

**GEBERIT MAPRESS COPPER
COPPER PIPES IN ACCORDANCE
WITH EN 1057
PRESSURE LOSS TABLES**

■ GEBERIT



DRUKVERLIESTABELLEN

**KNOW
HOW**
INSTALLED

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2 Drinking water pressure loss

2.1 Potable water 10 °C

Medium:	Water
Temperature:	10 °C
Density:	999.7 kg/m ³
Viscosity:	0.001306 Pa•s
Surface roughness:	0.0015 mm

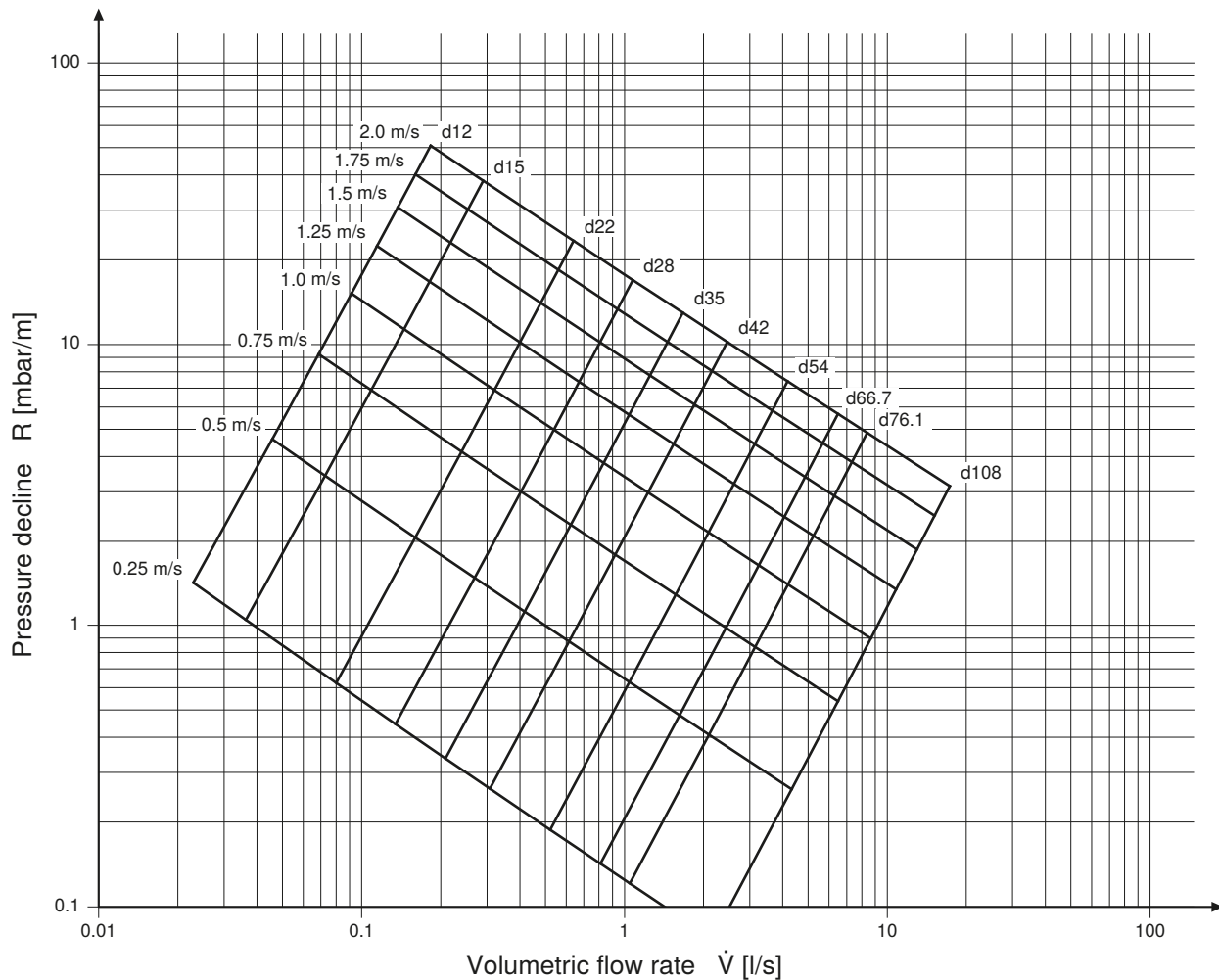


Table 1: Pressure loss for copper pipes in accordance with BS EN 1057, drinking water 10 °C, d12–35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.01	0.11	0.39	—	—	—	—	—	—	—	—
0.02	0.22	0.78	0.14	0.31	—	—	—	—	—	—
0.03	0.33	2.24	0.21	0.47	0.09	0.10	—	—	—	—
0.04	0.44	3.65	0.28	1.23	0.12	0.13	—	—	—	—
0.05	0.55	5.34	0.34	1.80	0.16	0.28	0.09	0.06	—	—
0.06	0.65	7.30	0.41	2.46	0.19	0.38	0.11	0.07	—	—
0.07	0.76	9.52	0.48	3.20	0.22	0.50	0.13	0.15	0.08	0.03
0.08	0.87	11.98	0.55	4.03	0.25	0.62	0.15	0.18	0.10	0.07
0.09	0.98	14.69	0.62	4.93	0.28	0.76	0.17	0.22	0.11	0.08
0.10	1.09	17.64	0.69	5.92	0.31	0.91	0.19	0.27	0.12	0.10
0.15	1.64	35.77	1.03	11.96	0.47	1.83	0.28	0.54	0.18	0.19
0.20	—	—	1.38	19.76	0.62	3.02	0.37	0.88	0.24	0.31
0.25	—	—	1.72	29.23	0.78	4.45	0.46	1.30	0.30	0.46
0.30	—	—	—	—	0.94	6.12	0.56	1.78	0.36	0.63
0.35	—	—	—	—	1.09	8.02	0.65	2.33	0.42	0.83
0.40	—	—	—	—	1.25	10.14	0.74	2.94	0.48	1.04
0.45	—	—	—	—	1.40	12.48	0.83	3.61	0.54	1.28
0.50	—	—	—	—	1.56	15.02	0.93	4.35	0.60	1.54
0.55	—	—	—	—	1.72	17.78	1.02	5.14	0.66	1.82
0.60	—	—	—	—	1.87	20.73	1.11	5.99	0.72	2.12
0.65	—	—	—	—	2.03	23.89	1.21	6.90	0.78	2.44
0.70	—	—	—	—	—	—	1.30	7.87	0.84	2.77
0.75	—	—	—	—	—	—	1.39	8.89	0.90	3.13
0.80	—	—	—	—	—	—	1.48	9.96	0.96	3.51
0.85	—	—	—	—	—	—	1.58	11.09	1.02	3.91
0.90	—	—	—	—	—	—	1.67	12.27	1.08	4.32
0.95	—	—	—	—	—	—	1.76	13.51	1.14	4.75
1.00	—	—	—	—	—	—	1.85	14.79	1.20	5.21
1.05	—	—	—	—	—	—	1.95	16.13	1.26	5.68
1.10	—	—	—	—	—	—	—	—	1.32	6.16
1.15	—	—	—	—	—	—	—	—	1.38	6.67
1.20	—	—	—	—	—	—	—	—	1.44	7.19
1.25	—	—	—	—	—	—	—	—	1.50	7.73
1.30	—	—	—	—	—	—	—	—	1.56	8.29
1.40	—	—	—	—	—	—	—	—	1.68	9.45
1.50	—	—	—	—	—	—	—	—	1.80	10.69
1.60	—	—	—	—	—	—	—	—	1.92	11.99
1.70	—	—	—	—	—	—	—	—	2.04	13.36

As a rule, the values highlighted in blue do not occur in drinking water installations.

Table 2: Pressure loss for copper pipes in accordance with BS EN 1057, drinking water 10 °C, d42-108 mm

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.10	0.08	0.04	—	—	—	—	—	—	—	—
0.15	0.12	0.08	—	—	—	—	—	—	—	—
0.20	0.16	0.13	0.10	0.04	—	—	—	—	—	—
0.25	0.20	0.18	0.12	0.05	—	—	—	—	—	—
0.30	0.24	0.25	0.14	0.07	0.09	0.03	—	—	—	—
0.35	0.28	0.33	0.17	0.09	0.11	0.03	0.08	0.02	—	—
0.40	0.32	0.41	0.19	0.12	0.12	0.04	0.10	0.02	—	—
0.45	0.37	0.51	0.22	0.15	0.14	0.05	0.11	0.03	—	—
0.50	0.41	0.61	0.24	0.17	0.15	0.06	0.12	0.03	—	—
0.55	0.45	0.72	0.26	0.21	0.17	0.07	0.13	0.04	—	—
0.60	0.49	0.84	0.29	0.24	0.18	0.08	0.14	0.05	—	—
0.65	0.53	0.97	0.31	0.27	0.20	0.10	0.15	0.05	—	—
0.70	0.57	1.10	0.33	0.31	0.22	0.11	0.17	0.06	0.08	0.01
0.75	0.61	1.24	0.36	0.35	0.23	0.12	0.18	0.07	0.09	0.01
0.80	0.65	1.39	0.38	0.39	0.25	0.14	0.19	0.08	0.09	0.01
0.85	0.69	1.55	0.41	0.44	0.26	0.15	0.20	0.08	0.10	0.02
0.90	0.73	1.71	0.43	0.49	0.28	0.17	0.21	0.09	0.10	0.02
0.95	0.77	1.88	0.45	0.53	0.29	0.19	0.23	0.10	0.11	0.02
1.00	0.81	2.06	0.48	0.58	0.31	0.21	0.24	0.11	0.12	0.02
1.05	0.85	2.24	0.50	0.64	0.32	0.22	0.25	0.12	0.12	0.02
1.10	0.89	2.44	0.53	0.69	0.34	0.24	0.26	0.13	0.13	0.02
1.15	0.93	2.63	0.55	0.75	0.35	0.26	0.27	0.14	0.13	0.03
1.20	0.97	2.84	0.57	0.80	0.37	0.28	0.29	0.15	0.14	0.03
1.25	1.01	3.05	0.60	0.86	0.38	0.30	0.30	0.16	0.14	0.03
1.30	1.06	3.27	0.62	0.93	0.40	0.32	0.31	0.18	0.15	0.03
1.40	1.14	3.73	0.67	1.05	0.43	0.37	0.33	0.20	0.16	0.04
1.50	1.22	4.22	0.72	1.19	0.46	0.42	0.36	0.23	0.17	0.04
1.60	1.30	4.73	0.77	1.34	0.49	0.47	0.38	0.25	0.18	0.05
1.70	1.38	5.27	0.81	1.49	0.52	0.52	0.41	0.28	0.20	0.05
1.80	1.46	5.83	0.86	1.64	0.55	0.58	0.43	0.31	0.21	0.06
1.90	1.54	6.42	0.91	1.81	0.59	0.63	0.45	0.34	0.22	0.06
2.00	1.62	7.03	0.96	1.98	0.62	0.69	0.48	0.38	0.23	0.07
2.10	1.71	7.67	1.00	2.16	0.65	0.76	0.50	0.41	0.24	0.07
2.20	1.79	8.33	1.05	2.35	0.68	0.82	0.52	0.45	0.25	0.08
2.30	1.87	9.02	1.10	2.54	0.71	0.89	0.55	0.48	0.27	0.09
2.40	1.95	9.73	1.15	2.74	0.74	0.96	0.57	0.52	0.28	0.09
2.50	2.03	10.47	1.20	2.95	0.77	1.03	0.60	0.56	0.29	0.10
2.60	—	—	1.24	3.16	0.80	1.10	0.62	0.60	0.30	0.11

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2.70	—	—	1.29	3.38	0.83	1.18	0.64	0.64	0.31	0.11
2.80	—	—	1.34	3.61	0.86	1.26	0.67	0.68	0.32	0.12
2.90	—	—	1.39	3.84	0.89	1.34	0.69	0.73	0.33	0.13
3.00	—	—	1.43	4.08	0.92	1.42	0.71	0.77	0.35	0.14
3.10	—	—	1.48	4.32	0.95	1.51	0.74	0.82	0.36	0.15
3.20	—	—	1.53	4.58	0.99	1.60	0.76	0.86	0.37	0.15
3.30	—	—	1.58	4.83	1.02	1.69	0.79	0.91	0.38	0.16
3.40	—	—	1.63	5.10	1.05	1.78	0.81	0.96	0.39	0.17
3.50	—	—	1.67	5.37	1.08	1.87	0.83	1.01	0.40	0.18
3.60	—	—	1.72	5.65	1.11	1.97	0.86	1.07	0.42	0.19
3.70	—	—	1.77	5.93	1.14	2.07	0.88	1.12	0.43	0.20
3.80	—	—	1.82	6.22	1.17	2.17	0.91	1.17	0.44	0.21
3.90	—	—	1.86	6.52	1.20	2.27	0.93	1.23	0.45	0.22
4.00	—	—	1.91	6.82	1.23	2.38	0.95	1.29	0.46	0.23
4.10	—	—	1.96	7.13	1.26	2.48	0.98	1.34	0.47	0.24
4.20	—	—	2.01	7.44	1.29	2.59	1.00	1.40	0.49	0.25
4.30	—	—	—	—	1.32	2.70	1.02	1.46	0.50	0.26
4.40	—	—	—	—	1.36	2.82	1.05	1.52	0.51	0.27
4.50	—	—	—	—	1.39	2.93	1.07	1.59	0.52	0.28
4.60	—	—	—	—	1.42	3.05	1.10	1.65	0.53	0.29
4.70	—	—	—	—	1.45	3.17	1.12	1.71	0.54	0.30
4.80	—	—	—	—	1.48	3.29	1.14	1.78	0.55	0.31
4.90	—	—	—	—	1.51	3.41	1.17	1.85	0.57	0.33
5.00	—	—	—	—	1.54	3.54	1.19	1.91	0.58	0.34
5.50	—	—	—	—	1.69	4.20	1.31	2.27	0.64	0.40
6.00	—	—	—	—	1.85	4.91	1.43	2.65	0.69	0.47
6.50	—	—	—	—	2.00	5.67	1.55	3.06	0.75	0.54
7.00	—	—	—	—	—	—	1.67	3.50	0.81	0.62
7.50	—	—	—	—	—	—	1.79	3.96	0.87	0.70
8.00	—	—	—	—	—	—	1.91	4.44	0.92	0.78
8.50	—	—	—	—	—	—	2.03	4.95	0.98	0.87
9.00	—	—	—	—	—	—	—	—	1.04	0.97
9.50	—	—	—	—	—	—	—	—	1.10	1.06
10.00	—	—	—	—	—	—	—	—	1.15	1.17
10.50	—	—	—	—	—	—	—	—	1.21	1.27
11.00	—	—	—	—	—	—	—	—	1.27	1.38
11.50	—	—	—	—	—	—	—	—	1.33	1.50
12.00	—	—	—	—	—	—	—	—	1.39	1.62
12.50	—	—	—	—	—	—	—	—	1.44	1.74

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
13.00	—	—	—	—	—	—	—	—	1.50	1.87
13.50	—	—	—	—	—	—	—	—	1.56	2.00
14.00	—	—	—	—	—	—	—	—	1.62	2.13
14.50	—	—	—	—	—	—	—	—	1.67	2.27
15.00	—	—	—	—	—	—	—	—	1.73	2.42
15.50	—	—	—	—	—	—	—	—	1.79	2.56
16.00	—	—	—	—	—	—	—	—	1.85	2.71
16.50	—	—	—	—	—	—	—	—	1.91	2.87
17.00	—	—	—	—	—	—	—	—	1.96	3.03

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As a rule, the values highlighted in blue do not occur in drinking water installations.

2.2 Drinking water 60 °C

Medium: Water
Temperature: 60 °C
Density: 983.2 kg/m³
Viscosity: 0.000467 Pa•s
Surface roughness: 0.0015 mm

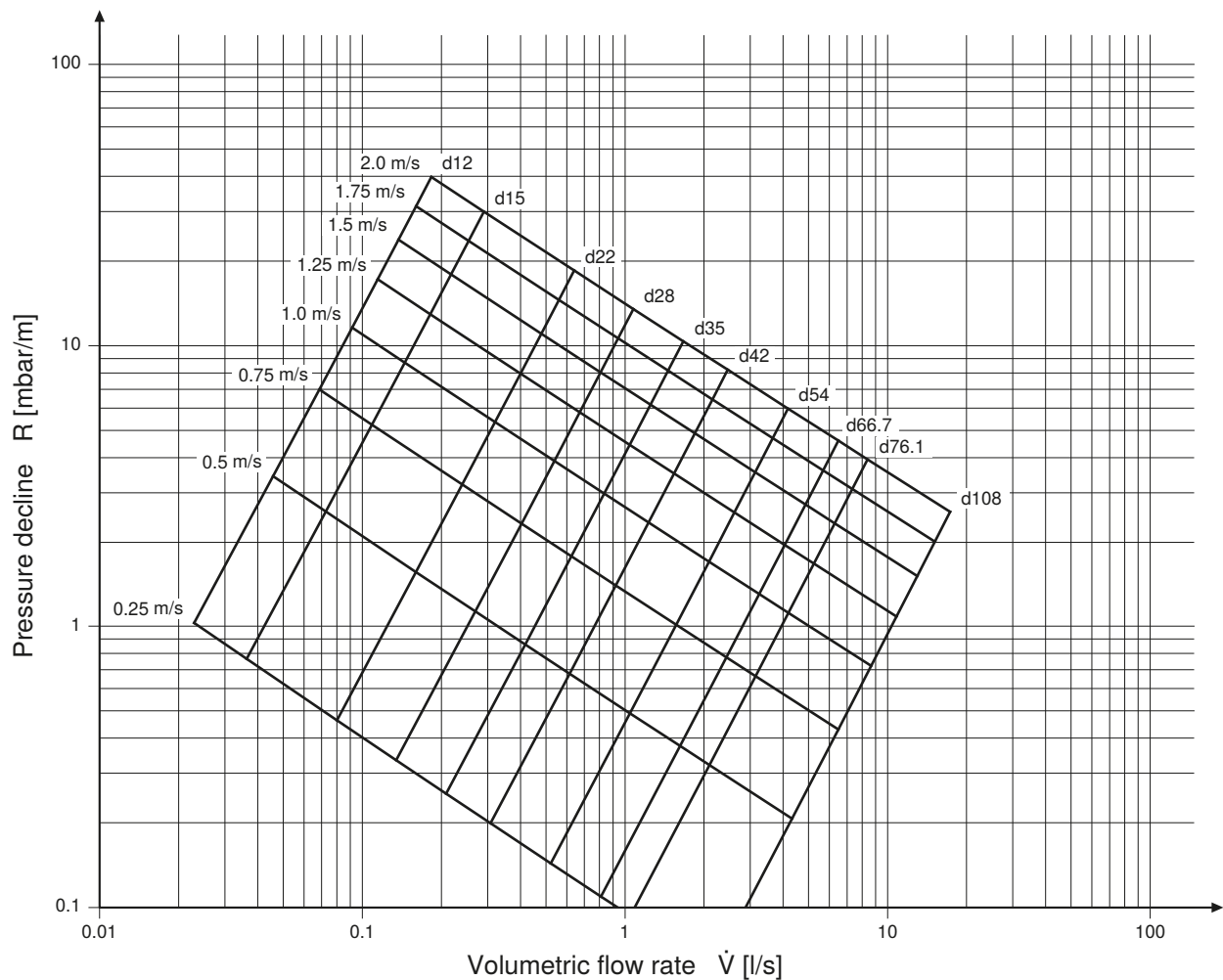


Table 3: Pressure loss for copper pipes in accordance with BS EN 1057, drinking water 60 °C, d12–35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.01	0.11	0.25	—	—	—	—	—	—	—	—
0.02	0.22	0.82	0.14	0.28	—	—	—	—	—	—
0.03	0.33	1.64	0.21	0.55	0.09	0.09	—	—	—	—
0.04	0.44	2.71	0.28	0.91	0.12	0.14	—	—	—	—
0.05	0.55	3.99	0.34	1.34	0.16	0.21	0.09	0.06	—	—
0.06	0.65	5.50	0.41	1.84	0.19	0.28	0.11	0.08	—	—
0.07	0.76	7.20	0.48	2.40	0.22	0.37	0.13	0.11	0.08	0.04
0.08	0.87	9.11	0.55	3.04	0.25	0.46	0.15	0.14	0.10	0.05
0.09	0.98	11.22	0.62	3.73	0.28	0.57	0.17	0.17	0.11	0.06
0.10	1.09	13.52	0.69	4.49	0.31	0.68	0.19	0.20	0.12	0.07
0.15	1.64	27.79	1.03	9.20	0.47	1.39	0.28	0.40	0.18	0.14
0.20	—	—	1.38	15.35	0.62	2.31	0.37	0.67	0.24	0.24
0.25	—	—	1.72	22.87	0.78	3.43	0.46	0.99	0.30	0.35
0.30	—	—	—	—	0.94	4.74	0.56	1.37	0.36	0.48
0.35	—	—	—	—	1.09	6.24	0.65	1.80	0.42	0.63
0.40	—	—	—	—	1.25	7.93	0.74	2.28	0.48	0.80
0.45	—	—	—	—	1.40	9.79	0.83	2.81	0.54	0.99
0.50	—	—	—	—	1.56	11.82	0.93	3.39	0.60	1.19
0.55	—	—	—	—	1.72	14.03	1.02	4.02	0.66	1.41
0.60	—	—	—	—	1.87	16.41	1.11	4.70	0.72	1.65
0.65	—	—	—	—	2.03	18.95	1.21	5.42	0.78	1.90
0.70	—	—	—	—	—	—	1.30	6.19	0.84	2.17
0.75	—	—	—	—	—	—	1.39	7.01	0.90	2.45
0.80	—	—	—	—	—	—	1.48	7.87	0.96	2.75
0.85	—	—	—	—	—	—	1.58	8.78	1.02	3.07
0.90	—	—	—	—	—	—	1.67	9.73	1.08	3.40
0.95	—	—	—	—	—	—	1.76	10.73	1.14	3.75
1.00	—	—	—	—	—	—	1.85	11.77	1.20	4.11
1.05	—	—	—	—	—	—	1.95	12.85	1.26	4.48
1.10	—	—	—	—	—	—	—	—	1.32	4.88
1.15	—	—	—	—	—	—	—	—	1.38	5.28
1.20	—	—	—	—	—	—	—	—	1.44	5.70
1.25	—	—	—	—	—	—	—	—	1.50	6.14
1.30	—	—	—	—	—	—	—	—	1.56	6.59
1.40	—	—	—	—	—	—	—	—	1.68	7.53
1.50	—	—	—	—	—	—	—	—	1.80	8.53
1.60	—	—	—	—	—	—	—	—	1.92	9.59
1.70	—	—	—	—	—	—	—	—	2.04	10.70

As a rule, the values highlighted in blue do not occur in drinking water installations.

