	1.4	0.03	1.1	0.01	0.8	0.01	0.5	0.00
17	4.0	0.30	2.3	0.08	1.5	0.03	1.1	0.01	0.8	0.01	0.6	0.00
18	4.2	0.33	2.4	0.09	1.6	0.03	1.2	0.02	0.9	0.01	0.6	0.00
19	4.4	0.37	2.6	0.10	1.7	0.03	1.3	0.02	0.9	0.01	0.6	0.00
20	4.7	0.40	2.7	0.11	1.7	0.04	1.3	0.02	1.0	0.01	0.7	0.00
21	4.9	0.44	2.9	0.12	1.8	0.04	1.4	0.02	1.0	0.01	0.7	0.00
22	5.1	0.48	3.0	0.13	1.9	0.04	1.5	0.02	1.1	0.01	0.7	0.00
23	5.3	0.52	3.1	0.14	2.0	0.05	1.5	0.02	1.1	0.01	0.8	0.00
24	5.6	0.56	3.3	0.15	2.1	0.05	1.6	0.03	1.2	0.01	0.8	0.00
25	5.8	0.61	3.4	0.16	2.2	0.06	1.7	0.03	1.2	0.01	0.8	0.10
30	7.0	0.85	4.1	0.23	2.6	0.08	2.0	0.04	1.4	0.02	1.0	0.10
35	8.1	1.13	4.8	0.30	3.1	0.10	2.3	0.05	1.7	0.02	1.1	0.10
40	9.3	1.45	5.4	0.39	3.5	0.13	2.6	0.07	1.9	0.03	1.3	0.10
45	10.5	1.80	6.1	0.48	3.9	0.16	3.0	0.08	2.2	0.04	1.5	0.02
50			6.8	0.58	4.4	0.20	3.3	0.10	2.4	0.05	1.6	0.02
55			7.5	0.70	4.8	0.23	3.6	0.12	2.6	0.05	1.8	0.02
60			8.2	0.82	5.2	0.28	4.0	0.14	2.9	0.06	2.0	0.03
65			8.8	0.95	5.7	0.32	4.3	0.16	3.1	0.07	2.1	0.03
70			9.5	1.09	6.1	0.37	4.6	0.19	3.4	0.08	2.3	0.03
75			10.2	1.24	6.5	0.42	5.0	0.21	3.6	0.10	2.5	0.04
80			10.9	1.40	7.0	0.47	5.3	0.24	3.8	0.11	2.6	0.04
85					7.4	0.52	5.6	0.27	4.1	0.12	2.8	0.05
90					7.8	0.58	6.0	0.30	4.3	0.13	2.9	0.05
95					8.3	0.65	6.3	0.33	4.6	0.15	3.1	0.06
100					8.7	0.71	6.6	0.36	4.8	0.16	3.3	0.06
105					9.2	0.78	6.9	0.39	5.0	0.18	3.4	0.07
110					9.6	0.85	7.3	0.43	5.3	0.19	3.6	0.08

42-108 mm

d [mm]	42		54		66.7		76.1		88.9		108	
di [mm]	39		51		63.7		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
115					10.0	0.92	7.6	0.47	5.5	0.21	3.8	0.08
120					10.5	1.00	7.9	0.50	5.8	0.23	3.9	0.09
125							8.3	0.54	6.0	0.25	4.1	0.10
130							8.6	0.59	6.2	0.26	4.3	0.10
135							8.9	0.63	6.5	0.28	4.4	0.11
140							9.3	0.67	6.7	0.30	4.6	0.12
145							9.6	0.72	7.0	0.32	4.7	0.13
150							9.9	0.76	7.2	0.35	4.9	0.14
160							10.6	0.86	7.7	0.39	5.2	0.15
170									8.1	0.44	5.6	0.17
180									8.6	0.48	5.9	0.19
190									9.1	0.54	6.2	0.21
200									9.6	0.59	6.5	0.23
210									10.1	0.65	6.9	0.25
220									10.5	0.71	7.2	0.27
230											7.5	0.30
240											7.8	0.32
250											8.2	0.35
300											9.8	0.49
315											10.3	0.54
325											10.6	0.57

compressed air 9 bar, depending on the volume flow, 12-35 mm

temperature: 20°C
density: 10.836 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.01 mm

d [mm]	12		15		18		22		28		35	
di [mm]	9.6		12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	1.0	0.19	0.6	0.05	0.4	0.02	0.2	0.01	0.1	0.00	0.1	0.00
0.5	1.9	0.65	1.1	0.18	0.7	0.06	0.5	0.02	0.3	0.01	0.2	0.00
0.75	2.9	1.34	1.7	0.36	1.1	0.13	0.7	0.05	0.4	0.01	0.3	0.00
1	3.8	2.26	2.2	0.60	1.5	0.21	1.0	0.08	0.6	0.02	0.3	0.01
1.25	4.8	3.40	2.8	0.90	1.8	0.32	1.2	0.12	0.7	0.03	0.4	0.01
1.5	5.8	4.75	3.3	1.25	2.2	0.44	1.5	0.17	0.8	0.05	0.5	0.01
1.75	6.7	6.32	3.9	1.65	2.5	0.58	1.7	0.22	1.0	0.06	0.6	0.02
2	7.7	8.10	4.5	2.11	2.9	0.74	2.0	0.29	1.1	0.08	0.7	0.02
2.25	8.6	10.09	5.0	2.62	3.3	0.92	2.2	0.35	1.3	0.09	0.8	0.03
2.5	9.6	12.28	5.6	3.18	3.6	1.11	2.4	0.43	1.4	0.11	0.9	0.03
2.75	10.6	14.69	6.1	3.79	4.0	1.33	2.7	0.51	1.6	0.13	0.9	0.04
3	11.5	17.31	6.7	4.46	4.4	1.56	2.9	0.59	1.7	0.16	1.0	0.05
3.25			7.2	5.17	4.7	1.80	3.2	0.69	1.8	0.18	1.1	0.06
3.5			7.8	5.94	5.1	2.06	3.4	0.78	2.0	0.21	1.2	0.06
3.75			8.4	6.75	5.4	2.34	3.7	0.89	2.1	0.23	1.3	0.07
4			8.9	7.62	5.8	2.64	3.9	1.00	2.3	0.26	1.4	0.08
4.5			10.0	9.51	6.5	3.28	4.4	1.24	2.5	0.33	1.6	0.10
5			11.1	11.59	7.3	3.99	4.9	1.51	2.8	0.39	1.7	0.12
5.5					8.0	4.77	5.4	1.80	3.1	0.47	1.9	0.14
6					8.7	5.62	5.9	2.11	3.4	0.55	2.1	0.17
6.5					9.4	6.52	6.4	2.45	3.7	0.64	2.2	0.19
7					10.2	7.50	6.9	2.81	4.0	0.73	2.4	0.22
7.5					10.9	8.54	7.3	3.20	4.2	0.83	2.6	0.25
8							7.8	3.61	4.5	0.93	2.8	0.28
8.5							8.3	4.04	4.8	1.04	2.9	0.31
9							8.8	4.49	5.1	1.15	3.1	0.34
9.5							9.3	4.97	5.4	1.28	3.3	0.38
10							9.8	5.48	5.7	1.40	3.5	0.42
10.5							10.3	6.01	5.9	1.54	3.6	0.46
11							10.8	6.56	6.2	1.67	3.8	0.50
11.5									6.5	1.82	4.0	0.54
12									6.8	1.97	4.1	0.58
12.5									7.1	2.12	4.3	0.63
13									7.4	2.29	4.5	0.68
13.5									7.6	2.45	4.7	0.72
14									7.9	2.63	4.8	0.78
14.5									8.2	2.80	5.0	0.83
15									8.5	2.99	5.2	0.88
16									9.1	3.37	5.5	0.99
17									9.6	3.78	5.9	1.11
18									10.2	4.21	6.2	1.23
19									10.8	4.66	6.6	1.37
20									11.3	5.14	6.9	1.50
21											7.3	1.65
22											7.6	1.80
23											7.9	1.95
24											8.3	2.11
25											8.6	2.28
30											10.4	3.22

42-108 mm

d [mm]	42		54		66.7		76.1		88.9		108	
di [mm]	39		51		63.7		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.00	0.0	0.00								
0.5	0.1	0.00	0.1	0.00								
0.75	0.2	0.00	0.1	0.00								
1	0.2	0.00	0.1	0.00								
1.25	0.3	0.00	0.2	0.00								
1.5	0.3	0.01	0.2	0.00								
1.75	0.4	0.01	0.2	0.00								
2	0.5	0.01	0.3	0.00								
2.25	0.5	0.01	0.3	0.00								
2.5	0.6	0.01	0.3	0.00								
2.75	0.6	0.02	0.4	0.00								
3	0.7	0.02	0.4	0.01								
3.25	0.8	0.02	0.4	0.01								
3.5	0.8	0.02	0.5	0.01								
3.75	0.9	0.03	0.5	0.01								
4	0.9	0.03	0.5	0.01								
4.5	1.0	0.04	0.6	0.01	0.4	0.00						
5	1.2	0.05	0.7	0.01	0.4	0.00						
5.5	1.3	0.06	0.7	0.01	0.5	0.01						
6	1.4	0.07	0.8	0.02	0.5	0.01						
6.5	1.5	0.08	0.9	0.02	0.6	0.01						
7	1.6	0.09	1.0	0.02	0.6	0.01						
7.5	1.7	0.11	1.0	0.03	0.7	0.01						
8	1.9	0.12	1.1	0.03	0.7	0.01						
8.5	2.0	0.13	1.2	0.03	0.7	0.01						
9	2.1	0.15	1.2	0.04	0.8	0.01						
9.5	2.2	0.16	1.3	0.04	0.8	0.01						
10	2.3	0.16	1.4	0.04	0.9	0.02	0.7	0.01	0.5	0.00	0.3	0.00
10.5	2.4	0.17	1.4	0.05	0.9	0.02	0.7	0.01	0.5	0.00	0.3	0.00
11	2.6	0.19	1.5	0.05	1.0	0.02	0.7	0.01	0.5	0.00	0.4	0.00
11.5	2.7	0.21	1.6	0.06	1.0	0.02	0.8	0.01	0.6	0.00	0.4	0.00
12	2.8	0.22	1.6	0.06	1.0	0.02	0.8	0.01	0.6	0.00	0.4	0.00
12.5	2.9	0.24	1.7	0.07	1.1	0.02	0.8	0.01	0.6	0.01	0.4	0.00
13	3.0	0.26	1.8	0.07	1.1	0.02	0.9	0.01	0.6	0.01	0.4	0.00
13.5	3.1	0.28	1.8	0.07	1.2	0.03	0.9	0.01	0.6	0.01	0.4	0.00
14	3.3	0.29	1.9	0.08	1.2	0.03	0.9	0.01	0.7	0.01	0.5	0.00
14.5	3.4	0.31	2.0	0.09	1.3	0.03	1.0	0.01	0.7	0.01	0.5	0.00
15	3.5	0.33	2.0	0.09	1.3	0.03	1.0	0.02	0.7	0.01	0.5	0.00
16	3.7	0.38	2.2	0.10	1.4	0.04	1.1	0.02	0.8	0.01	0.5	0.00
17	4.0	0.42	2.3	0.11	1.5	0.04	1.1	0.02	0.8	0.01	0.6	0.00
18	4.2	0.47	2.4	0.13	1.6	0.04	1.2	0.02	0.9	0.01	0.6	0.00
19	4.4	0.52	2.6	0.14	1.7	0.05	1.3	0.02	0.9	0.01	0.6	0.00
20	4.7	0.57	2.7	0.15	1.7	0.05	1.3	0.03	1.0	0.01	0.7	0.00
21	4.9	0.62	2.9	0.17	1.8	0.06	1.4	0.03	1.0	0.01	0.7	0.01
22	5.1	0.68	3.0	0.18	1.9	0.06	1.5	0.03	1.1	0.01	0.7	0.01
23	5.3	0.73	3.1	0.20	2.0	0.07	1.5	0.03	1.1	0.02	0.8	0.01
24	5.6	0.79	3.3	0.21	2.1	0.07	1.6	0.04	1.2	0.02	0.8	0.01
25	5.8	0.86	3.4	0.23	2.2	0.08	1.7	0.04	1.2	0.02	0.8	0.01
30	7.0	1.20	4.1	0.32	2.6	0.11	2.0	0.06	1.4	0.03	1.0	0.01
35	8.1	1.60	4.8	0.43	3.1	0.14	2.3	0.07	1.7	0.03	1.1	0.01
40	9.3	2.06	5.4	0.55	3.5	0.18	2.6	0.09	1.9	0.04	1.3	0.02
45	10.5	2.58	6.1	0.68	3.9	0.23	3.0	0.12	2.2	0.05	1.5	0.02
50			6.8	0.83	4.4	0.28	3.3	0.14	2.4	0.06	1.6	0.03
55			7.5	0.99	4.8	0.33	3.6	0.17	2.6	0.08	1.8	0.03
60			8.2	1.16	5.2	0.39	4.0	0.20	2.9	0.09	2.0	0.04
65			8.8	1.35	5.7	0.45	4.3	0.23	3.1	0.10	2.1	0.04
70			9.5	1.56	6.1	0.52	4.6	0.26	3.4	0.12	2.3	0.05
75			10.2	1.77	6.5	0.59	5.0	0.30	3.6	0.14	2.5	0.05
80			10.9	2.00	7.0	0.67	5.3	0.34	3.8	0.15	2.6	0.06
85					7.4	0.75	5.6	0.38	4.1	0.17	2.8	0.07
90					7.8	0.83	6.0	0.42	4.3	0.19	2.9	0.07
95					8.3	0.92	6.3	0.46	4.6	0.21	3.1	0.08
100					8.7	1.01	6.6	0.51	4.8	0.23	3.3	0.09
105					9.2	1.11	6.9	0.56	5.0	0.25	3.4	0.10

42-108 mm

d [mm]	42		54		66.7		76.1		88.9		108	
di [mm]	39		51		63.7		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
110					9.6	1.21	7.3	0.61	5.3	0.27	3.6	0.11
115					10.0	1.32	7.6	0.66	5.5	0.30	3.8	0.12
120					10.5	1.43	7.9	0.72	5.8	0.32	3.9	0.13
125							8.3	0.77	6.0	0.35	4.1	0.14
130							8.6	0.83	6.2	0.38	4.3	0.15
135							8.9	0.90	6.5	0.40	4.4	0.16
140							9.3	0.96	6.7	0.43	4.6	0.17
145							9.6	1.02	7.0	0.46	4.7	0.18
150							9.9	1.09	7.2	0.49	4.9	0.19
160							10.6	1.23	7.7	0.55	5.2	0.22
170									8.1	0.62	5.6	0.24
180									8.6	0.69	5.9	0.27
190									9.1	0.76	6.2	0.30
200									9.6	0.84	6.5	0.33
210									10.1	0.92	6.9	0.36
220									10.5	1.01	7.2	0.39
230											7.5	0.42
240											7.8	0.46
250											8.2	0.50
300											9.8	0.70
315											10.3	0.77
325											10.6	0.84

compressed air 12 bar, depending on the volume flow, 12-35 mm

temperature: 20°C
density: 14.448 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.01 mm

d [mm]	12		15		18		22		28		35	
di [mm]	9.6		12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	1.0	0.24	0.6	0.07	0.4	0.02	0.2	0.01	0.1	0.00	0.1	0.00
0.5	1.9	0.82	1.1	0.22	0.7	0.08	0.5	0.03	0.3	0.01	0.2	0.00
0.75	2.9	1.70	1.7	0.45	1.1	0.16	0.7	0.06	0.4	0.02	0.3	0.01
1	3.8	2.87	2.2	0.76	1.5	0.27	1.0	0.10	0.6	0.03	0.3	0.01
1.25	4.8	4.33	2.8	1.14	1.8	0.40	1.2	0.15	0.7	0.04	0.4	0.01
1.5	5.8	6.07	3.3	1.58	2.2	0.56	1.5	0.21	0.8	0.06	0.5	0.02
1.75	6.7	8.10	3.9	2.10	2.5	0.74	1.7	0.28	1.0	0.08	0.6	0.02
2	7.7	10.40	4.5	2.69	2.9	0.94	2.0	0.36	1.1	0.10	0.7	0.03
2.25	8.6	12.98	5.0	3.34	3.3	1.17	2.2	0.44	1.3	0.12	0.8	0.04
2.5	9.6	15.84	5.6	4.07	3.6	1.42	2.4	0.54	1.4	0.14	0.9	0.04
2.75	10.6	18.98	6.1	4.86	4.0	1.69	2.7	0.64	1.6	0.17	0.9	0.05
3	11.5	22.39	6.7	5.72	4.4	1.98	2.9	0.75	1.7	0.20	1.0	0.06
3.25			7.2	6.64	4.7	2.30	3.2	0.87	1.8	0.23	1.1	0.07
3.5			7.8	7.63	5.1	2.64	3.4	1.00	2.0	0.26	1.2	0.08
3.75			8.4	8.69	5.4	3.00	3.7	1.13	2.1	0.30	1.3	0.09
4			8.9	9.82	5.8	3.38	3.9	1.27	2.3	0.33	1.4	0.10
4.5			10.0	12.27	6.5	4.21	4.4	1.58	2.5	0.41	1.6	0.12
5			11.1	14.99	7.3	5.13	4.9	1.93	2.8	0.50	1.7	0.15
5.5					8.0	6.14	5.4	2.30	3.1	0.59	1.9	0.18
6					8.7	7.24	5.9	2.70	3.4	0.70	2.1	0.21
6.5					9.4	8.42	6.4	3.14	3.7	0.81	2.2	0.24
7					10.2	9.69	6.9	3.61	4.0	0.93	2.4	0.28
7.5					10.9	11.05	7.3	4.11	4.2	1.05	2.6	0.31
8							7.8	4.64	4.5	1.19	2.8	0.35
8.5							8.3	5.20	4.8	1.33	2.9	0.39
9							8.8	5.80	5.1	1.48	3.1	0.44
9.5							9.3	6.42	5.4	1.63	3.3	0.48
10							9.8	7.08	5.7	1.80	3.5	0.53
10.5							10.3	7.76	5.9	1.97	3.6	0.58
11							10.8	8.48	6.2	2.15	3.8	0.63
11.5									6.5	2.33	4.0	0.69
12									6.8	2.53	4.1	0.74
12.5									7.1	2.73	4.3	0.80
13									7.4	2.94	4.5	0.86
13.5									7.6	3.16	4.7	0.93
14									7.9	3.38	4.8	0.99
14.5									8.2	3.61	5.0	1.06
15									8.5	3.85	5.2	1.13
16									9.1	4.35	5.5	1.27
17									9.6	4.88	5.9	1.42
18									10.2	5.44	6.2	1.58
19									10.8	6.03	6.6	1.75
20											6.9	1.93
21											7.3	2.12
22											7.6	2.31
23											7.9	2.51
24											8.3	2.72
25											8.6	2.94
30											10.4	4.16

42-54 mm

d [mm]	42		54	
di [mm]	39		51	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.00	0.0	0.00
0.5	0.1	0.00	0.1	0.00
0.75	0.2	0.00	0.1	0.00
1	0.2	0.00	0.1	0.00
1.25	0.3	0.00	0.2	0.00
1.5	0.3	0.01	0.2	0.00
1.75	0.4	0.01	0.2	0.00
2	0.5	0.01	0.3	0.00
2.25	0.5	0.01	0.3	0.00
2.5	0.6	0.02	0.3	0.00
2.75	0.6	0.02	0.4	0.01
3	0.7	0.02	0.4	0.01
3.25	0.8	0.03	0.4	0.01
3.5	0.8	0.03	0.5	0.01
3.75	0.9	0.03	0.5	0.01
4	0.9	0.04	0.5	0.01
4.5	1.0	0.05	0.6	0.01
5	1.2	0.06	0.7	0.02
5.5	1.3	0.07	0.7	0.02
6	1.4	0.08	0.8	0.02
6.5	1.5	0.09	0.9	0.03
7	1.6	0.11	1.0	0.03
7.5	1.7	0.12	1.0	0.03
8	1.9	0.13	1.1	0.04
8.5	2.0	0.15	1.2	0.04
9	2.1	0.17	1.2	0.05
9.5	2.2	0.18	1.3	0.05
10	2.3	0.20	1.4	0.05
10.5	2.4	0.22	1.4	0.06
11	2.6	0.24	1.5	0.07
11.5	2.7	0.26	1.6	0.07
12	2.8	0.28	1.6	0.08
12.5	2.9	0.30	1.7	0.08
13	3.0	0.33	1.8	0.09
13.5	3.1	0.35	1.8	0.09
14	3.3	0.37	1.9	0.10
14.5	3.4	0.40	2.0	0.11
15	3.5	0.42	2.0	0.11
16	3.7	0.48	2.2	0.13
17	4.0	0.54	2.3	0.14
18	4.2	0.60	2.4	0.16
19	4.4	0.66	2.6	0.18
20	4.7	0.72	2.7	0.19

d [mm]	42		54	
di [mm]	39		51	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
21	4.9	0.79	2.9	0.21
22	5.1	0.86	3.0	0.23
23	5.3	0.94	3.1	0.25
24	5.6	1.02	3.3	0.27
25	5.8	1.10	3.4	0.29
30	7.0	1.55	4.1	0.41
35	8.1	2.07	4.8	0.55
40	9.3	2.66	5.4	0.70
45	10.5	3.33	6.1	0.87
50			6.8	1.06
55			7.5	1.27
60			8.2	1.50
65			8.8	1.75
70			9.5	2.01
75			10.2	2.29
80			10.9	2.60
85				
90				
95				
100				
105				
110				

compressed air 16 bar, depending on the volume flow, 12-35 mm

temperature: 20°C
density: 19.110 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.01 mm

d [mm]	12		15		18		22		28		35	
di [mm]	9.6		12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	1.0	0.30	0.6	0.08	0.4	0.03	0.2	0.01				
0.5	1.9	1.02	1.1	0.27	0.7	0.10	0.5	0.04	0.3	0.01		
0.75	2.9	2.14	1.7	0.56	1.1	0.20	0.7	0.08	0.4	0.02	0.3	0.01
1	3.8	3.63	2.2	0.95	1.5	0.34	1.0	0.13	0.6	0.03	0.3	0.01
1.25	4.8	5.50	2.8	1.43	1.8	0.50	1.2	0.19	0.7	0.05	0.4	0.02
1.5	5.8	7.75	3.3	2.00	2.2	0.70	1.5	0.27	0.8	0.07	0.5	0.02
1.75	6.7	10.35	3.9	2.66	2.5	0.93	1.7	0.35	1.0	0.09	0.6	0.03
2	7.7	13.33	4.5	3.42	2.9	1.19	2.0	0.45	1.1	0.12	0.7	0.04
2.25	8.6	16.68	5.0	4.26	3.3	1.48	2.2	0.56	1.3	0.15	0.8	0.04
2.5	9.6	20.39	5.6	5.18	3.6	1.79	2.4	0.68	1.4	0.18	0.9	0.05
2.75	10.6	24.46	6.1	6.21	4.0	2.14	2.7	0.81	1.6	0.21	0.9	0.06
3	11.5	28.91	6.7	7.31	4.4	2.52	2.9	0.95	1.7	0.25	1.0	0.07
3.25			7.2	8.51	4.7	2.92	3.2	1.10	1.8	0.29	1.1	0.09
3.5			7.8	9.79	5.1	3.36	3.4	1.26	2.0	0.33	1.2	0.10
3.75			8.4	11.16	5.4	3.82	3.7	1.43	2.1	0.37	1.3	0.11
4			8.9	12.62	5.8	4.31	3.9	1.62	2.3	0.42	1.4	0.13
4.5			10.0	15.81	6.5	5.39	4.4	2.01	2.5	0.52	1.6	0.16
5			11.1	19.35	7.3	6.58	4.9	2.45	2.8	0.63	1.7	0.19
5.5					8.0	7.88	5.4	2.93	3.1	0.75	1.9	0.22
6					8.7	9.30	5.9	3.45	3.4	0.88	2.1	0.26
6.5					9.4	10.84	6.4	4.02	3.7	1.03	2.2	0.30
7					10.2	12.49	6.9	4.62	4.0	1.18	2.4	0.35
7.5					10.9	14.25	7.3	5.27	4.2	1.34	2.6	0.40
8							7.8	5.95	4.5	1.51	2.8	0.45
8.5							8.3	6.68	4.8	1.69	2.9	0.50
9							8.8	7.45	5.1	1.88	3.1	0.55
9.5							9.3	8.26	5.4	2.08	3.3	0.61
10							9.8	9.11	5.7	2.30	3.5	0.67
10.5							10.3	10.01	5.9	2.52	3.6	0.74
11							10.8	10.94	6.2	2.75	3.8	0.80
11.5									6.5	2.99	4.0	0.87
12									6.8	3.24	4.1	0.95
12.5									7.1	3.50	4.3	1.02
13									7.4	3.77	4.5	1.10
13.5									7.6	4.05	4.7	1.18
14									7.9	4.34	4.8	1.26
14.5									8.2	4.64	5.0	1.35
15									8.5	4.95	5.2	1.44
16									9.1	5.60	5.5	1.62
17									9.6	6.29	5.9	1.82
18									10.2	7.02	6.2	2.03
19									10.8	7.78	6.6	2.25
20									11.3	8.59	6.9	2.48
21											7.3	2.72
22											7.6	2.97
23											7.9	3.23
24											8.3	3.50
25											8.6	3.79
30											10.4	5.37

42-54 mm

d [mm]	42		54	
di [mm]	39		51	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25				
0.5				
0.75				
1				
1.25	0.3	0.01		
1.5	0.3	0.01		
1.75	0.4	0.01		
2	0.5	0.01		
2.25	0.5	0.02	0.3	0.01
2.5	0.6	0.02	0.3	0.01
2.75	0.6	0.02	0.4	0.01
3	0.7	0.03	0.4	0.01
3.25	0.8	0.03	0.4	0.01
3.5	0.8	0.04	0.5	0.01
3.75	0.9	0.04	0.5	0.01
4	0.9	0.05	0.5	0.01
4.5	1.0	0.06	0.6	0.02
5	1.2	0.07	0.7	0.02
5.5	1.3	0.08	0.7	0.02
6	1.4	0.10	0.8	0.03
6.5	1.5	0.12	0.9	0.03
7	1.6	0.13	1.0	0.04
7.5	1.7	0.15	1.0	0.04
8	1.9	0.17	1.1	0.05
8.5	2.0	0.19	1.2	0.05
9	2.1	0.21	1.2	0.06
9.5	2.2	0.23	1.3	0.06
10	2.3	0.25	1.4	0.07
10.5	2.4	0.28	1.4	0.08
11	2.6	0.30	1.5	0.08
11.5	2.7	0.33	1.6	0.09
12	2.8	0.36	1.6	0.1
12.5	2.9	0.38	1.7	0.1
13	3.0	0.41	1.8	0.11
13.5	3.1	0.44	1.8	0.12
14	3.3	0.47	1.9	0.13
14.5	3.4	0.51	2.0	0.14
15	3.5	0.54	2.0	0.14
16	3.7	0.61	2.2	0.16
17	4.0	0.68	2.3	0.18
18	4.2	0.76	2.4	0.2
19	4.4	0.84	2.6	0.22
20	4.7	0.92	2.7	0.25
21	4.9	1.01	2.9	0.27
22	5.1	1.10	3.0	0.29
23	5.3	1.20	3.1	0.32
24	5.6	1.30	3.3	0.34
25	5.8	1.40	3.4	0.37
30	7.0	1.99	4.1	0.52
35	8.1	2.66	4.8	0.7
40	9.3	3.43	5.4	0.9
45	10.5	4.30	6.1	1.12
50			6.8	1.37
55			7.5	1.64
60			8.2	1.93
65			8.8	2.25
70			9.5	2.59
75			10.2	2.96
80			10.9	3.35

water 10°C, 15-35 mm

density: 999.7 kg/m³
viscosity: 0.0013 Pa·s
surface roughness: 0.0015 mm

d [mm]	15		18		22		28		35	
di [mm]	13		16		19.6		25.6		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.1	0.20	0.0	0.10						
0.02	0.2	0.50	0.1	0.20	0.1	0.10				
0.03	0.2	0.90	0.1	0.40	0.1	0.10				
0.04	0.3	1.50	0.2	0.60	0.1	0.20	0.1	0.10		
0.05	0.4	2.20	0.2	0.80	0.2	0.30	0.1	0.10		
0.06	0.5	3.10	0.3	1.20	0.2	0.40	0.1	0.10		
0.07	0.5	4.00	0.3	1.50	0.2	0.60	0.1	0.20	0.1	0.10
0.08	0.6	5.00	0.4	1.90	0.3	0.70	0.2	0.20	0.1	0.10
0.09	0.7	6.20	0.4	2.30	0.3	0.90	0.2	0.30	0.1	0.10
0.1	0.8	7.40	0.5	2.80	0.3	1.10	0.2	0.30	0.1	0.10
0.15	1.1	15.10	0.7	5.60	0.5	2.10	0.3	0.60	0.2	0.20
0.2	1.5	25.10	1.0	9.30	0.7	3.50	0.4	1.00	0.2	0.30
0.25	1.9	37.40	1.2	13.80	0.8	5.20	0.5	1.50	0.3	0.50
0.3	2.3	51.80	1.5	19.00	1.0	7.20	0.6	2.00	0.4	0.70
0.35	2.6	68.30	1.7	25.00	1.2	9.40	0.7	2.60	0.4	0.90
0.4	3.0	86.90	2.0	31.80	1.3	12.00	0.8	3.30	0.5	1.10
0.45	3.4	107.50	2.2	39.20	1.5	14.70	0.9	4.10	0.6	1.40
0.5	3.8	130.10	2.5	47.40	1.7	17.80	1.0	4.90	0.6	1.70
0.55			2.7	56.30	1.8	21.10	1.1	5.80	0.7	2.00
0.6			3.0	65.90	2.0	24.70	1.2	6.80	0.7	2.30
0.65			3.2	76.20	2.2	28.50	1.3	7.90	0.8	2.70
0.7			3.5	87.10	2.3	32.50	1.4	9.00	0.9	3.10
0.75			3.7	98.80	2.5	36.80	1.5	10.10	0.9	3.50
0.8			4.0	111.10	2.7	41.40	1.6	11.40	1.0	3.90
0.85			4.2	124.10	2.8	46.20	1.7	12.70	1.1	4.30
0.9			4.5	137.80	3.0	51.20	1.7	14.10	1.1	4.80
0.95			4.7	152.10	3.1	56.50	1.8	15.50	1.2	5.30
1					3.3	62.00	1.9	17.00	1.2	5.80
1.05					3.5	67.80	2.0	18.50	1.3	6.30
1.1					3.6	73.70	2.1	20.20	1.4	6.90
1.15					3.8	80.00	2.2	21.80	1.4	7.40
1.2					4.0	86.40	2.3	23.60	1.5	8.00
1.25					4.1	93.10	2.4	25.40	1.6	8.60
1.3					4.3	100.00	2.5	27.30	1.6	9.30
1.4					4.6	114.60	2.7	31.20	1.7	10.60
1.5					5.0	130.10	2.9	35.30	1.9	12.00
1.6					5.3	146.50	3.1	39.70	2.0	13.50
1.7					5.6	163.80	3.3	44.30	2.1	15.00
1.8					6.0	182.00	3.5	49.20	2.2	16.60
1.9					6.3	201.10	3.7	54.30	2.4	18.40
2					6.6	221.10	3.9	59.60	2.5	20.10
2.1							4.1	65.20	2.6	22.00
2.2							4.3	71.00	2.7	23.90
2.3							4.5	77.10	2.9	26.00
2.4							4.7	83.30	3.0	28.00
2.5							4.9	89.80	3.1	30.20
2.6							5.1	96.50	3.2	32.40
2.7							5.2	103.50	3.4	34.80
2.8							5.4	110.70	3.5	37.10
2.9							5.6	118.10	3.6	39.60
3							5.8	125.70	3.7	42.10
3.1							6.0	133.60	3.9	44.70
3.2							6.2	141.60	4.0	47.40
3.3							6.4	150.00	4.1	50.20
3.4							6.6	158.50	4.2	53.00
3.5							6.8	167.30	4.4	55.90
3.6							7.0	176.20	4.5	58.90
3.7							7.2	185.50	4.6	61.90
3.8							7.4	194.90	4.7	65.00
3.9							7.6	204.50	4.8	68.20
4							7.8	214.40	5.0	71.50
4.1							8.0	224.50	5.1	74.80
4.2									5.2	78.20
4.3									5.3	81.70
4.4									5.5	85.20
4.5									5.6	88.80
4.6									5.7	92.50
4.7									5.8	96.30