Table 4: Pressure loss for copper pipes in accordance with BS EN 1057, drinking water 60 °C, d42-108 mm

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.10	0.08	0.03	—	—	—	—	—	—	—	—
0.15	0.12	0.06	—	—	—	—	—	—	—	—
0.20	0.16	0.09	0.10	0.03	—	—	—	—	—	—
0.25	0.20	0.14	0.12	0.04	—	—	—	—	—	—
0.30	0.24	0.19	0.14	0.05	0.09	0.02	—	—	—	—
0.35	0.28	0.25	0.17	0.07	0.11	0.02	0.08	0.01	—	—
0.40	0.32	0.32	0.19	0.09	0.12	0.03	0.10	0.02	—	—
0.45	0.37	0.39	0.22	0.11	0.14	0.04	0.11	0.02	—	—
0.50	0.41	0.47	0.24	0.13	0.15	0.05	0.12	0.03	—	—
0.55	0.45	0.56	0.26	0.16	0.17	0.06	0.13	0.03	—	—
0.60	0.49	0.65	0.29	0.18	0.18	0.06	0.14	0.03	—	—
0.65	0.53	0.75	0.31	0.21	0.20	0.07	0.15	0.04	—	—
0.70	0.57	0.85	0.33	0.24	0.22	0.08	0.17	0.05	0.08	0.01
0.75	0.61	0.97	0.36	0.27	0.23	0.10	0.18	0.05	0.09	0.01
0.80	0.65	1.08	0.38	0.31	0.25	0.11	0.19	0.06	0.09	0.01
0.85	0.69	1.21	0.41	0.34	0.26	0.12	0.20	0.06	0.10	0.01
0.90	0.73	1.34	0.43	0.38	0.28	0.13	0.21	0.07	0.10	0.01
0.95	0.77	1.47	0.45	0.41	0.29	0.14	0.23	0.08	0.11	0.01
1.00	0.81	1.61	0.48	0.45	0.31	0.16	0.24	0.09	0.12	0.02
1.05	0.85	1.76	0.50	0.50	0.32	0.17	0.25	0.09	0.12	0.02
1.10	0.89	1.91	0.53	0.54	0.34	0.19	0.26	0.10	0.13	0.02
1.15	0.93	2.07	0.55	0.58	0.35	0.20	0.27	0.11	0.13	0.02
1.20	0.97	2.24	0.57	0.63	0.37	0.22	0.29	0.12	0.14	0.02
1.25	1.01	2.41	0.60	0.68	0.38	0.24	0.30	0.13	0.14	0.02
1.30	1.06	2.58	0.62	0.73	0.40	0.25	0.31	0.14	0.15	0.02
1.40	1.14	2.95	0.67	0.83	0.43	0.29	0.33	0.16	0.16	0.03
1.50	1.22	3.34	0.72	0.94	0.46	0.33	0.36	0.18	0.17	0.03
1.60	1.30	3.75	0.77	1.05	0.49	0.37	0.38	0.20	0.18	0.04
1.70	1.38	4.19	0.81	1.17	0.52	0.41	0.41	0.22	0.20	0.04
1.80	1.46	4.64	0.86	1.30	0.55	0.45	0.43	0.24	0.21	0.04
1.90	1.54	5.12	0.91	1.43	0.59	0.50	0.45	0.27	0.22	0.05
2.00	1.62	5.62	0.96	1.57	0.62	0.55	0.48	0.30	0.23	0.05
2.10	1.71	6.13	1.00	1.71	0.65	0.60	0.50	0.32	0.24	0.06
2.20	1.79	6.67	1.05	1.86	0.68	0.65	0.52	0.35	0.25	0.06
2.30	1.87	7.23	1.10	2.02	0.71	0.70	0.55	0.38	0.27	0.07
2.40	1.95	7.81	1.15	2.18	0.74	0.76	0.57	0.41	0.28	0.07
2.50	2.03	8.41	1.20	2.35	0.77	0.81	0.60	0.44	0.29	0.08
2.60	—	—	1.24	2.52	0.80	0.87	0.62	0.47	0.30	0.08

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2.70	—	—	1.29	2.70	0.83	0.94	0.64	0.51	0.31	0.09
2.80	—	—	1.34	2.88	0.86	1.00	0.67	0.54	0.32	0.09
2.90	—	—	1.39	3.07	0.89	1.06	0.69	0.57	0.33	0.10
3.00	—	—	1.43	3.26	0.92	1.13	0.71	0.61	0.35	0.11
3.10	—	—	1.48	3.46	0.95	1.20	0.74	0.65	0.36	0.11
3.20	—	—	1.53	3.67	0.99	1.27	0.76	0.69	0.37	0.12
3.30	—	—	1.58	3.88	1.02	1.34	0.79	0.72	0.38	0.13
3.40	—	—	1.63	4.09	1.05	1.42	0.81	0.76	0.39	0.13
3.50	—	—	1.67	4.31	1.08	1.49	0.83	0.81	0.40	0.14
3.60	—	—	1.72	4.54	1.11	1.57	0.86	0.85	0.42	0.15
3.70	—	—	1.77	4.77	1.14	1.65	0.88	0.89	0.43	0.16
3.80	—	—	1.82	5.01	1.17	1.73	0.91	0.93	0.44	0.16
3.90	—	—	1.86	5.25	1.20	1.82	0.93	0.98	0.45	0.17
4.00	—	—	1.91	5.50	1.23	1.90	0.95	1.03	0.46	0.18
4.10	—	—	1.96	5.75	1.26	1.99	0.98	1.07	0.47	0.19
4.20	—	—	2.01	6.01	1.29	2.08	1.00	1.12	0.49	0.20
4.30	—	—	—	—	1.32	2.17	1.02	1.17	0.50	0.20
4.40	—	—	—	—	1.36	2.26	1.05	1.22	0.51	0.21
4.50	—	—	—	—	1.39	2.35	1.07	1.27	0.52	0.22
4.60	—	—	—	—	1.42	2.45	1.10	1.32	0.53	0.23
4.70	—	—	—	—	1.45	2.55	1.12	1.37	0.54	0.24
4.80	—	—	—	—	1.48	2.65	1.14	1.43	0.55	0.25
4.90	—	—	—	—	1.51	2.75	1.17	1.48	0.57	0.26
5.00	—	—	—	—	1.54	2.85	1.19	1.53	0.58	0.27
5.50	—	—	—	—	1.69	3.39	1.31	1.82	0.64	0.32
6.00	—	—	—	—	1.85	3.97	1.43	2.14	0.69	0.37
6.50	—	—	—	—	2.00	4.59	1.55	2.47	0.75	0.43
7.00	—	—	—	—	—	—	1.67	2.83	0.81	0.49
7.50	—	—	—	—	—	—	1.79	3.20	0.87	0.56
8.00	—	—	—	—	—	—	1.91	3.60	0.92	0.63
8.50	—	—	—	—	—	—	2.03	4.02	0.98	0.70
9.00	—	—	—	—	—	—	—	—	1.04	0.78
9.50	—	—	—	—	—	—	—	—	1.10	0.86
10.00	—	—	—	—	—	—	—	—	1.15	0.94
10.50	—	—	—	—	—	—	—	—	1.21	1.03
11.00	—	—	—	—	—	—	—	—	1.27	1.12
11.50	—	—	—	—	—	—	—	—	1.33	1.21
12.00	—	—	—	—	—	—	—	—	1.39	1.31
12.50	—	—	—	—	—	—	—	—	1.44	1.41

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
13.00	—	—	—	—	—	—	—	—	1.50	1.52
13.50	—	—	—	—	—	—	—	—	1.56	1.62
14.00	—	—	—	—	—	—	—	—	1.62	1.73
14.50	—	—	—	—	—	—	—	—	1.67	1.85
15.00	—	—	—	—	—	—	—	—	1.73	1.97
15.50	—	—	—	—	—	—	—	—	1.79	2.09
16.00	—	—	—	—	—	—	—	—	1.85	2.21
16.50	—	—	—	—	—	—	—	—	1.91	2.34
17.00	—	—	—	—	—	—	—	—	1.96	2.47

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As a rule, the values highlighted in blue do not occur in drinking water installations.

3 Pressure loss, cooling

3.1 Recommended flow velocities

The following recommendations apply for the cooling pressure loss tables:

- Heat sink connection lines: Flow velocity ≤ 0.3 m/s
- Distribution pipes: Flow velocity ≤ 0.5 m/s
- Riser pipes and cellar pipes: Flow velocity ≤ 0.8 m/s

3.2 Cooling, inlet flow 10 °C / return flow 11 °C

Medium:	Water
Inlet flow temperature:	10 °C
Return temperature:	11 °C
Range:	1 K
Average temperature:	10.5 °C
Density:	999.7 kg/m ³
Viscosity:	0.0012891 Pa•s
Specific thermal capacity:	4,187.6 J/(kg•K)
Surface roughness:	0.0015 mm

Table 5: Pressure loss for copper pipes in accordance with BS EN 1057, cooling, inlet flow 10 °C / return flow 11 °C, d12–28 mm

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
50	43.0	0.13	0.461	0.08	0.183	–	–	–	–
100	86.0	0.26	0.922	0.16	0.367	0.07	0.075	–	–
150	129.0	0.39	3.014	0.25	1.021	0.11	0.113	0.07	0.040
200	171.9	0.52	4.921	0.33	1.662	0.15	0.260	0.09	0.053
250	214.9	0.65	7.214	0.41	2.431	0.19	0.378	0.11	0.067
300	257.9	0.78	9.874	0.49	3.323	0.22	0.515	0.13	0.152
350	300.9	0.91	12.888	0.58	4.331	0.26	0.670	0.16	0.197
400	343.9	1.04	16.244	0.66	5.452	0.30	0.842	0.18	0.247
450	386.9	1.17	19.932	0.74	6.683	0.34	1.030	0.20	0.302
500	429.8	1.30	23.946	0.82	8.021	0.37	1.234	0.22	0.362
550	472.8	1.43	28.278	0.90	9.464	0.41	1.455	0.24	0.426
600	515.8	1.56	32.923	0.99	11.010	0.45	1.690	0.27	0.495
700	601.8	1.83	43.130	1.15	14.404	0.52	2.206	0.31	0.645
800	687.7	–	–	1.32	18.190	0.60	2.781	0.35	0.812
900	773.7	–	–	1.48	22.358	0.67	3.412	0.40	0.995
1,000	859.7	–	–	1.64	26.900	0.75	4.099	0.44	1.194
1,100	945.6	–	–	1.81	31.809	0.82	4.840	0.49	1.409
1,200	1,031.6	–	–	1.97	37.078	0.89	5.635	0.53	1.639
1,300	1,117.6	–	–	–	–	0.97	6.482	0.58	1.884
1,400	1,203.6	–	–	–	–	1.04	7.381	0.62	2.144
1,500	1,289.5	–	–	–	–	1.12	8.330	0.66	2.418

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,600	1,375.5	—	—	—	—	1.19	9.330	0.71	2.707
1,700	1,461.5	—	—	—	—	1.27	10.380	0.75	3.010
1,800	1,547.4	—	—	—	—	1.34	11.478	0.80	3.327
1,900	1,633.4	—	—	—	—	1.42	12.625	0.84	3.658
2,000	1,719.4	—	—	—	—	1.49	13.821	0.89	4.002
2,500	2,149.2	—	—	—	—	1.86	20.502	1.11	5.925
3,000	2,579.0	—	—	—	—	—	—	1.33	8.174
3,500	3,008.9	—	—	—	—	—	—	1.55	10.737
4,000	3,438.7	—	—	—	—	—	—	1.77	13.605
4,500	3,868.6	—	—	—	—	—	—	1.99	16.772

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Table 6: Pressure loss for copper pipes in accordance with BS EN 1057, cooling, inlet flow 10 °C / return flow 11 °C, d35-54 mm

d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
200	171.9	0.06	0.022	—	—	—	—
250	214.9	0.07	0.028	—	—	—	—
300	257.9	0.09	0.033	0.06	0.015	—	—
350	300.9	0.10	0.071	0.07	0.018	—	—
400	343.9	0.11	0.089	0.08	0.036	—	—
450	386.9	0.13	0.108	0.09	0.043	0.05	0.008
500	429.8	0.14	0.129	0.10	0.052	0.06	0.009
550	472.8	0.16	0.152	0.11	0.061	0.06	0.018
600	515.8	0.17	0.177	0.12	0.071	0.07	0.020
700	601.8	0.20	0.230	0.14	0.092	0.08	0.026
800	687.7	0.23	0.289	0.16	0.116	0.09	0.033
900	773.7	0.26	0.354	0.17	0.141	0.10	0.041
1,000	859.7	0.29	0.425	0.19	0.169	0.11	0.049
1,100	945.6	0.31	0.501	0.21	0.200	0.13	0.057
1,200	1,031.6	0.34	0.582	0.23	0.232	0.14	0.066
1,300	1,117.6	0.37	0.669	0.25	0.266	0.15	0.076
1,400	1,203.6	0.40	0.760	0.27	0.303	0.16	0.087
1,500	1,289.5	0.43	0.857	0.29	0.341	0.17	0.098
1,600	1,375.5	0.46	0.959	0.31	0.381	0.18	0.109
1,700	1,461.5	0.49	1.066	0.33	0.424	0.19	0.121
1,800	1,547.4	0.52	1.178	0.35	0.468	0.21	0.134
1,900	1,633.4	0.54	1.294	0.37	0.514	0.22	0.147
2,000	1,719.4	0.57	1.416	0.39	0.562	0.23	0.160
2,500	2,149.2	0.72	2.093	0.48	0.830	0.29	0.236

d [mm]		35		42		54	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
3,000	2,579.0	0.86	2.883	0.58	1.142	0.34	0.325
3,500	3,008.9	1.00	3.783	0.68	1.497	0.40	0.425
4,000	3,438.7	1.14	4.789	0.78	1.894	0.46	0.537
4,500	3,868.6	1.29	5.898	0.87	2.331	0.51	0.660
5,000	4,298.4	1.43	7.110	0.97	2.808	0.57	0.795
5,500	4,728.2	1.57	8.421	1.07	3.324	0.63	0.940
6,000	5,158.1	1.72	9.829	1.16	3.878	0.69	1.096
6,500	5,587.9	1.86	11.335	1.26	4.469	0.74	1.263
7,000	6,017.8	—	—	1.36	5.098	0.80	1.439
7,500	6,447.6	—	—	1.45	5.763	0.86	1.626
8,000	6,877.4	—	—	1.55	6.465	0.91	1.823
8,500	7,307.3	—	—	1.65	7.202	0.97	2.030
9,000	7,737.1	—	—	1.75	7.975	1.03	2.247
9,500	8,167.0	—	—	1.84	8.782	1.09	2.474
10,000	8,596.8	—	—	1.94	9.625	1.14	2.710
10,500	9,026.7	—	—	—	—	1.20	2.956
11,000	9,456.5	—	—	—	—	1.26	3.211
11,500	9,886.3	—	—	—	—	1.31	3.475
12,000	10,316.2	—	—	—	—	1.37	3.749
12,500	10,746.0	—	—	—	—	1.43	4.033
13,000	11,175.9	—	—	—	—	1.49	4.325
13,500	11,605.7	—	—	—	—	1.54	4.626
14,000	12,035.5	—	—	—	—	1.60	4.937
14,500	12,465.4	—	—	—	—	1.66	5.257
15,000	12,895.2	—	—	—	—	1.71	5.585
15,500	13,325.1	—	—	—	—	1.77	5.923
16,000	13,754.9	—	—	—	—	1.83	6.269
16,500	14,184.7	—	—	—	—	1.88	6.624
17,000	14,614.6	—	—	—	—	1.94	6.988
17,500	15,044.4	—	—	—	—	2.00	7.360

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Table 7: Pressure loss for copper pipes in accordance with BS EN 1057, cooling, inlet flow 10 °C / return flow 11 °C, d66.7–108 mm

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
700	601.8	0.05	0.009	—	—	—	—
800	687.7	0.06	0.012	—	—	—	—
900	773.7	0.07	0.014	0.05	0.008	—	—
1,000	859.7	0.07	0.017	0.06	0.009	—	—

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,100	945.6	0.08	0.020	0.06	0.011	—	—
1,200	1,031.6	0.09	0.024	0.07	0.013	—	—
1,300	1,117.6	0.10	0.027	0.07	0.015	—	—
1,400	1,203.6	0.10	0.031	0.08	0.017	—	—
1,500	1,289.5	0.11	0.035	0.09	0.019	—	—
1,600	1,375.5	0.12	0.039	0.09	0.021	—	—
1,700	1,461.5	0.13	0.043	0.10	0.023	—	—
1,800	1,547.4	0.13	0.047	0.10	0.026	—	—
1,900	1,633.4	0.14	0.052	0.11	0.028	0.05	0.005
2,000	1,719.4	0.15	0.057	0.11	0.031	0.06	0.006
2,500	2,149.2	0.18	0.083	0.14	0.045	0.07	0.008
3,000	2,579.0	0.22	0.114	0.17	0.062	0.08	0.011
3,500	3,008.9	0.26	0.150	0.20	0.081	0.10	0.015
4,000	3,438.7	0.29	0.189	0.23	0.103	0.11	0.018
4,500	3,868.6	0.33	0.232	0.26	0.126	0.12	0.023
5,000	4,298.4	0.37	0.279	0.28	0.152	0.14	0.027
5,500	4,728.2	0.40	0.330	0.31	0.179	0.15	0.032
6,000	5,158.1	0.44	0.384	0.34	0.209	0.17	0.037
6,500	5,587.9	0.48	0.442	0.37	0.240	0.18	0.043
7,000	6,017.8	0.51	0.504	0.40	0.274	0.19	0.049
7,500	6,447.6	0.55	0.569	0.43	0.309	0.21	0.055
8,000	6,877.4	0.59	0.638	0.46	0.346	0.22	0.062
8,500	7,307.3	0.63	0.710	0.48	0.385	0.23	0.069
9,000	7,737.1	0.66	0.786	0.51	0.426	0.25	0.076
9,500	8,167.0	0.70	0.865	0.54	0.469	0.26	0.084
10,000	8,596.8	0.74	0.947	0.57	0.513	0.28	0.091
10,500	9,026.7	0.77	1.032	0.60	0.560	0.29	0.100
11,000	9,456.5	0.81	1.121	0.63	0.608	0.30	0.108
11,500	9,886.3	0.85	1.213	0.65	0.657	0.32	0.117
12,000	10,316.2	0.88	1.309	0.68	0.709	0.33	0.126
12,500	10,746.0	0.92	1.407	0.71	0.762	0.34	0.135
13,000	11,175.9	0.96	1.509	0.74	0.817	0.36	0.145
13,500	11,605.7	0.99	1.613	0.77	0.874	0.37	0.155
14,000	12,035.5	1.03	1.721	0.80	0.932	0.39	0.165
14,500	12,465.4	1.07	1.832	0.83	0.992	0.40	0.176
15,000	12,895.2	1.10	1.946	0.85	1.054	0.41	0.187
15,500	13,325.1	1.14	2.064	0.88	1.117	0.43	0.198
16,000	13,754.9	1.18	2.184	0.91	1.182	0.44	0.209
16,500	14,184.7	1.21	2.307	0.94	1.248	0.46	0.221

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d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17,000	14,614.6	1.25	2.433	0.97	1.317	0.47	0.233
17,500	15,044.4	1.29	2.563	1.00	1.386	0.48	0.246
18,000	15,474.3	1.32	2.695	1.02	1.458	0.50	0.258
18,500	15,904.1	1.36	2.830	1.05	1.531	0.51	0.271
19,000	16,333.9	1.40	2.968	1.08	1.606	0.52	0.284
19,500	16,763.8	1.43	3.109	1.11	1.682	0.54	0.297
20,000	17,193.6	1.47	3.253	1.14	1.759	0.55	0.311
20,500	17,623.5	1.51	3.400	1.17	1.839	0.57	0.325
21,000	18,053.3	1.54	3.550	1.20	1.920	0.58	0.339
21,500	18,483.1	1.58	3.703	1.22	2.002	0.59	0.354
22,000	18,913.0	1.62	3.859	1.25	2.086	0.61	0.369
22,500	19,342.8	1.66	4.017	1.28	2.172	0.62	0.384
23,000	19,772.7	1.69	4.179	1.31	2.259	0.63	0.399
23,500	20,202.5	1.73	4.343	1.34	2.347	0.65	0.414
24,000	20,632.3	1.77	4.510	1.37	2.438	0.66	0.430
24,500	21,062.2	1.80	4.680	1.39	2.529	0.68	0.446
25,000	21,492.0	1.84	4.853	1.42	2.622	0.69	0.463
25,500	21,921.9	1.88	5.029	1.45	2.717	0.70	0.479
26,000	22,351.7	1.91	5.207	1.48	2.813	0.72	0.496
26,500	22,781.5	1.95	5.388	1.51	2.911	0.73	0.513
27,000	23,211.4	1.99	5.572	1.54	3.010	0.74	0.531
27,500	23,641.2	—	—	1.57	3.111	0.76	0.548
28,000	24,071.1	—	—	1.59	3.213	0.77	0.566
28,500	24,500.9	—	—	1.62	3.317	0.79	0.585
29,000	24,930.7	—	—	1.65	3.422	0.80	0.603
29,500	25,360.6	—	—	1.68	3.528	0.81	0.622
30,000	25,790.4	—	—	1.71	3.636	0.83	0.641
32,500	27,939.6	—	—	1.85	4.199	0.90	0.739
35,000	30,088.8	—	—	1.99	4.797	0.97	0.844
37,500	32,238.0	—	—	—	—	1.03	0.955
40,000	34,387.2	—	—	—	—	1.10	1.072
42,500	36,536.4	—	—	—	—	1.17	1.195
45,000	38,685.6	—	—	—	—	1.24	1.324
47,500	40,834.8	—	—	—	—	1.31	1.459
50,000	42,984.0	—	—	—	—	1.38	1.600
52,500	45,133.3	—	—	—	—	1.45	1.746
55,000	47,282.5	—	—	—	—	1.52	1.899
57,500	49,431.7	—	—	—	—	1.59	2.057
60,000	51,580.9	—	—	—	—	1.66	2.221

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
62,500	53,730.1	—	—	—	—	1.72	2.390
65,000	55,879.3	—	—	—	—	1.79	2.565
67,500	58,028.5	—	—	—	—	1.86	2.746
70,000	60,177.7	—	—	—	—	1.93	2.932

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3.3 Cooling, inlet flow 8 °C / return flow 12 °C

Medium:	Water
Inlet flow temperature:	8 °C
Return temperature:	12 °C
Range:	4 K
Average temperature:	10 °C
Density:	999.7 kg/m ³
Viscosity:	0.001306 Pa•s
Specific thermal capacity:	4,188 J/(kg•K)
Surface roughness:	0.0015 mm

Table 8: Pressure loss for copper pipes in accordance with BS EN 1057, cooling, inlet flow 8 °C / return flow 12 °C, d12–28 mm