15-35 mm

d [mm]	15		18		22		28		35	
di [mm]	13		16		19.6		25.6		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.8									6.0	100.10
4.9									6.1	104.00
5									6.2	107.90
5.5									6.8	128.80
6									7.5	151.50
6.5									8.1	175.90
7									8.7	202.00
7.5									9.3	229.90
8									9.9	259.50

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.15	0.1	0.10								
0.2	0.2	0.10								
0.25	0.2	0.20	0.1	0.10						
0.3	0.3	0.30	0.1	0.10						
0.35	0.3	0.40	0.2	0.10						
0.4	0.3	0.40	0.2	0.10						
0.45	0.4	0.50	0.2	0.20						
0.5	0.4	0.70	0.2	0.20						
0.55	0.5	0.80	0.3	0.20						
0.6	0.5	0.90	0.3	0.30						
0.65	0.5	1.00	0.3	0.30	0.2	0.10				
0.7	0.6	1.20	0.3	0.30	0.2	0.10				
0.75	0.6	1.30	0.4	0.40	0.2	0.10				
0.8	0.7	1.50	0.4	0.40	0.2	0.10				
0.85	0.7	1.70	0.4	0.50	0.2	0.10				
0.9	0.8	1.90	0.4	0.50	0.2	0.10				
0.95	0.8	2.00	0.5	0.60	0.2	0.10	0.2	0.10		
1	0.8	2.20	0.5	0.60	0.2	0.10	0.2	0.10		
1.05	0.9	2.40	0.5	0.70	0.3	0.10	0.2	0.10		
1.1	0.9	2.70	0.5	0.70	0.3	0.10	0.2	0.10		
1.15	1.0	2.90	0.6	0.80	0.3	0.20	0.2	0.10		
1.2	1.0	3.10	0.6	0.90	0.3	0.20	0.2	0.10		
1.25	1.0	3.30	0.6	0.90	0.3	0.20	0.2	0.10		
1.3	1.1	3.60	0.6	1.00	0.3	0.20	0.2	0.10		
1.4	1.2	4.10	0.7	1.10	0.3	0.20	0.2	0.10		
1.5	1.3	4.60	0.7	1.30	0.4	0.20	0.3	0.10		
1.6	1.3	5.20	0.8	1.40	0.4	0.30	0.3	0.10		
1.7	1.4	5.80	0.8	1.60	0.4	0.30	0.3	0.10	0.2	0.10
1.8	1.5	6.40	0.9	1.80	0.4	0.30	0.3	0.20	0.2	0.10
1.9	1.6	7.10	0.9	1.90	0.5	0.40	0.3	0.20	0.2	0.10
2	1.7	7.70	1.0	2.10	0.5	0.40	0.4	0.20	0.2	0.10
2.1	1.8	8.40	1.0	2.30	0.5	0.40	0.4	0.20	0.2	0.10
2.2	1.8	9.20	1.1	2.50	0.5	0.50	0.4	0.20	0.3	0.10
2.3	1.9	9.90	1.1	2.70	0.6	0.50	0.4	0.20	0.3	0.10
2.4	2.0	10.70	1.2	2.90	0.6	0.60	0.4	0.30	0.3	0.10
2.5	2.1	11.60	1.2	3.20	0.6	0.60	0.4	0.30	0.3	0.10
2.6	2.2	12.40	1.3	3.40	0.6	0.60	0.5	0.30	0.3	0.10
2.7	2.3	13.30	1.3	3.60	0.7	0.70	0.5	0.30	0.3	0.10
2.8	2.3	14.20	1.4	3.90	0.7	0.70	0.5	0.30	0.3	0.10
2.9	2.4	15.10	1.4	4.10	0.7	0.80	0.5	0.40	0.3	0.10
3	2.5	16.10	1.5	4.40	0.7	0.80	0.5	0.40	0.4	0.10
3.1	2.6	17.10	1.5	4.70	0.8	0.90	0.5	0.40	0.4	0.20
3.2	2.7	18.10	1.6	4.90	0.8	0.90	0.6	0.40	0.4	0.20
3.3	2.8	19.10	1.6	5.20	0.8	1.00	0.6	0.50	0.4	0.20
3.4	2.8	20.20	1.7	5.50	0.8	1.00	0.6	0.50	0.4	0.20
3.5	2.9	21.30	1.7	5.80	0.9	1.10	0.6	0.50	0.4	0.20
3.6	3.0	22.40	1.8	6.10	0.9	1.20	0.6	0.50	0.4	0.20
3.9	3.3	25.90	1.9	7.10	1.0	1.30	0.7	0.60	0.5	0.20
4	3.3	27.20	2.0	7.40	1.0	1.40	0.7	0.60	0.5	0.20
4.1	3.4	28.40	2.0	7.70	1.0	1.50	0.7	0.70	0.5	0.30

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.2	3.5	29.70	2.1	8.10	1.0	1.50	0.7	0.70	0.5	0.30
4.3	3.6	31.00	2.1	8.40	1.1	1.60	0.8	0.70	0.5	0.30
4.4	3.7	32.30	2.2	8.80	1.1	1.60	0.8	0.80	0.5	0.30
4.5	3.8	33.70	2.2	9.10	1.1	1.70	0.8	0.80	0.5	0.30
4.6	3.9	35.10	2.3	9.50	1.1	1.80	0.8	0.80	0.5	0.30
4.7	3.9	36.50	2.3	9.90	1.2	1.90	0.8	0.80	0.6	0.30
4.8	4.0	37.90	2.3	10.30	1.2	1.90	0.8	0.90	0.6	0.30
4.9	4.1	39.40	2.4	10.70	1.2	2.00	0.9	0.90	0.6	0.30
5	4.2	40.90	2.4	11.10	1.2	2.10	0.9	0.90	0.6	0.40
5.5	4.6	48.70	2.7	13.20	1.3	2.50	1.0	1.10	0.6	0.40
6	5.0	57.20	2.9	15.40	1.5	2.90	1.1	1.30	0.7	0.50
6.5	5.4	66.30	3.2	17.90	1.6	3.30	1.1	1.50	0.8	0.60
7	5.9	76.10	3.4	20.50	1.7	3.80	1.2	1.70	0.8	0.70
7.5	6.3	86.50	3.7	23.20	1.8	4.30	1.3	2.00	0.9	0.70
8	6.7	97.50	3.9	26.10	2.0	4.90	1.4	2.20	0.9	0.80
8.5	7.1	109.10	4.2	29.20	2.1	5.40	1.5	2.50	1.0	0.90
9	7.5	121.40	4.4	32.50	2.2	6.00	1.6	2.70	1.1	1.00
9.5	8.0	134.30	4.7	35.90	2.3	6.60	1.7	3.00	1.1	1.10
10	8.4	147.80	4.9	39.40	2.4	7.30	1.8	3.30	1.2	1.20
10.5	8.8	162.00	5.1	43.10	2.6	8.00	1.9	3.60	1.2	1.40
11	9.2	176.70	5.4	47.00	2.7	8.70	1.9	3.90	1.3	1.50
11.5	9.6	192.10	5.6	51.10	2.8	9.40	2.0	4.30	1.4	1.60
12	10.0	208.10	5.9	55.30	2.9	10.20	2.1	4.60	1.4	1.70
12.5	10.5	224.70	6.1	59.60	3.1	10.90	2.2	4.90	1.5	1.90
13	10.9	241.90	6.4	64.10	3.2	11.80	2.3	5.30	1.5	2.00
13.5	11.3	259.80	6.6	68.80	3.3	12.60	2.4	5.70	1.6	2.10
14	11.7	278.20	6.9	73.60	3.4	13.50	2.5	6.10	1.6	2.30
14.5	12.1	297.30	7.1	78.60	3.6	14.40	2.6	6.50	1.7	2.40
15			7.3	83.70	3.7	15.30	2.6	6.90	1.8	2.60
15.5			7.6	89.00	3.8	16.30	2.7	7.30	1.8	2.70
16			7.8	94.40	3.9	17.20	2.8	7.80	1.9	2.90
16.5			8.1	100.00	4.0	18.20	2.9	8.20	1.9	3.10
17			8.3	105.80	4.2	19.30	3.0	8.70	2.0	3.20
17.5			8.6	111.70	4.3	20.30	3.1	9.20	2.1	3.40
18			8.8	117.80	4.4	21.40	3.2	9.60	2.1	3.60
18.5			9.1	124.00	4.5	22.50	3.3	10.10	2.2	3.80
19			9.3	130.30	4.7	23.70	3.4	10.60	2.2	4.00
19.5			9.5	136.90	4.8	24.80	3.4	11.20	2.3	4.20
20			9.8	143.50	4.9	26.00	3.5	11.70	2.4	4.40
21			10.3	157.30	5.1	28.50	3.7	12.80	2.5	4.80
22			10.8	171.70	5.4	31.00	3.9	13.90	2.6	5.20
23			11.3	186.80	5.6	33.70	4.1	15.10	2.7	5.60
24			11.7	202.40	5.9	36.50	4.2	16.40	2.8	6.10
25					6.1	39.40	4.4	17.70	2.9	6.60
26					6.4	42.40	4.6	19.00	3.1	7.00
27					6.6	45.40	4.8	20.40	3.2	7.50
28					6.9	48.60	4.9	21.80	3.3	8.10
29					7.1	51.90	5.1	23.20	3.4	8.60
30					7.3	55.30	5.3	24.70	3.5	9.20
31					7.6	58.80	5.5	26.30	3.6	9.70
32					7.8	62.40	5.7	27.90	3.8	10.30
33					8.1	66.10	5.8	29.50	3.9	10.90
34					8.3	69.90	6.0	31.20	4.0	11.50
35					8.6	73.80	6.2	33.00	4.1	12.20
36					8.8	77.80	6.4	34.70	4.2	12.80
37					9.1	82.00	6.5	36.60	4.4	13.50
38					9.3	86.20	6.7	38.40	4.5	14.20
39					9.6	90.50	6.9	40.30	4.6	14.90
40					9.8	94.90	7.1	42.30	4.7	15.60
41					10.0	99.40	7.2	44.30	4.8	16.30
42					10.3	104.00	7.4	46.30	4.9	17.10
43					10.5	108.80	7.6	48.40	5.1	17.80
44					10.8	113.60	7.8	50.50	5.2	18.60
45					11.0	118.50	7.9	52.70	5.3	19.40
46					11.3	123.50	8.1	54.90	5.4	20.20
47					11.5	128.70	8.3	57.20	5.5	21.00
48					11.8	133.90	8.5	59.50	5.7	21.90
49					12.0	139.20	8.7	61.80	5.8	22.70
50					12.2	144.60	8.8	64.20	5.9	23.60

water 60°C, 15-35 mm

density: 983.2 kg/m³
viscosity: 0.0005 Pa·s
surface roughness: 0.0015 mm

d [mm]	15		18		22		28		35	
di [mm]	13		16		19.6		25.6		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.1	0.10								
0.02	0.2	0.30	0.1	0.10						
0.03	0.2	0.70	0.1	0.30	0.1	0.10				
0.04	0.3	1.10	0.2	0.40	0.1	0.20				
0.05	0.4	1.70	0.2	0.60	0.2	0.20	0.1	0.10		
0.06	0.5	2.30	0.3	0.90	0.2	0.30	0.1	0.10		
0.07	0.5	3.10	0.3	1.10	0.2	0.40	0.1	0.10		
0.08	0.6	3.90	0.4	1.40	0.3	0.50	0.2	0.20	0.1	0.10
0.09	0.7	4.80	0.4	1.80	0.3	0.70	0.2	0.20	0.1	0.10
0.1	0.8	5.80	0.5	2.10	0.3	0.80	0.2	0.20	0.1	0.10
0.15	1.1	11.90	0.7	4.40	0.5	1.60	0.3	0.50	0.2	0.20
0.2	1.5	20.10	1.0	7.30	0.7	2.70	0.4	0.80	0.2	0.30
0.25	1.9	30.30	1.2	11.00	0.8	4.10	0.5	1.10	0.3	0.40
0.3	2.3	42.30	1.5	15.30	1.0	5.70	0.6	1.60	0.4	0.50
0.35	2.6	56.30	1.7	20.30	1.2	7.50	0.7	2.10	0.4	0.70
0.4	3.0	72.10	2.0	25.90	1.3	9.60	0.8	2.60	0.5	0.90
0.45	3.4	89.90	2.2	32.20	1.5	11.90	0.9	3.20	0.6	1.10
0.5	3.8	109.40	2.5	39.10	1.7	14.40	1.0	3.90	0.6	1.30
0.55			2.7	46.70	1.8	17.20	1.1	4.70	0.7	1.60
0.6			3.0	54.80	2.0	20.20	1.2	5.50	0.7	1.80
0.65			3.2	63.70	2.2	23.40	1.3	6.30	0.8	2.10
0.7			3.5	73.10	2.3	26.80	1.4	7.20	0.9	2.40
0.75			3.7	83.20	2.5	30.40	1.5	8.20	0.9	2.80
0.8			4.0	94.00	2.7	34.30	1.6	9.20	1.0	3.10
0.85			4.2	105.30	2.8	38.40	1.7	10.30	1.1	3.50
0.9			4.5	117.30	3.0	42.70	1.7	11.50	1.1	3.90
0.95			4.7	129.90	3.1	47.30	1.8	12.70	1.2	4.30
1					3.3	52.00	1.9	13.90	1.2	4.70
1.05					3.5	57.00	2.0	15.20	1.3	5.10
1.1					3.6	62.20	2.1	16.60	1.4	5.60
1.15					3.8	67.60	2.2	18.00	1.4	6.00
1.2					4.0	73.20	2.3	19.50	1.5	6.50
1.25					4.1	79.10	2.4	21.00	1.6	7.00
1.3					4.3	85.10	2.5	22.60	1.6	7.60
1.4					4.6	97.90	2.7	26.00	1.7	8.70
1.5					5.0	111.60	2.9	29.50	1.9	9.80
1.6					5.3	126.10	3.1	33.30	2.0	11.10
1.7					5.6	141.40	3.3	37.30	2.1	12.40
1.8					6.0	157.70	3.5	41.50	2.2	13.80
1.9					6.3	174.80	3.7	46.00	2.4	15.20
2					6.6	192.70	3.9	50.60	2.5	16.80
2.1							4.1	55.50	2.6	18.30
2.2							4.3	60.60	2.7	20.00
2.3							4.5	65.90	2.9	21.70
2.4							4.7	71.40	3.0	23.50
2.5							4.9	77.10	3.1	25.40
2.6							5.1	83.10	3.2	27.30
2.7							5.2	89.20	3.4	29.30
2.8							5.4	95.60	3.5	31.40
2.9							5.6	102.20	3.6	33.50
3							5.8	109.00	3.7	35.80
3.1							6.0	116.00	3.9	38.00
3.2							6.2	123.20	4.0	40.40
3.3							6.4	130.70	4.1	42.80
3.4							6.6	138.40	4.2	45.30
3.5							6.8	146.20	4.4	47.80
3.6							7.0	154.30	4.5	50.40
3.7							7.2	162.60	4.6	53.10
3.8							7.4	171.10	4.7	55.80
3.9							7.6	179.90	4.8	58.70
4							7.8	188.80	5.0	61.50
4.2									5.2	67.50
4.3									5.3	70.60
4.4									5.5	73.70
4.5									5.6	77.00
4.6									5.7	80.30

15-35 mm

d [mm]	15		18		22		28		35	
di [mm]	13		16		19.6		25.6		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.7									5.8	83.60
4.8									6.0	87.00
4.9									6.1	90.50
5									6.2	94.10
5.5									6.8	112.80
6									7.5	133.30
6.5									8.1	155.40
7									8.7	179.20
7.5									9.3	204.60
8									9.9	231.80

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.15	1.1	0.10								
0.2	0.2	0.10								
0.25	0.2	0.20								
0.3	2.1	0.20	0.1	0.10						
0.35	0.3	0.30	0.2	0.10						
0.4	0.3	0.30	0.2	0.10						
0.45	3.1	0.40	0.2	0.10						
0.5	0.4	0.50	0.2	0.10						
0.55	0.5	0.60	0.3	0.20						
0.6	4.1	0.70	0.3	0.20						
0.65	0.5	0.80	0.3	0.20						
0.7	0.6	0.90	0.3	0.30						
0.75	0.6	1.10	0.4	0.30	0.2	0.10				
0.8	1.1	1.20	0.4	0.30	0.2	0.10				
0.85	0.7	1.30	0.4	0.40	0.2	0.10				
0.9	0.8	1.50	0.4	0.40	0.2	0.10				
0.95	2.1	1.60	0.5	0.40	0.2	0.10				
1	0.8	1.80	0.5	0.50	0.2	0.10				
1.05	0.9	2.00	0.5	0.50	0.3	0.10				
1.1	3.1	2.10	0.5	0.60	0.3	0.10	0.2	0.10		
1.15	1.0	2.30	0.6	0.60	0.3	0.10	0.2	0.10		
1.2	1.0	2.50	0.6	0.70	0.3	0.10	0.2	0.10		
1.25	4.1	2.70	0.6	0.70	0.3	0.10	0.2	0.10		
1.3	1.1	2.90	0.6	0.80	0.3	0.10	0.2	0.10		
1.4	1.2	3.30	0.7	0.90	0.3	0.20	0.2	0.10		
1.5	5.1	3.70	0.7	1.00	0.4	0.20	0.3	0.10		
1.6	1.3	4.20	0.8	1.10	0.4	0.20	0.3	0.10		
1.7	1.4	4.70	0.8	1.30	0.4	0.20	0.3	0.10		
1.8	1.5	5.20	0.9	1.40	0.4	0.30	0.3	0.10		
1.9	2.1	5.80	0.9	1.60	0.5	0.30	0.3	0.10	0.2	0.10
2	1.7	6.30	1.0	1.70	0.5	0.30	0.4	0.10	0.2	0.10
2.1	1.8	6.90	1.0	1.90	0.5	0.30	0.4	0.20	0.2	0.10
2.2	3.1	7.60	1.1	2.00	0.5	0.40	0.4	0.20	0.3	0.10
2.3	1.9	8.20	1.1	2.20	0.6	0.40	0.4	0.20	0.3	0.10
2.4	2.0	8.90	1.2	2.40	0.6	0.40	0.4	0.20	0.3	0.10
2.5	4.1	9.60	1.2	2.60	0.6	0.50	0.4	0.20	0.3	0.10
2.6	2.2	10.30	1.3	2.80	0.6	0.50	0.5	0.20	0.3	0.10
2.7	2.3	11.00	1.3	3.00	0.7	0.50	0.5	0.30	0.3	0.10
2.8	5.1	11.80	1.4	3.20	0.7	0.60	0.5	0.30	0.3	0.10
2.9	2.4	12.60	1.4	3.40	0.7	0.60	0.5	0.30	0.3	0.10
3	2.5	13.40	1.5	3.60	0.7	0.70	0.5	0.30	0.4	0.10
3.1	6.1	14.30	1.5	3.80	0.8	0.70	0.5	0.30	0.4	0.10
3.2	2.7	15.10	1.6	4.00	0.8	0.80	0.6	0.30	0.4	0.10
3.3	2.8	16.00	1.6	4.30	0.8	0.80	0.6	0.40	0.4	0.10
3.4	2.8	17.00	1.7	4.50	0.8	0.80	0.6	0.40	0.4	0.10
3.5	3.1	17.90	1.7	4.80	0.9	0.90	0.6	0.40	0.4	0.20
3.6	3.0	18.90	1.8	5.00	0.9	0.90	0.6	0.40	0.4	0.20
3.9	3.3	21.90	1.9	5.80	1.0	1.10	0.7	0.50	0.5	0.20
4	3.3	23.00	2.0	6.10	1.0	1.10	0.7	0.50	0.5	0.20
4.1	5.1	24.10	2.0	6.40	1.0	1.20	0.7	0.50	0.5	0.20
4.2	3.5	25.20	2.1	6.70	1.0	1.20	0.7	0.60	0.5	0.20
4.3	3.6	26.30	2.1	7.00	1.1	1.30	0.8	0.60	0.5	0.20

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.4	6.1	27.50	2.2	7.30	1.1	1.30	0.8	0.60	0.5	0.20
4.5	3.8	28.70	2.2	7.60	1.1	1.40	0.8	0.60	0.5	0.20
4.6	3.9	29.90	2.3	7.90	1.1	1.50	0.8	0.70	0.5	0.20
4.7	7.1	31.10	2.3	8.20	1.2	1.50	0.8	0.70	0.6	0.30
4.8	4.0	32.40	2.3	8.60	1.2	1.60	0.8	0.70	0.6	0.30
4.9	4.1	33.70	2.4	8.90	1.2	1.60	0.9	0.70	0.6	0.30
5	4.2	35.00	2.4	9.30	1.2	1.70	0.9	0.80	0.6	0.30
5.5	4.1	41.90	2.7	11.10	1.3	2.00	1.0	0.90	0.6	0.30
6	5.0	49.40	2.9	13.00	1.5	2.40	1.1	1.10	0.7	0.40
6.5	5.4	57.50	3.2	15.10	1.6	2.70	1.1	1.20	0.8	0.50
7	5.1	66.20	3.4	17.40	1.7	3.20	1.2	1.40	0.8	0.50
7.5	6.3	75.50	3.7	19.80	1.8	3.60	1.3	1.60	0.9	0.60
8	6.7	85.40	3.9	22.30	2.0	4.00	1.4	1.80	0.9	0.70
8.5	6.1	95.90	4.2	25.00	2.1	4.50	1.5	2.00	1.0	0.80
9	7.5	107.00	4.4	27.90	2.2	5.00	1.6	2.30	1.1	0.80
9.5	8.0	118.70	4.7	30.90	2.3	5.60	1.7	2.50	1.1	0.90
10	7.1	131.00	4.9	34.10	2.4	6.10	1.8	2.70	1.2	1.00
10.5	8.8	143.90	5.1	37.40	2.6	6.70	1.9	3.00	1.2	1.10
11	9.2	157.30	5.4	40.80	2.7	7.30	1.9	3.30	1.3	1.20
11.5	8.1	171.40	5.6	44.40	2.8	7.90	2.0	3.50	1.4	1.30
12	10.0	186.10	5.9	48.20	2.9	8.60	2.1	3.80	1.4	1.40
12.5	10.5	201.40	6.1	52.10	3.1	9.30	2.2	4.10	1.5	1.50
13	10.9	217.20	6.4	56.10	3.2	10.00	2.3	4.50	1.5	1.60
13.5	5.1	233.70	6.6	60.30	3.3	10.70	2.4	4.80	1.6	1.80
14	11.7	250.70	6.9	64.70	3.4	11.50	2.5	5.10	1.6	1.90
14.5	12.1	268.40	7.1	69.20	3.6	12.30	2.6	5.50	1.7	2.00
15			7.3	73.80	3.7	13.10	2.6	5.80	1.8	2.10
15.5			7.6	78.60	3.8	13.90	2.7	6.20	1.8	2.30
16			7.8	83.50	3.9	14.80	2.8	6.60	1.9	2.40
16.5			8.1	88.60	4.0	15.70	2.9	7.00	1.9	2.60
17			8.3	93.80	4.2	16.60	3.0	7.40	2.0	2.70
17.5			8.6	99.20	4.3	17.50	3.1	7.80	2.1	2.90
18			8.8	104.80	4.4	18.50	3.2	8.20	2.1	3.00
18.5			9.1	110.40	4.5	19.40	3.3	8.60	2.2	3.20
19			9.3	116.30	4.7	20.40	3.4	9.10	2.2	3.30
19.5			9.5	122.20	4.8	21.50	3.4	9.50	2.3	3.50
20			9.8	128.30	4.9	22.50	3.5	10.00	2.4	3.70
21			10.3	141.00	5.1	24.70	3.7	11.00	2.5	4.00
22			10.8	154.30	5.4	27.00	3.9	12.00	2.6	4.40
23			11.3	168.20	5.6	29.40	4.1	13.00	2.7	4.80
24			11.7	182.60	5.9	31.90	4.2	14.10	2.8	5.20
25					6.1	34.50	4.4	15.20	2.9	5.60
26					6.4	37.10	4.6	16.40	3.1	6.00
27					6.6	39.90	4.8	17.60	3.2	6.40
28					6.9	42.80	4.9	18.90	3.3	6.90
29					7.1	45.80	5.1	20.20	3.4	7.40
30					7.3	48.90	5.3	21.50	3.5	7.80
31					7.6	52.00	5.5	22.90	3.6	8.30
32					7.8	55.30	5.7	24.40	3.8	8.90
33					8.1	58.70	5.8	25.80	3.9	9.40
34					8.3	62.10	6.0	27.30	4.0	9.90
35					8.6	65.70	6.2	28.90	4.1	10.50
36					8.8	69.40	6.4	30.50	4.2	11.10
37					9.1	73.10	6.5	32.10	4.4	11.70
38					9.3	77.00	6.7	33.80	4.5	12.30
39					9.6	80.90	6.9	35.50	4.6	12.90
40					9.8	85.00	7.1	37.30	4.7	13.50
41					10.0	89.10	7.2	39.10	4.8	14.20
42					10.3	93.40	7.4	41.00	4.9	14.80
43					10.5	97.70	7.6	42.90	5.1	15.50
44					10.8	102.20	7.8	44.80	5.2	16.20
45					11.0	106.70	7.9	46.80	5.3	16.90
46					11.3	111.40	8.1	48.80	5.4	17.60
47					11.5	116.10	8.3	50.90	5.5	18.40
48					11.8	120.90	8.5	53.00	5.7	19.10
49					12.0	125.90	8.7	55.10	5.8	19.90
50					12.2	130.90	8.8	57.30	5.9	20.70

compressed air 3 bar, depending on the volume flow, 15-35 mm

temperature: 20°C
density: 3.612 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.0015 mm

d [mm]	15		18		22		28		35	
di [mm]	13		16		19.6		25.6		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.5	0.0210	0.3	0.0080	0.2	0.0031	0.1	0.0009	0.1	0.0003
0.5	1.0	0.0672	0.7	0.0254	0.5	0.0098	0.3	0.0028	0.2	0.0010
0.75	1.6	0.1340	1.0	0.0504	0.7	0.0194	0.4	0.0056	0.3	0.0020
1	2.1	0.2195	1.4	0.0824	0.9	0.0317	0.5	0.0090	0.3	0.0032
1.25	2.6	0.3225	1.7	0.1208	1.2	0.0464	0.7	0.0132	0.4	0.0046
1.5	3.1	0.4422	2.1	0.1654	1.4	0.0634	0.8	0.0180	0.5	0.0063
1.75	3.7	0.5779	2.4	0.2160	1.6	0.0827	0.9	0.0234	0.6	0.0082
2	4.2	0.7292	2.8	0.2722	1.8	0.1041	1.1	0.0295	0.7	0.0103
2.25	4.7	0.8958	3.1	0.3341	2.1	0.1277	1.2	0.0361	0.8	0.0126
2.5	5.2	1.0771	3.5	0.4014	2.3	0.1533	1.3	0.0433	0.9	0.0151
2.75	5.8	1.2729	3.8	0.4740	2.5	0.1809	1.5	0.0510	0.9	0.0178
3	6.3	1.4831	4.1	0.5519	2.8	0.2104	1.6	0.0593	1.0	0.0206
3.25	6.8	1.7072	4.5	0.6349	3.0	0.2420	1.8	0.0682	1.1	0.0237
3.5	7.3	1.9453	4.8	0.7230	3.2	0.2754	1.9	0.0755	1.2	0.0269
3.75	7.8	2.1969	5.2	0.8161	3.5	0.3107	2.0	0.0874	1.3	0.0304
4	8.4	2.4621	5.5	0.9142	3.7	0.3479	2.2	0.0978	1.4	0.0340
4.5	9.4	3.0322	6.2	1.1248	4.1	0.4276	2.4	0.1201	1.6	0.0417
5	10.5	3.6546	6.9	1.3545	4.6	0.5146	2.7	0.1444	1.7	0.0500
5.5			7.6	1.6030	5.1	0.6085	3.0	0.1706	1.9	0.0591
6			8.3	1.8699	5.5	0.7094	3.2	0.1987	2.1	0.0688
6.5			9.0	2.1549	6.0	0.8170	3.5	0.2287	2.2	0.0791
7			9.7	2.4578	6.4	0.9314	3.8	0.2605	2.4	0.0901
7.5			10.4	2.8000	6.9	1.0523	4.0	0.2942	2.6	0.1017
8					7.4	1.1797	4.3	0.3296	2.8	0.1138
8.5					7.8	1.3136	4.6	0.3668	2.9	0.1266
9					8.3	1.4539	4.9	0.4058	3.1	0.1400
9.5					8.7	1.6004	5.1	0.4464	3.3	0.1540
10					9.2	1.7533	5.4	0.4888	3.5	0.1686
10.5					9.7	1.9123	5.7	0.5329	3.6	0.1837
11					10.1	2.0775	5.9	0.5787	3.8	0.1994
11.5							6.2	0.6262	4.0	0.2157
12							6.5	0.6753	4.1	0.2326
12.5							6.7	0.7260	4.3	0.2500
13							7.0	0.7784	4.5	0.2679
13.5							7.3	0.8324	4.7	0.2864
14							7.6	0.8880	4.8	0.3055
14.5							7.8	0.9453	5.0	0.3251
15							8.1	1.0041	5.2	0.3452
16							8.6	1.1264	5.5	0.3871
17							9.2	1.2551	5.9	0.4311
18							9.7	1.3899	6.2	0.4772
19							10.3	1.5309	6.6	0.5254
20							10.8	1.6780	6.9	0.5757
21									7.3	0.6280
22									7.6	0.6823
23									7.9	0.7386
24									8.3	0.7969
25									8.6	0.8572
30									10.4	1.1880