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
100	21.5	0.07	0.234	–	–	–	–	–	–
150	32.2	0.10	0.350	0.06	0.139	–	–	–	–
200	43.0	0.13	0.467	0.08	0.186	–	–	–	–
250	53.7	0.16	0.584	0.10	0.232	–	–	–	–
300	64.5	0.20	0.701	0.12	0.279	0.06	0.057	–	–
350	75.2	0.23	0.817	0.14	0.325	0.07	0.067	–	–
400	86.0	0.26	0.934	0.16	0.372	0.07	0.076	–	–
450	96.7	0.29	1.859	0.18	0.418	0.08	0.086	–	–
500	107.4	0.33	2.221	0.21	0.464	0.09	0.095	0.06	0.034
550	118.2	0.36	2.610	0.23	0.885	0.10	0.105	0.06	0.037
600	128.9	0.39	3.025	0.25	1.025	0.11	0.115	0.07	0.040
700	150.4	0.46	3.932	0.29	1.330	0.13	0.134	0.08	0.047
800	171.9	0.52	4.938	0.33	1.668	0.15	0.261	0.09	0.054
900	193.4	0.59	6.041	0.37	2.039	0.17	0.318	0.10	0.061
1,000	214.9	0.65	7.239	0.41	2.440	0.19	0.380	0.11	0.067
1,100	236.4	0.72	8.528	0.45	2.872	0.20	0.446	0.12	0.132
1,200	257.9	0.78	9.907	0.49	3.334	0.22	0.517	0.13	0.153
1,300	279.4	0.85	11.375	0.53	3.825	0.24	0.593	0.14	0.175
1,400	300.9	0.91	12.930	0.58	4.345	0.26	0.673	0.16	0.198
1,500	322.3	0.98	14.571	0.62	4.894	0.28	0.757	0.17	0.223
1,600	343.8	1.04	16.296	0.66	5.470	0.30	0.845	0.18	0.248
1,700	365.3	1.11	18.105	0.70	6.074	0.32	0.937	0.19	0.275
1,800	386.8	1.17	19.996	0.74	6.705	0.34	1.034	0.20	0.304
1,900	408.3	1.24	21.968	0.78	7.363	0.35	1.134	0.21	0.333
2,000	429.8	1.30	24.021	0.82	8.047	0.37	1.239	0.22	0.363
2,500	537.2	1.63	35.469	1.03	11.858	0.47	1.820	0.28	0.533
3,000	644.7	1.96	48.829	1.23	16.298	0.56	2.494	0.33	0.729
3,500	752.1	–	–	1.44	21.345	0.65	3.259	0.39	0.951
4,000	859.6	–	–	1.64	26.980	0.75	4.112	0.44	1.198

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
4,500	967.0	—	—	1.85	33.189	0.84	5.050	0.50	1.470
5,000	1,074.5	—	—	—	—	0.93	6.070	0.55	1.765
5,500	1,181.9	—	—	—	—	1.02	7.173	0.61	2.084
6,000	1,289.4	—	—	—	—	1.12	8.355	0.66	2.426
6,500	1,396.8	—	—	—	—	1.21	9.616	0.72	2.790
7,000	1,504.3	—	—	—	—	1.30	10.955	0.78	3.176
7,500	1,611.7	—	—	—	—	1.40	12.370	0.83	3.585
8,000	1,719.2	—	—	—	—	1.49	13.860	0.89	4.014
8,500	1,826.6	—	—	—	—	1.58	15.425	0.94	4.465
9,000	1,934.1	—	—	—	—	1.68	17.064	1.00	4.937
9,500	2,041.5	—	—	—	—	1.77	18.775	1.05	5.429
10,000	2,149.0	—	—	—	—	1.86	20.559	1.11	5.943
10,500	2,256.4	—	—	—	—	1.96	22.415	1.16	6.476
11,000	2,363.9	—	—	—	—	—	—	1.22	7.030
11,500	2,471.3	—	—	—	—	—	—	1.27	7.603
12,000	2,578.8	—	—	—	—	—	—	1.33	8.197
12,500	2,686.2	—	—	—	—	—	—	1.38	8.810
13,000	2,793.7	—	—	—	—	—	—	1.44	9.443
13,500	2,901.1	—	—	—	—	—	—	1.50	10.095
14,000	3,008.6	—	—	—	—	—	—	1.55	10.766
14,500	3,116.0	—	—	—	—	—	—	1.61	11.457
15,000	3,223.5	—	—	—	—	—	—	1.66	12.166
15,500	3,330.9	—	—	—	—	—	—	1.72	12.895
16,000	3,438.4	—	—	—	—	—	—	1.77	13.642
16,500	3,545.8	—	—	—	—	—	—	1.83	14.408
17,000	3,653.3	—	—	—	—	—	—	1.88	15.193
17,500	3,760.7	—	—	—	—	—	—	1.94	15.996
18,000	3,868.2	—	—	—	—	—	—	1.99	16.817

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Table 9: Pressure loss for copper pipes in accordance with BS EN 1057, cooling, inlet flow 8 °C / return flow 12 °C, d35-54 mm

d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
700	150.4	0.05	0.020	—	—	—	—
800	171.9	0.06	0.023	—	—	—	—
900	193.4	0.06	0.025	—	—	—	—
1,000	214.9	0.07	0.028	—	—	—	—
1,100	236.4	0.08	0.031	0.05	0.014	—	—
1,200	257.9	0.09	0.034	0.06	0.016	—	—

d [mm]		35		42		54	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,300	279.4	0.09	0.063	0.06	0.017	—	—
1,400	300.9	0.10	0.071	0.07	0.018	—	—
1,500	322.3	0.11	0.080	0.07	0.019	—	—
1,600	343.8	0.11	0.089	0.08	0.036	—	—
1,700	365.3	0.12	0.099	0.08	0.040	—	—
1,800	386.8	0.13	0.109	0.09	0.044	0.05	0.008
1,900	408.3	0.14	0.119	0.09	0.048	0.05	0.009
2,000	429.8	0.14	0.130	0.10	0.052	0.06	0.009
2,500	537.2	0.18	0.190	0.12	0.076	0.07	0.022
3,000	644.7	0.21	0.260	0.15	0.104	0.09	0.030
3,500	752.1	0.25	0.338	0.17	0.135	0.10	0.039
4,000	859.6	0.29	0.426	0.19	0.170	0.11	0.049
4,500	967.0	0.32	0.522	0.22	0.208	0.13	0.060
5,000	1,074.5	0.36	0.627	0.24	0.250	0.14	0.072
5,500	1,181.9	0.39	0.739	0.27	0.294	0.16	0.084
6,000	1,289.4	0.43	0.860	0.29	0.342	0.17	0.098
6,500	1,396.8	0.46	0.988	0.32	0.393	0.19	0.112
7,000	1,504.3	0.50	1.125	0.34	0.447	0.20	0.128
7,500	1,611.7	0.54	1.269	0.36	0.504	0.21	0.144
8,000	1,719.2	0.57	1.420	0.39	0.564	0.23	0.161
8,500	1,826.6	0.61	1.579	0.41	0.627	0.24	0.179
9,000	1,934.1	0.64	1.745	0.44	0.693	0.26	0.197
9,500	2,041.5	0.68	1.918	0.46	0.761	0.27	0.217
10,000	2,149.0	0.72	2.099	0.48	0.832	0.29	0.237
10,500	2,256.4	0.75	2.286	0.51	0.907	0.30	0.258
11,000	2,363.9	0.79	2.481	0.53	0.983	0.31	0.280
11,500	2,471.3	0.82	2.683	0.56	1.063	0.33	0.302
12,000	2,578.8	0.86	2.891	0.58	1.145	0.34	0.326
12,500	2,686.2	0.89	3.107	0.61	1.230	0.36	0.350
13,000	2,793.7	0.93	3.329	0.63	1.318	0.37	0.375
13,500	2,901.1	0.97	3.558	0.65	1.408	0.39	0.400
14,000	3,008.6	1.00	3.793	0.68	1.501	0.40	0.426
14,500	3,116.0	1.04	4.036	0.70	1.597	0.41	0.453
15,000	3,223.5	1.07	4.285	0.73	1.695	0.43	0.481
15,500	3,330.9	1.11	4.540	0.75	1.796	0.44	0.510
16,000	3,438.4	1.14	4.802	0.78	1.899	0.46	0.539
16,500	3,545.8	1.18	5.071	0.80	2.005	0.47	0.569
17,000	3,653.3	1.22	5.346	0.82	2.113	0.49	0.599
17,500	3,760.7	1.25	5.627	0.85	2.224	0.50	0.630

d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
18,000	3,868.2	1.29	5.915	0.87	2.338	0.51	0.662
18,500	3,975.6	1.32	6.209	0.90	2.453	0.53	0.695
19,000	4,083.1	1.36	6.509	0.92	2.572	0.54	0.728
19,500	4,190.5	1.39	6.816	0.95	2.692	0.56	0.762
20,000	4,298.0	1.43	7.129	0.97	2.816	0.57	0.797
20,500	4,405.4	1.47	7.448	0.99	2.941	0.59	0.833
21,000	4,512.9	1.50	7.774	1.02	3.069	0.60	0.869
21,500	4,620.3	1.54	8.105	1.04	3.200	0.61	0.905
22,000	4,727.8	1.57	8.443	1.07	3.333	0.63	0.943
22,500	4,835.2	1.61	8.787	1.09	3.468	0.64	0.981
23,000	4,942.7	1.65	9.137	1.12	3.606	0.66	1.020
23,500	5,050.1	1.68	9.493	1.14	3.746	0.67	1.059
24,000	5,157.6	1.72	9.856	1.16	3.888	0.69	1.099
24,500	5,265.0	1.75	10.224	1.19	4.033	0.70	1.140
25,000	5,372.5	1.79	10.598	1.21	4.180	0.71	1.181
25,500	5,479.9	1.82	10.978	1.24	4.330	0.73	1.224
26,000	5,587.4	1.86	11.365	1.26	4.481	0.74	1.266
26,500	5,694.8	1.90	11.757	1.28	4.636	0.76	1.310
27,000	5,802.3	1.93	12.155	1.31	4.792	0.77	1.354
27,500	5,909.7	1.97	12.559	1.33	4.951	0.79	1.398
28,000	6,017.2	—	—	1.36	5.112	0.80	1.443
28,500	6,124.6	—	—	1.38	5.275	0.81	1.489
29,000	6,232.1	—	—	1.41	5.441	0.83	1.536
29,500	6,339.5	—	—	1.43	5.608	0.84	1.583
30,000	6,447.0	—	—	1.45	5.779	0.86	1.631
32,500	6,984.2	—	—	1.58	6.663	0.93	1.879
35,000	7,521.5	—	—	1.70	7.604	1.00	2.143
37,500	8,058.7	—	—	1.82	8.599	1.07	2.423
40,000	8,596.0	—	—	1.94	9.650	1.14	2.717
42,500	9,133.2	—	—	—	—	1.21	3.027
45,000	9,670.5	—	—	—	—	1.28	3.351
47,500	10,207.7	—	—	—	—	1.36	3.690
50,000	10,745.0	—	—	—	—	1.43	4.043
52,500	11,282.2	—	—	—	—	1.50	4.411
55,000	11,819.5	—	—	—	—	1.57	4.793
57,500	12,356.7	—	—	—	—	1.64	5.189
60,000	12,894.0	—	—	—	—	1.71	5.599
62,500	13,431.2	—	—	—	—	1.78	6.023
65,000	13,968.5	—	—	—	—	1.86	6.461

d [mm]		35		42		54	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
67,500	14,505.7	—	—	—	—	1.93	6.913
70,000	15,043.0	—	—	—	—	2.00	7.379

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Table 10: Pressure loss for copper pipes in accordance with BS EN 1057, cooling, inlet flow 8 °C / return flow 12 °C, d66.7–108 mm

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
3,000	644.7	0.06	0.011	—	—	—	—
3,500	752.1	0.06	0.014	—	—	—	—
4,000	859.6	0.07	0.017	0.06	0.009	—	—
4,500	967.0	0.08	0.021	0.06	0.012	—	—
5,000	1,074.5	0.09	0.025	0.07	0.014	—	—
5,500	1,181.9	0.10	0.030	0.08	0.016	—	—
6,000	1,289.4	0.11	0.035	0.09	0.019	—	—
6,500	1,396.8	0.12	0.040	0.09	0.022	—	—
7,000	1,504.3	0.13	0.045	0.10	0.025	—	—
7,500	1,611.7	0.14	0.051	0.11	0.028	0.05	0.005
8,000	1,719.2	0.15	0.057	0.11	0.031	0.06	0.006
8,500	1,826.6	0.16	0.063	0.12	0.034	0.06	0.006
9,000	1,934.1	0.17	0.070	0.13	0.038	0.06	0.007
9,500	2,041.5	0.17	0.076	0.14	0.042	0.07	0.008
10,000	2,149.0	0.18	0.084	0.14	0.046	0.07	0.008
10,500	2,256.4	0.19	0.091	0.15	0.050	0.07	0.009
11,000	2,363.9	0.20	0.099	0.16	0.054	0.08	0.010
11,500	2,471.3	0.21	0.106	0.16	0.058	0.08	0.010
12,000	2,578.8	0.22	0.115	0.17	0.062	0.08	0.011
12,500	2,686.2	0.23	0.123	0.18	0.067	0.09	0.012
13,000	2,793.7	0.24	0.132	0.18	0.072	0.09	0.013
13,500	2,901.1	0.25	0.141	0.19	0.077	0.09	0.014
14,000	3,008.6	0.26	0.150	0.20	0.082	0.10	0.015
14,500	3,116.0	0.27	0.159	0.21	0.087	0.10	0.016
15,000	3,223.5	0.28	0.169	0.21	0.092	0.10	0.017
15,500	3,330.9	0.29	0.179	0.22	0.097	0.11	0.018
16,000	3,438.4	0.29	0.189	0.23	0.103	0.11	0.019
16,500	3,545.8	0.30	0.200	0.23	0.109	0.11	0.020
17,000	3,653.3	0.31	0.210	0.24	0.114	0.12	0.021
17,500	3,760.7	0.32	0.221	0.25	0.120	0.12	0.022
18,000	3,868.2	0.33	0.233	0.26	0.126	0.12	0.023
18,500	3,975.6	0.34	0.244	0.26	0.133	0.13	0.024

d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
19,000	4,083.1	0.35	0.256	0.27	0.139	0.13	0.025
19,500	4,190.5	0.36	0.268	0.28	0.145	0.13	0.026
20,000	4,298.0	0.37	0.280	0.28	0.152	0.14	0.027
20,500	4,405.4	0.38	0.292	0.29	0.159	0.14	0.028
21,000	4,512.9	0.39	0.305	0.30	0.166	0.14	0.030
21,500	4,620.3	0.40	0.318	0.31	0.173	0.15	0.031
22,000	4,727.8	0.40	0.331	0.31	0.180	0.15	0.032
22,500	4,835.2	0.41	0.344	0.32	0.187	0.16	0.033
23,000	4,942.7	0.42	0.358	0.33	0.194	0.16	0.035
23,500	5,050.1	0.43	0.371	0.33	0.202	0.16	0.036
24,000	5,157.6	0.44	0.385	0.34	0.209	0.17	0.037
24,500	5,265.0	0.45	0.400	0.35	0.217	0.17	0.039
25,000	5,372.5	0.46	0.414	0.36	0.225	0.17	0.040
25,500	5,479.9	0.47	0.429	0.36	0.233	0.18	0.042
26,000	5,587.4	0.48	0.444	0.37	0.241	0.18	0.043
26,500	5,694.8	0.49	0.459	0.38	0.249	0.18	0.045
27,000	5,802.3	0.50	0.474	0.38	0.257	0.19	0.046
27,500	5,909.7	0.51	0.490	0.39	0.266	0.19	0.048
28,000	6,017.2	0.51	0.505	0.40	0.274	0.19	0.049
28,500	6,124.6	0.52	0.522	0.41	0.283	0.20	0.051
29,000	6,232.1	0.53	0.538	0.41	0.292	0.20	0.052
29,500	6,339.5	0.54	0.554	0.42	0.301	0.20	0.054
30,000	6,447.0	0.55	0.571	0.43	0.310	0.21	0.055
32,500	6,984.2	0.60	0.658	0.46	0.357	0.22	0.064
35,000	7,521.5	0.64	0.750	0.50	0.407	0.24	0.072
37,500	8,058.7	0.69	0.847	0.53	0.459	0.26	0.082
40,000	8,596.0	0.74	0.949	0.57	0.515	0.28	0.092
42,500	9,133.2	0.78	1.057	0.60	0.573	0.29	0.102
45,000	9,670.5	0.83	1.170	0.64	0.634	0.31	0.113
47,500	10,207.7	0.87	1.288	0.68	0.698	0.33	0.124
50,000	10,745.0	0.92	1.411	0.71	0.764	0.34	0.136
52,500	11,282.2	0.97	1.539	0.75	0.833	0.36	0.148
55,000	11,819.5	1.01	1.671	0.78	0.905	0.38	0.161
57,500	12,356.7	1.06	1.809	0.82	0.980	0.40	0.174
60,000	12,894.0	1.10	1.952	0.85	1.057	0.41	0.187
62,500	13,431.2	1.15	2.099	0.89	1.136	0.43	0.201
65,000	13,968.5	1.20	2.251	0.92	1.218	0.45	0.216
67,500	14,505.7	1.24	2.408	0.96	1.303	0.47	0.231
70,000	15,043.0	1.29	2.569	1.00	1.390	0.48	0.246

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
72,500	15,580.2	1.33	2.735	1.03	1.480	0.50	0.262
75,000	16,117.5	1.38	2.906	1.07	1.572	0.52	0.278
77,500	16,654.7	1.43	3.082	1.10	1.667	0.53	0.295
80,000	17,192.0	1.47	3.262	1.14	1.764	0.55	0.312
82,500	17,729.2	1.52	3.446	1.17	1.864	0.57	0.330
85,000	18,266.5	1.56	3.636	1.21	1.966	0.59	0.347
87,500	18,803.7	1.61	3.829	1.24	2.070	0.60	0.366
90,000	19,341.0	1.65	4.027	1.28	2.177	0.62	0.385
92,500	19,878.2	1.70	4.230	1.32	2.287	0.64	0.404
95,000	20,415.5	1.75	4.437	1.35	2.398	0.66	0.423
97,500	20,952.7	1.79	4.649	1.39	2.512	0.67	0.444
100,000	21,490.0	1.84	4.865	1.42	2.629	0.69	0.464
105,000	22,564.5	1.93	5.310	1.49	2.869	0.72	0.506
110,000	23,639.0	—	—	1.57	3.119	0.76	0.550
115,000	24,713.5	—	—	1.64	3.377	0.79	0.595
120,000	25,788.0	—	—	1.71	3.645	0.83	0.642
125,000	26,862.5	—	—	1.78	3.923	0.86	0.691
130,000	27,937.0	—	—	1.85	4.209	0.90	0.741
135,000	29,011.5	—	—	1.92	4.504	0.93	0.793
140,000	30,086.0	—	—	1.99	4.809	0.97	0.846
145,000	31,160.5	—	—	—	—	1.00	0.901
150,000	32,235.0	—	—	—	—	1.03	0.957
160,000	34,384.0	—	—	—	—	1.10	1.074
170,000	36,533.0	—	—	—	—	1.17	1.198
180,000	38,681.9	—	—	—	—	1.24	1.327
190,000	40,830.9	—	—	—	—	1.31	1.462
200,000	42,979.9	—	—	—	—	1.38	1.604

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4 Pressure loss, heating

4.1 Recommended flow velocities

The following recommendations apply for the heating pressure loss tables:

- Radiator connection pipes: flow velocity ≤ 0.3 m/s
- Distribution pipes: flow velocity ≤ 0.5 m/s
- Riser pipes and cellar pipes: flow velocity ≤ 0.8 m/s

4.2 Heating, inlet flow 61 °C / return flow 60 °C

Medium:	Water
Inlet flow temperature:	61 °C
Return temperature:	60 °C
Range:	1 K
Average temperature:	60.5 °C
Density:	982.9 kg/m ³
Viscosity:	0.000463475 Pa•s
Specific thermal capacity:	4,183.2 J/(kg•K)
Surface roughness:	0.0015 mm

Table 11: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 61 °C / return flow 60 °C, d12–28 mm

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
50	43.0	0.13	0.349	0.08	0.118	—	—	—	—
100	86.1	0.27	1.141	0.17	0.384	0.08	0.060	—	—
150	129.1	0.40	2.302	0.25	0.772	0.11	0.119	0.07	0.035
200	172.1	0.53	3.799	0.33	1.271	0.15	0.195	0.09	0.057
250	215.1	0.66	5.614	0.42	1.875	0.19	0.287	0.11	0.084
300	258.2	0.80	7.735	0.50	2.579	0.23	0.394	0.14	0.115
350	301.2	0.93	10.150	0.59	3.380	0.27	0.515	0.16	0.150
400	344.2	1.06	12.852	0.67	4.274	0.30	0.650	0.18	0.189
450	387.3	1.19	15.835	0.75	5.260	0.34	0.799	0.20	0.232
500	430.3	1.33	19.092	0.84	6.336	0.38	0.961	0.23	0.279
550	473.3	1.46	22.620	0.92	7.499	0.42	1.136	0.25	0.330
600	516.4	1.59	26.414	1.00	8.750	0.46	1.323	0.27	0.384
700	602.4	1.86	34.786	1.17	11.505	0.53	1.736	0.32	0.503
800	688.5	—	—	1.34	14.592	0.61	2.197	0.36	0.636
900	774.5	—	—	1.51	18.005	0.68	2.707	0.41	0.782
1,000	860.6	—	—	1.67	21.738	0.76	3.262	0.45	0.942
1,100	946.6	—	—	1.84	25.785	0.83	3.864	0.50	1.115
1,200	1,032.7	—	—	—	—	0.91	4.510	0.54	1.300
1,300	1,118.8	—	—	—	—	0.99	5.201	0.59	1.498
1,400	1,204.8	—	—	—	—	1.06	5.935	0.63	1.708
1,500	1,290.9	—	—	—	—	1.14	6.713	0.68	1.931

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,600	1,376.9	—	—	—	—	1.21	7.533	0.72	2.166
1,700	1,463.0	—	—	—	—	1.29	8.396	0.77	2.412
1,800	1,549.1	—	—	—	—	1.37	9.301	0.81	2.671
1,900	1,635.1	—	—	—	—	1.44	10.247	0.86	2.941
2,000	1,721.2	—	—	—	—	1.52	11.235	0.90	3.223
2,500	2,151.5	—	—	—	—	1.90	16.779	1.13	4.803
3,000	2,581.8	—	—	—	—	—	—	1.35	6.660
3,500	3,012.0	—	—	—	—	—	—	1.58	8.787
4,000	3,442.3	—	—	—	—	—	—	1.80	11.178

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Table 12: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 61 °C / return flow 60 °C, d35-54 mm

d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
200	172.1	0.06	0.020	—	—	—	—
250	215.1	0.07	0.030	—	—	—	—
300	258.2	0.09	0.041	0.06	0.016	—	—
350	301.2	0.10	0.053	0.07	0.021	—	—
400	344.2	0.12	0.067	0.08	0.027	—	—
450	387.3	0.13	0.082	0.09	0.033	0.05	0.009
500	430.3	0.15	0.099	0.10	0.039	0.06	0.011
550	473.3	0.16	0.117	0.11	0.046	0.06	0.013
600	516.4	0.17	0.136	0.12	0.054	0.07	0.015
700	602.4	0.20	0.178	0.14	0.071	0.08	0.020
800	688.5	0.23	0.225	0.16	0.089	0.09	0.025
900	774.5	0.26	0.276	0.18	0.110	0.10	0.031
1,000	860.6	0.29	0.332	0.20	0.132	0.12	0.037
1,100	946.6	0.32	0.393	0.22	0.156	0.13	0.044
1,200	1,032.7	0.35	0.458	0.24	0.181	0.14	0.052
1,300	1,118.8	0.38	0.528	0.26	0.209	0.15	0.059
1,400	1,204.8	0.41	0.601	0.28	0.238	0.16	0.067
1,500	1,290.9	0.44	0.679	0.30	0.269	0.17	0.076
1,600	1,376.9	0.47	0.762	0.32	0.301	0.19	0.085
1,700	1,463.0	0.50	0.848	0.34	0.335	0.20	0.095
1,800	1,549.1	0.52	0.939	0.36	0.371	0.21	0.105
1,900	1,635.1	0.55	1.033	0.38	0.408	0.22	0.115
2,000	1,721.2	0.58	1.132	0.39	0.447	0.23	0.126
2,500	2,151.5	0.73	1.684	0.49	0.664	0.29	0.187
3,000	2,581.8	0.87	2.331	0.59	0.918	0.35	0.259

d [mm]		35		42		54	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
3,500	3,012.0	1.02	3.072	0.69	1.208	0.41	0.340
4,000	3,442.3	1.17	3.904	0.79	1.534	0.47	0.432
4,500	3,872.6	1.31	4.824	0.89	1.894	0.52	0.532
5,000	4,302.9	1.46	5.832	0.99	2.288	0.58	0.643
5,500	4,733.2	1.60	6.926	1.09	2.716	0.64	0.762
6,000	5,163.5	1.75	8.104	1.18	3.176	0.70	0.890
6,500	5,593.8	1.89	9.366	1.28	3.668	0.76	1.028
7,000	6,024.1	—	—	1.38	4.192	0.81	1.174
7,500	6,454.4	—	—	1.48	4.748	0.87	1.329
8,000	6,884.7	—	—	1.58	5.335	0.93	1.492
8,500	7,315.0	—	—	1.68	5.954	0.99	1.664
9,000	7,745.3	—	—	1.78	6.603	1.05	1.845
9,500	8,175.6	—	—	1.88	7.282	1.10	2.033
10,000	8,605.9	—	—	1.97	7.992	1.16	2.230
10,500	9,036.1	—	—	—	—	1.22	2.436
11,000	9,466.4	—	—	—	—	1.28	2.649
11,500	9,896.7	—	—	—	—	1.34	2.871
12,000	10,327.0	—	—	—	—	1.40	3.100
12,500	10,757.3	—	—	—	—	1.45	3.338
13,000	11,187.6	—	—	—	—	1.51	3.583
13,500	11,617.9	—	—	—	—	1.57	3.837
14,000	12,048.2	—	—	—	—	1.63	4.098
14,500	12,478.5	—	—	—	—	1.69	4.368
15,000	12,908.8	—	—	—	—	1.74	4.645
15,500	13,339.1	—	—	—	—	1.80	4.929
16,000	13,769.4	—	—	—	—	1.86	5.222
16,500	14,199.7	—	—	—	—	1.92	5.522
17,000	14,629.9	—	—	—	—	1.98	5.830

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Table 13: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 61 °C / return flow 60 °C, d66.7–108 mm

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
700	602.4	0.05	0.007	—	—	—	—
800	688.5	0.06	0.009	—	—	—	—
900	774.5	0.07	0.011	0.05	0.006	—	—
1,000	860.6	0.07	0.013	0.06	0.007	—	—
1,100	946.6	0.08	0.016	0.06	0.008	—	—
1,200	1,032.7	0.09	0.018	0.07	0.010	—	—

d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,300	1,118.8	0.10	0.021	0.08	0.011	—	—
1,400	1,204.8	0.10	0.024	0.08	0.013	—	—
1,500	1,290.9	0.11	0.027	0.09	0.015	—	—
1,600	1,376.9	0.12	0.030	0.09	0.016	—	—
1,700	1,463.0	0.13	0.033	0.10	0.018	—	—
1,800	1,549.1	0.13	0.037	0.10	0.020	0.05	0.004
1,900	1,635.1	0.14	0.040	0.11	0.022	0.05	0.004
2,000	1,721.2	0.15	0.044	0.12	0.024	0.06	0.004
2,500	2,151.5	0.19	0.066	0.14	0.036	0.07	0.006
3,000	2,581.8	0.22	0.091	0.17	0.049	0.08	0.009
3,500	3,012.0	0.26	0.119	0.20	0.064	0.10	0.011
4,000	3,442.3	0.30	0.151	0.23	0.082	0.11	0.015
4,500	3,872.6	0.34	0.186	0.26	0.101	0.13	0.018
5,000	4,302.9	0.37	0.224	0.29	0.121	0.14	0.022
5,500	4,733.2	0.41	0.265	0.32	0.144	0.15	0.025
6,000	5,163.5	0.45	0.310	0.35	0.168	0.17	0.030
6,500	5,593.8	0.49	0.358	0.38	0.194	0.18	0.034
7,000	6,024.1	0.52	0.408	0.41	0.221	0.20	0.039
7,500	6,454.4	0.56	0.462	0.43	0.250	0.21	0.044
8,000	6,884.7	0.60	0.519	0.46	0.280	0.22	0.050
8,500	7,315.0	0.64	0.578	0.49	0.313	0.24	0.055
9,000	7,745.3	0.67	0.641	0.52	0.346	0.25	0.061
9,500	8,175.6	0.71	0.706	0.55	0.381	0.27	0.067
10,000	8,605.9	0.75	0.774	0.58	0.418	0.28	0.074
10,500	9,036.1	0.79	0.845	0.61	0.456	0.29	0.080
11,000	9,466.4	0.82	0.919	0.64	0.496	0.31	0.087
11,500	9,896.7	0.86	0.995	0.67	0.537	0.32	0.095
12,000	10,327.0	0.90	1.075	0.70	0.580	0.34	0.102
12,500	10,757.3	0.94	1.157	0.72	0.624	0.35	0.110
13,000	11,187.6	0.97	1.242	0.75	0.670	0.37	0.118
13,500	11,617.9	1.01	1.329	0.78	0.717	0.38	0.126
14,000	12,048.2	1.05	1.419	0.81	0.766	0.39	0.135
14,500	12,478.5	1.09	1.512	0.84	0.816	0.41	0.143
15,000	12,908.8	1.12	1.607	0.87	0.867	0.42	0.152
15,500	13,339.1	1.16	1.706	0.90	0.920	0.44	0.161
16,000	13,769.4	1.20	1.806	0.93	0.974	0.45	0.171
16,500	14,199.7	1.24	1.910	0.96	1.030	0.46	0.181
17,000	14,629.9	1.27	2.016	0.99	1.087	0.48	0.191
17,500	15,060.2	1.31	2.124	1.01	1.145	0.49	0.201

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d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
18,000	15,490.5	1.35	2.236	1.04	1.205	0.51	0.211
18,500	15,920.8	1.39	2.349	1.07	1.266	0.52	0.222
19,000	16,351.1	1.42	2.466	1.10	1.329	0.53	0.233
19,500	16,781.4	1.46	2.585	1.13	1.392	0.55	0.244
20,000	17,211.7	1.50	2.706	1.16	1.458	0.56	0.255
20,500	17,642.0	1.54	2.830	1.19	1.524	0.58	0.267
21,000	18,072.3	1.57	2.957	1.22	1.592	0.59	0.279
21,500	18,502.6	1.61	3.086	1.25	1.662	0.60	0.291
22,000	18,932.9	1.65	3.217	1.27	1.732	0.62	0.303
22,500	19,363.2	1.69	3.351	1.30	1.804	0.63	0.316
23,000	19,793.5	1.72	3.488	1.33	1.878	0.65	0.328
23,500	20,223.8	1.76	3.627	1.36	1.952	0.66	0.341
24,000	20,654.0	1.80	3.768	1.39	2.028	0.67	0.354
24,500	21,084.3	1.83	3.912	1.42	2.106	0.69	0.368
25,000	21,514.6	1.87	4.059	1.45	2.184	0.70	0.382
25,500	21,944.9	1.91	4.208	1.48	2.264	0.72	0.395
26,000	22,375.2	1.95	4.359	1.51	2.346	0.73	0.410
26,500	22,805.5	1.98	4.513	1.54	2.428	0.74	0.424
27,000	23,235.8	—	—	1.56	2.512	0.76	0.438
27,500	23,666.1	—	—	1.59	2.597	0.77	0.453
28,000	24,096.4	—	—	1.62	2.684	0.79	0.468
28,500	24,526.7	—	—	1.65	2.772	0.80	0.483
29,000	24,957.0	—	—	1.68	2.861	0.81	0.499
29,500	25,387.3	—	—	1.71	2.951	0.83	0.515
30,000	25,817.6	—	—	1.74	3.043	0.84	0.530
32,500	27,969.0	—	—	1.88	3.520	0.91	0.613
35,000	30,120.5	—	—	—	—	0.98	0.701
37,500	32,271.9	—	—	—	—	1.05	0.795
40,000	34,423.4	—	—	—	—	1.12	0.893
42,500	36,574.9	—	—	—	—	1.19	0.997
45,000	38,726.3	—	—	—	—	1.26	1.106
47,500	40,877.8	—	—	—	—	1.33	1.221
50,000	43,029.3	—	—	—	—	1.40	1.340
52,500	45,180.7	—	—	—	—	1.47	1.464
55,000	47,332.2	—	—	—	—	1.54	1.594
57,500	49,483.6	—	—	—	—	1.61	1.728
60,000	51,635.1	—	—	—	—	1.69	1.868
62,500	53,786.6	—	—	—	—	1.76	2.012
65,000	55,938.0	—	—	—	—	1.83	2.162

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
67,500	58,089.5	—	—	—	—	1.90	2.316
70,000	60,241.0	—	—	—	—	1.97	2.475

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4.3 Heating, inlet flow 70 °C / return flow 55 °C

Medium:	Water
Inlet flow temperature:	70 °C
Return temperature:	55 °C
Range:	15 K
Average temperature:	32.5 °C
Density:	981.9 kg/m ³
Viscosity:	0.000450975 Pa·s
Specific thermal capacity:	4,184 J/(kg·K)
Surface roughness:	0.0015 mm

Table 14: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 70 °C / return flow 55 °C, d12–28 mm

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
300	17.2	0.05	0.066	–	–	–	–	–	–
400	22.9	0.07	0.088	–	–	–	–	–	–
500	28.7	0.09	0.110	0.06	0.044	–	–	–	–
600	34.4	0.11	0.237	0.07	0.052	–	–	–	–
700	40.2	0.12	0.308	0.08	0.105	–	–	–	–
800	45.9	0.14	0.387	0.09	0.131	–	–	–	–
900	51.6	0.16	0.472	0.10	0.160	–	–	–	–
1,000	57.4	0.18	0.565	0.11	0.191	0.05	0.018	–	–
1,100	63.1	0.19	0.665	0.12	0.225	0.06	0.035	–	–
1,200	68.8	0.21	0.772	0.13	0.261	0.06	0.041	–	–
1,300	74.6	0.23	0.886	0.15	0.299	0.07	0.046	–	–
1,400	80.3	0.25	1.007	0.16	0.339	0.07	0.053	–	–
1,500	86.0	0.27	1.134	0.17	0.382	0.08	0.059	–	–
1,600	91.8	0.28	1.267	0.18	0.426	0.08	0.066	–	–
1,700	97.5	0.30	1.407	0.19	0.473	0.09	0.073	0.05	0.022
1,800	103.3	0.32	1.553	0.20	0.522	0.09	0.081	0.05	0.024
1,900	109.0	0.34	1.705	0.21	0.573	0.10	0.089	0.06	0.026
2,000	114.7	0.35	1.864	0.22	0.626	0.10	0.097	0.06	0.028
2,500	143.4	0.44	2.747	0.28	0.920	0.13	0.142	0.08	0.042
3,000	172.1	0.53	3.776	0.34	1.263	0.15	0.194	0.09	0.057
3,500	200.8	0.62	4.945	0.39	1.652	0.18	0.253	0.11	0.074
4,000	229.4	0.71	6.251	0.45	2.086	0.20	0.319	0.12	0.093
4,500	258.1	0.80	7.690	0.50	2.563	0.23	0.391	0.14	0.114
5,000	286.8	0.89	9.260	0.56	3.084	0.25	0.470	0.15	0.137
5,500	315.5	0.97	10.958	0.61	3.646	0.28	0.555	0.17	0.162
6,000	344.2	1.06	12.781	0.67	4.249	0.30	0.646	0.18	0.188
6,500	372.8	1.15	14.729	0.73	4.893	0.33	0.743	0.20	0.216
7,000	401.5	1.24	16.799	0.78	5.577	0.35	0.846	0.21	0.246
7,500	430.2	1.33	18.991	0.84	6.300	0.38	0.955	0.23	0.277

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
8,000	458.9	1.42	21.302	0.89	7.062	0.41	1.070	0.24	0.310
8,500	487.6	1.51	23.731	0.95	7.863	0.43	1.190	0.26	0.345
9,000	516.3	1.59	26.277	1.01	8.702	0.46	1.316	0.27	0.381
9,500	544.9	1.68	28.940	1.06	9.578	0.48	1.447	0.29	0.419
10,000	573.6	1.77	31.719	1.12	10.492	0.51	1.584	0.30	0.459
10,500	602.3	1.86	34.611	1.17	11.443	0.53	1.726	0.32	0.500
11,000	631.0	1.95	37.617	1.23	12.431	0.56	1.874	0.33	0.542
11,500	659.7	—	—	1.28	13.456	0.58	2.027	0.35	0.586
12,000	688.3	—	—	1.34	14.516	0.61	2.185	0.36	0.632
12,500	717.0	—	—	1.40	15.613	0.63	2.349	0.38	0.679
13,000	745.7	—	—	1.45	16.745	0.66	2.518	0.39	0.728
13,500	774.4	—	—	1.51	17.913	0.68	2.692	0.41	0.778
14,000	803.1	—	—	1.56	19.117	0.71	2.871	0.42	0.829
14,500	831.7	—	—	1.62	20.356	0.73	3.055	0.44	0.882
15,000	860.4	—	—	1.68	21.629	0.76	3.244	0.45	0.937
15,500	889.1	—	—	1.73	22.938	0.78	3.439	0.47	0.992
16,000	917.8	—	—	1.79	24.281	0.81	3.638	0.48	1.050
16,500	946.5	—	—	1.84	25.658	0.84	3.843	0.50	1.108
17,000	975.1	—	—	1.90	27.070	0.86	4.052	0.51	1.168
17,500	1,003.8	—	—	1.95	28.516	0.89	4.267	0.53	1.230
18,000	1,032.5	—	—	—	—	0.91	4.486	0.54	1.293
18,500	1,061.2	—	—	—	—	0.94	4.710	0.56	1.357
19,000	1,089.9	—	—	—	—	0.96	4.939	0.57	1.423
19,500	1,118.5	—	—	—	—	0.99	5.174	0.59	1.490
20,000	1,147.2	—	—	—	—	1.01	5.412	0.60	1.558
20,500	1,175.9	—	—	—	—	1.04	5.656	0.62	1.628
21,000	1,204.6	—	—	—	—	1.06	5.905	0.63	1.699
21,500	1,233.3	—	—	—	—	1.09	6.158	0.65	1.772
22,000	1,262.0	—	—	—	—	1.11	6.416	0.66	1.846
22,500	1,290.6	—	—	—	—	1.14	6.679	0.68	1.921
23,000	1,319.3	—	—	—	—	1.16	6.946	0.69	1.997
23,500	1,348.0	—	—	—	—	1.19	7.218	0.71	2.075
24,000	1,376.7	—	—	—	—	1.22	7.495	0.72	2.154
24,500	1,405.4	—	—	—	—	1.24	7.777	0.74	2.235
25,000	1,434.0	—	—	—	—	1.27	8.063	0.75	2.317
25,500	1,462.7	—	—	—	—	1.29	8.354	0.77	2.400
26,000	1,491.4	—	—	—	—	1.32	8.650	0.78	2.484
26,500	1,520.1	—	—	—	—	1.34	8.950	0.80	2.570
27,000	1,548.8	—	—	—	—	1.37	9.255	0.81	2.657

d [mm]		12		15		22		28	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
27,500	1,577.4	—	—	—	—	1.39	9.564	0.83	2.745
28,000	1,606.1	—	—	—	—	1.42	9.878	0.84	2.835
28,500	1,634.8	—	—	—	—	1.44	10.197	0.86	2.926
29,000	1,663.5	—	—	—	—	1.47	10.520	0.87	3.018
29,500	1,692.2	—	—	—	—	1.49	10.847	0.89	3.112
30,000	1,720.8	—	—	—	—	1.52	11.180	0.90	3.206
32,500	1,864.2	—	—	—	—	1.65	12.909	0.98	3.699
35,000	2,007.6	—	—	—	—	1.77	14.749	1.05	4.223
37,500	2,151.1	—	—	—	—	1.90	16.701	1.13	4.779
40,000	2,294.5	—	—	—	—	—	—	1.20	5.365
42,500	2,437.9	—	—	—	—	—	—	1.28	5.981
45,000	2,581.3	—	—	—	—	—	—	1.35	6.628
47,500	2,724.7	—	—	—	—	—	—	1.43	7.304
50,000	2,868.1	—	—	—	—	—	—	1.50	8.010
52,500	3,011.5	—	—	—	—	—	—	1.58	8.746
55,000	3,154.9	—	—	—	—	—	—	1.66	9.510
57,500	3,298.3	—	—	—	—	—	—	1.73	10.304
60,000	3,441.7	—	—	—	—	—	—	1.81	11.126
62,500	3,585.1	—	—	—	—	—	—	1.88	11.977
65,000	3,728.5	—	—	—	—	—	—	1.96	12.857

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Table 15: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 70 °C / return flow 55 °C, d35-54 mm

d [mm]		35		42		54	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
3,000	172.1	0.06	0.020	—	—	—	—
3,500	200.8	0.07	0.026	—	—	—	—
4,000	229.4	0.08	0.033	0.05	0.013	—	—
4,500	258.1	0.09	0.041	0.06	0.016	—	—
5,000	286.8	0.10	0.049	0.07	0.019	—	—
5,500	315.5	0.11	0.057	0.07	0.023	—	—
6,000	344.2	0.12	0.067	0.08	0.027	—	—
6,500	372.8	0.13	0.077	0.09	0.031	0.05	0.009
7,000	401.5	0.14	0.087	0.09	0.035	0.05	0.010
7,500	430.2	0.15	0.098	0.10	0.039	0.06	0.011
8,000	458.9	0.16	0.110	0.11	0.044	0.06	0.013
8,500	487.6	0.17	0.122	0.11	0.049	0.07	0.014
9,000	516.3	0.17	0.135	0.12	0.054	0.07	0.015
9,500	544.9	0.18	0.148	0.13	0.059	0.07	0.017

d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
10,000	573.6	0.19	0.162	0.13	0.064	0.08	0.018
10,500	602.3	0.20	0.177	0.14	0.070	0.08	0.020
11,000	631.0	0.21	0.192	0.14	0.076	0.09	0.022
11,500	659.7	0.22	0.207	0.15	0.082	0.09	0.023
12,000	688.3	0.23	0.223	0.16	0.089	0.09	0.025
12,500	717.0	0.24	0.240	0.16	0.095	0.10	0.027
13,000	745.7	0.25	0.257	0.17	0.102	0.10	0.029
13,500	774.4	0.26	0.275	0.18	0.109	0.10	0.031
14,000	803.1	0.27	0.293	0.18	0.116	0.11	0.033
14,500	831.7	0.28	0.311	0.19	0.123	0.11	0.035
15,000	860.4	0.29	0.330	0.20	0.131	0.12	0.037
15,500	889.1	0.30	0.350	0.20	0.139	0.12	0.039
16,000	917.8	0.31	0.370	0.21	0.147	0.12	0.042
16,500	946.5	0.32	0.391	0.22	0.155	0.13	0.044
17,000	975.1	0.33	0.412	0.22	0.163	0.13	0.046
17,500	1,003.8	0.34	0.433	0.23	0.172	0.14	0.049
18,000	1,032.5	0.35	0.456	0.24	0.180	0.14	0.051
18,500	1,061.2	0.36	0.478	0.24	0.189	0.14	0.054
19,000	1,089.9	0.37	0.501	0.25	0.198	0.15	0.056
19,500	1,118.5	0.38	0.525	0.26	0.208	0.15	0.059
20,000	1,147.2	0.39	0.549	0.26	0.217	0.16	0.062
20,500	1,175.9	0.40	0.573	0.27	0.227	0.16	0.064
21,000	1,204.6	0.41	0.598	0.28	0.237	0.16	0.067
21,500	1,233.3	0.42	0.623	0.28	0.247	0.17	0.070
22,000	1,262.0	0.43	0.649	0.29	0.257	0.17	0.073
22,500	1,290.6	0.44	0.676	0.30	0.267	0.17	0.076
23,000	1,319.3	0.45	0.703	0.30	0.278	0.18	0.079
23,500	1,348.0	0.46	0.730	0.31	0.288	0.18	0.082
24,000	1,376.7	0.47	0.758	0.32	0.299	0.19	0.085
24,500	1,405.4	0.48	0.786	0.32	0.310	0.19	0.088
25,000	1,434.0	0.49	0.814	0.33	0.322	0.19	0.091
25,500	1,462.7	0.50	0.843	0.34	0.333	0.20	0.094
26,000	1,491.4	0.51	0.873	0.34	0.345	0.20	0.098
26,500	1,520.1	0.52	0.903	0.35	0.357	0.21	0.101
27,000	1,548.8	0.52	0.933	0.36	0.369	0.21	0.104
27,500	1,577.4	0.53	0.964	0.36	0.381	0.21	0.108
28,000	1,606.1	0.54	0.996	0.37	0.393	0.22	0.111
28,500	1,634.8	0.55	1.028	0.38	0.406	0.22	0.115
29,000	1,663.5	0.56	1.060	0.38	0.418	0.23	0.118

d [mm]		35		42		54	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
29,500	1,692.2	0.57	1.092	0.39	0.431	0.23	0.122
30,000	1,720.8	0.58	1.126	0.40	0.444	0.23	0.126
32,500	1,864.2	0.63	1.298	0.43	0.512	0.25	0.145
35,000	2,007.6	0.68	1.481	0.46	0.584	0.27	0.165
37,500	2,151.1	0.73	1.675	0.49	0.660	0.29	0.186
40,000	2,294.5	0.78	1.879	0.53	0.740	0.31	0.209
42,500	2,437.9	0.83	2.094	0.56	0.825	0.33	0.233
45,000	2,581.3	0.87	2.320	0.59	0.913	0.35	0.257
47,500	2,724.7	0.92	2.555	0.63	1.005	0.37	0.283
50,000	2,868.1	0.97	2.801	0.66	1.102	0.39	0.310
52,500	3,011.5	1.02	3.057	0.69	1.202	0.41	0.338
55,000	3,154.9	1.07	3.323	0.72	1.306	0.43	0.368
57,500	3,298.3	1.12	3.599	0.76	1.414	0.45	0.398
60,000	3,441.7	1.17	3.885	0.79	1.526	0.47	0.429
62,500	3,585.1	1.22	4.181	0.82	1.642	0.49	0.462
65,000	3,728.5	1.26	4.486	0.86	1.762	0.50	0.495
67,500	3,871.9	1.31	4.801	0.89	1.885	0.52	0.530
70,000	4,015.3	1.36	5.126	0.92	2.012	0.54	0.565
72,500	4,158.7	1.41	5.461	0.96	2.143	0.56	0.602
75,000	4,302.1	1.46	5.805	0.99	2.277	0.58	0.639
77,500	4,445.5	1.51	6.158	1.02	2.415	0.60	0.678
80,000	4,588.9	1.56	6.521	1.05	2.557	0.62	0.717
82,500	4,732.3	1.60	6.894	1.09	2.703	0.64	0.758
85,000	4,875.7	1.65	7.276	1.12	2.852	0.66	0.800
87,500	5,019.1	1.70	7.667	1.15	3.004	0.68	0.842
90,000	5,162.5	1.75	8.067	1.19	3.161	0.70	0.886
92,500	5,305.9	1.80	8.477	1.22	3.320	0.72	0.931
95,000	5,449.3	1.85	8.896	1.25	3.484	0.74	0.976
97,500	5,592.7	1.90	9.324	1.28	3.651	0.76	1.023
100,000	5,736.1	1.94	9.761	1.32	3.821	0.78	1.070
105,000	6,022.9	—	—	1.38	4.173	0.81	1.168
110,000	6,309.8	—	—	1.45	4.539	0.85	1.270
115,000	6,596.6	—	—	1.52	4.918	0.89	1.376
120,000	6,883.4	—	—	1.58	5.311	0.93	1.485
125,000	7,170.2	—	—	1.65	5.718	0.97	1.598
130,000	7,457.0	—	—	1.71	6.139	1.01	1.715
135,000	7,743.8	—	—	1.78	6.573	1.05	1.836
140,000	8,030.6	—	—	1.84	7.021	1.09	1.960
145,000	8,317.4	—	—	1.91	7.482	1.13	2.088