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0001	0.0	0.0000	0.0					
0.5	0.1	0.0004	0.1	0.0001	0.0					
0.75	0.2	0.0008	0.1	0.0002	0.1					
1	0.2	0.0013	0.1	0.0004	0.1					
1.25	0.3	0.0018	0.2	0.0005	0.1					
1.5	0.3	0.0025	0.2	0.0007	0.1					
1.75	0.4	0.0032	0.2	0.0009	0.1					
2	0.5	0.0041	0.3	0.0011	0.1					
2.25	0.5	0.0050	0.3	0.0014	0.2					
2.5	0.6	0.0059	0.3	0.0017	0.2					
2.75	0.6	0.0070	0.4	0.0020	0.2					
3	0.7	0.0081	0.4	0.0023	0.2					
3.25	0.8	0.0093	0.4	0.0026	0.2					
3.5	0.8	0.0106	0.5	0.0030	0.2					
3.75	0.9	0.0119	0.5	0.0034	0.3					
4	0.9	0.0133	0.5	0.0037	0.3					
4.5	1.0	0.0163	0.6	0.0046	0.3					
5	1.2	0.0196	0.7	0.0055	0.3					
5.5	1.3	0.0231	0.7	0.0065	0.4					
6	1.4	0.0269	0.8	0.0075	0.4					
6.5	1.5	0.0309	0.9	0.0087	0.4					
7	1.6	0.0352	1.0	0.0099	0.5					
7.5	1.7	0.0397	1.0	0.0111	0.5					
8	1.9	0.0444	1.1	0.0124	0.5					
8.5	2.0	0.0494	1.2	0.0138	0.6					
9	2.1	0.0546	1.2	0.0153	0.6					
9.5	2.2	0.0600	1.3	0.0168	0.6					
10	2.3	0.0657	1.4	0.0184	0.7	0.0036	0.5	0.0016	0.3	0.0006
10.5	2.4	0.0716	1.4	0.0200	0.7	0.0039	0.5	0.0018	0.3	0.0007
11	2.6	0.0777	1.5	0.0217	0.7	0.0042	0.5	0.0019	0.4	0.0007
11.5	2.7	0.0840	1.6	0.0234	0.8	0.0045	0.6	0.0021	0.4	0.0008
12	2.8	0.0905	1.6	0.0253	0.8	0.0049	0.6	0.0022	0.4	0.0009
12.5	2.9	0.0973	1.7	0.0271	0.9	0.0052	0.6	0.0024	0.4	0.0009
13	3.0	0.1043	1.8	0.0291	0.9	0.0056	0.6	0.0026	0.4	0.0010
13.5	3.1	0.1114	1.8	0.0310	0.9	0.0060	0.7	0.0028	0.4	0.0011
14	3.3	0.1188	1.9	0.0331	1.0	0.0064	0.7	0.0029	0.5	0.0011
14.5	3.4	0.1264	2.0	0.0352	1.0	0.0068	0.7	0.0031	0.5	0.0012
15	3.5	0.1342	2.0	0.0374	1.0	0.0072	0.7	0.0033	0.5	0.0013
16	3.7	0.1504	2.2	0.0419	1.1	0.0081	0.8	0.0037	0.5	0.0014
17	4.0	0.1675	2.3	0.0466	1.2	0.0090	0.8	0.0041	0.6	0.0016
18	4.2	0.1853	2.4	0.0515	1.2	0.0099	0.9	0.0046	0.6	0.0017
19	4.4	0.2040	2.6	0.0567	1.3	0.0109	0.9	0.0050	0.6	0.0019
20	4.7	0.2234	2.7	0.0621	1.4	0.0119	1.0	0.0055	0.7	0.0021
21	4.9	0.2436	2.9	0.0676	1.4	0.0130	1.0	0.0060	0.7	0.0023
22	5.1	0.2646	3.0	0.0734	1.5	0.0141	1.1	0.0065	0.7	0.0025
23	5.3	0.2864	3.1	0.0795	1.6	0.0152	1.1	0.0070	0.8	0.0027
24	5.6	0.3089	3.3	0.0857	1.6	0.0164	1.2	0.0075	0.8	0.0029
25	5.8	0.3322	3.4	0.0921	1.7	0.0177	1.2	0.0081	0.8	0.0031
30	7.0	0.4599	4.1	0.1273	2.0	0.0244	1.5	0.0112	1.0	0.0043
35	8.1	0.6058	4.8	0.1675	2.4	0.0320	1.7	0.0147	1.1	0.0056
40	9.3	0.7695	5.4	0.2125	2.7	0.0406	2.0	0.1860	1.3	0.0071
45	10.5	0.9506	6.1	0.2623	3.1	0.0500	2.2	0.0229	1.5	0.0087
50			6.8	0.3167	3.4	0.0603	2.5	0.0276	1.6	0.0105
55			7.5	0.3757	3.7	0.0715	2.7	0.0327	1.8	0.0124
60			8.2	0.4391	4.1	0.0835	2.9	0.0382	2.0	0.0145
65			8.8	0.5070	4.4	0.0963	3.2	0.0440	2.1	0.0167
70			9.5	0.5793	4.8	0.1099	3.4	0.0502	2.3	0.0190
75			10.2	0.6559	5.1	0.1244	3.7	0.0568	2.5	0.0215
80			10.9	0.7367	5.4	0.1396	3.9	0.0638	2.6	0.0241
85					5.8	0.1556	4.2	0.0711	2.8	0.0269
90					6.1	0.1724	4.4	0.0787	2.9	0.0298
95					6.5	0.1900	4.7	0.0867	3.1	0.0328
100					6.8	0.2084	4.9	0.0951	3.3	0.0359
105					7.1	0.2275	5.2	0.1038	3.4	0.0392
110					7.5	0.2473	5.4	0.1128	3.6	0.0426
115					7.8	0.2679	5.6	0.1222	3.8	0.0462

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
120					8.2	0.2893	5.9	0.1319	3.9	0.0498
125					8.5	0.3113	6.1	0.1419	4.1	0.0536
130					8.8	0.3342	6.4	0.1523	4.3	0.0575
135					9.2	0.3577	6.6	0.1630	4.4	0.0615
140					9.5	0.3820	6.9	0.1740	4.6	0.0657
145					9.9	0.4069	7.1	0.1854	4.7	0.0699
150					10.2	0.4326	7.4	0.1971	4.9	0.0743
160							7.9	0.2214	5.2	0.0835
170							8.3	0.2470	5.6	0.0931
180							8.8	0.2738	5.9	0.1032
190							9.3	0.3019	6.2	0.1137
200							9.8	0.3312	6.5	0.1248
210							10.3	0.3618	6.9	0.1362
220									7.2	0.1482
230									7.5	0.1605
240									7.8	0.1734
250									8.2	0.1866
300									9.8	0.2596
315									10.3	0.2836

compressed air 6 bar, depending on the volume flow, 15-35 mm

temperature: 20°C
density: 7.224 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.0015 mm

d [mm]	15		18		22		28		35	
di [mm]	12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.5	0.0336	0.3	0.0127	0.2	0.0049	0.1	0.0014	0.1	0.0005
0.5	1.0	0.1097	0.7	0.0412	0.5	0.0158	0.3	0.0045	0.2	0.0016
0.75	1.6	0.2211	1.0	0.0827	0.7	0.0317	0.4	0.0090	0.3	0.0031
1	2.1	0.3646	1.4	0.1361	0.9	0.0521	0.5	0.0147	0.3	0.0051
1.25	2.6	0.5385	1.7	0.2007	1.2	0.0766	0.7	0.0216	0.4	0.0075
1.5	3.1	0.7415	2.1	0.2760	1.4	0.1052	0.8	0.0297	0.5	0.0103
1.75	3.7	0.9726	2.4	0.3615	1.6	0.1377	0.9	0.0388	0.6	0.0135
2	4.2	1.2310	2.8	0.4571	1.8	0.1739	1.1	0.0489	0.7	0.0170
2.25	4.7	1.5161	3.1	0.5624	2.1	0.2138	1.2	0.0601	0.8	0.0208
2.5	5.2	1.8273	3.5	0.6773	2.3	0.2573	1.3	0.0722	0.9	0.0250
2.75	5.8	2.1642	3.8	0.8015	2.5	0.3043	1.5	0.0853	0.9	0.0295
3	6.3	2.5263	4.1	0.9349	2.8	0.3547	1.6	0.0994	1.0	0.0344
3.25	6.8	2.9133	4.5	1.0774	3.0	0.4085	1.8	0.1144	1.1	0.0396
3.5	7.3	3.3250	4.8	1.2289	3.2	0.4657	1.9	0.1303	1.2	0.0450
3.75	7.8	3.7609	5.2	1.3892	3.5	0.5261	2.0	0.1471	1.3	0.0508
4	8.4	4.2209	5.5	1.5582	3.7	0.5899	2.2	0.1648	1.4	0.0569
4.5	9.4	5.2121	6.2	1.9221	4.1	0.7269	2.4	0.2029	1.6	0.0700
5	10.5	6.2969	6.9	2.3198	4.6	0.8766	2.7	0.2444	1.7	0.0843
5.5			7.6	2.7510	5.1	1.0388	3.0	0.2894	1.9	0.0997
6			8.3	3.2149	5.5	1.2131	3.2	0.3376	2.1	0.1163
6.5			9.0	3.7114	6.0	1.3994	3.5	0.3892	2.2	0.1340
7			9.7	4.2399	6.4	1.5977	3.8	0.4440	2.4	0.1527
7.5			10.4	4.8000	6.9	1.8077	4.0	0.5020	2.6	0.1726
8					7.4	2.0293	4.3	0.5632	2.8	0.1936
8.5					7.8	2.2625	4.6	0.6275	2.9	0.2156
9					8.3	2.5070	4.9	0.6950	3.1	0.2386
9.5					8.7	2.7629	5.1	0.7654	3.3	0.2627
10					9.2	3.0299	5.4	0.8390	3.5	0.2878
10.5					9.7	3.3081	5.7	0.9155	3.6	0.3140
11					10.1	3.5974	5.9	0.9951	3.8	0.3411
11.5							6.2	1.0776	4.0	0.3693
12							6.5	1.1631	4.1	0.3985
12.5							6.7	1.2515	4.3	0.4286
13							7.0	1.3428	4.5	0.4597
13.5							7.3	1.4371	4.7	0.4918
14							7.6	1.5342	4.8	0.5249
14.5							7.8	1.6342	5.0	0.5590
15							8.1	1.7370	5.2	0.5940
16							8.6	1.9512	5.5	0.6669
17							9.2	2.1766	5.9	0.7435
18							9.7	2.4132	6.2	0.8239
19							10.3	2.6609	6.6	0.9080
20							10.8	2.9195	6.9	0.9958
21									7.3	1.0873
22									7.6	1.1824
23									7.9	1.2811
24									8.3	1.3833
25									8.6	1.4892
30									10.4	2.0710

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0002	0.0	0.0001						
0.5	0.1	0.0006	0.1	0.0002						
0.75	0.2	0.0012	0.1	0.0004						
1	0.2	0.0020	0.1	0.0006						
1.25	0.3	0.0030	0.2	0.0008						
1.5	0.3	0.0041	0.2	0.0011						
1.75	0.4	0.0053	0.2	0.0015						
2	0.5	0.0067	0.3	0.0019						
2.25	0.5	0.0082	0.3	0.0023						
2.5	0.6	0.0098	0.3	0.0028						
2.75	0.6	0.0116	0.4	0.0032						
3	0.7	0.0134	0.4	0.0038						
3.25	0.8	0.0155	0.4	0.0043						
3.5	0.8	0.0176	0.5	0.0049						
3.75	0.9	0.0198	0.5	0.0056						
4	0.9	0.0222	0.5	0.0062						
4.5	1.0	0.0273	0.6	0.0076						
5	1.2	0.0329	0.7	0.0092						
5.5	1.3	0.0388	0.7	0.0108						
6	1.4	0.0453	0.8	0.0126						
6.5	1.5	0.0521	0.9	0.0145						
7	1.6	0.0594	1.0	0.0165						
7.5	1.7	0.0671	1.0	0.0187						
8	1.9	0.0752	1.1	0.0209						
8.5	2.0	0.0837	1.2	0.0233						
9	2.1	0.0927	1.2	0.0258						
9.5	2.2	0.1020	1.3	0.0283						
10	2.3	0.1117	1.4	0.0310	0.7	0.0060	0.5	0.0027	0.3	0.0010
10.5	2.4	0.1218	1.4	0.0338	0.7	0.0065	0.5	0.0030	0.3	0.0011
11	2.6	0.1323	1.5	0.0367	0.7	0.0070	0.5	0.0032	0.4	0.0012
11.5	2.7	0.1432	1.6	0.0397	0.8	0.0076	0.6	0.0035	0.4	0.0013
12	2.8	0.1545	1.6	0.0428	0.8	0.0082	0.6	0.0038	0.4	0.0014
12.5	2.9	0.1661	1.7	0.0461	0.9	0.0088	0.6	0.0041	0.4	0.0015
13	3.0	0.1781	1.8	0.0494	0.9	0.0095	0.6	0.0043	0.4	0.0017
13.5	3.1	0.1905	1.8	0.0528	0.9	0.0101	0.7	0.0046	0.4	0.0018
14	3.3	0.2033	1.9	0.0563	1.0	0.0108	0.7	0.0049	0.5	0.0019
14.5	3.4	0.2164	2.0	0.0599	1.0	0.0115	0.7	0.0053	0.5	0.0020
15	3.5	0.2299	2.0	0.0637	1.0	0.0122	0.7	0.0056	0.5	0.0021
16	3.7	0.2580	2.2	0.0714	1.1	0.0137	0.8	0.0063	0.5	0.0024
17	4.0	0.2876	2.3	0.0795	1.2	0.0152	0.8	0.0070	0.6	0.0027
18	4.2	0.3185	2.4	0.0881	1.2	0.0168	0.9	0.0077	0.6	0.0029
19	4.4	0.3509	2.6	0.0970	1.3	0.0185	0.9	0.0085	0.6	0.0032
20	4.7	0.3847	2.7	0.1063	1.4	0.0203	1.0	0.0093	0.7	0.0035
21	4.9	0.4199	2.9	0.1159	1.4	0.0221	1.0	0.0101	0.7	0.0038
22	5.1	0.4565	3.0	0.1260	1.5	0.0240	1.1	0.0110	0.7	0.0042
23	5.3	0.4944	3.1	0.1364	1.6	0.0260	1.1	0.0119	0.8	0.0045
24	5.6	0.5338	3.3	0.1472	1.6	0.0280	1.2	0.0128	0.8	0.0049
25	5.8	0.5744	3.4	0.1584	1.7	0.0302	1.2	0.0138	0.8	0.0052
30	7.0	0.7978	4.1	0.2196	2.0	0.0417	1.5	0.0191	1.0	0.0072
35	8.1	1.0538	4.8	0.2896	2.4	0.0550	1.7	0.0251	1.1	0.0095
40	9.3	1.3420	5.4	0.3684	2.7	0.0698	2.0	0.0319	1.3	0.0121
45	10.5	1.6615	6.1	0.4556	3.1	0.0862	2.2	0.0394	1.5	0.0149
50			6.8	0.5511	3.4	0.1042	2.5	0.0475	1.6	0.0180
55			7.5	0.6548	3.7	0.1237	2.7	0.0564	1.8	0.0213
60			8.2	0.7665	4.1	0.1446	2.9	0.0660	2.0	0.0249
65			8.8	0.8863	4.4	0.1671	3.2	0.0762	2.1	0.0288
70			9.5	1.0139	4.8	0.1910	3.4	0.0870	2.3	0.0328
75			10.2	1.1494	5.1	0.2163	3.7	0.0985	2.5	0.0372
80			10.9	1.2926	5.4	0.2431	3.9	0.1107	2.6	0.0417
85					5.8	0.2712	4.2	0.1235	2.8	0.0465
90					6.1	0.3008	4.4	0.1369	2.9	0.0516
95					6.5	0.3318	4.7	0.1510	3.1	0.0569
100					6.8	0.3641	4.9	0.1656	3.3	0.0624
105					7.1	0.3978	5.2	0.1809	3.4	0.0681
110					7.5	0.4328	5.4	0.1968	3.6	0.0741
115					7.8	0.4692	5.6	0.2133	3.8	0.0803

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
120					8.2	0.5070	5.9	0.2304	3.9	0.0867
125					8.5	0.5460	6.1	0.2481	4.1	0.0933
130					8.8	0.5864	6.4	0.2664	4.3	0.1002
135					9.2	0.6281	6.6	0.2853	4.4	0.1073
140					9.5	0.6712	6.9	0.3047	4.6	0.1146
145					9.9	0.7155	7.1	0.3248	4.7	0.1221
150					10.2	0.7611	7.4	0.3455	4.9	0.1298
160							7.9	0.3885	5.2	0.1459
170							8.3	0.4338	5.6	0.1629
180							8.8	0.4814	5.9	0.1807
190							9.3	0.5313	6.2	0.1993
200							9.8	0.5834	6.5	0.2188
210							10.3	0.6377	6.9	0.2391
220									7.2	0.2602
230									7.5	0.2821
240									7.8	0.3049
250									8.2	0.3284
300									9.8	0.4581
315									10.3	0.5009

compressed air 9 bar, depending on the volume flow, 15-35 mm

temperature: 20°C
density: 10.836 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.0015 mm

d [mm]	15		18		22		28		35	
di [mm]	12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.5	0.0447	0.3	0.0168	0.2	0.0065	0.1	0.0019	0.1	0.0007
0.5	1.0	0.1474	0.7	0.0551	0.5	0.0211	0.3	0.0060	0.2	0.0021
0.75	1.6	0.2986	1.0	0.1114	0.7	0.0426	0.4	0.0120	0.3	0.0042
1	2.1	0.4944	1.4	0.1840	0.9	0.0701	0.5	0.0198	0.3	0.0069
1.25	2.6	0.7323	1.7	0.2720	1.2	0.1036	0.7	0.0291	0.4	0.0101
1.5	3.1	1.0107	2.1	0.3749	1.4	0.1425	0.8	0.0400	0.5	0.0139
1.75	3.7	1.3284	2.4	0.4921	1.6	0.1869	0.9	0.0524	0.6	0.0182
2	4.2	1.6842	2.8	0.6233	1.8	0.2365	1.1	0.0662	0.7	0.0229
2.25	4.7	2.0774	3.1	0.7680	2.1	0.2911	1.2	0.0815	0.8	0.0282
2.5	5.2	2.5073	3.5	0.9261	2.3	0.3508	1.3	0.0981	0.9	0.0339
2.75	5.8	2.9732	3.8	1.0973	2.5	0.4153	1.5	0.1160	0.9	0.0401
3	6.3	3.4747	4.1	1.2814	2.8	0.4846	1.6	0.1353	1.0	0.0467
3.25	6.8	4.0113	4.5	1.4782	3.0	0.5587	1.8	0.1558	1.1	0.0537
3.5	7.3	4.5827	4.8	1.6875	3.2	0.6374	1.9	0.1776	1.2	0.0612
3.75	7.8	5.1883	5.2	1.9093	3.5	0.7208	2.0	0.2007	1.3	0.0692
4	8.4	5.8280	5.5	2.1433	3.7	0.8087	2.2	0.2251	1.4	0.0775
4.5	9.4	7.2084	6.2	2.6478	4.1	0.9981	2.4	0.2775	1.6	0.0955
5	10.5	8.7216	6.9	3.2000	4.6	1.2051	2.7	0.3347	1.7	0.1151
5.5			7.6	3.7995	5.1	1.4296	3.0	0.3967	1.9	0.1363
6			8.3	4.4454	5.5	1.6713	3.2	0.4633	2.1	0.1591
6.5			9.0	5.1373	6.0	1.9300	3.5	0.5346	2.2	0.1834
7			9.7	5.8747	6.4	2.2054	3.8	0.6104	2.4	0.2093
7.5			10.4	6.7000	6.9	2.4975	4.0	0.6907	2.6	0.2367
8					7.4	2.8059	4.3	0.7754	2.8	0.2656
8.5					7.8	3.1307	4.6	0.8645	2.9	0.2960
9					8.3	3.4716	4.9	0.9581	3.1	0.3279
9.5					8.7	3.8285	5.1	1.0559	3.3	0.3612
10					9.2	4.2014	5.4	1.1580	3.5	0.3960
10.5					9.7	4.5901	5.7	1.2644	3.6	0.4322
11					10.1	4.9945	5.9	1.3750	3.8	0.4698
11.5							6.2	1.4898	4.0	0.5088
12							6.5	1.6088	4.1	0.5493
12.5							6.7	1.7319	4.3	0.5911
13							7.0	1.8592	4.5	0.6343
13.5							7.3	1.9906	4.7	0.6789
14							7.6	2.1260	4.8	0.7249
14.5							7.8	2.2655	5.0	0.7722
15							8.1	2.4091	5.2	0.8209
16							8.6	2.7083	5.5	0.9222
17							9.2	3.0235	5.9	1.0289
18							9.7	3.3545	6.2	1.1410
19							10.3	3.7013	6.6	1.2582
20							10.8	4.0637	6.9	1.3807
21									7.3	1.5083
22									7.6	1.6411
23									7.9	1.7790
24									8.3	1.9920
25									8.6	2.0701
30									10.4	2.8852

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0003	0.0	0.0001						
0.5	0.1	0.0008	0.1	0.0002						
0.75	0.2	0.0017	0.1	0.0005						
1	0.2	0.0027	0.1	0.0008						
1.25	0.3	0.0040	0.2	0.0011						
1.5	0.3	0.0054	0.2	0.0015						
1.75	0.4	0.0071	0.2	0.0020						
2	0.5	0.0090	0.3	0.0025						
2.25	0.5	0.0110	0.3	0.0031						
2.5	0.6	0.0132	0.3	0.0037						
2.75	0.6	0.0156	0.4	0.0044						
3	0.7	0.0182	0.4	0.0051						
3.25	0.8	0.0209	0.4	0.0059						
3.5	0.8	0.0239	0.5	0.0067						
3.75	0.9	0.0269	0.5	0.0075						
4	0.9	0.0302	0.5	0.0084						
4.5	1.0	0.0371	0.6	0.0103						
5	1.2	0.0447	0.7	0.0125						
5.5	1.3	0.0530	0.7	0.0147						
6	1.4	0.0618	0.8	0.0172						
6.5	1.5	0.0712	0.9	0.0198						
7	1.6	0.0812	1.0	0.0225						
7.5	1.7	0.0918	1.0	0.0255						
8	1.9	0.1030	1.1	0.0286						
8.5	2.0	0.1147	1.2	0.0318						
9	2.1	0.1270	1.2	0.0352						
9.5	2.2	0.1399	1.3	0.0387						
10	2.3	0.1533	1.4	0.0424	0.7	0.0081	0.5	0.0037	0.3	0.0014
10.5	2.4	0.1672	1.4	0.0463	0.7	0.0089	0.5	0.0041	0.3	0.0015
11	2.6	0.1817	1.5	0.0503	0.7	0.0096	0.5	0.0044	0.4	0.0017
11.5	2.7	0.1968	1.6	0.0544	0.8	0.0104	0.6	0.0048	0.4	0.0018
12	2.8	0.2124	1.6	0.0587	0.8	0.0112	0.6	0.0051	0.4	0.0020
12.5	2.9	0.2285	1.7	0.0631	0.9	0.0121	0.6	0.0055	0.4	0.0021
13	3.0	0.2451	1.8	0.0677	0.9	0.0129	0.6	0.0059	0.4	0.0023
13.5	3.1	0.2623	1.8	0.0724	0.9	0.0138	0.7	0.0063	0.4	0.0024
14	3.3	0.2800	1.9	0.0773	1.0	0.0147	0.7	0.0068	0.5	0.0026
14.5	3.4	0.2982	2.0	0.0823	1.0	0.0157	0.7	0.0072	0.5	0.0027
15	3.5	0.3169	2.0	0.0874	1.0	0.0167	0.7	0.0076	0.5	0.0029
16	3.7	0.3558	2.2	0.0981	1.1	0.0187	0.8	0.0086	0.5	0.0032
17	4.0	0.3968	2.3	0.1094	1.2	0.0208	0.8	0.0095	0.6	0.0036
18	4.2	0.4398	2.4	0.1212	1.2	0.0231	0.9	0.0105	0.6	0.0040
19	4.4	0.4849	2.6	0.1335	1.3	0.0254	0.9	0.0116	0.6	0.0044
20	4.7	0.5318	2.7	0.1464	1.4	0.0278	1.0	0.0127	0.7	0.0048
21	4.9	0.5808	2.9	0.1598	1.4	0.0304	1.0	0.0139	0.7	0.0053
22	5.1	0.6317	3.0	0.1737	1.5	0.0330	1.1	0.0151	0.7	0.0057
23	5.3	0.6845	3.1	0.1882	1.6	0.0357	1.1	0.0163	0.8	0.0062
24	5.6	0.7393	3.3	0.2031	1.6	0.0385	1.2	0.0176	0.8	0.0067
25	5.8	0.7960	3.4	0.2186	1.7	0.0415	1.2	0.0189	0.8	0.0072
30	7.0	1.1077	4.1	0.3037	2.0	0.0575	1.5	0.0262	1.0	0.0099
35	8.1	1.4658	4.8	0.4013	2.4	0.0758	1.7	0.0346	1.1	0.0131
40	9.3	1.8694	5.4	0.5110	2.7	0.0964	2.0	0.0440	1.3	0.0166
45	10.5	2.3177	6.1	0.6327	3.1	0.1192	2.2	0.0543	1.5	0.0205
50			6.8	0.7663	3.4	0.1442	2.5	0.0657	1.6	0.0248
55			7.5	0.9114	3.7	0.1713	2.7	0.0780	1.8	0.0294
60			8.2	1.0680	4.1	0.2005	2.9	0.0913	2.0	0.0344
65			8.8	1.2359	4.4	0.2318	3.2	0.1055	2.1	0.0397
70			9.5	1.4151	4.8	0.2652	3.4	0.1206	2.3	0.0454
75			10.2	1.6054	5.1	0.3006	3.7	0.1366	2.5	0.0514
80			10.9	1.8067	5.4	0.3380	3.9	0.1536	2.6	0.0578
85					5.8	0.3774	4.2	0.1714	2.8	0.0645
90					6.1	0.4188	4.4	0.1902	2.9	0.0715
95					6.5	0.4621	4.7	0.2098	3.1	0.0789
100					6.8	0.5074	4.9	0.2303	3.3	0.0865
105					7.1	0.5546	5.2	0.2517	3.4	0.0945
110					7.5	0.6038	5.4	0.2739	3.6	0.1028
115					7.8	0.6548	5.6	0.2970	3.8	0.1115

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
120					8.2	0.7078	5.9	0.3209	3.9	0.1204
125					8.5	0.7627	6.1	0.3457	4.1	0.1297
130					8.8	0.8194	6.4	0.3714	4.3	0.1393
135					9.2	0.8780	6.6	0.3978	4.4	0.1492
140					9.5	0.9385	6.9	0.4251	4.6	0.1594
145					9.9	1.0009	7.1	0.4533	4.7	0.1699
150					10.2	1.0651	7.4	0.4822	4.9	0.1807
160									5.2	0.2033
170									5.6	0.2270
180									5.9	0.2520
190									6.2	0.2781
200									6.5	0.3054
210									6.9	0.3339
220									7.2	0.3636
230									7.5	0.3944
240									7.8	0.4264
250									8.2	0.4595
300									9.8	0.6421
315									10.3	0.7024

compressed air 12 bar, depending on the volume flow, 15-35 mm

temperature: 20°C
density: 14.448 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.0015 mm

d [mm]	15		18		22		28		35	
di [mm]	12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.5	0.0549	0.3	0.0206	0.2	0.0079	0.1	0.0023	0.1	0.0008
0.5	1.0	0.1823	0.7	0.0681	0.5	0.0260	0.3	0.0074	0.2	0.0026
0.75	1.6	0.3708	1.0	0.1380	0.7	0.0526	0.4	0.0148	0.3	0.0052
1	2.1	0.6155	1.4	0.2285	0.9	0.0870	0.5	0.0245	0.3	0.0085
1.25	2.6	0.9137	1.7	0.3386	1.2	0.1286	0.7	0.0361	0.4	0.0125
1.5	3.1	1.2632	2.1	0.4675	1.4	0.1773	0.8	0.0497	0.5	0.0172
1.75	3.7	1.6625	2.4	0.6144	1.6	0.2328	0.9	0.0651	0.6	0.0225
2	4.2	2.1104	2.8	0.7791	1.8	0.2949	1.1	0.0824	0.7	0.0285
2.25	4.7	2.6060	3.1	0.9610	2.1	0.3635	1.2	0.1014	0.8	0.0350
2.5	5.2	3.1485	3.5	1.1599	2.3	0.4383	1.3	0.1222	0.9	0.0421
2.75	5.8	3.7370	3.8	1.3755	2.5	0.5194	1.5	0.1447	0.9	0.0499
3	6.3	4.3710	4.1	1.6075	2.8	0.6065	1.6	0.1688	1.0	0.0581
3.25	6.8	5.0501	4.5	1.8557	3.0	0.6997	1.8	0.1946	1.1	0.0670
3.5	7.3	5.7736	4.8	2.1199	3.2	0.7988	1.9	0.2220	1.2	0.0764
3.75	7.8	6.5412	5.2	2.4000	3.5	0.9039	2.0	0.2510	1.3	0.0863
4	8.4	7.3526	5.5	2.6958	3.7	1.0147	2.2	0.2816	1.4	0.0968
4.5	9.4	9.1051	6.2	3.3340	4.1	1.2535	2.4	0.3475	1.6	0.1193
5	10.5	11.0289	6.9	4.0335	4.6	1.5150	2.7	0.4195	1.7	0.1439
5.5			7.6	4.7935	5.1	1.7987	3.0	0.4975	1.9	0.1706
6			8.3	5.6132	5.5	2.1044	3.2	0.5815	2.1	0.1992
6.5			9.0	6.4920	6.0	2.4319	3.5	0.6714	2.2	0.2299
7			9.7	7.4294	6.4	2.7808	3.8	0.7671	2.4	0.2625
7.5			10.4	8.4000	6.9	3.1510	4.0	0.8685	2.6	0.2970
8					7.4	3.5424	4.3	0.9756	2.8	0.3334
8.5					7.8	3.9546	4.6	1.0883	2.9	0.3718
9					8.3	4.3876	4.9	1.2066	3.1	0.4120
9.5					8.7	4.8413	5.1	1.3304	3.3	0.4540
10					9.2	5.3154	5.4	1.4598	3.5	0.4979
10.5					9.7	5.8100	5.7	1.5945	3.6	0.5437
11					10.1	6.3248	5.9	1.7347	3.8	0.5912
11.5							6.2	1.8803	4.0	0.6405
12							6.5	2.0312	4.1	0.6917
12.5							6.7	2.1875	4.3	0.7446
13							7.0	2.3490	4.5	0.7993
13.5							7.3	2.5159	4.7	0.8557
14							7.6	2.6879	4.8	0.9139
14.5							7.8	2.8652	5.0	0.9738
15							8.1	3.0478	5.2	1.0355
16							8.6	3.4283	5.5	1.1640
17							9.2	3.8294	5.9	1.2994
18							9.7	4.2510	6.2	1.4415
19							10.3	4.6928	6.6	1.5904
20							10.8	5.1549	6.9	1.7460
21									7.3	1.9082
22									7.6	2.0770
23									7.9	2.2524
24									8.3	2.4344
25									8.6	2.6228
30									10.4	3.6617

42-54 mm

d [mm]	42		54	
di [mm]	39		51	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0003	0.0	0.0001
0.5	0.1	0.0010	0.1	0.0003
0.75	0.2	0.0020	0.1	0.0006
1	0.2	0.0033	0.1	0.0009
1.25	0.3	0.0049	0.2	0.0014
1.5	0.3	0.0067	0.2	0.0019
1.75	0.4	0.0088	0.2	0.0025
2	0.5	0.0111	0.3	0.0031
2.25	0.5	0.0137	0.3	0.0038
2.5	0.6	0.0164	0.3	0.0046
2.75	0.6	0.0194	0.4	0.0054
3	0.7	0.0226	0.4	0.0063
3.25	0.8	0.0261	0.4	0.0073
3.5	0.8	0.0297	0.5	0.0083
3.75	0.9	0.0336	0.5	0.0093
4	0.9	0.0376	0.5	0.0105
4.5	1.0	0.0463	0.6	0.0129
5	1.2	0.0559	0.7	0.0155
5.5	1.3	0.0662	0.7	0.0184
6	1.4	0.0772	0.8	0.0214
6.5	1.5	0.0891	0.9	0.0247
7	1.6	0.1016	1.0	0.0282
7.5	1.7	0.1150	1.0	0.0318
8	1.9	0.1290	1.1	0.0357
8.5	2.0	0.1438	1.2	0.0398
9	2.1	0.1593	1.2	0.0440
9.5	2.2	0.1755	1.3	0.0485
10	2.3	0.1924	1.4	0.0531
10.5	2.4	0.2100	1.4	0.0580
11	2.6	0.2282	1.5	0.0630
11.5	2.7	0.2472	1.6	0.0682
12	2.8	0.2669	1.6	0.0736
12.5	2.9	0.2872	1.7	0.0792
13	3.0	0.3082	1.8	0.0849
13.5	3.1	0.3299	1.8	0.0909
14	3.3	0.3522	1.9	0.0970
14.5	3.4	0.3752	2.0	0.1033
15	3.5	0.3989	2.0	0.1098
16	3.7	0.4482	2.2	0.1233
17	4.0	0.5000	2.3	0.1375
18	4.2	0.5545	2.4	0.1524
19	4.4	0.6115	2.6	0.1679
20	4.7	0.6710	2.7	0.1842
21	4.9	0.7330	2.9	0.2011
22	5.1	0.7975	3.0	0.2187
23	5.3	0.8646	3.1	0.2370
24	5.6	0.9340	3.3	0.2559
25	5.8	1.0060	3.4	0.2755
30	7.0	1.4020	4.1	0.3833
35	8.1	1.8577	4.8	0.5070
40	9.3	2.3720	5.4	0.6463
45	10.5	2.9440	6.1	0.8010
50			6.8	0.9708
55			7.5	1.1555
60			8.2	1.3550
65			8.8	1.5691
70			9.5	1.7977
75			10.2	2.0407
80			10.9	2.2979
85				
90				
95				
100				
105				
110				

compressed air 16 bar, depending on the volume flow, 15-35 mm

temperature: 20°C
density: 19.110 kg/m³
viscosity: 0.0000171 Pa·s
surface roughness: 0.0015 mm

d [mm]	12		15		18		22		28		35	
di [mm]	10		13		16		19.6		25.6		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.9	0.2331	0.5	0.0672	0.3	0.0252	0.2	0.0097	0.1	0.0015	0.1	0.0010
0.5	1.8	0.7853	1	0.2248	0.7	0.0837	0.5	0.0319	0.3	0.0090	0.2	0.0031
0.75	2.7	1.6101	1.6	0.4588	1	0.1704	0.7	0.0648	0.4	0.0182	0.3	0.0063
1	3.5	2.6889	2.1	0.7636	1.4	0.2829	0.9	0.1074	0.5	0.0301	0.3	0.0104
1.25	4.4	4.0104	2.6	1.1358	1.7	0.4200	1.2	0.1592	0.7	0.0446	0.4	0.1541
1.5	5.3	5.5671	3.1	1.5729	2.1	0.5807	1.4	0.2198	0.8	0.0614	0.5	0.0212
1.75	6.2	7.3533	3.7	2.0731	2.4	0.7643	1.6	0.2889	0.9	0.0806	0.6	0.0278
2	7.1	9.3647	4.2	2.6350	2.8	0.9702	1.8	0.3665	1.1	0.1021	0.7	0.0352
2.25	8.0	11.5987	4.7	3.2574	3.1	1.1980	2.1	0.4521	1.2	0.1258	0.8	0.0433
2.5	8.8	14.0450	5.2	3.9395	3.5	1.4472	2.3	0.5456	1.3	0.1517	0.9	0.0522
2.75	9.7	16.7187	5.8	4.6803	3.8	1.7177	2.5	0.6470	1.5	0.1797	0.9	0.0618
3	10.6	19.6021	6.3	5.4792	4.1	2.0090	2.8	0.7562	1.6	0.2099	1.0	0.0721
3.25			6.8	6.3357	4.5	2.3209	3	0.8729	1.8	0.2421	1.1	0.0832
3.5			7.3	7.2491	4.8	2.6532	3.2	0.9972	1.9	0.2764	1.2	0.0949
3.75			7.8	8.2189	5.2	3.0057	3.5	1.1290	2.0	0.3126	1.3	0.1073
4			8.4	9.2449	5.5	3.3783	3.7	1.2681	2.2	0.3509	1.4	0.1203
4.5			9.4	11.4637	6.2	4.1828	4.1	1.5682	2.4	0.4334	1.6	0.1485
5			10.5	13.9027	6.9	5.0656	4.6	1.8971	2.7	0.5236	1.7	0.1793
5.5					7.6	6.0259	5.1	2.2543	3.0	0.6216	1.9	0.2126
6					8.3	7.0628	5.5	2.6396	3.2	0.7270	2.1	0.2485
6.5					9	8.1755	6	3.0526	3.5	0.8399	2.2	0.2869
7					9.7	9.3636	6.4	3.4930	3.8	0.9602	2.4	0.3277
7.5					10.4	10.6265	6.9	3.9607	4.0	1.0877	2.6	0.3711
8							7.4	4.4553	4.3	1.2225	2.8	0.4168
8.5							7.8	4.9768	4.6	1.3645	2.9	0.4649
9							8.3	5.5249	4.9	1.5135	3.1	0.5154
9.5							8.7	6.0996	5.1	1.6696	3.3	0.5683
10							9.2	6.7005	5.4	1.8327	3.5	0.6235
10.5							9.7	7.3277	5.7	2.0028	3.6	0.6810
11							10.1	7.9810	5.9	2.1798	3.8	0.7408
11.5									6.2	2.3637	4.0	0.8029
12									6.5	2.5544	4.1	0.8673
12.5									6.7	2.7519	4.3	0.9340
13									7.0	2.9562	4.5	1.0029
13.5									7.3	3.1673	4.7	1.0741
14									7.6	3.3851	4.8	1.1475
14.5									7.8	3.6095	5.0	1.2231
15									8.1	3.8407	5.2	1.3009
16									8.6	4.3230	5.5	1.4631
17									9.2	4.8316	5.9	1.6341
18									9.7	5.3666	6.2	1.8138
19									10.3	5.9277	6.6	2.0020
20											6.9	2.1989
21											7.3	2.4042
22											7.6	2.0618
23											7.9	2.8403
24											8.3	3.0709
25											8.6	3.3099
30											10.3	4.6291

42-54 mm

d [mm]	42		54	
di [mm]	39		51	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0004		
0.5	0.1	0.0012	0.1	0.0003
0.75	0.2	0.0025	0.1	0.0007
1	0.3	0.0060	0.1	0.0012
1.25	0.3	0.0083	0.2	0.0017
1.5	0.4	0.0109	0.2	0.0023
1.75	0.5	0.0137	0.2	0.0030
2	0.5	0.0169	0.3	0.0038
2.25	0.6	0.0203	0.3	0.0047
2.5	0.6	0.0240	0.3	0.0057
2.75	0.7	0.0280	0.4	0.0067
3	0.8	0.0323	0.4	0.0078
3.25	0.8	0.0368	0.4	0.0090
3.5	0.9	0.0416	0.5	0.0102
3.75	0.9	0.0467	0.5	0.0116
4	1.0	0.0576	0.5	0.0130
4.5	1.2	0.0694	0.6	0.0160
5	1.3	0.0823	0.7	0.0192
5.5	1.4	0.0962	0.7	0.0228
6	1.5	0.1110	0.8	0.0266
6.5	1.6	0.1267	0.9	0.0307
7	1.7	0.1434	1.0	0.0350
7.5	1.9	0.1610	1.0	0.0396
8	2.0	0.1795	1.1	0.0444
8.5	2.1	0.1989	1.2	0.0495
9	2.2	0.2192	1.2	0.0549
9.5	2.3	0.2404	1.3	0.0604
10	2.4	0.2625	1.4	0.0662
10.5	2.6	0.2854	1.4	0.0722
11	2.7	0.3093	1.5	0.0786
11.5	2.8	0.3340	1.6	0.0851
12	2.9	0.3595	1.6	0.0918
12.5	3.0	0.3859	1.7	0.0987
13	3.1	0.4131	1.8	0.1061
13.5	3.3	0.4413	1.8	0.1135
14	3.4	0.4702	1.9	0.1212
14.5	3.5	0.5000	2.0	0.1291
15	3.7	0.5620	2.0	0.1373
16	4.0	0.6273	2.2	0.1542
17	4.2	0.6960	2.3	0.1720
18	4.4	0.7678	2.4	0.1907
19	4.7	0.8429	2.6	0.2103
20	4.9	0.9212	2.7	0.2307
21	5.1	1.0027	2.9	0.2520
22	5.3	1.0873	3.0	0.2742
23	5.6	1.1751	3.1	0.2972
24	5.8	1.2660	3.3	0.3210
25	7.0	1.7672	3.4	0.3457
30	8.1	2.3447	4.1	0.4815
35	9.3	2.9975	4.8	0.6377
40	10.5	3.7244	5.4	0.8138
45			6.1	1.0095
50			6.8	1.2245
55			7.5	1.4588
60			8.2	1.7119
65			8.8	1.9838
70			9.5	2.2743
75			10.2	2.5832
80				
85				
90				
95				
100				
105				
110				

gas, 1st gas family, depending on the volume flow, 15-35 mm

density: 0.61 kg/m³
viscosity: 0.000015 Pa.s
surface roughness: 0.0015 mm

d [mm]	15		18		22		28		35	
di [mm]	13		16		19.6		25.6		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.5	0.0067	0.3	0.0026	0.2	0.0010	0.1	0.0003	0.1	0.0001
0.50	1.0	0.0201	0.7	0.0077	0.5	0.0030	0.3	0.0009	0.2	0.0003
0.75	1.6	0.0387	1.0	0.0148	0.7	0.0058	0.4	0.0017	0.3	0.0006
1.00	2.1	0.0621	1.4	0.0237	0.9	0.0092	0.5	0.0027	0.3	0.0010
1.25	2.6	0.0899	1.7	0.0342	1.2	0.0133	0.7	0.0039	0.4	0.0014
1.50	3.1	0.1217	2.1	0.0462	1.4	0.0180	0.8	0.0052	0.5	0.0019
1.75	3.7	0.1575	2.4	0.0597	1.6	0.0232	0.9	0.0067	0.6	0.0024
2.00	4.2	0.1971	2.8	0.0746	1.8	0.0289	1.1	0.0083	0.7	0.0030
2.25	4.7	0.2404	3.1	0.0909	2.1	0.0352	1.2	0.0101	0.8	0.0036
2.50	5.2	0.2872	3.5	0.1085	2.3	0.0420	1.3	0.0121	0.9	0.0043
2.75	5.8	0.3375	3.8	0.1274	2.5	0.0492	1.5	0.0141	0.9	0.0050
3.00	6.3	0.3912	4.1	0.1475	2.8	0.0570	1.6	0.0163	1.0	0.0058
3.25	6.8	0.4483	4.5	0.1689	3.0	0.0652	1.8	0.0187	1.1	0.0066
3.50	7.3	0.5086	4.8	0.1915	3.2	0.0739	1.9	0.0212	1.2	0.0075
3.75	7.8	0.5722	5.2	0.2154	3.5	0.0830	2.0	0.0238	1.3	0.0084
4.00	8.4	0.6389	5.5	0.2403	3.7	0.0926	2.2	0.0265	1.4	0.0093
4.50	9.4	0.7817	6.2	0.2938	4.1	0.1131	2.4	0.0323	1.6	0.0114
5.00	10.5	0.9367	6.9	0.3517	4.6	0.1353	2.7	0.0386	1.7	0.0136
5.50			7.6	0.4140	5.1	0.1591	3.0	0.0453	1.9	0.0159
6.00			8.3	0.4807	5.5	0.1846	3.2	0.0525	2.1	0.0184
6.50			9.0	0.5516	6.0	0.2117	3.5	0.0602	2.2	0.0211
7.00			9.7	0.6266	6.4	0.2404	3.8	0.0683	2.4	0.0239
7.50			10.4	0.7	6.9	0.2706	4.0	0.0768	2.6	0.0269
8.00					7.4	0.3023	4.3	0.0858	2.8	0.0300
8.50					7.8	0.3356	4.6	0.0952	2.9	0.0333
9.00					8.3	0.3703	4.9	0.1049	3.1	0.0367
9.50					8.7	0.4065	5.1	0.1151	3.3	0.0402
10.00					9.2	0.4441	5.4	0.1257	3.5	0.0439
10.50					9.7	0.4832	5.7	0.1367	3.6	0.0477
11.00					10.1	0.5237	5.9	0.1481	3.8	0.0517
11.50							6.2	0.1599	4.0	0.0558
12.00							6.5	0.1721	4.1	0.0600
12.50							6.7	0.1846	4.3	0.0644
13.00							7.0	0.1976	4.5	0.0688
13.50							7.3	0.2109	4.7	0.0735
14.00							7.6	0.2246	4.8	0.0782
14.50							7.8	0.2386	5.0	0.0831
15.00							8.1	0.2531	5.2	0.0881
16.00							8.6	0.2830	5.5	0.0984
17.00							9.2	0.3144	5.9	0.1093
18.00							9.7	0.3472	6.2	0.1207
19.00							10.3	0.3814	6.6	0.1325
20.00							10.8	0.4170	6.9	0.1448
21.00									7.3	0.1576
22.00									7.6	0.1709
23.00									7.9	0.1846
24.00									8.3	0.1987
25.00									8.6	0.2134
30.00									10.4	0.2932

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0000	0.0	0.0000						
0.50	0.1	0.0001	0.1	0.0000						
0.75	0.2	0.0002	0.1	0.0001						
1.00	0.2	0.0004	0.1	0.0001						
1.25	0.3	0.0006	0.2	0.0002						
1.50	0.3	0.0007	0.2	0.0002						
1.75	0.4	0.0010	0.2	0.0003						
2.00	0.5	0.0012	0.3	0.0003						
2.25	0.5	0.0014	0.3	0.0004						
2.50	0.6	0.0017	0.3	0.0005						
2.75	0.6	0.0020	0.4	0.0006						
3.00	0.7	0.0023	0.4	0.0007						
3.25	0.8	0.0026	0.4	0.0008						
3.50	0.8	0.0030	0.5	0.0009						
3.75	0.9	0.0033	0.5	0.0010						
4.00	0.9	0.0037	0.5	0.0011						
4.50	1.0	0.0045	0.6	0.0013						
5.00	1.2	0.0054	0.7	0.0015						
5.50	1.3	0.0063	0.7	0.0018						
6.00	1.4	0.0073	0.8	0.0021						
6.50	1.5	0.0083	0.9	0.0024						
7.00	1.6	0.0095	1.0	0.0027						
7.50	1.7	0.0106	1.0	0.0030						
8.00	1.9	0.0118	1.1	0.0034						
8.50	2.0	0.0131	1.2	0.0037						
9.00	2.1	0.0145	1.2	0.0041						
9.50	2.2	0.0159	1.3	0.0045						
10.00	2.3	0.0173	1.4	0.0049	0.7	0.0010	0.5	0.0005	0.3	0.0002
10.50	2.4	0.0188	1.4	0.0053	0.7	0.0011	0.5	0.0005	0.3	0.0002
11.00	2.6	0.0204	1.5	0.0058	0.7	0.0011	0.5	0.0005	0.4	0.0002
11.50	2.7	0.0220	1.6	0.0062	0.8	0.0012	0.6	0.0006	0.4	0.0002
12.00	2.8	0.0236	1.6	0.0067	0.8	0.0013	0.6	0.0006	0.4	0.0002
12.50	2.9	0.0253	1.7	0.0072	0.9	0.0014	0.6	0.0007	0.4	0.0003
13.00	3.0	0.0271	1.8	0.0077	0.9	0.0015	0.6	0.0007	0.4	0.0003
13.50	3.1	0.0289	1.8	0.0082	0.9	0.0016	0.7	0.0007	0.4	0.0003
14.00	3.3	0.0307	1.9	0.0087	1.0	0.0017	0.7	0.0008	0.5	0.0003
14.50	3.4	0.0326	2.0	0.0092	1.0	0.0018	0.7	0.0008	0.5	0.0003
15.00	3.5	0.0346	2.0	0.0098	1.0	0.0019	0.7	0.0009	0.5	0.0003
16.00	3.7	0.0387	2.2	0.0109	1.1	0.0021	0.8	0.0010	0.5	0.0004
17.00	4.0	0.0429	2.3	0.0121	1.2	0.0024	0.8	0.0011	0.6	0.0004
18.00	4.2	0.0474	2.4	0.0134	1.2	0.0026	0.9	0.0012	0.6	0.0005
19.00	4.4	0.0520	2.6	0.0146	1.3	0.0029	0.9	0.0013	0.6	0.0005
20.00	4.7	0.0568	2.7	0.0160	1.4	0.0031	1.0	0.0015	0.7	0.0006
21.00	4.9	0.0618	2.9	0.0174	1.4	0.0034	1.0	0.0016	0.7	0.0006
22.00	5.1	0.0670	3.0	0.0188	1.5	0.0037	1.1	0.0017	0.7	0.0007
23.00	5.3	0.0723	3.1	0.0203	1.6	0.0040	1.1	0.0018	0.8	0.0007
24.00	5.6	0.0778	3.3	0.0219	1.6	0.0043	1.2	0.0020	0.8	0.0008
25.00	5.8	0.0836	3.4	0.0235	1.7	0.0046	1.2	0.0021	0.8	0.0008
30.00	7.0	0.1147	4.1	0.0322	2.0	0.0063	1.5	0.0029	1.0	0.0011
35.00	8.1	0.1500	4.8	0.0420	2.4	0.0082	1.7	0.0038	1.1	0.0015
40.00	9.3	0.1894	5.4	0.0530	2.7	0.0103	2.0	0.0048	1.3	0.0018
45.00	10.5	0.2328	6.1	0.0651	3.1	0.0126	2.2	0.0058	1.5	0.0022
50.00			6.8	0.0782	3.4	0.0151	2.5	0.0070	1.6	0.0027
55.00			7.5	0.0924	3.7	0.0179	2.7	0.0082	1.8	0.0032
60.00			8.2	0.1076	4.1	0.0208	2.9	0.0096	2.0	0.0037
65.00			8.8	0.1238	4.4	0.0239	3.2	0.0110	2.1	0.0042
70.00			9.5	0.1410	4.8	0.0272	3.4	0.0125	2.3	0.0048
75.00			10.2	0.1592	5.1	0.0307	3.7	0.0141	2.5	0.0054
80.00			10.9	0.1784	5.4	0.0344	3.9	0.0158	2.6	0.0060
85.00					5.8	0.0382	4.2	0.0176	2.8	0.0067
90.00					6.1	0.0422	4.4	0.0194	2.9	0.0074
95.00					6.5	0.0464	4.7	0.0214	3.1	0.0081
100.00					6.8	0.0508	4.9	0.0234	3.3	0.0089
105.00					7.1	0.0553	5.2	0.0254	3.4	0.0097
110.00					7.5	0.0601	5.4	0.0276	3.6	0.0105
115.00					7.8	0.0650	5.6	0.0298	3.8	0.0114

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
120.00					8.2	0.0700	5.9	0.0322	3.9	0.0123
125.00					8.5	0.0752	6.1	0.0345	4.1	0.0132
130.00					8.8	0.0806	6.4	0.0370	4.3	0.0141
135.00					9.2	0.0862	6.6	0.0396	4.4	0.0151
140.00					9.5	0.0919	6.9	0.0422	4.6	0.0161
145.00					9.9	0.0977	7.1	0.0449	4.7	0.0171
150.00					10.2	0.1038	7.4	0.0476	4.9	0.0181
160.00							7.9	0.0534	5.2	0.0203
170.00							8.3	0.0594	5.6	0.0226
180.00							8.8	0.0657	5.9	0.0250
190.00							9.3	0.0723	6.2	0.0275
200.00							9.8	0.0791	6.5	0.0301
210.00							10.3	0.0863	6.9	0.0328
220.00									7.2	0.0356
230.00									7.5	0.0385
240.00									7.8	0.0415
250.00									8.2	0.0446
300.00									9.8	0.0616

gas, 2nd gas family, depending on the volume flow, 15-35 mm

density: 0.79 kg/m³
viscosity: 0.000015 Pa.s
surface roughness: 0.0015 mm

d [mm]	15		18		22		28		35	
di [mm]	12.6		15.6		19		25		32	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.5	0.0077	0.3	0.0030	0.2	0.0012	0.1	0.0004	0.1	0.0001
0.50	1.0	0.0235	0.7	0.0090	0.5	0.0035	0.3	0.0010	0.2	0.0004
0.75	1.6	0.0457	1.0	0.0174	0.7	0.0068	0.4	0.0020	0.3	0.0007
1.00	2.1	0.0736	1.4	0.0280	0.9	0.0109	0.5	0.0032	0.3	0.0011
1.25	2.6	0.1068	1.7	0.0405	1.2	0.0157	0.7	0.0045	0.4	0.0016
1.50	3.1	0.1449	2.1	0.0549	1.4	0.0213	0.8	0.0061	0.5	0.0022
1.75	3.7	0.1879	2.4	0.0710	1.6	0.0275	0.9	0.0079	0.6	0.0028
2.00	4.2	0.2355	2.8	0.0889	1.8	0.0344	1.1	0.0099	0.7	0.0035
2.25	4.7	0.2875	3.1	0.1085	2.1	0.0419	1.2	0.0120	0.8	0.0042
2.50	5.2	0.3439	3.5	0.1296	2.3	0.0500	1.3	0.0143	0.9	0.0051
2.75	5.8	0.4046	3.8	0.1523	2.5	0.0588	1.5	0.0168	0.9	0.0059
3.00	6.3	0.4694	4.1	0.1766	2.8	0.0681	1.6	0.0195	1.0	0.0069
3.25	6.8	0.5383	4.5	0.2024	3.0	0.0779	1.8	0.0223	1.1	0.0078
3.50	7.3	0.6111	4.8	0.2297	3.2	0.0884	1.9	0.0252	1.2	0.0089
3.75	7.8	0.6880	5.2	0.2584	3.5	0.0994	2.0	0.0284	1.3	0.0100
4.00	8.4	0.7687	5.5	0.2885	3.7	0.1109	2.2	0.0316	1.4	0.0111
4.50	9.4	0.9415	6.2	0.3531	4.1	0.1356	2.4	0.0386	1.6	0.0135
5.00	10.5	1.1293	6.9	0.4231	4.6	0.1624	2.7	0.0462	1.7	0.0162
5.50			7.6	0.4986	5.1	0.1912	3.0	0.0543	1.9	0.0190
6.00			8.3	0.5793	5.5	0.2220	3.2	0.0630	2.1	0.0221
6.50			9.0	0.6653	6.0	0.2548	3.5	0.0723	2.2	0.0253
7.00			9.7	0.7563	6.4	0.2895	3.8	0.0820	2.4	0.0287
7.50			10.4	0.9	6.9	0.3261	4.0	0.0924	2.6	0.0323
8.00					7.4	0.3646	4.3	0.1032	2.8	0.0360
8.50					7.8	0.4049	4.6	0.1145	2.9	0.0400
9.00					8.3	0.4470	4.9	0.1264	3.1	0.0441
9.50					8.7	0.4910	5.1	0.1387	3.3	0.0484
10.00					9.2	0.5367	5.4	0.1516	3.5	0.0528
10.50					9.7	0.5842	5.7	0.1649	3.6	0.0574
11.00					10.1	0.6334	5.9	0.1787	3.8	0.0622
11.50							6.2	0.1930	4.0	0.0672
12.00							6.5	0.2078	4.1	0.0723
12.50							6.7	0.2230	4.3	0.0776
13.00							7.0	0.2387	4.5	0.0830
13.50							7.3	0.2549	4.7	0.0886
14.00							7.6	0.2715	4.8	0.0943
14.50							7.8	0.2886	5.0	0.1003
15.00							8.1	0.3061	5.2	0.1063
16.00							8.6	0.3425	5.5	0.1189
17.00							9.2	0.3807	5.9	0.1321
18.00							9.7	0.4206	6.2	0.1459
19.00							10.3	0.4623	6.6	0.1603
20.00							10.8	0.5056	6.9	0.1752
21.00									7.3	0.1908
22.00									7.6	0.2069
23.00									7.9	0.2236
24.00									8.3	0.2409
25.00									8.6	0.2587
30.00									10.4	0.3560

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0001	0.0	0.0000						
0.50	0.1	0.0002	0.1	0.0000						
0.75	0.2	0.0003	0.1	0.0001						
1.00	0.2	0.0005	0.1	0.0001						
1.25	0.3	0.0006	0.2	0.0002						
1.50	0.3	0.0009	0.2	0.0003						
1.75	0.4	0.0011	0.2	0.0003						
2.00	0.5	0.0014	0.3	0.0004						
2.25	0.5	0.0017	0.3	0.0005						
2.50	0.6	0.0020	0.3	0.0006						
2.75	0.6	0.0024	0.4	0.0007						
3.00	0.7	0.0027	0.4	0.0008						
3.25	0.8	0.0031	0.4	0.0009						
3.50	0.8	0.0035	0.5	0.0010						
3.75	0.9	0.0040	0.5	0.0011						
4.00	0.9	0.0044	0.5	0.0013						
4.50	1.0	0.0054	0.6	0.0015						
5.00	1.2	0.0064	0.7	0.0018						
5.50	1.3	0.0075	0.7	0.0021						
6.00	1.4	0.0087	0.8	0.0025						
6.50	1.5	0.0100	0.9	0.0028						
7.00	1.6	0.0113	1.0	0.0032						
7.50	1.7	0.0127	1.0	0.0036						
8.00	1.9	0.0142	1.1	0.0040						
8.50	2.0	0.0157	1.2	0.0045						
9.00	2.1	0.0173	1.2	0.0049						
9.50	2.2	0.0190	1.3	0.0054						
10.00	2.3	0.0208	1.4	0.0059	0.7	0.0012	0.5	0.0005	0.3	0.0002
10.50	2.4	0.0226	1.4	0.0064	0.7	0.0013	0.5	0.0006	0.3	0.0002
11.00	2.6	0.0245	1.5	0.0069	0.7	0.0014	0.5	0.0006	0.4	0.0002
11.50	2.7	0.0264	1.6	0.0075	0.8	0.0015	0.6	0.0007	0.4	0.0003
12.00	2.8	0.0284	1.6	0.0080	0.8	0.0016	0.6	0.0007	0.4	0.0003
12.50	2.9	0.0305	1.7	0.0086	0.9	0.0017	0.6	0.0008	0.4	0.0003
13.00	3.0	0.0326	1.8	0.0092	0.9	0.0018	0.6	0.0008	0.4	0.0003
13.50	3.1	0.0348	1.8	0.0098	0.9	0.0019	0.7	0.0009	0.4	0.0003
14.00	3.3	0.0370	1.9	0.0104	1.0	0.0020	0.7	0.0009	0.5	0.0004
14.50	3.4	0.0393	2.0	0.0111	1.0	0.0022	0.7	0.0010	0.5	0.0004
15.00	3.5	0.0417	2.0	0.0117	1.0	0.0023	0.7	0.0011	0.5	0.0004
16.00	3.7	0.0466	2.2	0.0131	1.1	0.0026	0.8	0.0012	0.5	0.0005
17.00	4.0	0.0518	2.3	0.0146	1.2	0.0028	0.8	0.0013	0.6	0.0005
18.00	4.2	0.0572	2.4	0.0161	1.2	0.0031	0.9	0.0015	0.6	0.0006
19.00	4.4	0.0628	2.6	0.0176	1.3	0.0034	0.9	0.0016	0.6	0.0006
20.00	4.7	0.0686	2.7	0.0193	1.4	0.0038	1.0	0.0017	0.7	0.0007
21.00	4.9	0.0747	2.9	0.0210	1.4	0.0041	1.0	0.0019	0.7	0.0007
22.00	5.1	0.0810	3.0	0.0227	1.5	0.0044	1.1	0.0020	0.7	0.0008
23.00	5.3	0.0875	3.1	0.0245	1.6	0.0048	1.1	0.0022	0.8	0.0009
24.00	5.6	0.0942	3.3	0.0264	1.6	0.0051	1.2	0.0024	0.8	0.0009
25.00	5.8	0.1011	3.4	0.0284	1.7	0.0055	1.2	0.0026	0.8	0.0010
30.00	7.0	0.1390	4.1	0.0389	2.0	0.0076	1.5	0.0035	1.0	0.0013
35.00	8.1	0.1820	4.8	0.0509	2.4	0.0099	1.7	0.0046	1.1	0.0017
40.00	9.3	0.2301	5.4	0.0643	2.7	0.0124	2.0	0.0057	1.3	0.0022
45.00	10.5	0.2830	6.1	0.0790	3.1	0.0153	2.2	0.0070	1.5	0.0027
50.00			6.8	0.0950	3.4	0.0183	2.5	0.0084	1.6	0.0032
55.00			7.5	0.1123	3.7	0.0217	2.7	0.0100	1.8	0.0038
60.00			8.2	0.1308	4.1	0.0252	2.9	0.0116	2.0	0.0044
65.00			8.8	0.1506	4.4	0.0290	3.2	0.0133	2.1	0.0051
70.00			9.5	0.1717	4.8	0.0330	3.4	0.0152	2.3	0.0058
75.00			10.2	0.1939	5.1	0.0373	3.7	0.0171	2.5	0.0065
80.00			10.9	0.2173	5.4	0.0417	3.9	0.0192	2.6	0.0073
85.00					5.8	0.0464	4.2	0.0213	2.8	0.0081
90.00					6.1	0.0514	4.4	0.0236	2.9	0.0090
95.00					6.5	0.0565	4.7	0.0259	3.1	0.0099
100.00					6.8	0.0618	4.9	0.0284	3.3	0.0108
105.00					7.1	0.0674	5.2	0.0309	3.4	0.0118
110.00					7.5	0.0732	5.4	0.0336	3.6	0.0128
115.00					7.8	0.0791	5.6	0.0363	3.8	0.0138