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d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
150,000	8,604.2	—	—	1.98	7.957	1.16	2.220
155,000	8,891.0	—	—	—	—	1.20	2.355
160,000	9,177.8	—	—	—	—	1.24	2.494
165,000	9,464.6	—	—	—	—	1.28	2.637
170,000	9,751.4	—	—	—	—	1.32	2.783
175,000	10,038.2	—	—	—	—	1.36	2.933
180,000	10,325.0	—	—	—	—	1.40	3.086
185,000	10,611.9	—	—	—	—	1.44	3.243
190,000	10,898.7	—	—	—	—	1.47	3.404
195,000	11,185.5	—	—	—	—	1.51	3.568
200,000	11,472.3	—	—	—	—	1.55	3.735
205,000	11,759.1	—	—	—	—	1.59	3.906
210,000	12,045.9	—	—	—	—	1.63	4.080
215,000	12,332.7	—	—	—	—	1.67	4.258
220,000	12,619.5	—	—	—	—	1.71	4.440
225,000	12,906.3	—	—	—	—	1.75	4.624
230,000	13,193.1	—	—	—	—	1.78	4.813
235,000	13,479.9	—	—	—	—	1.82	5.004
240,000	13,766.7	—	—	—	—	1.86	5.200
245,000	14,053.5	—	—	—	—	1.90	5.398
250,000	14,340.3	—	—	—	—	1.94	5.600
255,000	14,627.2	—	—	—	—	1.98	5.805

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Table 16: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 70 °C / return flow 55 °C, d66.7–108 mm

d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
10,500	602.3	0.05	0.007	—	—	—	—
11,000	631.0	0.05	0.008	—	—	—	—
11,500	659.7	0.06	0.008	—	—	—	—
12,000	688.3	0.06	0.009	—	—	—	—
12,500	717.0	0.06	0.010	—	—	—	—
13,000	745.7	0.06	0.010	0.05	0.006	—	—
13,500	774.4	0.07	0.011	0.05	0.006	—	—
14,000	803.1	0.07	0.012	0.05	0.006	—	—
14,500	831.7	0.07	0.012	0.06	0.007	—	—
15,000	860.4	0.07	0.013	0.06	0.007	—	—
15,500	889.1	0.08	0.014	0.06	0.008	—	—
16,000	917.8	0.08	0.015	0.06	0.008	—	—

d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
16,500	946.5	0.08	0.015	0.06	0.008	—	—
17,000	975.1	0.08	0.016	0.07	0.009	—	—
17,500	1,003.8	0.09	0.017	0.07	0.009	—	—
18,000	1,032.5	0.09	0.018	0.07	0.010	—	—
18,500	1,061.2	0.09	0.019	0.07	0.010	—	—
19,000	1,089.9	0.09	0.020	0.07	0.011	—	—
19,500	1,118.5	0.10	0.021	0.08	0.011	—	—
20,000	1,147.2	0.10	0.022	0.08	0.012	—	—
20,500	1,175.9	0.10	0.023	0.08	0.012	—	—
21,000	1,204.6	0.10	0.024	0.08	0.013	—	—
21,500	1,233.3	0.11	0.025	0.08	0.013	—	—
22,000	1,262.0	0.11	0.026	0.09	0.014	—	—
22,500	1,290.6	0.11	0.027	0.09	0.014	—	—
23,000	1,319.3	0.11	0.028	0.09	0.015	—	—
23,500	1,348.0	0.12	0.029	0.09	0.016	—	—
24,000	1,376.7	0.12	0.030	0.09	0.016	—	—
24,500	1,405.4	0.12	0.031	0.09	0.017	—	—
25,000	1,434.0	0.12	0.032	0.10	0.017	—	—
25,500	1,462.7	0.13	0.033	0.10	0.018	—	—
26,000	1,491.4	0.13	0.034	0.10	0.019	—	—
26,500	1,520.1	0.13	0.035	0.10	0.019	—	—
27,000	1,548.8	0.13	0.037	0.10	0.020	0.05	0.004
27,500	1,577.4	0.14	0.038	0.11	0.021	0.05	0.004
28,000	1,606.1	0.14	0.039	0.11	0.021	0.05	0.004
28,500	1,634.8	0.14	0.040	0.11	0.022	0.05	0.004
29,000	1,663.5	0.14	0.041	0.11	0.023	0.05	0.004
29,500	1,692.2	0.15	0.043	0.11	0.023	0.06	0.004
30,000	1,720.8	0.15	0.044	0.12	0.024	0.06	0.004
32,500	1,864.2	0.16	0.051	0.13	0.028	0.06	0.005
35,000	2,007.6	0.17	0.058	0.14	0.031	0.07	0.006
37,500	2,151.1	0.19	0.065	0.14	0.035	0.07	0.006
40,000	2,294.5	0.20	0.073	0.15	0.040	0.07	0.007
42,500	2,437.9	0.21	0.081	0.16	0.044	0.08	0.008
45,000	2,581.3	0.22	0.090	0.17	0.049	0.08	0.009
47,500	2,724.7	0.24	0.099	0.18	0.054	0.09	0.010
50,000	2,868.1	0.25	0.108	0.19	0.059	0.09	0.010
52,500	3,011.5	0.26	0.118	0.20	0.064	0.10	0.011
55,000	3,154.9	0.27	0.128	0.21	0.070	0.10	0.012
57,500	3,298.3	0.29	0.139	0.22	0.075	0.11	0.013

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
60,000	3,441.7	0.30	0.150	0.23	0.081	0.11	0.014
62,500	3,585.1	0.31	0.161	0.24	0.087	0.12	0.016
65,000	3,728.5	0.32	0.173	0.25	0.094	0.12	0.017
67,500	3,871.9	0.34	0.185	0.26	0.100	0.13	0.018
70,000	4,015.3	0.35	0.197	0.27	0.107	0.13	0.019
72,500	4,158.7	0.36	0.210	0.28	0.114	0.14	0.020
75,000	4,302.1	0.37	0.223	0.29	0.121	0.14	0.021
77,500	4,445.5	0.39	0.236	0.30	0.128	0.15	0.023
80,000	4,588.9	0.40	0.250	0.31	0.135	0.15	0.024
82,500	4,732.3	0.41	0.264	0.32	0.143	0.15	0.025
85,000	4,875.7	0.42	0.279	0.33	0.151	0.16	0.027
87,500	5,019.1	0.44	0.293	0.34	0.159	0.16	0.028
90,000	5,162.5	0.45	0.308	0.35	0.167	0.17	0.030
92,500	5,305.9	0.46	0.324	0.36	0.175	0.17	0.031
95,000	5,449.3	0.47	0.340	0.37	0.184	0.18	0.033
97,500	5,592.7	0.49	0.356	0.38	0.193	0.18	0.034
100,000	5,736.1	0.50	0.372	0.39	0.201	0.19	0.036
105,000	6,022.9	0.52	0.406	0.41	0.220	0.20	0.039
110,000	6,309.8	0.55	0.442	0.43	0.239	0.21	0.042
115,000	6,596.6	0.57	0.478	0.44	0.259	0.22	0.046
120,000	6,883.4	0.60	0.516	0.46	0.279	0.22	0.049
125,000	7,170.2	0.62	0.555	0.48	0.300	0.23	0.053
130,000	7,457.0	0.65	0.596	0.50	0.322	0.24	0.057
135,000	7,743.8	0.67	0.638	0.52	0.344	0.25	0.061
140,000	8,030.6	0.70	0.681	0.54	0.368	0.26	0.065
145,000	8,317.4	0.72	0.725	0.56	0.392	0.27	0.069
150,000	8,604.2	0.75	0.770	0.58	0.416	0.28	0.073
155,000	8,891.0	0.77	0.817	0.60	0.441	0.29	0.078
160,000	9,177.8	0.80	0.865	0.62	0.467	0.30	0.082
165,000	9,464.6	0.82	0.915	0.64	0.494	0.31	0.087
170,000	9,751.4	0.85	0.965	0.66	0.521	0.32	0.092
175,000	10,038.2	0.87	1.017	0.68	0.549	0.33	0.097
180,000	10,325.0	0.90	1.070	0.70	0.577	0.34	0.102
185,000	10,611.9	0.92	1.124	0.72	0.607	0.35	0.107
190,000	10,898.7	0.95	1.179	0.73	0.636	0.36	0.112
195,000	11,185.5	0.97	1.236	0.75	0.667	0.37	0.117
200,000	11,472.3	1.00	1.294	0.77	0.698	0.37	0.123
205,000	11,759.1	1.02	1.352	0.79	0.730	0.38	0.128
210,000	12,045.9	1.05	1.413	0.81	0.762	0.39	0.134

d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
215,000	12,332.7	1.07	1.474	0.83	0.795	0.40	0.140
220,000	12,619.5	1.10	1.536	0.85	0.829	0.41	0.146
225,000	12,906.3	1.12	1.600	0.87	0.863	0.42	0.151
230,000	13,193.1	1.15	1.665	0.89	0.898	0.43	0.158
235,000	13,479.9	1.17	1.731	0.91	0.933	0.44	0.164
240,000	13,766.7	1.20	1.798	0.93	0.969	0.45	0.170
245,000	14,053.5	1.22	1.867	0.95	1.006	0.46	0.177
250,000	14,340.3	1.25	1.936	0.97	1.044	0.47	0.183
255,000	14,627.2	1.27	2.007	0.99	1.082	0.48	0.190
260,000	14,914.0	1.30	2.079	1.01	1.120	0.49	0.196
265,000	15,200.8	1.32	2.152	1.02	1.160	0.50	0.203
270,000	15,487.6	1.35	2.226	1.04	1.199	0.51	0.210
275,000	15,774.4	1.37	2.301	1.06	1.240	0.52	0.217
280,000	16,061.2	1.40	2.377	1.08	1.281	0.52	0.224
285,000	16,348.0	1.42	2.455	1.10	1.323	0.53	0.232
290,000	16,634.8	1.45	2.534	1.12	1.365	0.54	0.239
295,000	16,921.6	1.47	2.613	1.14	1.408	0.55	0.246
300,000	17,208.4	1.50	2.694	1.16	1.451	0.56	0.254
310,000	17,782.0	1.55	2.859	1.20	1.540	0.58	0.269
320,000	18,355.6	1.60	3.029	1.24	1.631	0.60	0.285
330,000	18,929.3	1.65	3.203	1.28	1.725	0.62	0.302
340,000	19,502.9	1.70	3.382	1.31	1.821	0.64	0.318
350,000	20,076.5	1.75	3.565	1.35	1.919	0.66	0.335
360,000	20,650.1	1.80	3.752	1.39	2.020	0.67	0.353
370,000	21,223.7	1.85	3.944	1.43	2.123	0.69	0.371
380,000	21,797.3	1.90	4.140	1.47	2.228	0.71	0.389
390,000	22,370.9	1.95	4.341	1.51	2.336	0.73	0.408
400,000	22,944.6	2.00	4.546	1.55	2.446	0.75	0.427
410,000	23,518.2	—	—	1.59	2.558	0.77	0.446
420,000	24,091.8	—	—	1.62	2.672	0.79	0.466
430,000	24,665.4	—	—	1.66	2.789	0.81	0.486
440,000	25,239.0	—	—	1.70	2.908	0.82	0.507
450,000	25,812.6	—	—	1.74	3.030	0.84	0.528
460,000	26,386.2	—	—	1.78	3.153	0.86	0.549
470,000	26,959.8	—	—	1.82	3.279	0.88	0.571
480,000	27,533.5	—	—	1.86	3.408	0.90	0.593
490,000	28,107.1	—	—	1.89	3.538	0.92	0.616
500,000	28,680.7	—	—	1.93	3.671	0.94	0.639
550,000	31,548.8	—	—	—	—	1.03	0.760

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
600,000	34,416.8	—	—	—	—	1.12	0.889
650,000	37,284.9	—	—	—	—	1.22	1.029
700,000	40,153.0	—	—	—	—	1.31	1.177
750,000	43,021.0	—	—	—	—	1.41	1.334
800,000	45,889.1	—	—	—	—	1.50	1.501
850,000	48,757.2	—	—	—	—	1.59	1.676
900,000	51,625.2	—	—	—	—	1.69	1.860
950,000	54,493.3	—	—	—	—	1.78	2.053
1,000,000	57,361.4	—	—	—	—	1.87	2.255
1,050,000	60,229.4	—	—	—	—	1.97	2.465

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4.4 Heating, inlet flow 45 °C / return flow 35 °C

Medium:	Water
Inlet flow temperature:	45 °C
Return temperature:	35 °C
Range:	10 K
Average temperature:	40 °C
Density:	992.2 kg/m ³
Viscosity:	0.0006533 Pa•s
Specific thermal capacity:	4,182 J/(kg•K)
Surface roughness:	0.0015 mm

Table 17: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 45 °C / return flow 35 °C, d12–28 mm

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
200	17.2	0.05	0.094	–	–	–	–	–	–
300	25.8	0.08	0.141	–	–	–	–	–	–
400	34.4	0.11	0.189	0.07	0.075	–	–	–	–
500	43.0	0.13	0.236	0.08	0.094	–	–	–	–
600	51.6	0.16	0.523	0.10	0.113	–	–	–	–
700	60.3	0.18	0.679	0.12	0.230	0.05	0.027	–	–
800	68.9	0.21	0.852	0.13	0.289	0.06	0.031	–	–
900	77.5	0.24	1.042	0.15	0.352	0.07	0.035	–	–
1,000	86.1	0.26	1.247	0.17	0.421	0.08	0.066	–	–
1,100	94.7	0.29	1.468	0.18	0.495	0.08	0.077	–	–
1,200	103.3	0.32	1.704	0.20	0.575	0.09	0.089	0.05	0.016
1,300	111.9	0.34	1.956	0.22	0.659	0.10	0.102	0.06	0.030
1,400	120.5	0.37	2.222	0.23	0.748	0.11	0.116	0.06	0.034
1,500	129.1	0.39	2.502	0.25	0.842	0.11	0.131	0.07	0.039
1,600	137.7	0.42	2.797	0.27	0.941	0.12	0.146	0.07	0.043
1,700	146.3	0.45	3.106	0.28	1.044	0.13	0.162	0.08	0.048
1,800	154.9	0.47	3.429	0.30	1.152	0.14	0.178	0.08	0.052
1,900	163.6	0.50	3.765	0.32	1.264	0.14	0.195	0.08	0.057
2,000	172.2	0.53	4.116	0.33	1.381	0.15	0.213	0.09	0.063
2,500	215.2	0.66	6.066	0.41	2.032	0.19	0.313	0.11	0.092
3,000	258.2	0.79	8.340	0.50	2.789	0.23	0.428	0.13	0.125
3,500	301.3	0.92	10.925	0.58	3.649	0.26	0.559	0.16	0.163
4,000	344.3	1.05	13.813	0.66	4.608	0.30	0.704	0.18	0.206
4,500	387.4	1.18	16.995	0.75	5.664	0.34	0.864	0.20	0.252
5,000	430.4	1.32	20.467	0.83	6.814	0.38	1.038	0.22	0.303
5,500	473.5	1.45	24.222	0.91	8.057	0.41	1.226	0.25	0.357
6,000	516.5	1.58	28.256	1.00	9.391	0.45	1.427	0.27	0.415
6,500	559.5	1.71	32.566	1.08	10.815	0.49	1.642	0.29	0.477
7,000	602.6	1.84	37.147	1.16	12.328	0.53	1.870	0.31	0.543

d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
7,500	645.6	1.97	41.995	1.24	13.927	0.56	2.110	0.34	0.613
8,000	688.7	—	—	1.33	15.613	0.60	2.363	0.36	0.686
8,500	731.7	—	—	1.41	17.384	0.64	2.629	0.38	0.763
9,000	774.7	—	—	1.49	19.240	0.68	2.907	0.40	0.843
9,500	817.8	—	—	1.58	21.180	0.71	3.198	0.42	0.927
10,000	860.8	—	—	1.66	23.202	0.75	3.500	0.45	1.014
10,500	903.9	—	—	1.74	25.306	0.79	3.815	0.47	1.104
11,000	946.9	—	—	1.82	27.493	0.83	4.142	0.49	1.199
11,500	990.0	—	—	1.91	29.760	0.86	4.480	0.51	1.296
12,000	1,033.0	—	—	1.99	32.107	0.90	4.830	0.54	1.397
12,500	1,076.0	—	—	—	—	0.94	5.192	0.56	1.501
13,000	1,119.1	—	—	—	—	0.98	5.566	0.58	1.608
13,500	1,162.1	—	—	—	—	1.02	5.951	0.60	1.719
14,000	1,205.2	—	—	—	—	1.05	6.347	0.63	1.833
14,500	1,248.2	—	—	—	—	1.09	6.755	0.65	1.950
15,000	1,291.2	—	—	—	—	1.13	7.174	0.67	2.070
15,500	1,334.3	—	—	—	—	1.17	7.604	0.69	2.194
16,000	1,377.3	—	—	—	—	1.20	8.045	0.72	2.320
16,500	1,420.4	—	—	—	—	1.24	8.498	0.74	2.450
17,000	1,463.4	—	—	—	—	1.28	8.961	0.76	2.583
17,500	1,506.5	—	—	—	—	1.32	9.436	0.78	2.719
18,000	1,549.5	—	—	—	—	1.35	9.921	0.80	2.858
18,500	1,592.5	—	—	—	—	1.39	10.417	0.83	3.000
19,000	1,635.6	—	—	—	—	1.43	10.924	0.85	3.146
19,500	1,678.6	—	—	—	—	1.47	11.442	0.87	3.294
20,000	1,721.7	—	—	—	—	1.50	11.971	0.89	3.445
20,500	1,764.7	—	—	—	—	1.54	12.510	0.92	3.600
21,000	1,807.7	—	—	—	—	1.58	13.060	0.94	3.757
21,500	1,850.8	—	—	—	—	1.62	13.620	0.96	3.918
22,000	1,893.8	—	—	—	—	1.65	14.191	0.98	4.081
22,500	1,936.9	—	—	—	—	1.69	14.773	1.01	4.247
23,000	1,979.9	—	—	—	—	1.73	15.365	1.03	4.417
23,500	2,023.0	—	—	—	—	1.77	15.968	1.05	4.589
24,000	2,066.0	—	—	—	—	1.80	16.581	1.07	4.764
24,500	2,109.0	—	—	—	—	1.84	17.204	1.10	4.942
25,000	2,152.1	—	—	—	—	1.88	17.838	1.12	5.123
25,500	2,195.1	—	—	—	—	1.92	18.482	1.14	5.307
26,000	2,238.2	—	—	—	—	1.96	19.136	1.16	5.494
26,500	2,281.2	—	—	—	—	1.99	19.801	1.18	5.684

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d [mm]		12		15		22		28	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
27,000	2,324.2	—	—	—	—	—	—	1.21	5.876
27,500	2,367.3	—	—	—	—	—	—	1.23	6.072
28,000	2,410.3	—	—	—	—	—	—	1.25	6.270
28,500	2,453.4	—	—	—	—	—	—	1.27	6.471
29,000	2,496.4	—	—	—	—	—	—	1.30	6.675
29,500	2,539.5	—	—	—	—	—	—	1.32	6.882
30,000	2,582.5	—	—	—	—	—	—	1.34	7.092
32,500	2,797.7	—	—	—	—	—	—	1.45	8.183
35,000	3,012.9	—	—	—	—	—	—	1.56	9.343
37,500	3,228.1	—	—	—	—	—	—	1.68	10.572
40,000	3,443.3	—	—	—	—	—	—	1.79	11.870
42,500	3,658.5	—	—	—	—	—	—	1.90	13.234

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Table 18: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 45 °C / return flow 35 °C, d35-54 mm

d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,800	154.9	0.05	0.019	—	—	—	—
1,900	163.6	0.05	0.021	—	—	—	—
2,000	172.2	0.06	0.022	—	—	—	—
2,500	215.2	0.07	0.033	—	—	—	—
3,000	258.2	0.09	0.045	0.06	0.018	—	—
3,500	301.3	0.10	0.058	0.07	0.023	—	—
4,000	344.3	0.12	0.073	0.08	0.029	—	—
4,500	387.4	0.13	0.090	0.09	0.036	0.05	0.010
5,000	430.4	0.14	0.108	0.10	0.043	0.06	0.012
5,500	473.5	0.16	0.127	0.11	0.051	0.06	0.015
6,000	516.5	0.17	0.147	0.12	0.059	0.07	0.017
6,500	559.5	0.19	0.169	0.13	0.067	0.07	0.019
7,000	602.6	0.20	0.193	0.14	0.077	0.08	0.022
7,500	645.6	0.22	0.217	0.15	0.086	0.09	0.025
8,000	688.7	0.23	0.243	0.16	0.097	0.09	0.028
8,500	731.7	0.25	0.270	0.17	0.107	0.10	0.031
9,000	774.7	0.26	0.298	0.18	0.119	0.10	0.034
9,500	817.8	0.27	0.328	0.19	0.130	0.11	0.037
10,000	860.8	0.29	0.359	0.20	0.142	0.12	0.041
10,500	903.9	0.30	0.391	0.21	0.155	0.12	0.044
11,000	946.9	0.32	0.424	0.22	0.168	0.13	0.048
11,500	990.0	0.33	0.458	0.23	0.182	0.13	0.052

d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
12,000	1,033.0	0.35	0.493	0.23	0.196	0.14	0.056
12,500	1,076.0	0.36	0.530	0.24	0.210	0.14	0.060
13,000	1,119.1	0.38	0.568	0.25	0.225	0.15	0.064
13,500	1,162.1	0.39	0.607	0.26	0.241	0.16	0.068
14,000	1,205.2	0.40	0.647	0.27	0.256	0.16	0.073
14,500	1,248.2	0.42	0.688	0.28	0.273	0.17	0.078
15,000	1,291.2	0.43	0.730	0.29	0.289	0.17	0.082
15,500	1,334.3	0.45	0.774	0.30	0.306	0.18	0.087
16,000	1,377.3	0.46	0.818	0.31	0.324	0.18	0.092
16,500	1,420.4	0.48	0.864	0.32	0.342	0.19	0.097
17,000	1,463.4	0.49	0.910	0.33	0.360	0.20	0.102
17,500	1,506.5	0.51	0.958	0.34	0.379	0.20	0.108
18,000	1,549.5	0.52	1.007	0.35	0.398	0.21	0.113
18,500	1,592.5	0.53	1.057	0.36	0.418	0.21	0.119
19,000	1,635.6	0.55	1.108	0.37	0.438	0.22	0.124
19,500	1,678.6	0.56	1.160	0.38	0.459	0.22	0.130
20,000	1,721.7	0.58	1.213	0.39	0.480	0.23	0.136
20,500	1,764.7	0.59	1.267	0.40	0.501	0.24	0.142
21,000	1,807.7	0.61	1.322	0.41	0.523	0.24	0.148
21,500	1,850.8	0.62	1.378	0.42	0.545	0.25	0.154
22,000	1,893.8	0.64	1.436	0.43	0.567	0.25	0.161
22,500	1,936.9	0.65	1.494	0.44	0.590	0.26	0.167
23,000	1,979.9	0.66	1.553	0.45	0.614	0.27	0.174
23,500	2,023.0	0.68	1.613	0.46	0.637	0.27	0.181
24,000	2,066.0	0.69	1.675	0.47	0.662	0.28	0.187
24,500	2,109.0	0.71	1.737	0.48	0.686	0.28	0.194
25,000	2,152.1	0.72	1.800	0.49	0.711	0.29	0.201
25,500	2,195.1	0.74	1.865	0.50	0.736	0.29	0.208
26,000	2,238.2	0.75	1.930	0.51	0.762	0.30	0.216
26,500	2,281.2	0.77	1.997	0.52	0.788	0.31	0.223
27,000	2,324.2	0.78	2.064	0.53	0.815	0.31	0.231
27,500	2,367.3	0.79	2.132	0.54	0.842	0.32	0.238
28,000	2,410.3	0.81	2.202	0.55	0.869	0.32	0.246
28,500	2,453.4	0.82	2.272	0.56	0.897	0.33	0.254
29,000	2,496.4	0.84	2.343	0.57	0.925	0.33	0.262
29,500	2,539.5	0.85	2.416	0.58	0.953	0.34	0.270
30,000	2,582.5	0.87	2.489	0.59	0.982	0.35	0.278
32,500	2,797.7	0.94	2.870	0.64	1.132	0.37	0.320
35,000	3,012.9	1.01	3.275	0.68	1.291	0.40	0.365

d [mm]		35		42		54	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
37,500	3,228.1	1.08	3.704	0.73	1.459	0.43	0.412
40,000	3,443.3	1.15	4.157	0.78	1.637	0.46	0.462
42,500	3,658.5	1.23	4.633	0.83	1.824	0.49	0.514
45,000	3,873.7	1.30	5.131	0.88	2.019	0.52	0.569
47,500	4,089.0	1.37	5.653	0.93	2.224	0.55	0.626
50,000	4,304.2	1.44	6.197	0.98	2.437	0.58	0.686
52,500	4,519.4	1.52	6.764	1.03	2.659	0.61	0.748
55,000	4,734.6	1.59	7.353	1.08	2.890	0.63	0.813
57,500	4,949.8	1.66	7.964	1.13	3.129	0.66	0.880
60,000	5,165.0	1.73	8.597	1.17	3.377	0.69	0.949
62,500	5,380.2	1.80	9.251	1.22	3.633	0.72	1.021
65,000	5,595.4	1.88	9.928	1.27	3.897	0.75	1.095
67,500	5,810.6	1.95	10.626	1.32	4.170	0.78	1.171
70,000	6,025.8	—	—	1.37	4.452	0.81	1.250
72,500	6,241.0	—	—	1.42	4.741	0.84	1.331
75,000	6,456.2	—	—	1.47	5.039	0.86	1.414
77,500	6,671.4	—	—	1.52	5.345	0.89	1.500
80,000	6,886.7	—	—	1.57	5.658	0.92	1.587
82,500	7,101.9	—	—	1.61	5.980	0.95	1.677
85,000	7,317.1	—	—	1.66	6.311	0.98	1.769
87,500	7,532.3	—	—	1.71	6.649	1.01	1.864
90,000	7,747.5	—	—	1.76	6.995	1.04	1.960
92,500	7,962.7	—	—	1.81	7.349	1.07	2.059
95,000	8,177.9	—	—	1.86	7.711	1.09	2.160
97,500	8,393.1	—	—	1.91	8.080	1.12	2.263
100,000	8,608.3	—	—	1.96	8.458	1.15	2.368
105,000	9,038.7	—	—	—	—	1.21	2.585
110,000	9,469.2	—	—	—	—	1.27	2.810
115,000	9,899.6	—	—	—	—	1.33	3.044
120,000	10,330.0	—	—	—	—	1.38	3.286
125,000	10,760.4	—	—	—	—	1.44	3.537
130,000	11,190.8	—	—	—	—	1.50	3.796
135,000	11,621.2	—	—	—	—	1.56	4.063
140,000	12,051.6	—	—	—	—	1.61	4.339
145,000	12,482.1	—	—	—	—	1.67	4.622
150,000	12,912.5	—	—	—	—	1.73	4.914
155,000	13,342.9	—	—	—	—	1.79	5.214
160,000	13,773.3	—	—	—	—	1.84	5.521
165,000	14,203.7	—	—	—	—	1.90	5.837

d [mm]		35		42		54	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
170,000	14,634.1	—	—	—	—	1.96	6.161

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Table 19: Pressure loss for copper pipes in accordance with BS EN 1057, heating, inlet flow 45 °C / return flow 35 °C, d66.7–108 mm

d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
7,000	602.6	0.05	0.008	—	—	—	—
7,500	645.6	0.06	0.009	—	—	—	—
8,000	688.7	0.06	0.010	—	—	—	—
8,500	731.7	0.06	0.011	—	—	—	—
9,000	774.7	0.07	0.012	0.05	0.007	—	—
9,500	817.8	0.07	0.013	0.05	0.007	—	—
10,000	860.8	0.07	0.014	0.06	0.008	—	—
10,500	903.9	0.08	0.016	0.06	0.009	—	—
11,000	946.9	0.08	0.017	0.06	0.009	—	—
11,500	990.0	0.09	0.018	0.07	0.010	—	—
12,000	1,033.0	0.09	0.020	0.07	0.011	—	—
12,500	1,076.0	0.09	0.021	0.07	0.012	—	—
13,000	1,119.1	0.10	0.023	0.07	0.012	—	—
13,500	1,162.1	0.10	0.024	0.08	0.013	—	—
14,000	1,205.2	0.10	0.026	0.08	0.014	—	—
14,500	1,248.2	0.11	0.027	0.08	0.015	—	—
15,000	1,291.2	0.11	0.029	0.09	0.016	—	—
15,500	1,334.3	0.12	0.031	0.09	0.017	—	—
16,000	1,377.3	0.12	0.032	0.09	0.018	—	—
16,500	1,420.4	0.12	0.034	0.09	0.019	—	—
17,000	1,463.4	0.13	0.036	0.10	0.020	—	—
17,500	1,506.5	0.13	0.038	0.10	0.021	—	—
18,000	1,549.5	0.13	0.040	0.10	0.022	0.05	0.004
18,500	1,592.5	0.14	0.042	0.11	0.023	0.05	0.004
19,000	1,635.6	0.14	0.044	0.11	0.024	0.05	0.004
19,500	1,678.6	0.14	0.046	0.11	0.025	0.05	0.004
20,000	1,721.7	0.15	0.048	0.11	0.026	0.06	0.005
20,500	1,764.7	0.15	0.050	0.12	0.027	0.06	0.005
21,000	1,807.7	0.16	0.052	0.12	0.028	0.06	0.005
21,500	1,850.8	0.16	0.054	0.12	0.030	0.06	0.005
22,000	1,893.8	0.16	0.056	0.13	0.031	0.06	0.006
22,500	1,936.9	0.17	0.059	0.13	0.032	0.06	0.006
23,000	1,979.9	0.17	0.061	0.13	0.033	0.06	0.006

d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
23,500	2,023.0	0.17	0.063	0.13	0.034	0.07	0.006
24,000	2,066.0	0.18	0.066	0.14	0.036	0.07	0.006
24,500	2,109.0	0.18	0.068	0.14	0.037	0.07	0.007
25,000	2,152.1	0.19	0.071	0.14	0.038	0.07	0.007
25,500	2,195.1	0.19	0.073	0.15	0.040	0.07	0.007
26,000	2,238.2	0.19	0.076	0.15	0.041	0.07	0.007
26,500	2,281.2	0.20	0.078	0.15	0.043	0.07	0.008
27,000	2,324.2	0.20	0.081	0.16	0.044	0.08	0.008
27,500	2,367.3	0.20	0.084	0.16	0.045	0.08	0.008
28,000	2,410.3	0.21	0.086	0.16	0.047	0.08	0.008
28,500	2,453.4	0.21	0.089	0.16	0.048	0.08	0.009
29,000	2,496.4	0.22	0.092	0.17	0.050	0.08	0.009
29,500	2,539.5	0.22	0.094	0.17	0.051	0.08	0.009
30,000	2,582.5	0.22	0.097	0.17	0.053	0.08	0.009
32,500	2,797.7	0.24	0.112	0.19	0.061	0.09	0.011
35,000	3,012.9	0.26	0.128	0.20	0.069	0.10	0.012
37,500	3,228.1	0.28	0.144	0.22	0.078	0.10	0.014
40,000	3,443.3	0.30	0.162	0.23	0.088	0.11	0.016
42,500	3,658.5	0.32	0.180	0.24	0.098	0.12	0.017
45,000	3,873.7	0.33	0.199	0.26	0.108	0.13	0.019
47,500	4,089.0	0.35	0.219	0.27	0.119	0.13	0.021
50,000	4,304.2	0.37	0.240	0.29	0.130	0.14	0.023
52,500	4,519.4	0.39	0.261	0.30	0.142	0.15	0.025
55,000	4,734.6	0.41	0.284	0.32	0.154	0.15	0.027
57,500	4,949.8	0.43	0.307	0.33	0.166	0.16	0.030
60,000	5,165.0	0.45	0.331	0.34	0.180	0.17	0.032
62,500	5,380.2	0.46	0.356	0.36	0.193	0.17	0.034
65,000	5,595.4	0.48	0.382	0.37	0.207	0.18	0.037
67,500	5,810.6	0.50	0.409	0.39	0.221	0.19	0.039
70,000	6,025.8	0.52	0.436	0.40	0.236	0.19	0.042
72,500	6,241.0	0.54	0.464	0.42	0.251	0.20	0.045
75,000	6,456.2	0.56	0.493	0.43	0.267	0.21	0.047
77,500	6,671.4	0.58	0.523	0.45	0.283	0.22	0.050
80,000	6,886.7	0.59	0.553	0.46	0.299	0.22	0.053
82,500	7,101.9	0.61	0.584	0.47	0.316	0.23	0.056
85,000	7,317.1	0.63	0.616	0.49	0.333	0.24	0.059
87,500	7,532.3	0.65	0.649	0.50	0.351	0.24	0.062
90,000	7,747.5	0.67	0.682	0.52	0.369	0.25	0.065
92,500	7,962.7	0.69	0.717	0.53	0.388	0.26	0.069

d [mm]		66.7		77.6		108	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
95,000	8,177.9	0.71	0.752	0.55	0.407	0.26	0.072
97,500	8,393.1	0.72	0.787	0.56	0.426	0.27	0.075
100,000	8,608.3	0.74	0.824	0.57	0.446	0.28	0.079
105,000	9,038.7	0.78	0.899	0.60	0.486	0.29	0.086
110,000	9,469.2	0.82	0.977	0.63	0.528	0.31	0.093
115,000	9,899.6	0.85	1.058	0.66	0.572	0.32	0.101
120,000	10,330.0	0.89	1.142	0.69	0.617	0.33	0.109
125,000	10,760.4	0.93	1.229	0.72	0.664	0.35	0.117
130,000	11,190.8	0.96	1.318	0.75	0.712	0.36	0.126
135,000	11,621.2	1.00	1.411	0.78	0.762	0.38	0.134
140,000	12,051.6	1.04	1.506	0.80	0.813	0.39	0.143
145,000	12,482.1	1.08	1.604	0.83	0.866	0.40	0.153
150,000	12,912.5	1.11	1.705	0.86	0.921	0.42	0.162
155,000	13,342.9	1.15	1.808	0.89	0.977	0.43	0.172
160,000	13,773.3	1.19	1.915	0.92	1.034	0.45	0.182
165,000	14,203.7	1.22	2.024	0.95	1.093	0.46	0.192
170,000	14,634.1	1.26	2.136	0.98	1.153	0.47	0.203
175,000	15,064.6	1.30	2.250	1.00	1.214	0.49	0.214
180,000	15,495.0	1.34	2.367	1.03	1.278	0.50	0.225
185,000	15,925.4	1.37	2.487	1.06	1.342	0.51	0.236
190,000	16,355.8	1.41	2.610	1.09	1.408	0.53	0.248
195,000	16,786.2	1.45	2.735	1.12	1.476	0.54	0.259
200,000	17,216.6	1.48	2.863	1.15	1.544	0.56	0.271
205,000	17,647.1	1.52	2.994	1.18	1.615	0.57	0.284
210,000	18,077.5	1.56	3.127	1.21	1.686	0.58	0.296
215,000	18,507.9	1.60	3.263	1.23	1.760	0.60	0.309
220,000	18,938.3	1.63	3.401	1.26	1.834	0.61	0.322
225,000	19,368.7	1.67	3.542	1.29	1.910	0.63	0.335
230,000	19,799.1	1.71	3.686	1.32	1.987	0.64	0.349
235,000	20,229.6	1.74	3.832	1.35	2.066	0.65	0.362
240,000	20,660.0	1.78	3.981	1.38	2.146	0.67	0.376
245,000	21,090.4	1.82	4.132	1.41	2.227	0.68	0.391
250,000	21,520.8	1.86	4.286	1.44	2.310	0.70	0.405
255,000	21,951.2	1.89	4.443	1.46	2.394	0.71	0.420
260,000	22,381.6	1.93	4.602	1.49	2.480	0.72	0.435
265,000	22,812.1	1.97	4.763	1.52	2.567	0.74	0.450
270,000	23,242.5	—	—	1.55	2.655	0.75	0.465
275,000	23,672.9	—	—	1.58	2.745	0.77	0.481
280,000	24,103.3	—	—	1.61	2.836	0.78	0.497

d [mm]		66.7		77.6		108	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
285,000	24,533.7	—	—	1.64	2.928	0.79	0.513
290,000	24,964.1	—	—	1.67	3.022	0.81	0.529
295,000	25,394.5	—	—	1.69	3.117	0.82	0.545
300,000	25,825.0	—	—	1.72	3.213	0.83	0.562
310,000	26,685.8	—	—	1.78	3.410	0.86	0.596
320,000	27,546.6	—	—	1.84	3.611	0.89	0.632
330,000	28,407.5	—	—	1.89	3.819	0.92	0.668
340,000	29,268.3	—	—	1.95	4.031	0.95	0.704
350,000	30,129.1	—	—	—	—	0.97	0.742
360,000	30,990.0	—	—	—	—	1.00	0.781
370,000	31,850.8	—	—	—	—	1.03	0.821
380,000	32,711.6	—	—	—	—	1.06	0.861
390,000	33,572.5	—	—	—	—	1.09	0.902
400,000	34,433.3	—	—	—	—	1.11	0.945
410,000	35,294.1	—	—	—	—	1.14	0.988
420,000	36,154.9	—	—	—	—	1.17	1.032
430,000	37,015.8	—	—	—	—	1.20	1.077
440,000	37,876.6	—	—	—	—	1.22	1.122
450,000	38,737.4	—	—	—	—	1.25	1.169
460,000	39,598.3	—	—	—	—	1.28	1.216
470,000	40,459.1	—	—	—	—	1.31	1.265
480,000	41,319.9	—	—	—	—	1.34	1.314
490,000	42,180.8	—	—	—	—	1.36	1.364
500,000	43,041.6	—	—	—	—	1.39	1.415
550,000	47,345.8	—	—	—	—	1.53	1.682
600,000	51,649.9	—	—	—	—	1.67	1.969
650,000	55,954.1	—	—	—	—	1.81	2.278
700,000	60,258.2	—	—	—	—	1.95	2.606

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5 Pressure loss, compressed air

5.1 Compressed air, 3 bar

Medium:	Compressed air
Overpressure:	3 bar
Absolute pressure:	4 bar
Temperature:	20 °C
Density:	4.771 kg/m ³
Viscosity:	0.0000182635 Pa•s
Surface roughness:	0.0015 mm

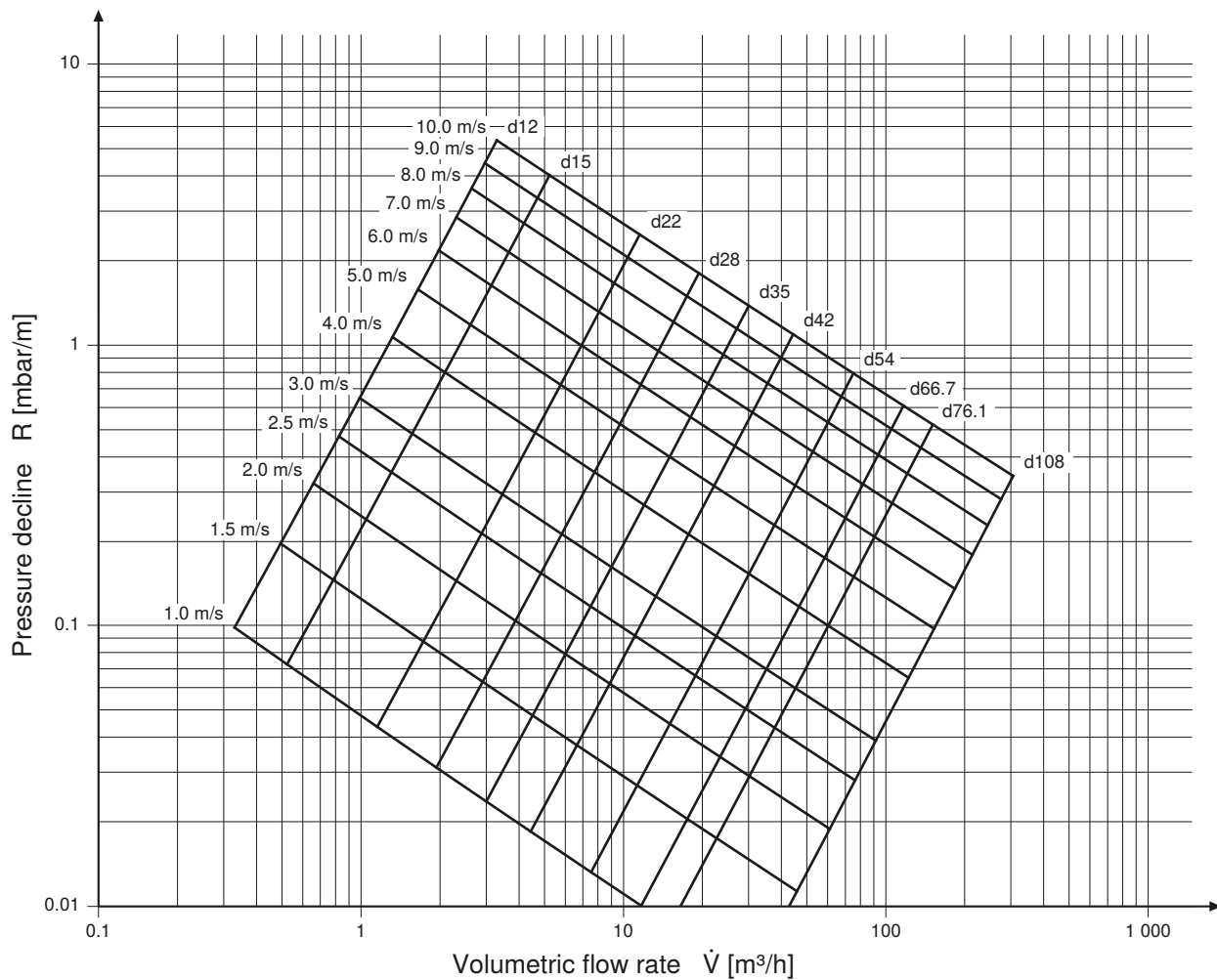


Table 20: Pressure loss for copper pipes in accordance with BS EN 1057, compressed air 3 bar, d12-35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.50	1.52	0.1997	0.96	0.0675	—	—	—	—	—	—
0.75	2.27	0.4005	1.43	0.1348	—	—	—	—	—	—
1.00	3.03	0.6588	1.91	0.2211	0.87	0.0342	—	—	—	—
1.25	3.79	0.9710	2.39	0.3253	1.08	0.0501	—	—	—	—
1.50	4.55	1.3349	2.87	0.4465	1.30	0.0686	—	—	—	—
1.75	5.31	1.7485	3.35	0.5840	1.52	0.0895	0.90	0.0262	—	—
2.00	6.06	2.2106	3.82	0.7375	1.73	0.1128	1.03	0.0329	—	—
2.25	6.82	2.7198	4.30	0.9064	1.95	0.1384	1.16	0.0404	—	—
2.50	7.58	3.2753	4.78	1.0905	2.17	0.1662	1.29	0.0484	—	—
2.75	8.34	3.8762	5.26	1.2894	2.38	0.1963	1.42	0.0571	0.92	0.0203
3.00	9.10	4.5216	5.74	1.5029	2.60	0.2285	1.55	0.0665	1.00	0.0236
3.25	9.85	5.2110	6.21	1.7307	2.82	0.2628	1.67	0.0764	1.08	0.0271
3.50	—	—	6.69	1.9727	3.03	0.2992	1.80	0.0869	1.16	0.0308
3.75	—	—	7.17	2.2287	3.25	0.3377	1.93	0.0981	1.25	0.0348
4.00	—	—	7.65	2.4984	3.47	0.3782	2.06	0.1098	1.33	0.0389
4.50	—	—	8.60	3.0787	3.90	0.4653	2.32	0.1349	1.50	0.0478
5.00	—	—	9.56	3.7126	4.33	0.5602	2.58	0.1622	1.66	0.0574
5.50	—	—	—	—	4.77	0.6628	2.83	0.1918	1.83	0.0678
6.00	—	—	—	—	5.20	0.7730	3.09	0.2235	2.00	0.0790
6.50	—	—	—	—	5.63	0.8906	3.35	0.2574	2.16	0.0909
7.00	—	—	—	—	6.07	1.0156	3.61	0.2933	2.33	0.1035
7.50	—	—	—	—	6.50	1.1479	3.86	0.3313	2.50	0.1169
8.00	—	—	—	—	6.93	1.2873	4.12	0.3713	2.66	0.1309
8.50	—	—	—	—	7.37	1.4339	4.38	0.4133	2.83	0.1457
9.00	—	—	—	—	7.80	1.5874	4.64	0.4574	3.00	0.1611
9.50	—	—	—	—	8.23	1.7479	4.89	0.5034	3.16	0.1773
10.00	—	—	—	—	8.67	1.9153	5.15	0.5513	3.33	0.1941
10.50	—	—	—	—	9.10	2.0896	5.41	0.6012	3.49	0.2116
11.00	—	—	—	—	9.53	2.2706	5.67	0.6530	3.66	0.2297
11.50	—	—	—	—	9.97	2.4584	5.93	0.7067	3.83	0.2485
12.00	—	—	—	—	—	—	6.18	0.7623	3.99	0.2680
12.50	—	—	—	—	—	—	6.44	0.8197	4.16	0.2881
13.00	—	—	—	—	—	—	6.70	0.8791	4.33	0.3089
13.50	—	—	—	—	—	—	6.96	0.9402	4.49	0.3303
14.00	—	—	—	—	—	—	7.21	1.0032	4.66	0.3523
14.50	—	—	—	—	—	—	7.47	1.0681	4.83	0.3750
15.00	—	—	—	—	—	—	7.73	1.1347	4.99	0.3983
16.00	—	—	—	—	—	—	8.24	1.2734	5.32	0.4467