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		51		72.1		84.9		104	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
120.00					8.2	0.0853	5.9	0.0391	3.9	0.0149
125.00					8.5	0.0917	6.1	0.0421	4.1	0.0160
130.00					8.8	0.0983	6.4	0.0451	4.3	0.0171
135.00					9.2	0.1051	6.6	0.0482	4.4	0.0183
140.00					9.5	0.1121	6.9	0.0514	4.6	0.0195
145.00					9.9	0.1193	7.1	0.0547	4.7	0.0208
150.00					10.2	0.1266	7.4	0.0580	4.9	0.0221
160.00							7.9	0.0651	5.2	0.0247
170.00							8.3	0.0724	5.6	0.0275
180.00							8.8	0.0802	5.9	0.0304
190.00							9.3	0.0882	6.2	0.0335
200.00							9.8	0.0967	6.5	0.0367
210.00							10.3	0.1054	6.9	0.0400
220.00									7.2	0.0434
230.00									7.5	0.0470
240.00									7.8	0.0507
250.00									8.2	0.0545
300.00									9.8	0.0753

water 10°C, DIN EN / DVGW quality copper tubes, 12-35 mm

density: 999.8 kg/m³
pressure: 1 bar
viscosity: 0.0013 Pa·s
surface roughness: 0.0015 mm

d [mm]	12		15		18		22		28		35	
di [mm]	10		13		16		20		25		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.1	0.5	0.1	0.2	0.0	0.1	0.032	0.0	0.020	0.007	0.012	0.002
0.02	0.3	1.6	0.2	0.5	0.1	0.2	0.064	0.1	0.041	0.023	0.025	0.007
0.03	0.4	3.2	0.2	0.9	0.1	0.4	0.095	0.1	0.061	0.044	0.037	0.014
0.04	0.5	5.3	0.3	1.5	0.2	0.6	0.127	0.2	0.081	0.072	0.050	0.023
0.05	0.6	7.8	0.4	2.2	0.2	0.8	0.159	0.3	0.102	0.1	0.062	0.033
0.06	0.8	10.7	0.5	3.1	0.3	1.2	0.191	0.4	0.122	0.1	0.075	0.044
0.07	0.9	14.0	0.5	4.0	0.3	1.5	0.223	0.5	0.143	0.2	0.087	0.058
0.08	1.0	17.6	0.6	5.1	0.4	1.9	0.255	0.7	0.163	0.2	0.099	0.072
0.09	1.1	21.6	0.7	6.2	0.4	2.3	0.286	0.8	0.183	0.3	0.112	0.088
0.10	1.3	26.0	0.8	7.4	0.5	2.8	0.318	1.0	0.204	0.3	0.124	0.105
0.15	1.9	53.3	1.1	15.1	0.7	5.6	0.477	1.9	0.306	0.7	0.187	0.210
0.20	2.5	89.1	1.5	25.1	1.0	9.3	0.637	3.2	0.407	1.1	0.249	0.344
0.25	3.2	133.1	1.9	37.4	1.2	13.8	0.796	4.7	0.509	1.6	0.311	0.506
0.30	3.8	185.1	2.3	51.8	1.5	19.0	0.95	6.5	0.611	2.2	0.373	0.695
0.35	4.5	245.1	2.6	68.3	1.7	25.0	1.11	8.6	0.713	2.9	0.435	0.909
0.40	5.1	312.7	3.0	86.9	2.0	31.8	1.27	10.9	0.815	3.7	0.497	1.1
0.45	5.7	388.1	3.4	107.5	2.2	39.2	1.43	13.4	0.917	4.6	0.560	1.4
0.50	6.4	471.2	3.8	130.1	2.5	47.4	1.59	16.1	1.02	5.5	0.622	1.7
0.55	7.0	561.8	4.1	154.8	2.7	56.3	1.75	19.1	1.12	6.5	0.684	2.0
0.60			4.5	181.4	3.0	65.9	1.91	22.4	1.22	7.6	0.746	2.3
0.65			4.9	210.0	3.2	76.2	2.07	25.8	1.32	8.8	0.808	2.7
0.70			5.3	240.6	3.5	87.2	2.23	29.5	1.43	10.1	0.870	3.1
0.75			5.7	273.1	3.7	98.8	2.39	33.4	1.53	11.4	0.933	3.5
0.80			6.0	307.6	4.0	111.1	2.55	37.5	1.63	12.8	0.995	3.9
0.85			6.4	344.0	4.2	124.1	2.71	41.9	1.73	14.2	1.06	4.3
0.90			6.8	382.3	4.5	137.8	2.86	46.4	1.83	15.8	1.12	4.8
0.95			7.2	422.6	4.7	152.1	3.02	51.2	1.94	17.4	1.18	5.3
1.00					5.0	167.1	3.18	56.2	2.04	19.0	1.24	5.8
1.05					5.2	182.8	3.34	61.4	2.14	20.8	1.31	6.3
1.10					5.5	199.1	3.50	66.8	2.24	22.6	1.37	6.9
1.15					5.7	216.1	3.66	72.5	2.34	24.5	1.43	7.4
1.20					6.0	233.8	3.82	78.3	2.44	26.5	1.49	8.0
1.25					6.2	252.1	3.98	84.4	2.55	28.5	1.55	8.6
1.30					6.5	271.0	4.14	90.6	2.65	30.6	1.62	9.3
1.40					7.0	310.9	4.46	103.8	2.85	35.0	1.74	10.6
1.50					7.5	353.3	4.77	117.8	3.06	39.6	1.87	12.0
1.60					8.0	398.4	5.09	132.6	3.26	44.6	1.99	13.5
1.70					8.5	446.0	5.41	148.3	3.46	49.8	2.11	15.0
1.80					9.0	496.2	5.73	164.8	3.67	55.2	2.24	16.6
1.90					9.4	548.9	6.05	182.1	3.87	61.0	2.36	18.4
2.00					9.9	604.3	6.37	200.2	4.07	67.0	2.49	20.1
2.10							6.68	219.1	4.28	73.2	2.61	22.0
2.20							7.00	238.9	4.48	79.8	2.74	23.9
2.30							7.32	259.4	4.69	86.5	2.86	26.0
2.40							7.64	280.8	4.89	93.6	2.98	28.0
2.50							7.96	303.0	5.09	100.9	3.11	30.2
2.60							8.28	326.0	5.30	108.5	3.23	32.4
2.70							8.59	349.7	5.50	116.3	3.36	34.8
2.80							8.91	374.3	5.70	124.4	3.48	37.1
2.90							9.23	399.7	5.91	132.7	3.61	39.6
3.00							9.55	425.9	6.11	141.3	3.73	42.1
3.10							9.87	452.9	6.32	150.1	3.85	44.7
3.20							10.19	480.7	6.52	159.2	3.98	47.4
3.30							10.50	509.3	6.72	168.6	4.10	50.2
3.40							10.82	538.7	6.93	178.2	4.23	53.0
3.50							11.14	568.8	7.13	188.0	4.35	55.9
3.80							12.10	664.2	7.74	219.1	4.72	65.0
3.90							12.41	697.5	7.95	230.0	4.85	68.2
4.00							12.73	731.7	8.15	241.1	4.97	71.5
4.10							13.05	766.6	8.35	252.5	5.10	74.8
4.20									8.56	264.1	5.22	78.2

12-35 mm

d [mm]	12		15		18		22		28		35	
di [mm]	10		13		16		20		25		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.30									8.76	276.0	5.35	81.7
4.40									8.96	288.2	5.47	85.2
4.50									9.17	300.5	5.60	88.8
4.60									9.37	313.2	5.72	92.5
4.70									9.57	326.0	5.84	96.3
4.80									9.78	339.2	5.97	100.1
4.90									9.98	352.6	6.09	104.0
5.00									10.19	366.2	6.22	108.0
5.50									11.20	438.1	6.84	128.8
6.00									12.22	516.2	7.46	151.5
6.50									13.24	600.5	8.08	175.9
7.00									14.26	691.0	8.70	202.0
7.50									15.28	787.7	9.33	229.9
8.00									16.30	890.5	9.95	259.5
8.50											10.57	290.9
9.00											11.19	323.9
9.50											11.81	358.7
10.00											12.43	395.2
10.50											13.06	433.4
11.00											13.68	473.3
11.50											14.30	515.0
12.00											14.92	558.3
12.50											15.54	603.4
13.00											16.16	650.1
13.50											16.79	698.6
14.00											17.41	748.7
14.50											18.03	800.6

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		50		72.1		84.9		103	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.008	0.001	0.005	0.000	0.002	0.000	0.002	0.000	0.001	0.000
0.02	0.017	0.003	0.010	0.001	0.005	0.000	0.004	0.000	0.002	0.000
0.03	0.025	0.006	0.015	0.002	0.007	0.000	0.005	0.000	0.004	0.000
0.04	0.033	0.009	0.020	0.003	0.010	0.001	0.007	0.000	0.005	0.000
0.05	0.042	0.013	0.025	0.004	0.012	0.001	0.009	0.000	0.006	0.000
0.06	0.050	0.018	0.031	0.006	0.015	0.001	0.011	0.000	0.007	0.000
0.07	0.059	0.023	0.036	0.007	0.017	0.001	0.012	0.001	0.008	0.000
0.08	0.067	0.029	0.041	0.009	0.020	0.002	0.014	0.001	0.010	0.000
0.09	0.075	0.035	0.046	0.011	0.022	0.002	0.016	0.001	0.011	0.000
0.10	0.084	0.042	0.051	0.013	0.024	0.002	0.018	0.001	0.012	0.000
0.15	0.126	0.083	0.076	0.026	0.037	0.005	0.026	0.002	0.018	0.001
0.20	0.167	0.135	0.102	0.042	0.049	0.007	0.035	0.003	0.024	0.001
0.25	0.209	0.198	0.127	0.061	0.061	0.011	0.044	0.005	0.030	0.002
0.30	0.251	0.272	0.153	0.084	0.073	0.015	0.053	0.007	0.036	0.003
0.35	0.293	0.355	0.178	0.109	0.086	0.019	0.062	0.009	0.042	0.004
0.40	0.335	0.448	0.204	0.138	0.098	0.024	0.071	0.011	0.048	0.005
0.45	0.377	0.550	0.229	0.169	0.110	0.030	0.079	0.014	0.054	0.006
0.50	0.419	0.661	0.255	0.203	0.122	0.036	0.088	0.017	0.060	0.007
0.55	0.460	0.781	0.280	0.240	0.135	0.042	0.097	0.020	0.066	0.008
0.60	0.502	0.910	0.306	0.279	0.147	0.049	0.106	0.023	0.072	0.009
0.65	0.544	1.0	0.331	0.321	0.159	0.056	0.115	0.026	0.078	0.010
0.70	0.586	1.2	0.357	0.365	0.171	0.064	0.124	0.030	0.084	0.012
0.75	0.628	1.3	0.382	0.412	0.184	0.072	0.132	0.033	0.090	0.013
0.80	0.670	1.5	0.407	0.461	0.196	0.081	0.141	0.037	0.096	0.015
0.85	0.712	1.7	0.433	0.513	0.208	0.090	0.150	0.041	0.102	0.017
0.90	0.753	1.9	0.458	0.568	0.220	0.099	0.159	0.046	0.108	0.018
0.95	0.795	2.0	0.484	0.624	0.233	0.109	0.168	0.050	0.114	0.020
1.00	0.837	2.2	0.509	0.683	0.245	0.119	0.177	0.055	0.120	0.022
1.05	0.879	2.4	0.535	0.745	0.257	0.130	0.185	0.060	0.126	0.024
1.10	0.921	2.7	0.560	0.808	0.269	0.141	0.194	0.065	0.132	0.026
1.15	0.96	2.9	0.586	0.874	0.282	0.153	0.203	0.070	0.138	0.028
1.20	1.00	3.1	0.611	0.943	0.294	0.164	0.212	0.076	0.144	0.030
1.25	1.05	3.3	0.637	1.0	0.306	0.177	0.221	0.081	0.150	0.032
1.30	1.09	3.6	0.662	1.1	0.318	0.189	0.230	0.087	0.156	0.035
1.40	1.17	4.1	0.713	1.2	0.343	0.216	0.247	0.099	0.168	0.039
1.50	1.26	4.6	0.764	1.4	0.367	0.243	0.265	0.112	0.180	0.045
1.60	1.34	5.2	0.815	1.6	0.392	0.273	0.283	0.125	0.192	0.050
1.70	1.42	5.8	0.866	1.7	0.416	0.304	0.300	0.139	0.204	0.055
1.80	1.51	6.4	0.917	1.9	0.441	0.336	0.318	0.154	0.216	0.061
1.90	1.59	7.1	0.97	2.1	0.465	0.369	0.336	0.169	0.228	0.067
2.00	1.67	7.7	1.02	2.3	0.490	0.405	0.353	0.185	0.240	0.074
2.10	1.76	8.4	1.07	2.6	0.514	0.441	0.371	0.202	0.252	0.080
2.20	1.84	9.2	1.12	2.8	0.539	0.479	0.389	0.219	0.264	0.087
2.30	1.93	9.9	1.17	3.0	0.563	0.518	0.406	0.237	0.276	0.094
2.40	2.01	10.7	1.22	3.2	0.588	0.559	0.424	0.256	0.288	0.102
2.50	2.09	11.6	1.27	3.5	0.612	0.601	0.442	0.275	0.300	0.109
2.60	2.18	12.4	1.32	3.7	0.637	0.644	0.459	0.295	0.312	0.117
2.70	2.26	13.3	1.38	4.0	0.661	0.689	0.477	0.315	0.324	0.125
2.80	2.34	14.2	1.43	4.3	0.686	0.735	0.495	0.336	0.336	0.133
2.90	2.43	15.1	1.48	4.5	0.710	0.783	0.512	0.358	0.348	0.142
3.00	2.51	16.1	1.53	4.8	0.735	0.831	0.530	0.380	0.360	0.151
3.10	2.60	17.1	1.58	5.1	0.759	0.881	0.548	0.403	0.372	0.160
3.20	2.68	18.1	1.63	5.4	0.784	0.933	0.565	0.426	0.384	0.169
3.30	2.76	19.1	1.68	5.7	0.808	1.0	0.583	0.450	0.396	0.179
3.40	2.85	20.2	1.73	6.1	0.833	1.0	0.601	0.475	0.408	0.188
3.50	2.93	21.3	1.78	6.4	0.857	1.1	0.618	0.500	0.420	0.198
3.60	3.01	22.4	1.83	6.7	0.882	1.2	0.636	0.526	0.432	0.208
3.70	3.10	23.6	1.88	7.1	0.906	1.2	0.654	0.552	0.444	0.219
3.80	3.18	24.7	1.94	7.4	0.931	1.3	0.671	0.579	0.456	0.229
3.90	3.26	25.9	1.99	7.8	0.96	1.3	0.689	0.606	0.468	0.240
4.00	3.35	27.2	2.04	8.1	0.98	1.4	0.707	0.634	0.480	0.251
4.10	3.43	28.4	2.09	8.5	1.00	1.5	0.724	0.663	0.492	0.262
4.20	3.52	29.7	2.14	8.9	1.03	1.5	0.742	0.692	0.504	0.274

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39		50		72.1		84.9		103	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.30	3.60	31.0	2.19	9.3	1.05	1.6	0.760	0.722	0.516	0.286
4.40	3.68	32.3	2.24	9.7	1.08	1.6	0.777	0.752	0.528	0.298
4.50	3.77	33.7	2.29	10.1	1.10	1.7	0.795	0.783	0.540	0.310
4.60	3.85	35.1	2.34	10.5	1.13	1.8	0.813	0.814	0.552	0.322
4.70	3.93	36.5	2.39	10.9	1.15	1.9	0.830	0.846	0.564	0.335
5.00	4.19	40.9	2.55	12.2	1.22	2.1	0.883	0.945	0.600	0.374
5.50	4.60	48.7	2.80	14.5	1.35	2.5	0.97	1.12	0.660	0.443
6.00	5.02	57.2	3.06	17.0	1.47	2.9	1.06	1.31	0.720	0.518
6.50	5.44	66.3	3.31	19.7	1.59	3.3	1.15	1.51	0.780	0.597
7.00	5.86	76.1	3.57	22.5	1.71	3.8	1.24	1.73	0.840	0.682
7.50	6.28	86.5	3.82	25.6	1.84	4.3	1.32	1.96	0.900	0.772
8.00	6.70	97.5	4.07	28.8	1.96	4.9	1.41	2.20	0.960	0.867
8.50	7.12	109.1	4.33	32.2	2.08	5.4	1.50	2.46	1.020	0.967
9.00	7.53	121.4	4.58	35.8	2.20	6.0	1.59	2.72	1.080	1.072
9.50	7.95	134.3	4.84	39.5	2.33	6.6	1.68	3.01	1.14	1.18
10.00	8.37	147.8	5.09	43.5	2.45	7.3	1.77	3.30	1.20	1.30
10.50	8.79	162.0	5.35	47.6	2.57	8.0	1.85	3.60	1.26	1.42
11.00	9.21	176.7	5.60	51.8	2.69	8.7	1.94	3.92	1.32	1.54
11.50	9.63	192.1	5.86	56.3	2.82	9.4	2.031	4.25	1.38	1.67
12.00	10.05	208.1	6.11	60.9	2.94	10.2	2.120	4.59	1.44	1.80
12.50	10.46	224.7	6.37	65.7	3.06	10.9	2.208	4.95	1.50	1.94
13.00	10.88	242.0	6.62	70.7	3.18	11.8	2.296	5.31	1.56	2.08
13.50	11.30	259.8	6.88	75.9	3.31	12.6	2.385	5.69	1.62	2.23
14.00	11.72	278.3	7.13	81.2	3.43	13.5	2.473	6.08	1.68	2.38
14.50	12.14	297.3	7.38	86.7	3.55	14.4	2.561	6.49	1.74	2.54
15.00	12.56	317.0	7.64	92.3	3.67	15.3	2.650	6.90	1.80	2.70
15.50	12.98	337.3	7.89	98.2	3.80	16.3	2.738	7.33	1.86	2.87
16.00	13.39	358.2	8.15	104.2	3.92	17.2	2.826	7.77	1.92	3.04
16.50	13.81	379.8	8.40	110.4	4.04	18.2	2.915	8.22	1.98	3.21
17.00	14.23	401.9	8.66	116.7	4.16	19.3	3.003	8.68	2.04	3.39
17.50	14.65	424.6	8.91	123.2	4.29	20.3	3.091	9.15	2.10	3.58
18.00	15.07	448.0	9.17	129.9	4.41	21.4	3.180	9.64	2.16	3.77
18.50	15.49	472.0	9.42	136.8	4.53	22.5	3.268	10.14	2.22	3.96
19.00	15.91	496.5	9.68	143.8	4.65	23.7	3.356	10.64	2.28	4.16
19.50	16.32	521.7	9.93	151.0	4.78	24.8	3.445	11.17	2.34	4.36
20.00	16.74	547.5	10.19	158.4	4.90	26.0	3.533	11.70	2.40	4.57
21.00					5.14	28.5	3.709	12.80	2.52	4.99
22.00					5.39	31.0	3.886	13.94	2.64	5.43
23.00					5.63	33.7	4.063	15.13	2.76	5.90
24.00					5.88	36.5	4.239	16.37	2.88	6.37
25.00					6.12	39.4	4.416	17.65	3.00	6.87
26.00					6.37	42.4	4.593	18.98	3.12	7.38
27.00					6.61	45.4	4.769	20.35	3.24	7.91
28.00					6.86	48.6	4.946	21.77	3.36	8.46
29.00					7.10	51.9	5.123	23.24	3.48	9.02
30.00					7.35	55.3	5.299	24.74	3.60	9.61
31.00					7.59	58.8	5.476	26.30	3.72	10.20
32.00							5.653	27.90	3.84	10.82
33.00							5.829	29.54	3.96	11.45
34.00							6.006	31.23	4.08	12.10
35.00							6.182	32.96	4.20	12.77
36.00							6.359	34.74	4.32	13.45
37.00							6.536	36.56	4.44	14.15
38.00							6.712	38.42	4.56	14.87
39.00							6.889	40.33	4.68	15.60
40.00							7.066	42.29	4.80	16.35
41.00							7.242	44.28	4.92	17.11
42.00							7.419	46.33	5.04	17.90
43.00							7.596	48.41	5.16	18.70
44.00							7.772	50.54	5.28	19.51
45.00							7.949	52.72	5.40	20.34
46.00									5.52	21.19
47.00									5.64	22.06
48.00									5.76	22.94
49.00									5.88	23.84
50.00									6.00	24.75

water 60°C, DIN EN / DVGW quality copper tubes, 12-35 mm

density: 983.2 kg/m³
pressure: 1 bar
viscosity: 0.0013 Pa·s
surface roughness: 0.0015 mm

d [mm]	12		15		18		22		28		35	
di [mm]	10		13		16		20		25		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.1	0.5	0.1	0.2	0.0	0.1	0.032	0.0	0.020	0.007	0.012	0.002
0.02	0.3	1.6	0.2	0.5	0.1	0.2	0.064	0.1	0.041	0.023	0.025	0.007
0.03	0.4	3.2	0.2	0.9	0.1	0.4	0.095	0.1	0.061	0.044	0.037	0.014
0.04	0.5	5.2	0.3	1.5	0.2	0.6	0.127	0.2	0.081	0.071	0.050	0.022
0.05	0.6	7.7	0.4	2.2	0.2	0.8	0.159	0.3	0.102	0.1	0.062	0.032
0.06	0.8	10.5	0.5	3.0	0.3	1.1	0.191	0.4	0.122	0.1	0.075	0.044
0.07	0.9	13.8	0.5	4.0	0.3	1.5	0.223	0.5	0.143	0.2	0.087	0.057
0.08	1.0	17.4	0.6	5.0	0.4	1.9	0.255	0.6	0.163	0.2	0.099	0.071
0.09	1.1	21.4	0.7	6.1	0.4	2.3	0.286	0.8	0.183	0.3	0.112	0.087
0.10	1.3	25.7	0.8	7.3	0.5	2.7	0.318	1.0	0.204	0.3	0.124	0.104
0.15	1.9	52.6	1.1	14.9	0.7	5.5	0.477	1.9	0.306	0.7	0.187	0.207
0.20	2.5	88.0	1.5	24.8	1.0	9.2	0.637	3.2	0.407	1.1	0.249	0.340
0.25	3.2	131.4	1.9	36.9	1.2	13.6	0.796	4.7	0.509	1.6	0.311	0.500
0.30	3.8	182.6	2.3	51.1	1.5	18.8	0.95	6.4	0.611	2.2	0.373	0.686
0.35	4.5	241.7	2.6	67.4	1.7	24.7	1.11	8.5	0.713	2.9	0.435	0.897
0.40	5.1	308.4	3.0	85.7	2.0	31.4	1.27	10.7	0.815	3.7	0.497	1.1
0.45	5.7	382.7	3.4	106.0	2.2	38.7	1.43	13.2	0.917	4.5	0.560	1.4
0.50	6.4	464.6	3.8	128.4	2.5	46.8	1.59	15.9	1.02	5.5	0.622	1.7
0.55	7.0	553.9	4.1	152.7	2.7	55.6	1.75	18.9	1.12	6.5	0.684	2.0
0.60			4.5	178.9	3.0	65.0	1.91	22.1	1.22	7.5	0.746	2.3
0.65			4.9	207.1	3.2	75.2	2.07	25.5	1.32	8.7	0.808	2.7
0.70			5.3	237.3	3.5	86.0	2.23	29.1	1.43	9.9	0.870	3.0
0.75			5.7	269.3	3.7	97.5	2.39	33.0	1.53	11.2	0.933	3.4
0.80			6.0	303.3	4.0	109.6	2.55	37.0	1.63	12.6	0.995	3.8
0.85			6.4	339.2	4.2	122.4	2.71	41.3	1.73	14.0	1.06	4.3
0.90			6.8	376.9	4.5	135.9	2.86	45.8	1.83	15.6	1.12	4.7
0.95			7.2	416.6	4.7	150.0	3.02	50.5	1.94	17.1	1.18	5.2
1.00					5.0	164.8	3.18	55.4	2.04	18.8	1.24	5.7
1.05					5.2	180.3	3.34	60.6	2.14	20.5	1.31	6.2
1.10					5.5	196.4	3.50	65.9	2.24	22.3	1.37	6.8
1.15					5.7	213.1	3.66	71.5	2.34	24.2	1.43	7.3
1.20					6.0	230.5	3.82	77.2	2.44	26.1	1.49	7.9
1.25					6.2	248.5	3.98	83.2	2.55	28.1	1.55	8.5
1.30					6.5	267.2	4.14	89.4	2.65	30.2	1.62	9.1
1.40					7.0	306.5	4.46	102.4	2.85	34.5	1.74	10.4
1.50					7.5	348.3	4.77	116.2	3.06	39.1	1.87	11.8
1.60					8.0	392.7	5.09	130.8	3.26	44.0	1.99	13.3
1.70					8.5	439.6	5.41	146.2	3.46	49.1	2.11	14.8
1.80					9.0	489.0	5.73	162.5	3.67	54.5	2.24	16.4
1.90					9.4	541.0	6.05	179.5	3.87	60.1	2.36	18.1
2.00					9.9	595.5	6.37	197.4	4.07	66.1	2.49	19.9
2.10							6.68	216.0	4.28	72.2	2.61	21.7
2.20							7.00	235.5	4.48	78.7	2.74	23.6
2.30							7.32	255.7	4.69	85.3	2.86	25.6
2.40							7.64	276.8	4.89	92.3	2.98	27.7
2.50							7.96	298.6	5.09	99.5	3.11	29.8
2.60							8.28	321.3	5.30	106.9	3.23	32.0
2.70							8.59	344.7	5.50	114.6	3.36	34.3
2.80							8.91	368.9	5.70	122.6	3.48	36.6
2.90							9.23	393.9	5.91	130.8	3.61	39.1
3.00							9.55	419.7	6.11	139.3	3.73	41.6
3.10							9.87	446.3	6.32	148.0	3.85	44.1
3.20							10.19	473.7	6.52	157.0	3.98	46.8
3.30							10.50	501.8	6.72	166.2	4.10	49.5
3.40							10.82	530.8	6.93	175.6	4.23	52.3
3.50							11.14	560.5	7.13	185.4	4.35	55.1
3.60							11.46	591.0	7.33	195.3	4.48	58.0
3.90							12.41	687.2	7.95	226.7	4.85	67.2
4.00							12.73	720.9	8.15	237.7	4.97	70.5
4.10							13.05	755.3	8.35	248.9	5.10	73.7
4.20									8.56	260.3	5.22	77.1

12-35 mm

d [mm]	12		15		18		22		28		35	
di [mm]	10		13		16		20		25		32	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.30									8.76	272.0	5.35	80.5
4.40									8.96	284.0	5.47	84.0
4.50									9.17	296.2	5.60	87.6
4.60									9.37	308.6	5.72	91.2
4.70									9.57	321.3	5.84	94.9
4.80									9.78	334.2	5.97	98.7
4.90									9.98	347.4	6.09	102.5
5.00									10.19	360.8	6.22	106.4
5.50									11.20	431.6	6.84	127.0
6.00									12.22	508.6	7.46	149.3
6.50									13.24	591.6	8.08	173.4
7.00									14.26	680.7	8.70	199.1
7.50									15.28	775.9	9.33	226.6
8.00									16.30	877.2	9.95	255.7
8.50											10.57	286.6
9.00											11.19	319.2
9.50											11.81	353.4
10.00											12.43	389.4
10.50											13.06	427.0
11.00											13.68	466.3
11.50											14.30	507.3
12.00											14.92	550.0
12.50											15.54	594.3
13.00											16.16	640.4
13.50											16.79	688.1
14.00											17.41	737.4
14.50											18.03	788.5