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17.00	—	—	—	—	—	—	8.76	1.4192	5.66	0.4977
18.00	—	—	—	—	—	—	9.27	1.5722	5.99	0.5511
19.00	—	—	—	—	—	—	9.79	1.7321	6.32	0.6069
20.00	—	—	—	—	—	—	—	—	6.66	0.6651
21.00	—	—	—	—	—	—	—	—	6.99	0.7257
22.00	—	—	—	—	—	—	—	—	7.32	0.7886
23.00	—	—	—	—	—	—	—	—	7.65	0.8539
24.00	—	—	—	—	—	—	—	—	7.99	0.9215
25.00	—	—	—	—	—	—	—	—	8.32	0.9915
30.00	—	—	—	—	—	—	—	—	9.98	1.3753

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Table 21: Pressure loss for copper pipes in accordance with BS EN 1057, compressed air 3 bar, d42-108 mm

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
4.00	0.90	0.0155	—	—	—	—	—	—	—	—
4.50	1.01	0.0190	—	—	—	—	—	—	—	—
5.00	1.13	0.0228	—	—	—	—	—	—	—	—
5.50	1.24	0.0269	—	—	—	—	—	—	—	—
6.00	1.35	0.0313	—	—	—	—	—	—	—	—
6.50	1.47	0.0360	0.86	0.0103	—	—	—	—	—	—
7.00	1.58	0.0410	0.93	0.0117	—	—	—	—	—	—
7.50	1.69	0.0463	1.00	0.0132	—	—	—	—	—	—
8.00	1.80	0.0518	1.06	0.0147	—	—	—	—	—	—
8.50	1.92	0.0577	1.13	0.0164	—	—	—	—	—	—
9.00	2.03	0.0638	1.20	0.0181	—	—	—	—	—	—
9.50	2.14	0.0701	1.26	0.0199	—	—	—	—	—	—
10.00	2.26	0.0768	1.33	0.0218	0.86	0.0077	—	—	—	—
10.50	2.37	0.0837	1.39	0.0237	0.90	0.0083	—	—	—	—
11.00	2.48	0.0908	1.46	0.0257	0.94	0.0090	—	—	—	—
11.50	2.59	0.0982	1.53	0.0278	0.98	0.0098	—	—	—	—
12.00	2.71	0.1059	1.59	0.0300	1.03	0.0105	—	—	—	—
12.50	2.82	0.1138	1.66	0.0322	1.07	0.0113	—	—	—	—
13.00	2.93	0.1220	1.73	0.0345	1.11	0.0121	0.86	0.0066	—	—
13.50	3.04	0.1304	1.79	0.0369	1.15	0.0129	0.89	0.0070	—	—
14.00	3.16	0.1391	1.86	0.0393	1.20	0.0138	0.93	0.0075	—	—
14.50	3.27	0.1480	1.93	0.0419	1.24	0.0147	0.96	0.0080	—	—
15.00	3.38	0.1571	1.99	0.0444	1.28	0.0156	0.99	0.0085	—	—
16.00	3.61	0.1762	2.13	0.0498	1.37	0.0174	1.06	0.0095	—	—

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17.00	3.83	0.1962	2.26	0.0554	1.45	0.0194	1.13	0.0105	—	—
18.00	4.06	0.2172	2.39	0.0613	1.54	0.0215	1.19	0.0117	—	—
19.00	4.29	0.2391	2.52	0.0675	1.63	0.0236	1.26	0.0128	—	—
20.00	4.51	0.2619	2.66	0.0739	1.71	0.0259	1.32	0.0140	—	—
21.00	4.74	0.2857	2.79	0.0806	1.80	0.0282	1.39	0.0153	—	—
22.00	4.96	0.3104	2.92	0.0875	1.88	0.0306	1.46	0.0166	—	—
23.00	5.19	0.3360	3.06	0.0947	1.97	0.0331	1.52	0.0180	—	—
24.00	5.41	0.3625	3.19	0.1021	2.05	0.0357	1.59	0.0194	—	—
25.00	5.64	0.3899	3.32	0.1098	2.14	0.0384	1.65	0.0208	—	—
30.00	6.77	0.5402	3.99	0.1519	2.57	0.0530	1.99	0.0287	0.98	0.0053
35.00	7.89	0.7122	4.65	0.2000	2.99	0.0697	2.32	0.0378	1.14	0.0070
40.00	9.02	0.9053	5.31	0.2539	3.42	0.0885	2.65	0.0479	1.31	0.0089
45.00	—	—	5.98	0.3136	3.85	0.1092	2.98	0.0591	1.47	0.0109
50.00	—	—	6.64	0.3788	4.28	0.1318	3.31	0.0713	1.63	0.0132
55.00	—	—	7.31	0.4496	4.70	0.1563	3.64	0.0845	1.80	0.0156
60.00	—	—	7.97	0.5258	5.13	0.1827	3.97	0.0987	1.96	0.0183
65.00	—	—	8.63	0.6073	5.56	0.2109	4.30	0.1140	2.13	0.0210
70.00	—	—	9.30	0.6941	5.99	0.2409	4.63	0.1301	2.29	0.0240
75.00	—	—	9.96	0.7861	6.42	0.2727	4.96	0.1473	2.45	0.0272
80.00	—	—	—	—	6.84	0.3063	5.29	0.1654	2.62	0.0305
85.00	—	—	—	—	7.27	0.3417	5.63	0.1844	2.78	0.0340
90.00	—	—	—	—	7.70	0.3787	5.96	0.2044	2.94	0.0376
95.00	—	—	—	—	8.13	0.4175	6.29	0.2253	3.11	0.0415
100.00	—	—	—	—	8.55	0.4580	6.62	0.2471	3.27	0.0455
105.00	—	—	—	—	8.98	0.5002	6.95	0.2698	3.43	0.0496
110.00	—	—	—	—	9.41	0.5441	7.28	0.2934	3.60	0.0539
115.00	—	—	—	—	9.84	0.5896	7.61	0.3179	3.76	0.0584
120.00	—	—	—	—	—	—	7.94	0.3433	3.92	0.0630
125.00	—	—	—	—	—	—	8.27	0.3696	4.09	0.0678
130.00	—	—	—	—	—	—	8.60	0.3967	4.25	0.0728
135.00	—	—	—	—	—	—	8.94	0.4247	4.41	0.0779
140.00	—	—	—	—	—	—	9.27	0.4536	4.58	0.0832
145.00	—	—	—	—	—	—	9.60	0.4833	4.74	0.0886
150.00	—	—	—	—	—	—	9.93	0.5139	4.90	0.0942
155.00	—	—	—	—	—	—	—	—	5.07	0.0999
160.00	—	—	—	—	—	—	—	—	5.23	0.1058
165.00	—	—	—	—	—	—	—	—	5.40	0.1118
170.00	—	—	—	—	—	—	—	—	5.56	0.1180
175.00	—	—	—	—	—	—	—	—	5.72	0.1243

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
180.00	—	—	—	—	—	—	—	—	5.89	0.1308
185.00	—	—	—	—	—	—	—	—	6.05	0.1375
190.00	—	—	—	—	—	—	—	—	6.21	0.1442
195.00	—	—	—	—	—	—	—	—	6.38	0.1512
200.00	—	—	—	—	—	—	—	—	6.54	0.1582
205.00	—	—	—	—	—	—	—	—	6.70	0.1655
210.00	—	—	—	—	—	—	—	—	6.87	0.1728
215.00	—	—	—	—	—	—	—	—	7.03	0.1804
220.00	—	—	—	—	—	—	—	—	7.19	0.1880
225.00	—	—	—	—	—	—	—	—	7.36	0.1958
230.00	—	—	—	—	—	—	—	—	7.52	0.2038
235.00	—	—	—	—	—	—	—	—	7.68	0.2119
240.00	—	—	—	—	—	—	—	—	7.85	0.2201
245.00	—	—	—	—	—	—	—	—	8.01	0.2285
250.00	—	—	—	—	—	—	—	—	8.17	0.2370
255.00	—	—	—	—	—	—	—	—	8.34	0.2456
260.00	—	—	—	—	—	—	—	—	8.50	0.2544
265.00	—	—	—	—	—	—	—	—	8.67	0.2634
270.00	—	—	—	—	—	—	—	—	8.83	0.2725
275.00	—	—	—	—	—	—	—	—	8.99	0.2817
280.00	—	—	—	—	—	—	—	—	9.16	0.2911
285.00	—	—	—	—	—	—	—	—	9.32	0.3006
290.00	—	—	—	—	—	—	—	—	9.48	0.3102
295.00	—	—	—	—	—	—	—	—	9.65	0.3200
300.00	—	—	—	—	—	—	—	—	9.81	0.3299

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5.2 Compressed air, 6 bar

Medium:	Compressed air
Overpressure:	6 bar
Absolute pressure:	7 bar
Temperature:	20 °C
Density:	8.352 kg/m ³
Viscosity:	0.000018302 Pa·s
Surface roughness:	0.0015 mm

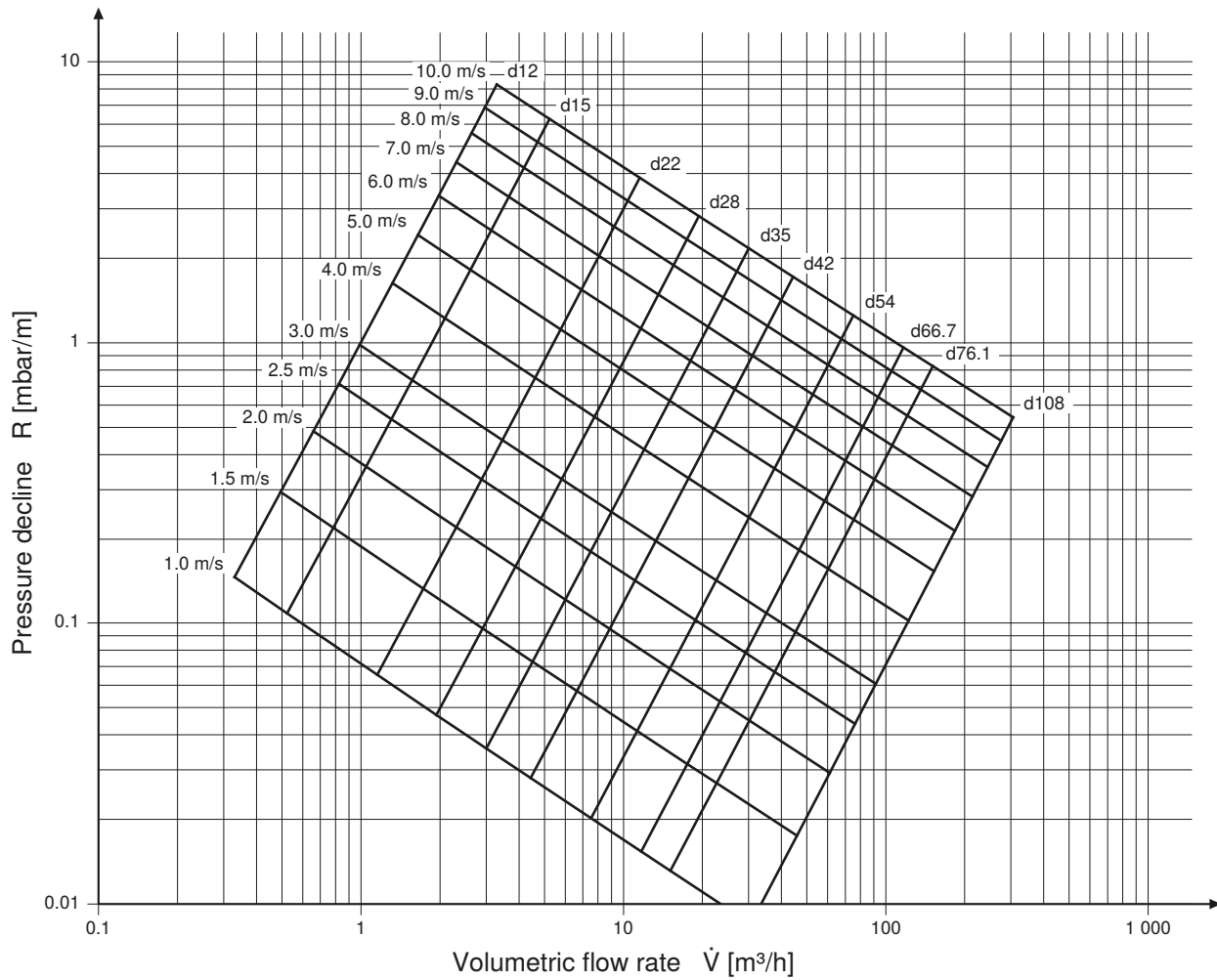


Table 22: Pressure loss for copper pipes in accordance with BS EN 1057, compressed air 6 bar, d12-35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.50	1.52	0.2989	0.96	0.1005	—	—	—	—	—	—
0.75	2.27	0.6046	1.43	0.2025	—	—	—	—	—	—
1.00	3.03	0.9999	1.91	0.3340	0.87	0.0512	—	—	—	—
1.25	3.79	1.4800	2.39	0.4934	1.08	0.0753	—	—	—	—
1.50	4.55	2.0415	2.87	0.6794	1.30	0.1035	—	—	—	—
1.75	5.31	2.6818	3.35	0.8912	1.52	0.1354	0.90	0.0394	—	—
2.00	6.06	3.3989	3.82	1.1281	1.73	0.1711	1.03	0.0497	—	—
2.25	6.82	4.1911	4.30	1.3894	1.95	0.2104	1.16	0.0611	—	—
2.50	7.58	5.0570	4.78	1.6747	2.17	0.2532	1.29	0.0734	—	—
2.75	8.34	5.9953	5.26	1.9835	2.38	0.2995	1.42	0.0868	0.92	0.0307
3.00	9.10	7.0052	5.74	2.3155	2.60	0.3491	1.55	0.1011	1.00	0.0357
3.25	9.85	8.0855	6.21	2.6703	2.82	0.4021	1.67	0.1163	1.08	0.0411
3.50	—	—	6.69	3.0477	3.03	0.4584	1.80	0.1325	1.16	0.0468
3.75	—	—	7.17	3.4474	3.25	0.5180	1.93	0.1497	1.25	0.0528
4.00	—	—	7.65	3.8691	3.47	0.5808	2.06	0.1677	1.33	0.0592
4.50	—	—	8.60	4.7778	3.90	0.7158	2.32	0.2065	1.50	0.0728
5.00	—	—	9.56	5.7724	4.33	0.8633	2.58	0.2488	1.66	0.0877
5.50	—	—	—	—	4.77	1.0231	2.83	0.2946	1.83	0.1037
6.00	—	—	—	—	5.20	1.1949	3.09	0.3438	2.00	0.1210
6.50	—	—	—	—	5.63	1.3786	3.35	0.3963	2.16	0.1394
7.00	—	—	—	—	6.07	1.5740	3.61	0.4522	2.33	0.1590
7.50	—	—	—	—	6.50	1.7810	3.86	0.5113	2.50	0.1796
8.00	—	—	—	—	6.93	1.9995	4.12	0.5737	2.66	0.2015
8.50	—	—	—	—	7.37	2.2293	4.38	0.6392	2.83	0.2244
9.00	—	—	—	—	7.80	2.4704	4.64	0.7080	3.00	0.2484
9.50	—	—	—	—	8.23	2.7226	4.89	0.7798	3.16	0.2735
10.00	—	—	—	—	8.67	2.9860	5.15	0.8548	3.33	0.2997
10.50	—	—	—	—	9.10	3.2603	5.41	0.9328	3.49	0.3269
11.00	—	—	—	—	9.53	3.5455	5.67	1.0139	3.66	0.3552
11.50	—	—	—	—	9.97	3.8416	5.93	1.0981	3.83	0.3846
12.00	—	—	—	—	—	—	6.18	1.1853	3.99	0.4150
12.50	—	—	—	—	—	—	6.44	1.2754	4.16	0.4464
13.00	—	—	—	—	—	—	6.70	1.3686	4.33	0.4788
13.50	—	—	—	—	—	—	6.96	1.4647	4.49	0.5123
14.00	—	—	—	—	—	—	7.21	1.5637	4.66	0.5468
14.50	—	—	—	—	—	—	7.47	1.6657	4.83	0.5823
15.00	—	—	—	—	—	—	7.73	1.7706	4.99	0.6188
16.00	—	—	—	—	—	—	8.24	1.9890	5.32	0.6947

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17.00	—	—	—	—	—	—	8.76	2.2190	5.66	0.7747
18.00	—	—	—	—	—	—	9.27	2.4604	5.99	0.8585
19.00	—	—	—	—	—	—	9.79	2.7130	6.32	0.9462
20.00	—	—	—	—	—	—	—	—	6.66	1.0378
21.00	—	—	—	—	—	—	—	—	6.99	1.1332
22.00	—	—	—	—	—	—	—	—	7.32	1.2323
23.00	—	—	—	—	—	—	—	—	7.65	1.3353
24.00	—	—	—	—	—	—	—	—	7.99	1.4420
25.00	—	—	—	—	—	—	—	—	8.32	1.5524
30.00	—	—	—	—	—	—	—	—	9.98	2.1594

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Table 23: Pressure loss for copper pipes in accordance with BS EN 1057, compressed air 6 bar, d42-108 mm

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
4.00	0.90	0.0235	—	—	—	—	—	—	—	—
4.50	1.01	0.0288	—	—	—	—	—	—	—	—
5.00	1.13	0.0347	—	—	—	—	—	—	—	—
5.50	1.24	0.0410	—	—	—	—	—	—	—	—
6.00	1.35	0.0478	—	—	—	—	—	—	—	—
6.50	1.47	0.0551	0.86	0.0156	—	—	—	—	—	—
7.00	1.58	0.0628	0.93	0.0178	—	—	—	—	—	—
7.50	1.69	0.0709	1.00	0.0201	—	—	—	—	—	—
8.00	1.80	0.0795	1.06	0.0225	—	—	—	—	—	—
8.50	1.92	0.0885	1.13	0.0250	—	—	—	—	—	—
9.00	2.03	0.0980	1.20	0.0277	—	—	—	—	—	—
9.50	2.14	0.1078	1.26	0.0305	—	—	—	—	—	—
10.00	2.26	0.1181	1.33	0.0334	0.86	0.0117	—	—	—	—
10.50	2.37	0.1288	1.39	0.0364	0.90	0.0127	—	—	—	—
11.00	2.48	0.1399	1.46	0.0395	0.94	0.0138	—	—	—	—
11.50	2.59	0.1515	1.53	0.0427	0.98	0.0149	—	—	—	—
12.00	2.71	0.1634	1.59	0.0461	1.03	0.0161	—	—	—	—
12.50	2.82	0.1757	1.66	0.0495	1.07	0.0173	—	—	—	—
13.00	2.93	0.1884	1.73	0.0531	1.11	0.0186	0.86	0.0101	—	—
13.50	3.04	0.2016	1.79	0.0568	1.15	0.0198	0.89	0.0108	—	—
14.00	3.16	0.2151	1.86	0.0606	1.20	0.0212	0.93	0.0115	—	—
14.50	3.27	0.2290	1.93	0.0645	1.24	0.0225	0.96	0.0122	—	—
15.00	3.38	0.2433	1.99	0.0685	1.28	0.0239	0.99	0.0130	—	—
16.00	3.61	0.2730	2.13	0.0768	1.37	0.0268	1.06	0.0145	—	—

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17.00	3.83	0.3043	2.26	0.0856	1.45	0.0299	1.13	0.0162	—	—
18.00	4.06	0.3371	2.39	0.0948	1.54	0.0331	1.19	0.0179	—	—
19.00	4.29	0.3714	2.52	0.1044	1.63	0.0364	1.26	0.0197	—	—
20.00	4.51	0.4072	2.66	0.1144	1.71	0.0399	1.32	0.0216	—	—
21.00	4.74	0.4445	2.79	0.1248	1.80	0.0435	1.39	0.0236	—	—
22.00	4.96	0.4833	2.92	0.1356	1.88	0.0473	1.46	0.0256	—	—
23.00	5.19	0.5235	3.06	0.1468	1.97	0.0512	1.52	0.0277	—	—
24.00	5.41	0.5651	3.19	0.1585	2.05	0.0552	1.59	0.0299	—	—
25.00	5.64	0.6082	3.32	0.1705	2.14	0.0594	1.65	0.0321	—	—
30.00	6.77	0.8449	3.99	0.2365	2.57	0.0822	1.99	0.0445	0.98	0.0082
35.00	7.89	1.1164	4.65	0.3120	2.99	0.1084	2.32	0.0586	1.14	0.0108
40.00	9.02	1.4218	5.31	0.3969	3.42	0.1378	2.65	0.0744	1.31	0.0137
45.00	—	—	5.98	0.4909	3.85	0.1703	2.98	0.0919	1.47	0.0170
50.00	—	—	6.64	0.5939	4.28	0.2058	3.31	0.1111	1.63	0.0205
55.00	—	—	7.31	0.7057	4.70	0.2444	3.64	0.1319	1.80	0.0243
60.00	—	—	7.97	0.8263	5.13	0.2860	3.97	0.1543	1.96	0.0284
65.00	—	—	8.63	0.9556	5.56	0.3305	4.30	0.1782	2.13	0.0327
70.00	—	—	9.30	1.0933	5.99	0.3780	4.63	0.2037	2.29	0.0374
75.00	—	—	9.96	1.2395	6.42	0.4283	4.96	0.2308	2.45	0.0423
80.00	—	—	—	—	6.84	0.4814	5.29	0.2594	2.62	0.0476
85.00	—	—	—	—	7.27	0.5374	5.63	0.2895	2.78	0.0530
90.00	—	—	—	—	7.70	0.5962	5.96	0.3210	2.94	0.0588
95.00	—	—	—	—	8.13	0.6577	6.29	0.3541	3.11	0.0648
100.00	—	—	—	—	8.55	0.7220	6.62	0.3886	3.27	0.0711
105.00	—	—	—	—	8.98	0.7891	6.95	0.4246	3.43	0.0776
110.00	—	—	—	—	9.41	0.8588	7.28	0.4621	3.60	0.0844
115.00	—	—	—	—	9.84	0.9313	7.61	0.5009	3.76	0.0915
120.00	—	—	—	—	—	—	7.94	0.5413	3.92	0.0988
125.00	—	—	—	—	—	—	8.27	0.5830	4.09	0.1064
130.00	—	—	—	—	—	—	8.60	0.6261	4.25	0.1142
135.00	—	—	—	—	—	—	8.94	0.6707	4.41	0.1223
140.00	—	—	—	—	—	—	9.27	0.7167	4.58	0.1306
145.00	—	—	—	—	—	—	9.60	0.7640	4.74	0.1392
150.00	—	—	—	—	—	—	9.93	0.8128	4.90	0.1480
155.00	—	—	—	—	—	—	—	—	5.07	0.1571
160.00	—	—	—	—	—	—	—	—	5.23	0.1664
165.00	—	—	—	—	—	—	—	—	5.40	0.1760
170.00	—	—	—	—	—	—	—	—	5.56	0.1858
175.00	—	—	—	—	—	—	—	—	5.72	0.1958