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39.0		50.0		72.1		84.9		103.0	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.008	0.001	0.005	0.000	0.002	0.000	0.002	0.000	0.001	0.000
0.02	0.017	0.003	0.010	0.001	0.005	0.000	0.004	0.000	0.002	0.000
0.03	0.025	0.006	0.015	0.002	0.007	0.000	0.005	0.000	0.004	0.000
0.04	0.033	0.009	0.020	0.003	0.010	0.001	0.007	0.000	0.005	0.000
0.05	0.042	0.013	0.025	0.004	0.012	0.001	0.009	0.000	0.006	0.000
0.06	0.050	0.017	0.031	0.005	0.015	0.001	0.011	0.000	0.007	0.000
0.07	0.059	0.023	0.036	0.007	0.017	0.001	0.012	0.001	0.008	0.000
0.08	0.067	0.028	0.041	0.009	0.020	0.002	0.014	0.001	0.010	0.000
0.09	0.075	0.034	0.046	0.011	0.022	0.002	0.016	0.001	0.011	0.000
0.10	0.084	0.041	0.051	0.013	0.024	0.002	0.018	0.001	0.012	0.000
0.15	0.126	0.082	0.076	0.025	0.037	0.005	0.026	0.002	0.018	0.001
0.20	0.167	0.133	0.102	0.041	0.049	0.007	0.035	0.003	0.024	0.001
0.25	0.209	0.196	0.127	0.061	0.061	0.011	0.044	0.005	0.030	0.002
0.30	0.251	0.268	0.153	0.083	0.073	0.015	0.053	0.007	0.036	0.003
0.35	0.293	0.351	0.178	0.108	0.086	0.019	0.062	0.009	0.042	0.004
0.40	0.335	0.442	0.204	0.136	0.098	0.024	0.071	0.011	0.048	0.004
0.45	0.377	0.543	0.229	0.167	0.110	0.030	0.079	0.014	0.054	0.005
0.50	0.419	0.653	0.255	0.200	0.122	0.035	0.088	0.016	0.060	0.007
0.55	0.460	0.771	0.280	0.237	0.135	0.042	0.097	0.019	0.066	0.008
0.60	0.502	0.899	0.306	0.275	0.147	0.049	0.106	0.022	0.072	0.009
0.65	0.544	1.0	0.331	0.317	0.159	0.056	0.115	0.026	0.078	0.010
0.70	0.586	1.2	0.357	0.361	0.171	0.063	0.124	0.029	0.084	0.012
0.75	0.628	1.3	0.382	0.407	0.184	0.071	0.132	0.033	0.090	0.013
0.80	0.670	1.5	0.407	0.456	0.196	0.080	0.141	0.037	0.096	0.015
0.85	0.712	1.7	0.433	0.507	0.208	0.089	0.150	0.041	0.102	0.016
0.90	0.753	1.8	0.458	0.560	0.220	0.098	0.159	0.045	0.108	0.018
0.95	0.795	2.0	0.484	0.616	0.233	0.108	0.168	0.050	0.114	0.020
1.00	0.837	2.2	0.509	0.675	0.245	0.118	0.177	0.054	0.120	0.022
1.05	0.879	2.4	0.535	0.735	0.257	0.128	0.185	0.059	0.126	0.024
1.10	0.921	2.6	0.560	0.798	0.269	0.139	0.194	0.064	0.132	0.026
1.15	0.96	2.8	0.586	0.863	0.282	0.151	0.203	0.069	0.138	0.028
1.20	1.00	3.1	0.611	0.931	0.294	0.162	0.212	0.075	0.144	0.030
1.25	1.05	3.3	0.637	1.0	0.306	0.174	0.221	0.080	0.150	0.032
1.30	1.09	3.5	0.662	1.1	0.318	0.187	0.230	0.086	0.156	0.034
1.40	1.17	4.0	0.713	1.2	0.343	0.213	0.247	0.098	0.168	0.039
1.50	1.26	4.6	0.764	1.4	0.367	0.240	0.265	0.110	0.180	0.044
1.60	1.34	5.1	0.815	1.5	0.392	0.269	0.283	0.124	0.192	0.049
1.70	1.42	5.7	0.866	1.7	0.416	0.300	0.300	0.137	0.204	0.055
1.80	1.51	6.3	0.917	1.9	0.441	0.331	0.318	0.152	0.216	0.061
1.90	1.59	7.0	0.97	2.1	0.465	0.365	0.336	0.167	0.228	0.067
2.00	1.67	7.6	1.02	2.3	0.490	0.399	0.353	0.183	0.240	0.073
2.10	1.76	8.3	1.07	2.5	0.514	0.435	0.371	0.199	0.252	0.079
2.20	1.84	9.1	1.12	2.7	0.539	0.473	0.389	0.217	0.264	0.086
2.30	1.93	9.8	1.17	3.0	0.563	0.512	0.406	0.234	0.276	0.093
2.40	2.01	10.6	1.22	3.2	0.588	0.552	0.424	0.253	0.288	0.100
2.50	2.09	11.4	1.27	3.4	0.612	0.593	0.442	0.271	0.300	0.108
2.60	2.18	12.2	1.32	3.7	0.637	0.636	0.459	0.291	0.312	0.116
2.70	2.26	13.1	1.38	3.9	0.661	0.680	0.477	0.311	0.324	0.124
2.80	2.34	14.0	1.43	4.2	0.686	0.726	0.495	0.332	0.336	0.132
2.90	2.43	14.9	1.48	4.5	0.710	0.772	0.512	0.353	0.348	0.140
3.00	2.51	15.9	1.53	4.8	0.735	0.821	0.530	0.375	0.360	0.149
3.10	2.60	16.8	1.58	5.1	0.759	0.870	0.548	0.398	0.372	0.158
3.20	2.68	17.8	1.63	5.4	0.784	0.921	0.565	0.421	0.384	0.167
3.30	2.76	18.9	1.68	5.7	0.808	1.0	0.583	0.444	0.396	0.176
3.40	2.85	19.9	1.73	6.0	0.833	1.0	0.601	0.469	0.408	0.186
3.50	2.93	21.0	1.78	6.3	0.857	1.1	0.618	0.493	0.420	0.196
3.60	3.01	22.1	1.83	6.6	0.882	1.1	0.636	0.519	0.432	0.206
3.70	3.10	23.2	1.88	7.0	0.906	1.2	0.654	0.545	0.444	0.216
3.80	3.18	24.4	1.94	7.3	0.931	1.3	0.671	0.571	0.456	0.226
3.90	3.26	25.6	1.99	7.7	0.96	1.3	0.689	0.598	0.468	0.237
4.00	3.35	26.8	2.04	8.0	0.98	1.4	0.707	0.626	0.480	0.248
4.10	3.43	28.0	2.09	8.4	1.00	1.4	0.724	0.654	0.492	0.259
4.20	3.52	29.3	2.14	8.8	1.03	1.5	0.742	0.683	0.504	0.270
4.30	3.60	30.6	2.19	9.1	1.05	1.6	0.760	0.712	0.516	0.282

42-108 mm

d [mm]	42		54		76.1		88.9		108	
di [mm]	39.0		50.0		72.1		84.9		103.0	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.40	3.68	31.9	2.24	9.5	1.08	1.6	0.777	0.742	0.528	0.294
4.50	3.77	33.2	2.29	9.9	1.10	1.7	0.795	0.772	0.540	0.306
4.60	3.85	34.6	2.34	10.3	1.13	1.8	0.813	0.803	0.552	0.318
4.70	3.93	36.0	2.39	10.7	1.15	1.8	0.830	0.835	0.564	0.330
5.00	4.19	40.3	2.55	12.0	1.22	2.0	0.883	0.933	0.600	0.369
5.50	4.60	48.1	2.80	14.3	1.35	2.4	0.97	1.11	0.660	0.437
6.00	5.02	56.4	3.06	16.8	1.47	2.8	1.06	1.29	0.720	0.511
6.50	5.44	65.4	3.31	19.4	1.59	3.3	1.15	1.49	0.780	0.590
7.00	5.86	75.0	3.57	22.2	1.71	3.8	1.24	1.71	0.840	0.673
7.50	6.28	85.2	3.82	25.2	1.84	4.3	1.32	1.93	0.900	0.762
8.00	6.70	96.1	4.07	28.4	1.96	4.8	1.41	2.17	0.960	0.856
8.50	7.12	107.6	4.33	31.7	2.08	5.3	1.50	2.42	1.020	0.954
9.00	7.53	119.7	4.58	35.3	2.20	5.9	1.59	2.69	1.080	1.058
9.50	7.95	132.4	4.84	39.0	2.33	6.5	1.68	2.96	1.14	1.17
10.00	8.37	145.7	5.09	42.8	2.45	7.2	1.77	3.25	1.20	1.28
10.50	8.79	159.6	5.35	46.9	2.57	7.9	1.85	3.55	1.26	1.40
11.00	9.21	174.2	5.60	51.1	2.69	8.5	1.94	3.87	1.32	1.52
11.50	9.63	189.3	5.86	55.5	2.82	9.3	2.031	4.19	1.38	1.65
12.00	10.05	205.1	6.11	60.1	2.94	10.0	2.120	4.53	1.44	1.78
12.50	10.46	221.4	6.37	64.8	3.06	10.8	2.208	4.88	1.50	1.91
13.00	10.88	238.4	6.62	69.7	3.18	11.6	2.296	5.24	1.56	2.06
13.50	11.30	256.0	6.88	74.8	3.31	12.4	2.385	5.62	1.62	2.20
14.00	11.72	274.2	7.13	80.0	3.43	13.3	2.473	6.00	1.68	2.35
14.50	12.14	292.9	7.38	85.4	3.55	14.2	2.561	6.40	1.74	2.51
15.00	12.56	312.3	7.64	91.0	3.67	15.1	2.650	6.81	1.80	2.67
15.50	12.98	332.3	7.89	96.7	3.80	16.0	2.738	7.23	1.86	2.83
16.00	13.39	352.9	8.15	102.7	3.92	17.0	2.826	7.66	1.92	3.00
16.50	13.81	374.1	8.40	108.8	4.04	18.0	2.915	8.10	1.98	3.17
17.00	14.23	395.9	8.66	115.0	4.16	19.0	3.003	8.56	2.04	3.35
17.50	14.65	418.3	8.91	121.4	4.29	20.0	3.091	9.03	2.10	3.53
18.00	15.07	441.3	9.17	128.0	4.41	21.1	3.180	9.50	2.16	3.71
18.50	15.49	464.9	9.42	134.8	4.53	22.2	3.268	9.99	2.22	3.90
19.00	15.91	489.1	9.68	141.7	4.65	23.3	3.356	10.50	2.28	4.10
19.50	16.32	513.9	9.93	148.8	4.78	24.5	3.445	11.01	2.34	4.30
20.00	16.74	539.3	10.19	156.1	4.90	25.7	3.533	11.53	2.40	4.50
21.00					5.14	28.1	3.709	12.62	2.52	4.92
22.00					5.39	30.6	3.886	13.75	2.64	5.36
23.00					5.63	33.2	4.063	14.92	2.76	5.81
24.00					5.88	36.0	4.239	16.14	2.88	6.29
25.00					6.12	38.8	4.416	17.40	3.00	6.77
26.00					6.37	41.7	4.593	18.71	3.12	7.28
27.00					6.61	44.8	4.769	20.07	3.24	7.80
28.00					6.86	47.9	4.946	21.46	3.36	8.34
29.00					7.10	51.2	5.123	22.91	3.48	8.90
30.00					7.35	54.5	5.299	24.39	3.60	9.47
31.00					7.59	58.0	5.476	25.92	3.72	10.06
32.00							5.653	27.50	3.84	10.67
33.00							5.829	29.12	3.96	11.29
34.00							6.006	30.78	4.08	11.93
35.00							6.182	32.49	4.20	12.59
36.00							6.359	34.24	4.32	13.26
37.00							6.536	36.03	4.44	13.95
38.00							6.712	37.87	4.56	14.66
39.00							6.889	39.75	4.68	15.38
40.00							7.066	41.68	4.80	16.12
41.00							7.242	43.64	4.92	16.87
42.00							7.419	45.66	5.04	17.64
43.00							7.596	47.71	5.16	18.43
44.00							7.772	49.81	5.28	19.23
45.00							7.949	51.95	5.40	20.05
46.00									5.52	20.89
47.00									5.64	21.74
48.00									5.76	22.61
49.00									5.88	23.50
50.00									6.00	24.40

water 10°C, copper tubes according to EN 1057, 12-35 mm

density: 999.8 kg/m³
pressure: 1 bar
viscosity: 0.0013 Pa·s
surface roughness: 0.0015 mm

d [mm]	12		15		22		28		35	
di [mm]	10.8		13.6		20.2		26.2		32.6	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.1	0.4	0.1	0.1	0.0	0.020	0.0	0.006	0.012	0.002
0.02	0.2	1.1	0.1	0.4	0.1	0.061	0.0	0.018	0.024	0.007
0.03	0.3	2.3	0.2	0.8	0.1	0.120	0.1	0.036	0.036	0.013
0.04	0.4	3.7	0.3	1.2	0.1	0.194	0.1	0.057	0.048	0.021
0.05	0.5	5.4	0.3	1.8	0.2	0.282	0.1	0.083	0.060	0.030
0.06	0.7	7.4	0.4	2.5	0.2	0.384	0.1	0.113	0.072	0.041
0.07	0.8	9.7	0.5	3.2	0.2	0.499	0.1	0.147	0.084	0.053
0.08	0.9	12.2	0.6	4.1	0.2	0.627	0.1	0.184	0.096	0.066
0.09	1.0	15.0	0.6	5.0	0.3	0.767	0.2	0.225	0.108	0.081
0.10	1.1	18.0	0.7	6.0	0.3	0.919	0.2	0.269	0.120	0.096
0.15	1.6	36.8	1.0	12.2	0.5	1.9	0.3	0.540	0.180	0.192
0.20	2.2	61.4	1.4	20.2	0.6	3.1	0.4	0.887	0.240	0.315
0.25	2.7	91.6	1.7	30.1	0.8	4.5	0.5	1.3	0.300	0.463
0.30	3.3	127.3	2.1	41.6	0.9	6.2	0.6	1.8	0.359	0.636
0.35	3.8	168.2	2.4	54.9	1.1	8.2	0.6	2.4	0.419	0.832
0.40	4.4	214.5	2.8	69.8	1.2	10.3	0.7	3.0	0.479	1.1
0.45	4.9	266.0	3.1	86.3	1.4	12.8	0.8	3.7	0.539	1.3
0.50	5.5	322.6	3.4	104.5	1.6	15.4	0.9	4.4	0.599	1.6
0.55	6.0	384.4	3.8	124.2	1.7	18.2	1.0	5.2	0.659	1.8
0.60			4.1	145.5	1.9	21.3	1.1	6.1	0.719	2.1
0.65			4.5	168.4	2.0	24.6	1.2	7.0	0.779	2.5
0.70			4.8	192.8	2.2	28.1	1.3	8.0	0.839	2.8
0.75			5.2	218.8	2.3	31.8	1.4	9.1	0.899	3.2
0.80			5.5	246.4	2.5	35.8	1.5	10.2	0.958	3.6
0.85			5.9	275.5	2.7	39.9	1.6	11.3	1.02	4.0
0.90			6.2	306.1	2.8	44.2	1.7	12.6	1.08	4.4
0.95			6.5	338.2	3.0	48.8	1.8	13.8	1.14	4.8
1.00					3.1	53.5	1.9	15.2	1.20	5.3
1.05					3.3	58.5	1.9	16.6	1.26	5.8
1.10					3.4	63.7	2.0	18.0	1.32	6.3
1.15					3.6	69.0	2.1	19.5	1.38	6.8
1.20					3.7	74.6	2.2	21.1	1.44	7.3
1.25					3.9	80.4	2.3	22.7	1.50	7.9
1.30					4.1	86.3	2.4	24.4	1.56	8.5
1.40					4.4	98.9	2.6	27.9	1.68	9.7
1.50					4.7	112.2	2.8	31.6	1.80	11.0
1.60					5.0	126.3	3.0	35.5	1.92	12.3
1.70					5.3	141.2	3.2	39.6	2.04	13.7
1.80					5.6	156.9	3.3	44.0	2.16	15.2
1.90					5.9	173.4	3.5	48.5	2.28	16.8
2.00					6.2	190.6	3.7	53.3	2.40	18.4
2.10					6.6	208.6	3.9	58.2	2.52	20.1
2.20					6.9	227.4	4.1	63.4	2.64	21.9
2.30					7.2	247.0	4.3	68.8	2.76	23.7
2.40					7.5	267.3	4.5	74.4	2.88	25.6
2.50					7.8	288.4	4.6	80.2	3.00	27.6
2.60					8.1	310.3	4.8	86.2	3.11	29.6
2.70					8.4	332.9	5.0	92.4	3.23	31.7
2.80					8.7	356.3	5.2	98.8	3.35	33.9
2.90					9.0	380.5	5.4	105.4	3.47	36.2
3.00					9.4	405.4	5.6	112.2	3.59	38.5
3.10					9.7	431.0	5.8	119.2	3.71	40.9
3.20					10.0	457.5	5.9	126.4	3.83	43.3
3.50					10.9	541.3	6.5	149.2	4.19	51.0
3.60					11.2	570.8	6.7	157.2	4.31	53.7
3.70					11.5	601.0	6.9	165.4	4.43	56.5
3.80					11.9	632.0	7.0	173.8	4.55	59.4
3.90					12.2	663.7	7.2	182.4	4.67	62.3
4.00					12.5	696.2	7.4	191.2	4.79	65.2
4.10					12.8	729.4	7.6	200.2	4.91	68.3
4.20							7.8	209.4	5.03	71.4

12-35 mm

d [mm]	12		15		22		28		35	
di [mm]	10.8		13.6		20.2		26.2		32.6	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.30							8.0	218.8	5.15	74.5
4.40							8.2	228.4	5.27	77.8
4.50							8.3	238.2	5.39	81.1
4.60							8.5	248.2	5.51	84.4
4.70							8.7	258.4	5.63	87.9
4.80							8.9	268.7	5.75	91.3
4.90							9.1	279.3	5.87	94.9
5.00							9.3	290.1	5.99	98.5
5.50							10.2	346.9	6.59	117.6
6.00							11.1	408.6	7.19	138.2
6.50							12.1	475.1	7.79	160.5
7.00							13.0	546.5	8.39	184.3
7.50							13.9	622.8	8.99	209.7
8.00							14.8	703.9	9.58	236.7
8.50									10.18	265.2
9.00									10.78	295.3
9.50									11.38	327.0
10.00									11.98	360.2
10.50									12.58	395.0
11.00									13.18	431.4
11.50									13.78	469.3
12.00									14.38	508.7
12.50									14.98	549.7
13.00									15.57	592.3
13.50									16.17	636.4
14.00									16.77	682.0
14.50									17.37	729.2

42-108 mm

d [mm]	42		54		66.7		76.1		108	
di [mm]	39.6		51.6		64.3		73.1		105.0	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.008	0.001	0.005	0.000	0.003	0.000	0.002	0.000	0.001	0.000
0.02	0.016	0.003	0.010	0.001	0.006	0.000	0.005	0.000	0.002	0.000
0.03	0.024	0.005	0.014	0.002	0.009	0.001	0.007	0.000	0.003	0.000
0.04	0.032	0.008	0.019	0.002	0.012	0.001	0.010	0.000	0.005	0.000
0.05	0.041	0.012	0.024	0.004	0.015	0.001	0.012	0.001	0.006	0.000
0.06	0.049	0.016	0.029	0.005	0.018	0.002	0.014	0.001	0.007	0.000
0.07	0.057	0.021	0.033	0.006	0.022	0.002	0.017	0.001	0.008	0.000
0.08	0.065	0.027	0.038	0.008	0.025	0.003	0.019	0.002	0.009	0.000
0.09	0.073	0.032	0.043	0.009	0.028	0.003	0.021	0.002	0.010	0.000
0.10	0.081	0.039	0.048	0.011	0.031	0.004	0.024	0.002	0.012	0.000
0.15	0.122	0.077	0.072	0.022	0.046	0.008	0.036	0.004	0.017	0.001
0.20	0.162	0.126	0.096	0.036	0.062	0.013	0.048	0.007	0.023	0.001
0.25	0.203	0.184	0.120	0.053	0.077	0.019	0.060	0.010	0.029	0.002
0.30	0.244	0.253	0.143	0.072	0.092	0.026	0.071	0.014	0.035	0.003
0.35	0.284	0.330	0.167	0.094	0.108	0.033	0.083	0.018	0.040	0.003
0.40	0.325	0.416	0.191	0.119	0.123	0.042	0.095	0.023	0.046	0.004
0.45	0.365	0.511	0.215	0.146	0.139	0.051	0.107	0.028	0.052	0.005
0.50	0.406	0.615	0.239	0.175	0.154	0.062	0.119	0.034	0.058	0.006
0.55	0.447	0.726	0.263	0.206	0.169	0.073	0.131	0.040	0.064	0.007
0.60	0.487	0.846	0.287	0.240	0.185	0.084	0.143	0.046	0.069	0.008
0.65	0.528	1.0	0.311	0.276	0.200	0.097	0.155	0.053	0.075	0.010
0.70	0.568	1.1	0.335	0.314	0.216	0.110	0.167	0.060	0.081	0.011
0.75	0.609	1.3	0.359	0.355	0.231	0.125	0.179	0.068	0.087	0.012
0.80	0.650	1.4	0.383	0.397	0.246	0.139	0.191	0.076	0.092	0.014
0.85	0.690	1.6	0.406	0.442	0.262	0.155	0.203	0.084	0.098	0.015
0.90	0.731	1.7	0.430	0.488	0.277	0.171	0.214	0.093	0.104	0.017
0.95	0.771	1.9	0.454	0.537	0.293	0.188	0.226	0.102	0.110	0.018
1.00	0.812	2.1	0.478	0.588	0.308	0.206	0.238	0.112	0.115	0.020
1.05	0.853	2.3	0.502	0.641	0.323	0.224	0.250	0.122	0.121	0.022
1.10	0.893	2.5	0.526	0.695	0.339	0.243	0.262	0.132	0.127	0.024
1.15	0.934	2.7	0.550	0.752	0.354	0.263	0.274	0.143	0.133	0.026
1.20	0.97	2.9	0.574	0.811	0.370	0.284	0.286	0.154	0.139	0.028
1.25	1.01	3.1	0.598	0.872	0.385	0.305	0.298	0.165	0.144	0.030
1.30	1.06	3.3	0.622	0.934	0.400	0.327	0.310	0.177	0.150	0.032
1.40	1.14	3.8	0.669	1.1	0.431	0.372	0.334	0.202	0.162	0.036
1.50	1.22	4.3	0.717	1.2	0.462	0.420	0.357	0.228	0.173	0.041
1.60	1.30	4.8	0.765	1.4	0.493	0.471	0.381	0.255	0.185	0.046
1.70	1.38	5.4	0.813	1.5	0.524	0.524	0.405	0.284	0.196	0.051
1.80	1.46	5.9	0.861	1.7	0.554	0.580	0.429	0.314	0.208	0.056
1.90	1.54	6.6	0.909	1.8	0.585	0.639	0.453	0.346	0.219	0.062
2.00	1.62	7.2	0.96	2.0	0.616	0.700	0.477	0.379	0.231	0.067
2.10	1.71	7.8	1.00	2.2	0.647	0.763	0.500	0.413	0.243	0.073
2.20	1.79	8.5	1.05	2.4	0.678	0.829	0.524	0.448	0.254	0.080
2.30	1.87	9.2	1.10	2.6	0.708	0.897	0.548	0.485	0.266	0.086
2.40	1.95	10.0	1.15	2.8	0.739	1.0	0.572	0.523	0.277	0.093
2.50	2.03	10.7	1.20	3.0	0.770	1.0	0.596	0.563	0.289	0.100
2.60	2.11	11.5	1.24	3.2	0.801	1.1	0.620	0.603	0.300	0.107
2.70	2.19	12.3	1.29	3.4	0.831	1.2	0.643	0.645	0.312	0.114
2.80	2.27	13.2	1.34	3.7	0.862	1.3	0.667	0.688	0.323	0.122
2.90	2.35	14.0	1.39	3.9	0.893	1.4	0.691	0.733	0.335	0.130
3.00	2.44	14.9	1.43	4.2	0.924	1.4	0.715	0.778	0.346	0.138
3.10	2.52	15.9	1.48	4.4	0.95	1.5	0.739	0.825	0.358	0.146
3.20	2.60	16.8	1.53	4.7	0.99	1.6	0.762	0.873	0.370	0.154
3.30	2.68	17.8	1.58	4.9	1.02	1.7	0.786	0.92	0.381	0.163
3.40	2.76	18.8	1.63	5.2	1.05	1.8	0.810	0.97	0.393	0.172
3.50	2.84	19.8	1.67	5.5	1.08	1.9	0.834	1.02	0.404	0.181
3.60	2.92	20.8	1.72	5.8	1.11	2.0	0.858	1.08	0.416	0.190
3.70	3.00	21.9	1.77	6.1	1.14	2.1	0.882	1.13	0.427	0.199
3.80	3.09	23.0	1.82	6.4	1.17	2.2	0.905	1.19	0.439	0.209
3.90	3.17	24.1	1.86	6.7	1.20	2.3	0.93	1.24	0.450	0.219
4.00	3.25	25.2	1.91	7.0	1.23	2.4	0.95	1.30	0.462	0.229
4.10	3.33	26.4	1.96	7.3	1.26	2.5	0.98	1.36	0.473	0.239
4.20	3.41	27.6	2.01	7.6	1.29	2.6	1.00	1.42	0.485	0.250
4.30	3.49	28.8	2.06	8.0	1.32	2.7	1.02	1.48	0.497	0.261
4.40	3.57	30.0	2.10	8.3	1.36	2.9	1.05	1.54	0.508	0.271

42-108 mm

d [mm]	42		54		66.7		76.1		108	
di [mm]	39.6		51.6		64.3		73.1		105.0	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.50	3.65	31.3	2.15	8.6	1.39	3.0	1.07	1.61	0.520	0.282
4.60	3.73	32.6	2.20	9.0	1.42	3.1	1.10	1.67	0.531	0.294
4.70	3.82	33.9	2.25	9.3	1.45	3.2	1.12	1.74	0.543	0.305
5.00	4.06	38.0	2.39	10.5	1.54	3.6	1.19	1.94	0.577	0.341
5.50	4.47	45.2	2.63	12.4	1.69	4.3	1.31	2.31	0.635	0.404
6.00	4.87	53.1	2.87	14.6	1.85	5.0	1.43	2.70	0.693	0.472
6.50	5.28	61.5	3.11	16.9	2.00	5.8	1.55	3.12	0.751	0.545
7.00	5.68	70.6	3.35	19.3	2.16	6.6	1.67	3.56	0.808	0.622
7.50	6.09	80.2	3.59	21.9	2.31	7.5	1.79	4.04	0.866	0.704
8.00	6.50	90.4	3.83	24.7	2.46	8.5	1.91	4.54	0.924	0.791
8.50	6.90	101.2	4.06	27.6	2.62	9.4	2.03	5.07	0.982	0.882
9.00	7.31	112.6	4.30	30.7	2.77	10.5	2.14	5.62	1.039	0.977
9.50	7.71	124.5	4.54	33.9	2.93	11.6	2.26	6.20	1.10	1.08
10.00	8.12	137.1	4.78	37.2	3.08	12.7	2.38	6.81	1.15	1.18
10.50	8.53	150.2	5.02	40.7	3.23	13.9	2.50	7.45	1.21	1.29
11.00	8.93	163.9	5.26	44.4	3.39	15.1	2.62	8.11	1.27	1.40
11.50	9.34	178.1	5.50	48.2	3.54	16.4	2.74	8.79	1.33	1.52
12.00	9.74	192.9	5.74	52.2	3.70	17.8	2.86	9.50	1.39	1.64
12.50	10.15	208.3	5.98	56.3	3.85	19.1	2.98	10.24	1.44	1.77
13.00	10.56	224.3	6.22	60.5	4.00	20.6	3.10	11.00	1.50	1.90
13.50	10.96	240.8	6.46	64.9	4.16	22.1	3.22	11.79	1.56	2.03
14.00	11.37	257.9	6.69	69.5	4.31	23.6	3.34	12.60	1.62	2.17
14.50	11.77	275.6	6.93	74.2	4.47	25.2	3.45	13.44	1.67	2.31
15.00	12.18	293.8	7.17	79.0	4.62	26.8	3.57	14.31	1.73	2.46
15.50	12.58	312.6	7.41	84.0	4.77	28.5	3.69	15.20	1.79	2.61
16.00	12.99	331.9	7.65	89.2	4.93	30.2	3.81	16.11	1.85	2.77
16.50	13.40	351.9	7.89	94.4	5.08	32.0	3.93	17.05	1.91	2.93
17.00	13.80	372.4	8.13	99.9	5.24	33.8	4.05	18.01	1.96	3.09
17.50	14.21	393.4	8.37	105.4	5.39	35.6	4.17	19.00	2.02	3.26
18.00	14.61	415.0	8.61	111.1	5.54	37.5	4.29	20.02	2.08	3.43
18.50	15.02	437.2	8.85	117.0	5.70	39.5	4.41	21.06	2.14	3.61
19.00	15.43	460.0	9.09	123.0	5.85	41.5	4.53	22.12	2.19	3.79
19.50	15.83	483.3	9.32	129.2	6.01	43.6	4.65	23.21	2.25	3.97
20.00	16.24	507.2	9.56	135.4	6.16	45.7	4.77	24.32	2.31	4.16
21.00					6.47	50.0	5.00	26.62	2.43	4.55
22.00							5.24	29.02	2.54	4.95
23.00							5.48	31.51	2.66	5.37
24.00							5.72	34.10	2.77	5.80
25.00							5.96	36.79	2.89	6.26
26.00							6.20	39.58	3.00	6.72
27.00							6.43	42.46	3.12	7.20
28.00							6.67	45.44	3.23	7.70
29.00							6.91	48.51	3.35	8.22
30.00							7.15	51.68	3.46	8.75
31.00							7.39	54.95	3.58	9.29
32.00									3.70	9.85
33.00									3.81	10.43
34.00									3.93	11.02
35.00									4.04	11.62
36.00									4.16	12.24
37.00									4.27	12.88
38.00									4.39	13.53
39.00									4.50	14.20
40.00									4.62	14.88
41.00									4.73	15.57
42.00									4.85	16.29
43.00									4.97	17.01
44.00									5.08	17.75
45.00									5.20	18.51
46.00									5.31	19.28
47.00									5.43	20.07
48.00									5.54	20.87
49.00									5.66	21.69
50.00									5.77	22.52

water 60°C, copper tubes according to EN 1057, 12-35 mm

density: 983.2 kg/m³
pressure: 1 bar
viscosity: 0.0013 Pa·s
surface roughness: 0.0015 mm

d [mm]	12		15		22		28		35	
di [mm]	10.8		13.6		20.2		26.2		32.6	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.1	0.4	0.1	0.1	0.0	0.020	0.0	0.006	0.012	0.002
0.02	0.2	1.1	0.1	0.4	0.1	0.061	0.0	0.018	0.024	0.007
0.03	0.3	2.2	0.2	0.8	0.1	0.119	0.1	0.035	0.036	0.013
0.04	0.4	3.6	0.3	1.2	0.1	0.192	0.1	0.057	0.048	0.021
0.05	0.5	5.3	0.3	1.8	0.2	0.279	0.1	0.082	0.060	0.030
0.06	0.7	7.3	0.4	2.5	0.2	0.380	0.1	0.112	0.072	0.040
0.07	0.8	9.6	0.5	3.2	0.2	0.494	0.1	0.145	0.084	0.052
0.08	0.9	12.1	0.6	4.0	0.2	0.620	0.1	0.182	0.096	0.065
0.09	1.0	14.8	0.6	4.9	0.3	0.758	0.2	0.222	0.108	0.080
0.10	1.1	17.8	0.7	5.9	0.3	0.908	0.2	0.266	0.120	0.095
0.15	1.6	36.3	1.0	12.0	0.5	1.8	0.3	0.533	0.180	0.190
0.20	2.2	60.6	1.4	20.0	0.6	3.0	0.4	0.877	0.240	0.311
0.25	2.7	90.4	1.7	29.7	0.8	4.5	0.5	1.3	0.300	0.458
0.30	3.3	125.5	2.1	41.1	0.9	6.1	0.6	1.8	0.359	0.628
0.35	3.8	166.0	2.4	54.2	1.1	8.1	0.6	2.3	0.419	0.821
0.40	4.4	211.6	2.8	68.8	1.2	10.2	0.7	2.9	0.479	1.0
0.45	4.9	262.3	3.1	85.2	1.4	12.6	0.8	3.6	0.539	1.3
0.50	5.5	318.1	3.4	103.0	1.6	15.2	0.9	4.4	0.599	1.5
0.55	6.0	379.0	3.8	122.5	1.7	18.0	1.0	5.2	0.659	1.8
0.60			4.1	143.5	1.9	21.0	1.1	6.0	0.719	2.1
0.65			4.5	166.1	2.0	24.3	1.2	6.9	0.779	2.4
0.70			4.8	190.2	2.2	27.7	1.3	7.9	0.839	2.8
0.75			5.2	215.8	2.3	31.4	1.4	9.0	0.899	3.1
0.80			5.5	242.9	2.5	35.3	1.5	10.0	0.958	3.5
0.85			5.9	271.6	2.7	39.4	1.6	11.2	1.02	3.9
0.90			6.2	301.8	2.8	43.6	1.7	12.4	1.08	4.3
0.95			6.5	333.4	3.0	48.1	1.8	13.7	1.14	4.8
1.00					3.1	52.8	1.9	15.0	1.20	5.2
1.05					3.3	57.7	1.9	16.4	1.26	5.7
1.10					3.4	62.8	2.0	17.8	1.32	6.2
1.15					3.6	68.1	2.1	19.3	1.38	6.7
1.20					3.7	73.6	2.2	20.8	1.44	7.2
1.25					3.9	79.3	2.3	22.4	1.50	7.8
1.30					4.1	85.1	2.4	24.0	1.56	8.4
1.40					4.4	97.5	2.6	27.5	1.68	9.5
1.50					4.7	110.6	2.8	31.1	1.80	10.8
1.60					5.0	124.6	3.0	35.0	1.92	12.1
1.70					5.3	139.2	3.2	39.1	2.04	13.5
1.80					5.6	154.7	3.3	43.4	2.16	15.0
1.90					5.9	170.9	3.5	47.8	2.28	16.5
2.00					6.2	187.9	3.7	52.5	2.40	18.2
2.10					6.6	205.7	3.9	57.4	2.52	19.8
2.20					6.9	224.2	4.1	62.5	2.64	21.6
2.30					7.2	243.5	4.3	67.8	2.76	23.4
2.40					7.5	263.5	4.5	73.4	2.88	25.3
2.50					7.8	284.3	4.6	79.1	3.00	27.2
2.60					8.1	305.8	4.8	85.0	3.11	29.2
2.70					8.4	328.1	5.0	91.1	3.23	31.3
2.80					8.7	351.2	5.2	97.4	3.35	33.5
2.90					9.0	375.0	5.4	103.9	3.47	35.7
3.00					9.4	399.5	5.6	110.6	3.59	38.0
3.10					9.7	424.8	5.8	117.5	3.71	40.3
3.20					10.0	450.8	5.9	124.6	3.83	42.7
3.50					10.9	533.4	6.5	147.1	4.19	50.3
3.60					11.2	562.4	6.7	155.0	4.31	53.0
3.70					11.5	592.2	6.9	163.1	4.43	55.7
3.80					11.9	622.7	7.0	171.3	4.55	58.5
3.90					12.2	653.9	7.2	179.8	4.67	61.4
4.00					12.5	685.9	7.4	188.5	4.79	64.3
4.10					12.8	718.6	7.6	197.4	4.91	67.3
4.20							7.8	206.4	5.03	70.4

12-35 mm

d [mm]	12		15		22		28		35	
di [mm]	10.8		13.6		20.2		26.2		32.6	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.30							8.0	215.7	5.15	73.5
4.40							8.2	225.1	5.27	76.7
4.50							8.3	234.8	5.39	79.9
4.60							8.5	244.6	5.51	83.2
4.70							8.7	254.6	5.63	86.6
4.80							8.9	264.9	5.75	90.1
4.90							9.1	275.3	5.87	93.6
5.00							9.3	285.9	5.99	97.1
5.50							10.2	341.8	6.59	115.9
6.00							11.1	402.6	7.19	136.2
6.50							12.1	468.1	7.79	158.2
7.00							13.0	538.5	8.39	181.6
7.50							13.9	613.6	8.99	206.6
8.00							14.8	693.4	9.58	233.2
8.50									10.18	261.3
9.00									10.78	291.0
9.50									11.38	322.2
10.00									11.98	354.9
10.50									12.58	389.2
11.00									13.18	425.0
11.50									13.78	462.3
12.00									14.38	501.1
12.50									14.98	541.5
13.00									15.57	583.4
13.50									16.17	626.8
14.00									16.77	671.8
14.50									17.37	718.3

42-108 mm

d [mm]	42		54		66.7		76.1		108	
di [mm]	39.6		51.6		63.7		72.1		103	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.01	0.008	0.001	0.005	0.000	0.003	0.000	0.002	0.000	0.001	0.000
0.02	0.016	0.003	0.010	0.001	0.006	0.000	0.005	0.000	0.002	0.000
0.03	0.024	0.005	0.014	0.002	0.009	0.001	0.007	0.000	0.003	0.000
0.04	0.032	0.008	0.019	0.002	0.012	0.001	0.010	0.000	0.005	0.000
0.05	0.041	0.012	0.024	0.004	0.015	0.001	0.012	0.001	0.006	0.000
0.06	0.049	0.016	0.029	0.005	0.018	0.002	0.014	0.001	0.007	0.000
0.07	0.057	0.021	0.033	0.006	0.022	0.002	0.017	0.001	0.008	0.000
0.08	0.065	0.026	0.038	0.008	0.025	0.003	0.019	0.002	0.009	0.000
0.09	0.073	0.032	0.043	0.009	0.028	0.003	0.021	0.002	0.010	0.000
0.10	0.081	0.038	0.048	0.011	0.031	0.004	0.024	0.002	0.012	0.000
0.15	0.122	0.076	0.072	0.022	0.046	0.008	0.036	0.004	0.017	0.001
0.20	0.162	0.124	0.096	0.036	0.062	0.013	0.048	0.007	0.023	0.001
0.25	0.203	0.182	0.120	0.052	0.077	0.019	0.060	0.010	0.029	0.002
0.30	0.244	0.250	0.143	0.071	0.092	0.025	0.071	0.014	0.035	0.003
0.35	0.284	0.326	0.167	0.093	0.108	0.033	0.083	0.018	0.040	0.003
0.40	0.325	0.411	0.191	0.117	0.123	0.041	0.095	0.023	0.046	0.004
0.45	0.365	0.505	0.215	0.144	0.139	0.051	0.107	0.028	0.052	0.005
0.50	0.406	0.607	0.239	0.173	0.154	0.061	0.119	0.033	0.058	0.006
0.55	0.447	0.717	0.263	0.204	0.169	0.072	0.131	0.039	0.064	0.007
0.60	0.487	0.836	0.287	0.237	0.185	0.083	0.143	0.045	0.069	0.008
0.65	0.528	1.0	0.311	0.273	0.200	0.096	0.155	0.052	0.075	0.009
0.70	0.568	1.1	0.335	0.310	0.216	0.109	0.167	0.059	0.081	0.011
0.85	0.690	1.5	0.406	0.436	0.262	0.153	0.203	0.083	0.098	0.015
0.90	0.731	1.7	0.430	0.482	0.277	0.169	0.214	0.092	0.104	0.017
0.95	0.771	1.9	0.454	0.530	0.293	0.186	0.226	0.101	0.110	0.018
1.00	0.812	2.1	0.478	0.580	0.308	0.203	0.238	0.111	0.115	0.020
1.05	0.853	2.2	0.502	0.633	0.323	0.222	0.250	0.120	0.121	0.022
1.10	0.893	2.4	0.526	0.687	0.339	0.240	0.262	0.131	0.127	0.023
1.15	0.934	2.6	0.550	0.743	0.354	0.260	0.274	0.141	0.133	0.025
1.20	0.97	2.8	0.574	0.801	0.370	0.280	0.286	0.152	0.139	0.027
1.25	1.01	3.1	0.598	0.861	0.385	0.301	0.298	0.163	0.144	0.029
1.30	1.06	3.3	0.622	0.922	0.400	0.322	0.310	0.175	0.150	0.031
1.40	1.14	3.7	0.669	1.1	0.431	0.367	0.334	0.199	0.162	0.036
1.50	1.22	4.2	0.717	1.2	0.462	0.415	0.357	0.225	0.173	0.040
1.60	1.30	4.8	0.765	1.3	0.493	0.465	0.381	0.252	0.185	0.045
1.70	1.38	5.3	0.813	1.5	0.524	0.518	0.405	0.281	0.196	0.050
1.80	1.46	5.9	0.861	1.6	0.554	0.573	0.429	0.310	0.208	0.055
1.90	1.54	6.5	0.909	1.8	0.585	0.630	0.453	0.341	0.219	0.061
2.00	1.62	7.1	0.96	2.0	0.616	0.691	0.477	0.374	0.231	0.066
2.10	1.71	7.7	1.00	2.2	0.647	0.753	0.500	0.408	0.243	0.072
2.20	1.79	8.4	1.05	2.4	0.678	0.818	0.524	0.443	0.254	0.079
2.30	1.87	9.1	1.10	2.5	0.708	0.885	0.548	0.479	0.266	0.085
2.40	1.95	9.8	1.15	2.7	0.739	1.0	0.572	0.517	0.277	0.092
2.50	2.03	10.6	1.20	3.0	0.770	1.0	0.596	0.555	0.289	0.098
2.60	2.11	11.4	1.24	3.2	0.801	1.1	0.620	0.595	0.300	0.105
2.70	2.19	12.2	1.29	3.4	0.831	1.2	0.643	0.637	0.312	0.113
2.80	2.27	13.0	1.34	3.6	0.862	1.3	0.667	0.679	0.323	0.120
2.90	2.35	13.9	1.39	3.9	0.893	1.3	0.691	0.723	0.335	0.128
3.00	2.44	14.7	1.43	4.1	0.924	1.4	0.715	0.768	0.346	0.136
3.10	2.52	15.6	1.48	4.3	0.95	1.5	0.739	0.814	0.358	0.144
3.20	2.60	16.6	1.53	4.6	0.99	1.6	0.762	0.862	0.370	0.152
3.30	2.68	17.5	1.58	4.9	1.02	1.7	0.786	0.91	0.381	0.161
3.40	2.76	18.5	1.63	5.1	1.05	1.8	0.810	0.96	0.393	0.169
3.50	2.84	19.5	1.67	5.4	1.08	1.9	0.834	1.01	0.404	0.178
3.60	2.92	20.5	1.72	5.7	1.11	2.0	0.858	1.06	0.416	0.188
3.70	3.00	21.6	1.77	6.0	1.14	2.1	0.882	1.12	0.427	0.197
3.80	3.09	22.7	1.82	6.3	1.17	2.2	0.905	1.17	0.439	0.206
3.90	3.17	23.8	1.86	6.6	1.20	2.3	0.93	1.23	0.450	0.216
4.00	3.25	24.9	1.91	6.9	1.23	2.4	0.95	1.28	0.462	0.226
4.10	3.33	26.0	1.96	7.2	1.26	2.5	0.98	1.34	0.473	0.236
4.20	3.41	27.2	2.01	7.5	1.29	2.6	1.00	1.40	0.485	0.247
4.30	3.49	28.4	2.06	7.8	1.32	2.7	1.02	1.46	0.497	0.257
4.40	3.57	29.6	2.10	8.2	1.36	2.8	1.05	1.52	0.508	0.268
4.50	3.65	30.9	2.15	8.5	1.39	2.9	1.07	1.59	0.520	0.279
4.60	3.73	32.1	2.20	8.9	1.42	3.1	1.10	1.65	0.531	0.290

42-108 mm

d [mm]	42		54		66.7		76.1		108	
di [mm]	39.6		51.6		63.7		72.1		103	
V [l/s]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
4.70	3.82	33.4	2.25	9.2	1.45	3.2	1.12	1.71	0.543	0.301
4.80	3.90	34.7	2.30	9.6	1.48	3.3	1.14	1.78	0.554	0.313
4.90	3.98	36.1	2.34	9.9	1.51	3.4	1.17	1.85	0.566	0.324
5.00	4.06	37.4	2.39	10.3	1.54	3.6	1.19	1.92	0.577	0.336
5.50	4.47	44.6	2.63	12.3	1.69	4.2	1.31	2.27	0.635	0.399
6.00	4.87	52.3	2.87	14.4	1.85	4.9	1.43	2.66	0.693	0.466
6.50	5.28	60.7	3.11	16.6	2.00	5.7	1.55	3.08	0.751	0.538
7.00	5.68	69.6	3.35	19.1	2.16	6.5	1.67	3.52	0.808	0.614
7.50	6.09	79.1	3.59	21.6	2.31	7.4	1.79	3.98	0.866	0.695
8.00	6.50	89.1	3.83	24.3	2.46	8.3	1.91	4.48	0.924	0.780
8.50	6.90	99.8	4.06	27.2	2.62	9.3	2.03	5.00	0.982	0.870
9.00	7.31	111.0	4.30	30.2	2.77	10.3	2.14	5.55	1.039	0.964
9.50	7.71	122.8	4.54	33.4	2.93	11.4	2.26	6.12	1.10	1.06
10.00	8.12	135.1	4.78	36.7	3.08	12.5	2.38	6.72	1.15	1.17
10.50	8.53	148.0	5.02	40.2	3.23	13.7	2.50	7.34	1.21	1.27
11.00	8.93	161.5	5.26	43.8	3.39	14.9	2.62	7.99	1.27	1.38
11.50	9.34	175.5	5.50	47.5	3.54	16.2	2.74	8.67	1.33	1.50
12.00	9.74	190.1	5.74	51.4	3.70	17.5	2.86	9.37	1.39	1.62
12.50	10.15	205.3	5.98	55.5	3.85	18.9	2.98	10.10	1.44	1.74
13.00	10.56	221.0	6.22	59.7	4.00	20.3	3.10	10.85	1.50	1.87
13.50	10.96	237.3	6.46	64.0	4.16	21.7	3.22	11.63	1.56	2.01
14.00	11.37	254.1	6.69	68.5	4.31	23.3	3.34	12.43	1.62	2.14
14.50	11.77	271.5	6.93	73.1	4.47	24.8	3.45	13.26	1.67	2.28
15.00	12.18	289.4	7.17	77.9	4.62	26.4	3.57	14.11	1.73	2.43
15.50	12.58	307.9	7.41	82.8	4.77	28.1	3.69	14.98	1.79	2.58
16.00	12.99	327.0	7.65	87.9	4.93	29.8	3.81	15.89	1.85	2.73
17.50	14.21	387.5	8.37	103.9	5.39	35.1	4.17	18.74	2.02	3.21
18.00	14.61	408.8	8.61	109.5	5.54	37.0	4.29	19.74	2.08	3.38
19.50	15.83	476.0	9.32	127.3	6.01	42.9	4.65	22.88	2.25	3.92
20.00	16.24	499.5	9.56	133.5	6.16	45.0	4.77	23.98	2.31	4.10
21.00					6.47	49.3	5.00	26.24	2.43	4.48
22.00							5.24	28.60	2.54	4.88
23.00							5.48	31.06	2.66	5.29
24.00							5.72	33.62	2.77	5.72
25.00							5.96	36.27	2.89	6.17
26.00							6.20	39.01	3.00	6.63
27.00							6.43	41.85	3.12	7.10
28.00							6.67	44.78	3.23	7.60
29.00							6.91	47.81	3.35	8.10
30.00							7.15	50.94	3.46	8.62
31.00							7.39	54.16	3.58	9.16
32.00									3.70	9.71
33.00									3.81	10.28
34.00									3.93	10.86
35.00									4.04	11.46
36.00									4.16	12.07
37.00									4.27	12.70
38.00									4.39	13.34
39.00									4.50	14.00
40.00									4.62	14.67
41.00									4.73	15.35
42.00									4.85	16.05
43.00									4.97	16.77
44.00									5.08	17.50
45.00									5.20	18.25
46.00									5.31	19.01
47.00									5.43	19.78
48.00									5.54	20.57
49.00									5.66	21.38
50.00									5.77	22.20

compressed air 3 bar, depending on the volume flow, 12-22 mm

temperature: 20°C
density: 3.612 kg/m³
viscosity: 0.0000171 Pa.s
surface roughness: 0.0015 mm

d[mm]	12		15		18		22	
di [mm]	10		13		16		20	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.9	0.0716	0.5	0.0210	0.3	0.0080	0.2	0.0028
0.50	1.8	0.2308	1.0	0.0672	0.7	0.0254	0.4	0.0089
0.75	2.7	0.4622	1.6	0.1340	1.0	0.0504	0.7	0.0177
1.00	3.5	0.7592	2.1	0.2195	1.4	0.0824	0.9	0.0288
1.25	4.4	1.1180	2.6	0.3225	1.7	0.1208	1.1	0.0422
1.50	5.3	1.5358	3.1	0.4422	2.1	0.1654	1.3	0.0576
1.75	6.2	2.0105	3.7	0.5779	2.4	0.2160	1.5	0.0751
2.00	7.1	2.5405	4.2	0.7292	2.8	0.2722	1.8	0.0946
2.25	8.0	3.1244	4.7	0.8958	3.1	0.3341	2.0	0.1160
2.50	8.8	3.7610	5.2	1.0771	3.5	0.4014	2.2	0.1393
2.75	9.7	4.4494	5.8	1.2729	3.8	0.4740	2.4	0.1643
3.00	10.6	5.1887	6.3	1.4831	4.1	0.5519	2.7	0.1912
3.25			6.8	1.7072	4.5	0.6349	2.9	0.2198
3.50			7.3	1.9453	4.8	0.7230	3.1	0.2502
3.75			7.8	2.1969	5.2	0.8161	3.3	0.2822
4.00			8.4	2.4621	5.5	0.9142	3.5	0.3160
4.50			9.4	3.0322	6.2	1.1248	4.0	0.3884
5.00			10.5	3.6546	6.9	1.3545	4.4	0.4674
5.50					7.6	1.6030	4.9	0.5527
6.00					8.3	1.8699	5.3	0.6442
6.50					9.0	2.1549	5.7	0.7419
7.00					9.7	2.4578	6.2	0.8457
7.50					10.4	2.8	6.6	0.9555
8.00							7.1	1.0711
8.50							7.5	1.1926
9.00							8.0	1.3199
9.50							8.4	1.4529
10.00							8.8	1.5916
10.50							9.3	1.7359
11.00							9.7	1.8858

28-54 mm

d[mm]	28		35		42		54	
di [mm]	25		32		39		50	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0010	0.1	0.0003	0.1	0.0001	0.0	0.0000
0.50	0.3	0.0032	0.2	0.0010	0.1	0.0004	0.1	0.0001
0.75	0.4	0.0062	0.3	0.0020	0.2	0.0008	0.1	0.0002
1.00	0.6	0.0101	0.3	0.0032	0.2	0.0013	0.1	0.0004
1.25	0.7	0.0147	0.4	0.0046	0.3	0.0018	0.2	0.0006
1.50	0.8	0.0201	0.5	0.0063	0.3	0.0025	0.2	0.0008
1.75	1.0	0.0262	0.6	0.0082	0.4	0.0032	0.2	0.0010
2.00	1.1	0.0330	0.7	0.0103	0.5	0.0041	0.3	0.0013
2.25	1.3	0.0404	0.8	0.0126	0.5	0.0050	0.3	0.0015
2.50	1.4	0.0484	0.9	0.0151	0.6	0.0059	0.4	0.0018
2.75	1.6	0.0571	0.9	0.0178	0.6	0.0070	0.4	0.0022
3.00	1.7	0.0664	1.0	0.0206	0.7	0.0081	0.4	0.0025
3.25	1.8	0.0763	1.1	0.0237	0.8	0.0093	0.5	0.0029
3.50	2.0	0.0868	1.2	0.0269	0.8	0.0106	0.5	0.0033
3.75	2.1	0.0978	1.3	0.0304	0.9	0.0119	0.5	0.0037
4.00	2.3	0.1095	1.4	0.0340	0.9	0.0133	0.6	0.0041
4.50	2.5	0.1344	1.6	0.0417	1.0	0.0163	0.6	0.0050
5.00	2.8	0.1616	1.7	0.0500	1.2	0.0196	0.7	0.0060
5.50	3.1	0.1910	1.9	0.0591	1.3	0.0231	0.8	0.0071
6.00	3.4	0.2225	2.1	0.0688	1.4	0.0269	0.8	0.0083
6.50	3.7	0.2561	2.2	0.0791	1.5	0.0309	0.9	0.0095
7.00	4.0	0.2917	2.4	0.0901	1.6	0.0352	1.0	0.0108
7.50	4.2	0.3294	2.6	0.1017	1.7	0.0397	1.1	0.0122
8.00	4.5	0.3691	2.8	0.1138	1.9	0.0444	1.1	0.0137
8.50	4.8	0.4108	2.9	0.1266	2.0	0.0494	1.2	0.0152
9.00	5.1	0.4544	3.1	0.1400	2.1	0.0546	1.3	0.0168
9.50	5.4	0.5000	3.3	0.1540	2.2	0.0600	1.3	0.0184
10.00	5.7	0.5475	3.5	0.1686	2.3	0.0657	1.4	0.0202
10.50	5.9	0.5969	3.6	0.1837	2.4	0.0716	1.5	0.0220
11.00	6.2	0.6482	3.8	0.1994	2.6	0.0777	1.6	0.0238
11.50	6.5	0.7014	4.0	0.2157	2.7	0.0840	1.6	0.0258
12.00	6.8	0.7564	4.1	0.2326	2.8	0.0905	1.7	0.0277
12.50	7.1	0.8133	4.3	0.2500	2.9	0.0973	1.8	0.0298
13.00	7.4	0.8720	4.5	0.2679	3.0	0.1043	1.8	0.0319
13.50	7.6	0.9325	4.7	0.2864	3.1	0.1114	1.9	0.0341
14.00	7.9	0.9948	4.8	0.3055	3.3	0.1188	2.0	0.0364
14.50	8.2	1.0590	5.0	0.3251	3.4	0.1264	2.1	0.0387
15.00	8.5	1.1249	5.2	0.3452	3.5	0.1342	2.1	0.0411
16.00	9.1	1.2620	5.5	0.3871	3.7	0.1504	2.3	0.0460
17.00	9.6	1.4062	5.9	0.4311	4.0	0.1675	2.4	0.0512
18.00	10.2	1.5574	6.2	0.4772	4.2	0.1853	2.5	0.0566
19.00	10.8	1.7154	6.6	0.5254	4.4	0.2040	2.7	0.0623
20.00	11.3	1.8803	6.9	0.5757	4.7	0.2234	2.8	0.0682
21.00			7.3	0.6280	4.9	0.2436	3.0	0.0743
22.00			7.6	0.6823	5.1	0.2646	3.1	0.0807
23.00			7.9	0.7386	5.3	0.2864	3.3	0.0873
24.00			8.3	0.7969	5.6	0.3089	3.4	0.0942
25.00			8.6	0.8572	5.8	0.3322	3.5	0.1012
30.00			10.4	1.1880	7.0	0.4599	4.2	0.1400
35.00					8.1	0.6058	5.0	0.1841
40.00					9.3	0.7695	5.7	0.2337
45.00					10.5	0.9506	6.4	0.2884
50.00							7.1	0.3483
55.00							7.8	0.4131
60.00							8.5	0.4830
65.00							9.2	0.5576
70.00							9.9	0.6372
75.00							10.6	0.7214
80.00							11.3	0.8104

compressed air 6 bar, depending on the volume flow, 12-22 mm

temperature: 20°C
density: 7.224 kg/m³
viscosity: 0.0000171 Pa.s
surface roughness: 0.0015 mm

d[mm]	12		15		18		22	
di [mm]	10		13		16		20	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.9	0.1154	0.5	0.0336	0.3	0.0127	0.2	0.0045
0.50	1.8	0.3796	1.0	0.1097	0.7	0.0412	0.4	0.0144
0.75	2.7	0.7679	1.6	0.2211	1.0	0.0827	0.7	0.0288
1.00	3.5	1.2702	2.1	0.3646	1.4	0.1361	0.9	0.0473
1.25	4.4	1.8805	2.6	0.5385	1.7	0.2007	1.1	0.0696
1.50	5.3	2.5943	3.1	0.7415	2.1	0.2760	1.3	0.0956
1.75	6.2	3.4085	3.7	0.9726	2.4	0.3615	1.5	0.1251
2.00	7.1	4.3205	4.2	1.2310	2.8	0.4571	1.8	0.1580
2.25	8.0	5.3281	4.7	1.5161	3.1	0.5624	2.0	0.1942
2.50	8.8	6.4296	5.2	1.8273	3.5	0.6773	2.2	0.2337
2.75	9.7	7.6236	5.8	2.1642	3.8	0.8015	2.4	0.2763
3.00	10.6	8.9087	6.3	2.5263	4.1	0.9349	2.7	0.3221
3.25			6.8	2.9133	4.5	1.0774	2.9	0.3710
3.50			7.3	3.3250	4.8	1.2289	3.1	0.4228
3.75			7.8	3.7609	5.2	1.3892	3.3	0.4777
4.00			8.4	4.2209	5.5	1.5582	3.5	0.5356
4.50			9.4	5.2121	6.2	1.9221	4.0	0.6600
5.00			10.5	6.2969	6.9	2.3198	4.4	0.7958
5.50					7.6	2.7510	4.9	0.9429
6.00					8.3	3.2149	5.3	1.1011
6.50					9.0	3.7114	5.7	1.2701
7.00					9.7	4.2399	6.2	1.4500
7.50					10.4	4.8	6.6	1.6405
8.00							7.1	1.8415
8.50							7.5	2.0530
9.00							8.0	2.2748
9.50							8.4	2.5068
10.00							8.8	2.7490
10.50							9.3	3.0013
11.00							9.7	3.2636
11.50							10.2	3.5358
12.00							10.6	3.8180

28-54 mm

d[mm]	28		35		42		54	
di [mm]	25		32		39		50	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0016	0.1	0.0005	0.1	0.0002	0.0	0.0001
0.50	0.3	0.0050	0.2	0.0016	0.1	0.0006	0.1	0.0002
0.75	0.4	0.0101	0.3	0.0031	0.2	0.0012	0.1	0.0004
1.00	0.6	0.0165	0.3	0.0051	0.2	0.0020	0.1	0.0006
1.25	0.7	0.0242	0.4	0.0075	0.3	0.0030	0.2	0.0009
1.50	0.8	0.0332	0.5	0.0103	0.3	0.0041	0.2	0.0013
1.75	1.0	0.0434	0.6	0.0135	0.4	0.0053	0.2	0.0016
2.00	1.1	0.0547	0.7	0.0170	0.5	0.0067	0.3	0.0021
2.25	1.3	0.0672	0.8	0.0208	0.5	0.0082	0.3	0.0025
2.50	1.4	0.0808	0.9	0.0250	0.6	0.0098	0.4	0.0030
2.75	1.6	0.0955	0.9	0.0295	0.6	0.0116	0.4	0.0036
3.00	1.7	0.1112	1.0	0.0344	0.7	0.0134	0.4	0.0041
3.25	1.8	0.1280	1.1	0.0396	0.8	0.0155	0.5	0.0048
3.50	2.0	0.1459	1.2	0.0450	0.8	0.0176	0.5	0.0054
3.75	2.1	0.1647	1.3	0.0508	0.9	0.0198	0.5	0.0061
4.00	2.3	0.1845	1.4	0.0569	0.9	0.0222	0.6	0.0068
4.50	2.5	0.2272	1.6	0.0700	1.0	0.0273	0.6	0.0084
5.00	2.8	0.2737	1.7	0.0843	1.2	0.0329	0.7	0.0101
5.50	3.1	0.3241	1.9	0.0997	1.3	0.0388	0.8	0.0119
6.00	3.4	0.3782	2.1	0.1163	1.4	0.0453	0.8	0.0139
6.50	3.7	0.4360	2.2	0.1340	1.5	0.0521	0.9	0.0160
7.00	4.0	0.4974	2.4	0.1527	1.6	0.0594	1.0	0.0182
7.50	4.2	0.5624	2.6	0.1726	1.7	0.0671	1.1	0.0205
8.00	4.5	0.6310	2.8	0.1936	1.9	0.0752	1.1	0.0230
8.50	4.8	0.7031	2.9	0.2156	2.0	0.0837	1.2	0.0256
9.00	5.1	0.7787	3.1	0.2386	2.1	0.0927	1.3	0.0283
9.50	5.4	0.8577	3.3	0.2627	2.2	0.1020	1.3	0.0311
10.00	5.7	0.9402	3.5	0.2878	2.3	0.1117	1.4	0.0341
10.50	5.9	1.0260	3.6	0.3140	2.4	0.1218	1.5	0.0372
11.00	6.2	1.1152	3.8	0.3411	2.6	0.1323	1.6	0.0404
11.50	6.5	1.2077	4.0	0.3693	2.7	0.1432	1.6	0.0437
12.00	6.8	1.3036	4.1	0.3985	2.8	0.1545	1.7	0.0471
12.50	7.1	1.4027	4.3	0.4286	2.9	0.1661	1.8	0.0506
13.00	7.4	1.5051	4.5	0.4597	3.0	0.1781	1.8	0.0543
13.50	7.6	1.6108	4.7	0.4918	3.1	0.1905	1.9	0.0580
14.00	7.9	1.7197	4.8	0.5249	3.3	0.2033	2.0	0.0619
14.50	8.2	1.8319	5.0	0.5590	3.4	0.2164	2.1	0.0659
15.00	8.5	1.9472	5.2	0.5940	3.5	0.2299	2.1	0.0700
16.00	9.1	2.1875	5.5	0.6669	3.7	0.2580	2.3	0.0785
17.00	9.6	2.4403	5.9	0.7435	4.0	0.2876	2.4	0.0874
18.00	10.2	2.7057	6.2	0.8239	4.2	0.3185	2.5	0.0968
19.00	10.8	2.9836	6.6	0.9080	4.4	0.3509	2.7	0.1066
20.00	11.3	3.2738	6.9	0.9958	4.7	0.3847	2.8	0.1168
21.00			7.3	1.0873	4.9	0.4199	3.0	0.1275
22.00			7.6	1.1824	5.1	0.4565	3.1	0.1385
23.00			7.9	1.2811	5.3	0.4944	3.3	0.1500
24.00			8.3	1.3833	5.6	0.5338	3.4	0.1619
25.00			8.6	1.4892	5.8	0.5744	3.5	0.1741
30.00			10.4	2.0710	7.0	0.7978	4.2	0.2415
35.00					8.1	1.0538	5.0	0.3186
40.00					9.3	1.3420	5.7	0.4052
45.00					10.5	1.6615	6.4	0.5011
50.00							7.1	0.6062
55.00							7.8	0.7204
60.00							8.5	0.8434
65.00							9.2	0.9752
70.00							9.9	1.1157
75.00							10.6	1.2649
80.00							11.3	1.4225

compressed air 9 bar, depending on the volume flow, 12-22 mm

temperature: 20°C
density: 10.836 kg/m³
viscosity: 0.0000171 Pa.s
surface roughness: 0.0015 mm

d[mm]	12		15		18		22	
di [mm]	10		13		16		20	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.9	0.1541	0.5	0.0447	0.3	0.0168	0.2	0.0059
0.50	1.8	0.5119	1.0	0.1474	0.7	0.0551	0.4	0.0192
0.75	2.7	1.0415	1.6	0.2986	1.0	0.1114	0.7	0.0387
1.00	3.5	1.7296	2.1	0.4944	1.4	0.1840	0.9	0.0637
1.25	4.4	2.5683	2.6	0.7323	1.7	0.2720	1.1	0.0941
1.50	5.3	3.5521	3.1	1.0107	2.1	0.3749	1.3	0.1295
1.75	6.2	4.6768	3.7	1.3284	2.4	0.4921	1.5	0.1697
2.00	7.1	5.9391	4.2	1.6842	2.8	0.6233	1.8	0.2147
2.25	8.0	7.3365	4.7	2.0774	3.1	0.7680	2.0	0.2644
2.50	8.8	8.8667	5.2	2.5073	3.5	0.9261	2.2	0.3185
2.75	9.7	10.5278	5.8	2.9732	3.8	1.0973	2.4	0.3770
3.00	10.6	12.3183	6.3	3.4747	4.1	1.2814	2.7	0.4400
3.25			6.8	4.0113	4.5	1.4782	2.9	0.5072
3.50			7.3	4.5827	4.8	1.6875	3.1	0.5786
3.75			7.8	5.1883	5.2	1.9093	3.3	0.6543
4.00			8.4	5.8280	5.5	2.1433	3.5	0.7340
4.50			9.4	7.2084	6.2	2.6478	4.0	0.9058
5.00			10.5	8.7216	6.9	3.2000	4.4	1.0937
5.50					7.6	3.7995	4.9	1.2973
6.00					8.3	4.4454	5.3	1.5165
6.50					9.0	5.1373	5.7	1.7511
7.00					9.7	5.8747	6.2	2.0009
7.50					10.4	6.7	6.6	2.2656
8.00							7.1	2.5453
8.50							7.5	2.8397
9.00							8.0	3.1488
9.50							8.4	3.4724
10.00							8.8	3.8104
10.50							9.3	4.1627
11.00							9.7	4.5292
11.50							10.2	4.9099
12.00							10.6	5.3047

28-54 mm

d[mm]	28		35		42		54	
di [mm]	25		32		39		50	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0021	0.1	0.0007	0.1	0.0003	0.0	0.0001
0.50	0.3	0.0067	0.2	0.0021	0.1	0.0008	0.1	0.0003
0.75	0.4	0.0135	0.3	0.0042	0.2	0.0017	0.1	0.0005
1.00	0.6	0.0221	0.3	0.0069	0.2	0.0027	0.1	0.0008
1.25	0.7	0.0326	0.4	0.0101	0.3	0.0040	0.2	0.0012
1.50	0.8	0.0448	0.5	0.0139	0.3	0.0054	0.2	0.0017
1.75	1.0	0.0587	0.6	0.0182	0.4	0.0071	0.2	0.0022
2.00	1.1	0.0742	0.7	0.0229	0.5	0.0090	0.3	0.0028
2.25	1.3	0.0912	0.8	0.0282	0.5	0.0110	0.3	0.0034
2.50	1.4	0.1098	0.9	0.0339	0.6	0.0132	0.4	0.0041
2.75	1.6	0.1299	0.9	0.0401	0.6	0.0156	0.4	0.0048
3.00	1.7	0.1515	1.0	0.0467	0.7	0.0182	0.4	0.0056
3.25	1.8	0.1745	1.1	0.0537	0.8	0.0209	0.5	0.0064
3.50	2.0	0.1990	1.2	0.0612	0.8	0.0239	0.5	0.0073
3.75	2.1	0.2248	1.3	0.0692	0.9	0.0269	0.5	0.0083
4.00	2.3	0.2521	1.4	0.0775	0.9	0.0302	0.6	0.0092
4.50	2.5	0.3108	1.6	0.0955	1.0	0.0371	0.6	0.0114
5.00	2.8	0.3750	1.7	0.1151	1.2	0.0447	0.7	0.0137
5.50	3.1	0.4444	1.9	0.1363	1.3	0.0530	0.8	0.0162
6.00	3.4	0.5191	2.1	0.1591	1.4	0.0618	0.8	0.0189
6.50	3.7	0.5990	2.2	0.1834	1.5	0.0712	0.9	0.0217
7.00	4.0	0.6840	2.4	0.2093	1.6	0.0812	1.0	0.0248
7.50	4.2	0.7740	2.6	0.2367	1.7	0.0918	1.1	0.0280
8.00	4.5	0.8690	2.8	0.2656	1.9	0.1030	1.1	0.0314
8.50	4.8	0.9690	2.9	0.2960	2.0	0.1147	1.2	0.0350
9.00	5.1	1.0739	3.1	0.3279	2.1	0.1270	1.3	0.0387
9.50	5.4	1.1836	3.3	0.3612	2.2	0.1399	1.3	0.0426
10.00	5.7	1.2981	3.5	0.3960	2.3	0.1533	1.4	0.0467
10.50	5.9	1.4175	3.6	0.4322	2.4	0.1672	1.5	0.0509
11.00	6.2	1.5415	3.8	0.4698	2.6	0.1817	1.6	0.0553
11.50	6.5	1.6703	4.0	0.5088	2.7	0.1968	1.6	0.0598
12.00	6.8	1.8038	4.1	0.5493	2.8	0.2124	1.7	0.0645
12.50	7.1	1.9420	4.3	0.5911	2.9	0.2285	1.8	0.0694
13.00	7.4	2.0847	4.5	0.6343	3.0	0.2451	1.8	0.0744
13.50	7.6	2.2321	4.7	0.6789	3.1	0.2623	1.9	0.0796
14.00	7.9	2.3841	4.8	0.7249	3.3	0.2800	2.0	0.0850
14.50	8.2	2.5407	5.0	0.7722	3.4	0.2982	2.1	0.0905
15.00	8.5	2.7018	5.2	0.8209	3.5	0.3169	2.1	0.0961
16.00	9.1	3.0375	5.5	0.9222	3.7	0.3558	2.3	0.1079
17.00	9.6	3.3912	5.9	1.0289	4.0	0.3968	2.4	0.1203
18.00	10.2	3.7628	6.2	1.1410	4.2	0.4398	2.5	0.1333
19.00	10.8	4.1520	6.6	1.2582	4.4	0.4849	2.7	0.1468
20.00	11.3	4.5589	6.9	1.3807	4.7	0.5318	2.8	0.1610
21.00			7.3	1.5083	4.9	0.5808	3.0	0.1757
22.00			7.6	1.6411	5.1	0.6317	3.1	0.1911
23.00			7.9	1.7790	5.3	0.6845	3.3	0.2070
24.00			8.3	1.9220	5.6	0.7393	3.4	0.2234
25.00			8.6	2.0701	5.8	0.7960	3.5	0.2405
30.00			10.4	2.8852	7.0	1.1077	4.2	0.3341
35.00					8.1	1.4658	5.0	0.4415
40.00					9.3	1.8694	5.7	0.5623
45.00					10.5	2.3177	6.4	0.6963
50.00							7.1	0.8432
55.00							7.8	1.0030
60.00							8.5	1.1754
65.00							9.2	1.3604
70.00							9.9	1.5577
75.00							10.6	1.7673
80.00							11.3	1.9890

gas, 1st gas family, depending on the volume flow, 12-22 mm

density: 0.61 kg/m³
viscosity: 0.000015 Pa.s
surface roughness: 0.0015 mm

d [mm]	12		15		18		22	
di [mm]	10		13		16		20	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.9	0.0222	0.5	0.0067	0.3	0.0026	0.2	0.0009
0.50	1.8	0.0674	1.0	0.0201	0.7	0.0077	0.4	0.0028
0.75	2.7	0.1310	1.6	0.0387	1.0	0.0148	0.7	0.0053
1.00	3.5	0.2108	2.1	0.0621	1.4	0.0237	0.9	0.0084
1.25	4.4	0.3059	2.6	0.0899	1.7	0.0342	1.1	0.0121
1.50	5.3	0.4153	3.1	0.1217	2.1	0.0462	1.3	0.0164
1.75	6.2	0.5384	3.7	0.1575	2.4	0.0597	1.5	0.0211
2.00	7.1	0.6748	4.2	0.1971	2.8	0.0746	1.8	0.0263
2.25	8.0	0.8240	4.7	0.2404	3.1	0.0909	2.0	0.0320
2.50	8.8	0.9857	5.2	0.2872	3.5	0.1085	2.2	0.0382
2.75	9.7	1.1596	5.8	0.3375	3.8	0.1274	2.4	0.0448
3.00	10.6	1.3454	6.3	0.3912	4.1	0.1475	2.7	0.0518
3.25			6.8	0.4483	4.5	0.1689	2.9	0.0593
3.50			7.3	0.5086	4.8	0.1915	3.1	0.0672
3.75			7.8	0.5722	5.2	0.2154	3.3	0.0755
4.00			8.4	0.6389	5.5	0.2403	3.5	0.0842
4.50			9.4	0.7817	6.2	0.2938	4.0	0.1028
5.00			10.5	0.9367	6.9	0.3517	4.4	0.1230
5.50					7.6	0.4140	4.9	0.1447
6.00					8.3	0.4807	5.3	0.1678
6.50					9.0	0.5516	5.7	0.1925
7.00					9.7	0.6266	6.2	0.2185
7.50					10.4	0.7	6.6	0.2460
8.00							7.1	0.2748
8.50							7.5	0.3050
9.00							8.0	0.3366
9.50							8.4	0.3695
10.00							8.8	0.4037
10.50							9.3	0.4392
11.00							9.7	0.4759

28-54 mm

d [mm]	28		35		42		54	
di [mm]	25		32		39		50	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0003	0.1	0.0001	0.1	0.0000	0.0	0.0000
0.50	0.3	0.0010	0.2	0.0003	0.1	0.0001	0.1	0.0000
0.75	0.4	0.0019	0.3	0.0006	0.2	0.0002	0.1	0.0001
1.00	0.6	0.0030	0.3	0.0010	0.2	0.0004	0.1	0.0001
1.25	0.7	0.0043	0.4	0.0014	0.3	0.0006	0.2	0.0002
1.50	0.8	0.0058	0.5	0.0019	0.3	0.0007	0.2	0.0002
1.75	1.0	0.0075	0.6	0.0024	0.4	0.0010	0.2	0.0003
2.00	1.1	0.0093	0.7	0.0030	0.5	0.0012	0.3	0.0004
2.25	1.3	0.0113	0.8	0.0036	0.5	0.0014	0.3	0.0005
2.50	1.4	0.0135	0.9	0.0043	0.6	0.0017	0.4	0.0005
2.75	1.6	0.0158	0.9	0.0050	0.6	0.0020	0.4	0.0006
3.00	1.7	0.0183	1.0	0.0058	0.7	0.0023	0.4	0.0007
3.25	1.8	0.0209	1.1	0.0066	0.8	0.0026	0.5	0.0008
3.50	2.0	0.0236	1.2	0.0075	0.8	0.0030	0.5	0.0009
3.75	2.1	0.0265	1.3	0.0084	0.9	0.0033	0.5	0.0010
4.00	2.3	0.0296	1.4	0.0093	0.9	0.0037	0.6	0.0012
4.50	2.5	0.0361	1.6	0.0114	1.0	0.0045	0.6	0.0014
5.00	2.8	0.0431	1.7	0.0136	1.2	0.0054	0.7	0.0017
5.50	3.1	0.0507	1.9	0.0159	1.3	0.0063	0.8	0.0020
6.00	3.4	0.0587	2.1	0.0184	1.4	0.0073	0.8	0.0023
6.50	3.7	0.0673	2.2	0.0211	1.5	0.0083	0.9	0.0026
7.00	4.0	0.0764	2.4	0.0239	1.6	0.0095	1.0	0.0030
7.50	4.2	0.0859	2.6	0.0269	1.7	0.0106	1.1	0.0033
8.00	4.5	0.0959	2.8	0.0300	1.9	0.0118	1.1	0.0037
8.50	4.8	0.1064	2.9	0.0333	2.0	0.0131	1.2	0.0041
9.00	5.1	0.1174	3.1	0.0367	2.1	0.0145	1.3	0.0045
9.50	5.4	0.1288	3.3	0.0402	2.2	0.0159	1.3	0.0049
10.00	5.7	0.1406	3.5	0.0439	2.3	0.0173	1.4	0.0054
10.50	5.9	0.1529	3.6	0.0477	2.4	0.0188	1.5	0.0058
11.00	6.2	0.1657	3.8	0.0517	2.6	0.0204	1.6	0.0063
11.50	6.5	0.1789	4.0	0.0558	2.7	0.0220	1.6	0.0068
12.00	6.8	0.1925	4.1	0.0600	2.8	0.0236	1.7	0.0073
12.50	7.1	0.2066	4.3	0.0644	2.9	0.0253	1.8	0.0079
13.00	7.4	0.2210	4.5	0.0688	3.0	0.0271	1.8	0.0084
13.50	7.6	0.2359	4.7	0.0735	3.1	0.0289	1.9	0.0090
14.00	7.9	0.2512	4.8	0.0782	3.3	0.0307	2.0	0.0095
14.50	8.2	0.2670	5.0	0.0831	3.4	0.0326	2.1	0.0101
15.00	8.5	0.2831	5.2	0.0881	3.5	0.0346	2.1	0.0107
16.00	9.1	0.3166	5.5	0.0984	3.7	0.0387	2.3	0.0120
17.00	9.6	0.3518	5.9	0.1093	4.0	0.0429	2.4	0.0133
18.00	10.2	0.3885	6.2	0.1207	4.2	0.0474	2.5	0.0147
19.00	10.8	0.4268	6.6	0.1325	4.4	0.0520	2.7	0.0161
20.00	11.3	0.4667	6.9	0.1448	4.7	0.0568	2.8	0.0176
21.00			7.3	0.1576	4.9	0.0618	3.0	0.0191
22.00			7.6	0.1709	5.1	0.0670	3.1	0.0207
23.00			7.9	0.1846	5.3	0.0723	3.3	0.0223
24.00			8.3	0.1987	5.6	0.0778	3.4	0.0240
25.00			8.6	0.2134	5.8	0.0836	3.5	0.0258
30.00			10.4	0.2932	7.0	0.1147	4.2	0.0353
35.00					8.1	0.1500	5.0	0.0462
40.00					9.3	0.1894	5.7	0.0582
45.00					10.5	0.2328	6.4	0.0715
50.00							7.1	0.0859
55.00							7.8	0.1015
60.00							8.5	0.1182
65.00							9.2	0.1361
70.00							9.9	0.1550
75.00							10.6	0.1750
80.00							11.3	0.1960

gas, 2nd gas family, depending on the volume flow, 12-22 mm

density: 0.79 kg/m³
viscosity: 0.000015 Pa.s
surface roughness: 0.0015 mm

d [mm]	12		15		18		22	
di [mm]	10		13		16		20	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.9	0.0258	0.5	0.0077	0.3	0.0030	0.2	0.0011
0.50	1.8	0.0794	1.0	0.0235	0.7	0.0090	0.4	0.0032
0.75	2.7	0.1551	1.6	0.0457	1.0	0.0174	0.7	0.0062
1.00	3.5	0.2506	2.1	0.0736	1.4	0.0280	0.9	0.0099
1.25	4.4	0.3646	2.6	0.1068	1.7	0.0405	1.1	0.0143
1.50	5.3	0.4960	3.1	0.1449	2.1	0.0549	1.3	0.0194
1.75	6.2	0.6442	3.7	0.1879	2.4	0.0710	1.5	0.0250
2.00	7.1	0.8085	4.2	0.2355	2.8	0.0889	1.8	0.0313
2.25	8.0	0.9885	4.7	0.2875	3.1	0.1085	2.0	0.0381
2.50	8.8	1.1837	5.2	0.3439	3.5	0.1296	2.2	0.0455
2.75	9.7	1.3939	5.8	0.4046	3.8	0.1523	2.4	0.0534
3.00	10.6	1.6186	6.3	0.4694	4.1	0.1766	2.7	0.0619
3.25			6.8	0.5383	4.5	0.2024	2.9	0.0709
3.50			7.3	0.6111	4.8	0.2297	3.1	0.0804
3.75			7.8	0.6880	5.2	0.2584	3.3	0.0904
4.00			8.4	0.7687	5.5	0.2885	3.5	0.1009
4.50			9.4	0.9415	6.2	0.3531	4.0	0.1233
5.00			10.5	1.1293	6.9	0.4231	4.4	0.1477
5.50					7.6	0.4986	4.9	0.1738
6.00					8.3	0.5793	5.3	0.2018
6.50					9.0	0.6653	5.7	0.2316
7.00					9.7	0.7563	6.2	0.2632
7.50					10.4	0.9	6.6	0.2964
8.00							7.1	0.3314
8.50							7.5	0.3680
9.00							8.0	0.4063
9.50							8.4	0.4462
10.00							8.8	0.4877
10.50							9.3	0.5308
11.00							9.7	0.5755

28-54 mm

d [mm]	28		35		42		54	
di [mm]	25		32		39		50	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.0004	0.1	0.0001	0.1	0.0001	0.0	0.0000
0.50	0.3	0.0012	0.2	0.0004	0.1	0.0002	0.1	0.0000
0.75	0.4	0.0022	0.3	0.0007	0.2	0.0003	0.1	0.0001
1.00	0.6	0.0035	0.3	0.0011	0.2	0.0005	0.1	0.0001
1.25	0.7	0.0051	0.4	0.0016	0.3	0.0006	0.2	0.0002
1.50	0.8	0.0069	0.5	0,w0022	0.3	0.0009	0.2	0.0003
1.75	1.0	0.0088	0.6	0.0028	0.4	0.0011	0.2	0.0004
2.00	1.1	0.0110	0.7	0.0035	0.5	0.0014	0.3	0.0004
2.25	1.3	0.0134	0.8	0.0042	0.5	0.0017	0.3	0.0005
2.50	1.4	0.0160	0.9	0.0051	0.6	0.0020	0.4	0.0006
2.75	1.6	0.0188	0.9	0.0059	0.6	0.0024	0.4	0.0007
3.00	1.7	0.0217	1.0	0.0069	0.7	0.0027	0.4	0.0009
3.25	1.8	0.0249	1.1	0.0078	0.8	0.0031	0.5	0.0010
3.50	2.0	0.0282	1.2	0.0089	0.8	0.0035	0.5	0.0011
3.75	2.1	0.0317	1.3	0.0100	0.9	0.0040	0.5	0.0012
4.00	2.3	0.0353	1.4	0.0111	0.9	0.0044	0.6	0.0014
4.50	2.5	0.0432	1.6	0.0135	1.0	0.0054	0.6	0.0017
5.00	2.8	0.0516	1.7	0.0162	1.2	0.0064	0.7	0.0020
5.50	3.1	0.0607	1.9	0.0190	1.3	0.0075	0.8	0.0023
6.00	3.4	0.0705	2.1	0.0221	1.4	0.0087	0.8	0.0027
6.50	3.7	0.0808	2.2	0.0253	1.5	0.0100	0.9	0.0031
7.00	4.0	0.0918	2.4	0.0287	1.6	0.0113	1.0	0.0035
7.50	4.2	0.1033	2.6	0.0323	1.7	0.0127	1.1	0.0040
8.00	4.5	0.1154	2.8	0.0360	1.9	0.0142	1.1	0.0044
8.50	4.8	0.1281	2.9	0.0400	2.0	0.0157	1.2	0.0049
9.00	5.1	0.1414	3.1	0.0441	2.1	0.0173	1.3	0.0054
9.50	5.4	0.1552	3.3	0.0484	2.2	0.0190	1.3	0.0059
10.00	5.7	0.1696	3.5	0.0528	2.3	0.0208	1.4	0.0064
10.50	5.9	0.1845	3.6	0.0574	2.4	0.0226	1.5	0.0070
11.00	6.2	0.1999	3.8	0.0622	2.6	0.0245	1.6	0.0076
11.50	6.5	0.2159	4.0	0.0672	2.7	0.0264	1.6	0.0082
12.00	6.8	0.2325	4.1	0.0723	2.8	0.0284	1.7	0.0088
12.50	7.1	0.2495	4.3	0.0776	2.9	0.0305	1.8	0.0094
13.00	7.4	0.2671	4.5	0.0830	3.0	0.0326	1.8	0.0101
13.50	7.6	0.2852	4.7	0.0886	3.1	0.0348	1.9	0.0108
14.00	7.9	0.3038	4.8	0.0943	3.3	0.0370	2.0	0.0115
14.50	8.2	0.3229	5.0	0.1003	3.4	0.0393	2.1	0.0122
15.00	8.5	0.3425	5.2	0.1063	3.5	0.0417	2.1	0.0129
16.00	9.1	0.3833	5.5	0.1189	3.7	0.0466	2.3	0.0144
17.00	9.6	0.4260	5.9	0.1321	4.0	0.0518	2.4	0.0160
18.00	10.2	0.4707	6.2	0.1459	4.2	0.0572	2.5	0.0177
19.00	10.8	0.5174	6.6	0.1603	4.4	0.0628	2.7	0.0194
20.00	11.3	0.5660	6.9	0.1752	4.7	0.0686	2.8	0.0212
21.00			7.3	0.1908	4.9	0.0747	3.0	0.0230
22.00			7.6	0.2069	5.1	0.0810	3.1	0.0250
23.00			7.9	0.2236	5.3	0.0875	3.3	0.0270
24.00			8.3	0.2409	5.6	0.0942	3.4	0.0290
25.00			8.6	0.2587	5.8	0.1011	3.5	0.0311
30.00			10.4	0.3560	7.0	0.1390	4.2	0.0427
35.00					8.1	0.1820	5.0	0.0559
40.00					9.3	0.2301	5.7	0.0706
45.00					10.5	0.2830	6.4	0.0868
50.00							7.1	0.1044
55.00							7.8	0.1234
60.00							8.5	0.1438
65.00							9.2	0.1655
70.00							9.9	0.1887
75.00							10.6	0.2131
80.00							11.3	0.2388

gas, 3rd gas family, depending on the volume flow, 12-22 mm

density: 540 kg/m³
viscosity: 0.0002 Pa.s
surface roughness: 0.0015 mm

d [mm]	12		15		18		22	
di [mm]	10		13		16		20	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.9	5.31	0.5	1.52	0.3	0.56	0.2	0.20
0.50	1.8	18.26	1.0	5.17	0.7	1.91	0.4	0.66
0.75	2.7	37.90	1.6	10.68	1.0	3.94	0.7	1.35
1.00	3.5	63.89	2.1	17.93	1.4	6.59	0.9	2.26
1.25	4.4	96.00	2.6	26.84	1.7	9.84	1.1	3.36
1.50	5.3	134.12	3.1	37.38	2.1	13.68	1.3	4.66
1.75	6.2	178.13	3.7	49.51	2.4	18.08	1.5	6.15
2.00	7.1	227.98	4.2	63.20	2.8	23.04	1.8	7.83
2.25	8.0	283.60	4.7	78.43	3.1	28.55	2.0	9.69
2.50	8.8	344.96	5.2	95.19	3.5	34.60	2.2	11.73
2.75	9.7	412.02	5.8	113.46	3.8	41.19	2.4	13.94
3.00	10.6	484.74	6.3	133.23	4.1	48.31	2.7	16.33
3.25			6.8	154.49	4.5	55.95	2.9	18.90
3.50			7.3	177.24	4.8	64.11	3.1	21.63
3.75			7.8	201.46	5.2	72.79	3.3	24.54
4.00			8.4	227.15	5.5	81.99	3.5	27.61
4.50			9.4	282.91	6.2	101.92	4.0	34.26
5.00			10.5	344.50	6.9	123.88	4.4	41.58
5.50					7.6	147.86	4.9	49.55
6.00					8.3	173.84	5.3	58.17
6.50					9.0	201.82	5.7	67.44
7.00					9.7	231.79	6.2	77.36
7.50					10.4	263.73	6.6	87.91
8.00							7.1	99.10
8.50							7.5	110.92
9.00							8.0	123.37
9.50							8.4	136.45
10.00							8.8	150.16
10.50							9.3	164.49
11.00							9.7	179.45

28-54 mm

d [mm]	28		35		42		54	
di [mm]	25		32		39		50	
V [m³/h]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]	v [m/s]	Δp [mbar/m]
0.25	0.1	0.07	0.1	0.02	0.1	0.01	0.0	0.00
0.50	0.3	0.23	0.2	0.07	0.1	0.03	0.1	0.01
0.75	0.4	0.46	0.3	0.14	0.2	0.06	0.1	0.02
1.00	0.6	0.77	0.3	0.24	0.2	0.09	0.1	0.03
1.25	0.7	1.15	0.4	0.35	0.3	0.14	0.2	0.04
1.50	0.8	1.60	0.5	0.49	0.3	0.19	0.2	0.06
1.75	1.0	2.10	0.6	0.64	0.4	0.25	0.2	0.08
2.00	1.1	2.67	0.7	0.82	0.5	0.32	0.3	0.10
2.25	1.3	3.30	0.8	1.01	0.5	0.39	0.3	0.12
2.50	1.4	3.99	0.9	1.22	0.6	0.47	0.4	0.14
2.75	1.6	4.74	0.9	1.44	0.6	0.56	0.4	0.17
3.00	1.7	5.55	1.0	1.69	0.7	0.65	0.4	0.20
3.25	1.8	6.42	1.1	1.95	0.8	0.75	0.5	0.23
3.50	2.0	7.34	1.2	2.23	0.8	0.86	0.5	0.26
3.75	2.1	8.32	1.3	2.53	0.9	0.97	0.5	0.30
4.00	2.3	9.35	1.4	2.84	0.9	1.09	0.6	0.33
4.50	2.5	11.59	1.6	3.51	1.0	1.35	0.6	0.41
5.00	2.8	14.04	1.7	4.25	1.2	1.64	0.7	0.49
5.50	3.1	16.71	1.9	5.05	1.3	1.94	0.8	0.59
6.00	3.4	19.60	2.1	5.92	1.4	2.28	0.8	0.69
6.50	3.7	22.70	2.2	6.85	1.5	2.63	0.9	0.79
7.00	4.0	26.00	2.4	7.84	1.6	3.01	1.0	0.91
7.50	4.2	29.52	2.6	8.89	1.7	3.41	1.1	1.03
8.00	4.5	33.24	2.8	10.00	1.9	3.83	1.1	1.16
8.50	4.8	37.17	2.9	11.17	2.0	4.28	1.2	1.29
9.00	5.1	41.31	3.1	12.40	2.1	4.75	1.3	1.43
9.50	5.4	45.65	3.3	13.70	2.2	5.24	1.3	1.58
10.00	5.7	50.19	3.5	15.05	2.3	5.76	1.4	1.73
10.50	5.9	54.94	3.6	16.46	2.4	6.29	1.5	1.89
11.00	6.2	59.88	3.8	17.93	2.6	6.85	1.6	2.06
11.50	6.5	65.03	4.0	19.45	2.7	7.43	1.6	2.23
12.00	6.8	70.38	4.1	21.04	2.8	8.04	1.7	2.41
12.50	7.1	75.93	4.3	22.68	2.9	8.66	1.8	2.60
13.00	7.4	81.68	4.5	24.39	3.0	9.31	1.8	2.79
13.50	7.6	87.62	4.7	26.14	3.1	9.97	1.9	2.99
14.00	7.9	93.77	4.8	27.96	3.3	10.66	2.0	3.19
14.50	8.2	100.11	5.0	29.83	3.4	11.37	2.1	3.40
15.00	8.5	106.65	5.2	31.76	3.5	12.10	2.1	3.62
16.00	9.1	120.32	5.5	35.79	3.7	13.63	2.3	4.07
17.00	9.6	134.78	5.9	40.05	4.0	15.23	2.4	4.55
18.00	10.2	150.02	6.2	44.53	4.2	16.93	2.5	5.05
19.00	10.8	166.04	6.6	49.24	4.4	18.70	2.7	5.58
20.00	11.3	182.84	6.9	54.17	4.7	20.56	2.8	6.13
21.00			7.3	59.32	4.9	22.50	3.0	6.70
22.00			7.6	64.69	5.1	24.53	3.1	7.30
23.00			7.9	70.28	5.3	26.63	3.3	7.92
24.00			8.3	76.10	5.6	28.82	3.4	8.57
25.00			8.6	82.13	5.8	31.08	3.5	9.24
30.00			10.4	115.58	7.0	43.63	4.2	12.93
35.00					8.1	58.17	5.0	17.20
40.00					9.3	74.69	5.7	22.03
45.00					10.5	93.17	6.4	27.43
50.00							7.1	33.38
55.00							7.8	39.88
60.00							8.5	46.93
65.00							9.2	54.53
70.00							9.9	62.67
75.00							10.6	71.36
80.00							11.3	80.58

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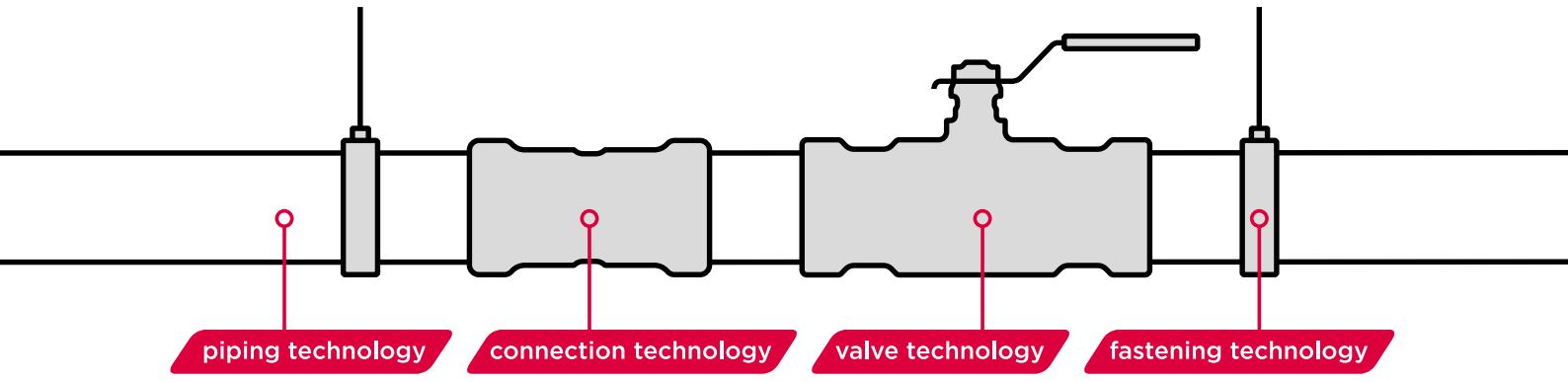

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5007631-2024-2.0 EN