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
180.00	—	—	—	—	—	—	—	—	5.89	0.2061
185.00	—	—	—	—	—	—	—	—	6.05	0.2166
190.00	—	—	—	—	—	—	—	—	6.21	0.2274
195.00	—	—	—	—	—	—	—	—	6.38	0.2384
200.00	—	—	—	—	—	—	—	—	6.54	0.2497
205.00	—	—	—	—	—	—	—	—	6.70	0.2611
210.00	—	—	—	—	—	—	—	—	6.87	0.2728
215.00	—	—	—	—	—	—	—	—	7.03	0.2848
220.00	—	—	—	—	—	—	—	—	7.19	0.2970
225.00	—	—	—	—	—	—	—	—	7.36	0.3094
230.00	—	—	—	—	—	—	—	—	7.52	0.3220
235.00	—	—	—	—	—	—	—	—	7.68	0.3349
240.00	—	—	—	—	—	—	—	—	7.85	0.3480
245.00	—	—	—	—	—	—	—	—	8.01	0.3614
250.00	—	—	—	—	—	—	—	—	8.17	0.3749
255.00	—	—	—	—	—	—	—	—	8.34	0.3887
260.00	—	—	—	—	—	—	—	—	8.50	0.4028
265.00	—	—	—	—	—	—	—	—	8.67	0.4170
270.00	—	—	—	—	—	—	—	—	8.83	0.4315
275.00	—	—	—	—	—	—	—	—	8.99	0.4462
280.00	—	—	—	—	—	—	—	—	9.16	0.4611
285.00	—	—	—	—	—	—	—	—	9.32	0.4763
290.00	—	—	—	—	—	—	—	—	9.48	0.4917
295.00	—	—	—	—	—	—	—	—	9.65	0.5073
300.00	—	—	—	—	—	—	—	—	9.81	0.5231

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5.3 Compressed air, 8 bar

Medium:	Compressed air
Overpressure:	8 bar
Absolute pressure:	9 bar
Temperature:	20 °C
Density:	10.739 kg/m ³
Viscosity:	0.00001833 Pa•s
Surface roughness:	0.0015 mm

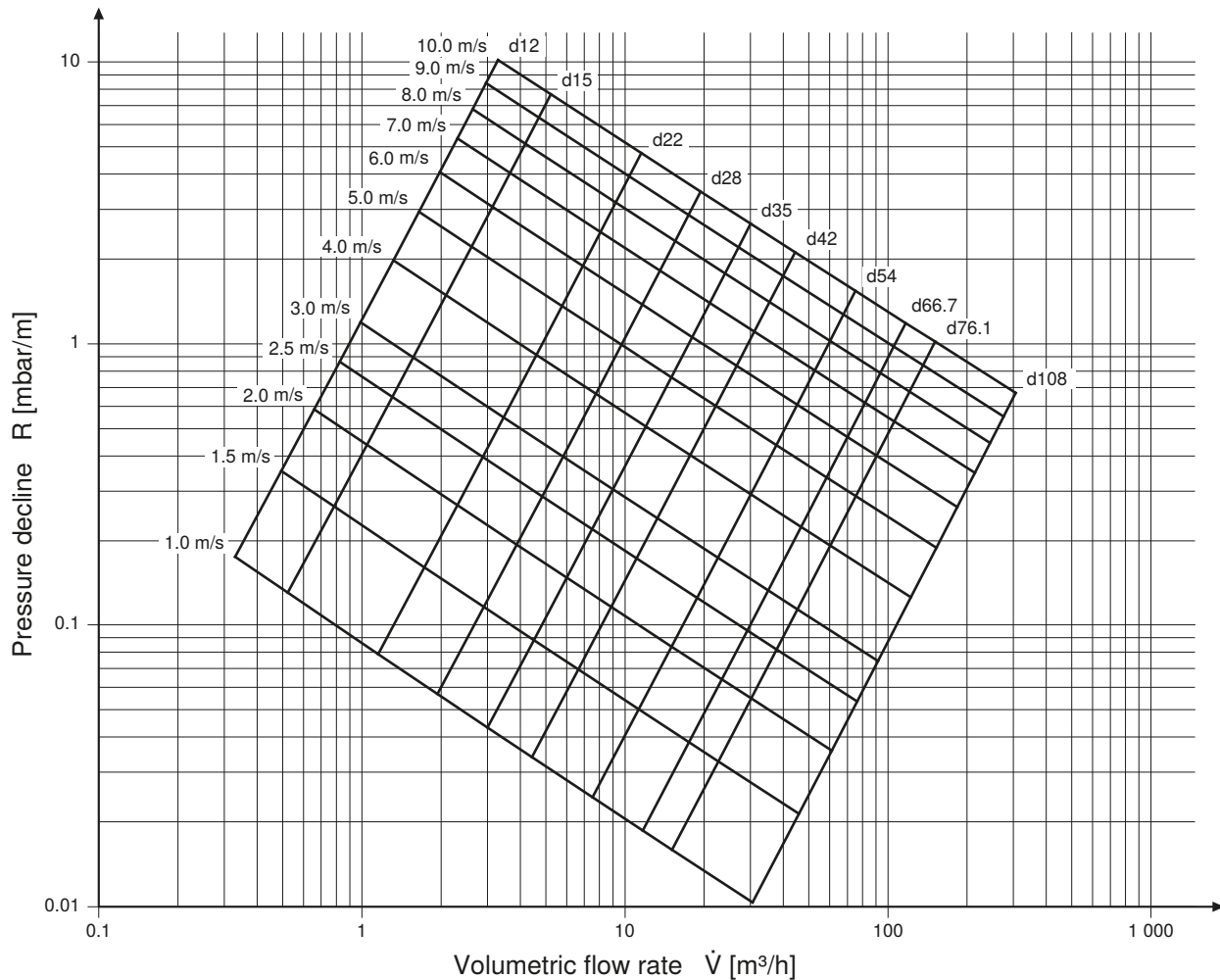


Table 24: Pressure loss for copper pipes in accordance with BS EN 1057, compressed air 8 bar, d12-35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.50	1.52	0.3597	0.96	0.1206	—	—	—	—	—	—
0.75	2.27	0.7300	1.43	0.2439	—	—	—	—	—	—
1.00	3.03	1.2102	1.91	0.4033	0.87	0.0616	—	—	—	—
1.25	3.79	1.7946	2.39	0.5969	1.08	0.0908	—	—	—	—
1.50	4.55	2.4792	2.87	0.8232	1.30	0.1249	—	—	—	—
1.75	5.31	3.2610	3.35	1.0811	1.52	0.1637	0.90	0.0475	—	—
2.00	6.06	4.1376	3.82	1.3699	1.73	0.2070	1.03	0.0600	—	—
2.25	6.82	5.1070	4.30	1.6888	1.95	0.2548	1.16	0.0738	—	—
2.50	7.58	6.1677	4.78	2.0372	2.17	0.3069	1.29	0.0888	—	—
2.75	8.34	7.3182	5.26	2.4147	2.38	0.3632	1.42	0.1050	0.92	0.0371
3.00	9.10	8.5573	5.74	2.8208	2.60	0.4237	1.55	0.1224	1.00	0.0432
3.25	9.85	9.8841	6.21	3.2552	2.82	0.4883	1.67	0.1410	1.08	0.0497
3.50	—	—	6.69	3.7175	3.03	0.5570	1.80	0.1607	1.16	0.0567
3.75	—	—	7.17	4.2074	3.25	0.6297	1.93	0.1815	1.25	0.0640
4.00	—	—	7.65	4.7245	3.47	0.7063	2.06	0.2035	1.33	0.0717
4.50	—	—	8.60	5.8400	3.90	0.8713	2.32	0.2508	1.50	0.0883
5.00	—	—	9.56	7.0619	4.33	1.0517	2.58	0.3024	1.66	0.1064
5.50	—	—	—	—	4.77	1.2471	2.83	0.3583	1.83	0.1259
6.00	—	—	—	—	5.20	1.4575	3.09	0.4183	2.00	0.1470
6.50	—	—	—	—	5.63	1.6825	3.35	0.4825	2.16	0.1694
7.00	—	—	—	—	6.07	1.9221	3.61	0.5508	2.33	0.1933
7.50	—	—	—	—	6.50	2.1760	3.86	0.6232	2.50	0.2185
8.00	—	—	—	—	6.93	2.4442	4.12	0.6995	2.66	0.2452
8.50	—	—	—	—	7.37	2.7264	4.38	0.7798	2.83	0.2732
9.00	—	—	—	—	7.80	3.0226	4.64	0.8639	3.00	0.3026
9.50	—	—	—	—	8.23	3.3326	4.89	0.9520	3.16	0.3333
10.00	—	—	—	—	8.67	3.6564	5.15	1.0439	3.33	0.3653
10.50	—	—	—	—	9.10	3.9939	5.41	1.1396	3.49	0.3986
11.00	—	—	—	—	9.53	4.3449	5.67	1.2391	3.66	0.4333
11.50	—	—	—	—	9.97	4.7094	5.93	1.3424	3.83	0.4692
12.00	—	—	—	—	—	—	6.18	1.4494	3.99	0.5064
12.50	—	—	—	—	—	—	6.44	1.5601	4.16	0.5449
13.00	—	—	—	—	—	—	6.70	1.6745	4.33	0.5847
13.50	—	—	—	—	—	—	6.96	1.7926	4.49	0.6257
14.00	—	—	—	—	—	—	7.21	1.9143	4.66	0.6680
14.50	—	—	—	—	—	—	7.47	2.0397	4.83	0.7115
15.00	—	—	—	—	—	—	7.73	2.1687	4.99	0.7563
16.00	—	—	—	—	—	—	8.24	2.4374	5.32	0.8495

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17.00	—	—	—	—	—	—	8.76	2.7204	5.66	0.9476
18.00	—	—	—	—	—	—	9.27	3.0177	5.99	1.0506
19.00	—	—	—	—	—	—	9.79	3.3290	6.32	1.1584
20.00	—	—	—	—	—	—	—	—	6.66	1.2709
21.00	—	—	—	—	—	—	—	—	6.99	1.3882
22.00	—	—	—	—	—	—	—	—	7.32	1.5102
23.00	—	—	—	—	—	—	—	—	7.65	1.6369
24.00	—	—	—	—	—	—	—	—	7.99	1.7682
25.00	—	—	—	—	—	—	—	—	8.32	1.9041
30.00	—	—	—	—	—	—	—	—	9.98	2.6523

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Table 25: Pressure loss for copper pipes in accordance with BS EN 1057, compressed air 8 bar, d42-108 mm

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
4.00	0.90	0.0284	—	—	—	—	—	—	—	—
4.50	1.01	0.0349	—	—	—	—	—	—	—	—
5.00	1.13	0.0420	—	—	—	—	—	—	—	—
5.50	1.24	0.0497	—	—	—	—	—	—	—	—
6.00	1.35	0.0580	—	—	—	—	—	—	—	—
6.50	1.47	0.0669	0.86	0.0189	—	—	—	—	—	—
7.00	1.58	0.0762	0.93	0.0215	—	—	—	—	—	—
7.50	1.69	0.0862	1.00	0.0243	—	—	—	—	—	—
8.00	1.80	0.0966	1.06	0.0273	—	—	—	—	—	—
8.50	1.92	0.1076	1.13	0.0304	—	—	—	—	—	—
9.00	2.03	0.1192	1.20	0.0336	—	—	—	—	—	—
9.50	2.14	0.1312	1.26	0.0370	—	—	—	—	—	—
10.00	2.26	0.1438	1.33	0.0405	0.86	0.0142	—	—	—	—
10.50	2.37	0.1568	1.39	0.0442	0.90	0.0154	—	—	—	—
11.00	2.48	0.1704	1.46	0.0480	0.94	0.0168	—	—	—	—
11.50	2.59	0.1845	1.53	0.0519	0.98	0.0181	—	—	—	—
12.00	2.71	0.1991	1.59	0.0560	1.03	0.0196	—	—	—	—
12.50	2.82	0.2141	1.66	0.0602	1.07	0.0210	—	—	—	—
13.00	2.93	0.2297	1.73	0.0646	1.11	0.0226	0.86	0.0122	—	—
13.50	3.04	0.2458	1.79	0.0691	1.15	0.0241	0.89	0.0131	—	—
14.00	3.16	0.2623	1.86	0.0737	1.20	0.0257	0.93	0.0139	—	—
14.50	3.27	0.2793	1.93	0.0785	1.24	0.0274	0.96	0.0148	—	—
15.00	3.38	0.2968	1.99	0.0834	1.28	0.0291	0.99	0.0158	—	—
16.00	3.61	0.3333	2.13	0.0936	1.37	0.0326	1.06	0.0177	—	—

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17.00	3.83	0.3716	2.26	0.1043	1.45	0.0363	1.13	0.0197	—	—
18.00	4.06	0.4119	2.39	0.1155	1.54	0.0402	1.19	0.0218	—	—
19.00	4.29	0.4539	2.52	0.1273	1.63	0.0443	1.26	0.0240	—	—
20.00	4.51	0.4978	2.66	0.1395	1.71	0.0486	1.32	0.0263	—	—
21.00	4.74	0.5436	2.79	0.1523	1.80	0.0530	1.39	0.0287	—	—
22.00	4.96	0.5912	2.92	0.1655	1.88	0.0576	1.46	0.0312	—	—
23.00	5.19	0.6405	3.06	0.1793	1.97	0.0624	1.52	0.0337	—	—
24.00	5.41	0.6917	3.19	0.1935	2.05	0.0673	1.59	0.0364	—	—
25.00	5.64	0.7446	3.32	0.2083	2.14	0.0724	1.65	0.0391	—	—
30.00	6.77	1.0357	3.99	0.2892	2.57	0.1004	1.99	0.0543	0.98	0.0100
35.00	7.89	1.3699	4.65	0.3819	2.99	0.1325	2.32	0.0715	1.14	0.0132
40.00	9.02	1.7463	5.31	0.4862	3.42	0.1685	2.65	0.0909	1.31	0.0167
45.00	—	—	5.98	0.6019	3.85	0.2084	2.98	0.1124	1.47	0.0207
50.00	—	—	6.64	0.7287	4.28	0.2521	3.31	0.1359	1.63	0.0250
55.00	—	—	7.31	0.8665	4.70	0.2995	3.64	0.1615	1.80	0.0296
60.00	—	—	7.97	1.0151	5.13	0.3507	3.97	0.1890	1.96	0.0347
65.00	—	—	8.63	1.1745	5.56	0.4055	4.30	0.2184	2.13	0.0400
70.00	—	—	9.30	1.3444	5.99	0.4639	4.63	0.2498	2.29	0.0457
75.00	—	—	9.96	1.5249	6.42	0.5258	4.96	0.2831	2.45	0.0518
80.00	—	—	—	—	6.84	0.5913	5.29	0.3182	2.62	0.0582
85.00	—	—	—	—	7.27	0.6603	5.63	0.3553	2.78	0.0649
90.00	—	—	—	—	7.70	0.7328	5.96	0.3942	2.94	0.0720
95.00	—	—	—	—	8.13	0.8087	6.29	0.4349	3.11	0.0794
100.00	—	—	—	—	8.55	0.8881	6.62	0.4775	3.27	0.0871
105.00	—	—	—	—	8.98	0.9709	6.95	0.5218	3.43	0.0952
110.00	—	—	—	—	9.41	1.0571	7.28	0.5680	3.60	0.1035
115.00	—	—	—	—	9.84	1.1466	7.61	0.6160	3.76	0.1122
120.00	—	—	—	—	—	—	7.94	0.6657	3.92	0.1212
125.00	—	—	—	—	—	—	8.27	0.7173	4.09	0.1305
130.00	—	—	—	—	—	—	8.60	0.7705	4.25	0.1402
135.00	—	—	—	—	—	—	8.94	0.8256	4.41	0.1501
140.00	—	—	—	—	—	—	9.27	0.8824	4.58	0.1604
145.00	—	—	—	—	—	—	9.60	0.9409	4.74	0.1709
150.00	—	—	—	—	—	—	9.93	1.0012	4.90	0.1818
155.00	—	—	—	—	—	—	—	—	5.07	0.1930
160.00	—	—	—	—	—	—	—	—	5.23	0.2045
165.00	—	—	—	—	—	—	—	—	5.40	0.2162
170.00	—	—	—	—	—	—	—	—	5.56	0.2283
175.00	—	—	—	—	—	—	—	—	5.72	0.2407

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
180.00	—	—	—	—	—	—	—	—	5.89	0.2534
185.00	—	—	—	—	—	—	—	—	6.05	0.2664
190.00	—	—	—	—	—	—	—	—	6.21	0.2797
195.00	—	—	—	—	—	—	—	—	6.38	0.2932
200.00	—	—	—	—	—	—	—	—	6.54	0.3071
205.00	—	—	—	—	—	—	—	—	6.70	0.3213
210.00	—	—	—	—	—	—	—	—	6.87	0.3357
215.00	—	—	—	—	—	—	—	—	7.03	0.3505
220.00	—	—	—	—	—	—	—	—	7.19	0.3655
225.00	—	—	—	—	—	—	—	—	7.36	0.3808
230.00	—	—	—	—	—	—	—	—	7.52	0.3965
235.00	—	—	—	—	—	—	—	—	7.68	0.4124
240.00	—	—	—	—	—	—	—	—	7.85	0.4286
245.00	—	—	—	—	—	—	—	—	8.01	0.4450
250.00	—	—	—	—	—	—	—	—	8.17	0.4618
255.00	—	—	—	—	—	—	—	—	8.34	0.4789
260.00	—	—	—	—	—	—	—	—	8.50	0.4962
265.00	—	—	—	—	—	—	—	—	8.67	0.5138
270.00	—	—	—	—	—	—	—	—	8.83	0.5317
275.00	—	—	—	—	—	—	—	—	8.99	0.5499
280.00	—	—	—	—	—	—	—	—	9.16	0.5684
285.00	—	—	—	—	—	—	—	—	9.32	0.5871
290.00	—	—	—	—	—	—	—	—	9.48	0.6062
295.00	—	—	—	—	—	—	—	—	9.65	0.6255
300.00	—	—	—	—	—	—	—	—	9.81	0.6451

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5.4 Compressed air, 10 bar

Medium:	Compressed air
Overpressure:	10 bar
Absolute pressure:	11 bar
Temperature:	20 °C
Density:	13.133 kg/m ³
Viscosity:	0.0000183576 Pa•s
Surface roughness:	0.0015 mm

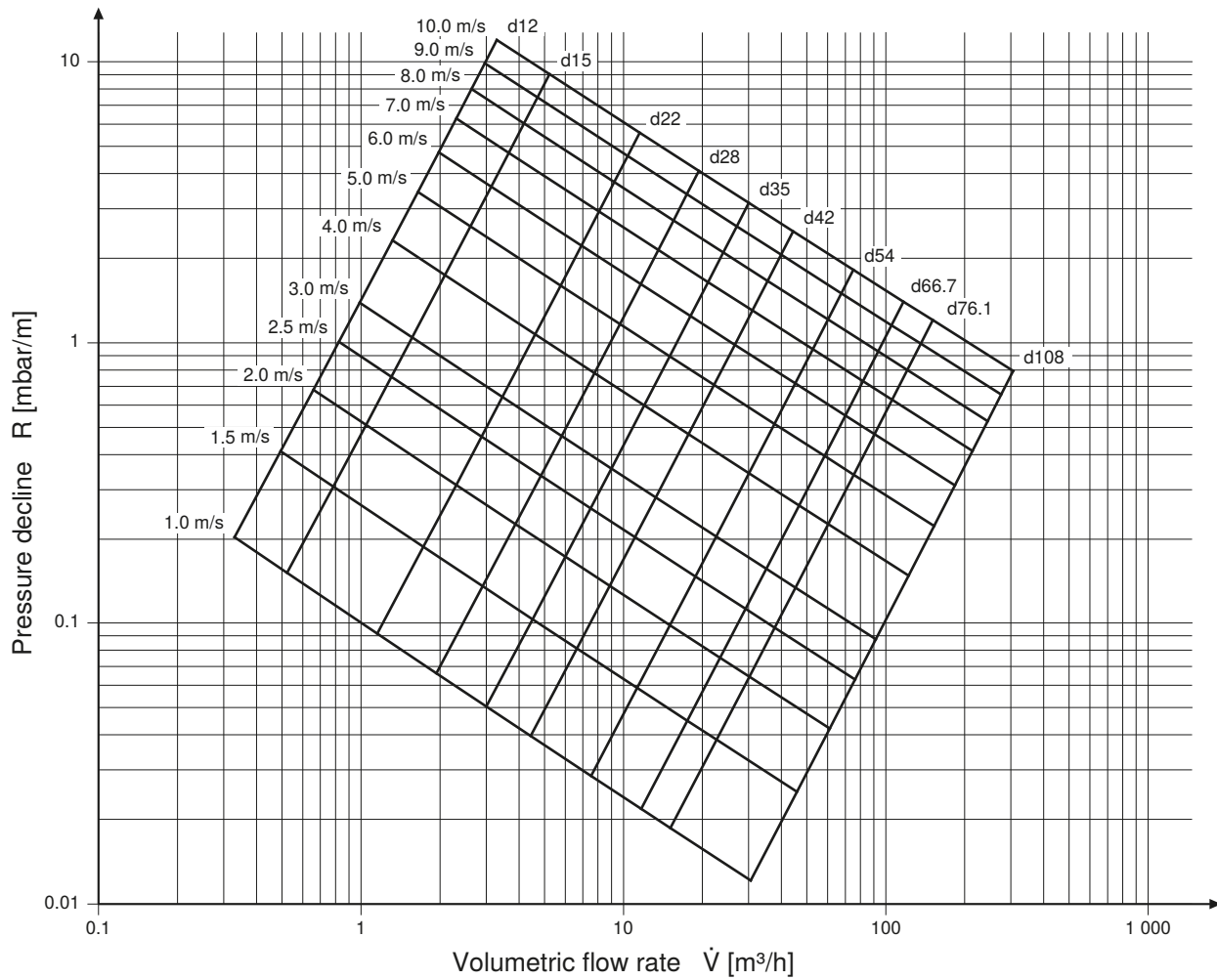


Table 26: Pressure loss for copper pipes in accordance with BS EN 1057, compressed air 10 bar, d12-35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.50	1.52	0.4178	0.96	0.1399	—	—	—	—	—	—
0.75	2.27	0.8502	1.43	0.2836	—	—	—	—	—	—
1.00	3.03	1.4122	1.91	0.4698	0.87	0.0715	—	—	—	—
1.25	3.79	2.0973	2.39	0.6962	1.08	0.1056	—	—	—	—
1.50	4.55	2.9009	2.87	0.9613	1.30	0.1455	—	—	—	—
1.75	5.31	3.8197	3.35	1.2637	1.52	0.1908	0.90	0.0553	—	—
2.00	6.06	4.8509	3.82	1.6027	1.73	0.2415	1.03	0.0699	—	—
2.25	6.82	5.9923	4.30	1.9772	1.95	0.2974	1.16	0.0860	—	—
2.50	7.58	7.2421	4.78	2.3868	2.17	0.3584	1.29	0.1035	—	—
2.75	8.34	8.5989	5.26	2.8309	2.38	0.4244	1.42	0.1225	0.92	0.0432
3.00	9.10	10.0612	5.74	3.3088	2.60	0.4954	1.55	0.1429	1.00	0.0504
3.25	9.85	11.6281	6.21	3.8204	2.82	0.5712	1.67	0.1646	1.08	0.0580
3.50	—	—	6.69	4.3650	3.03	0.6518	1.80	0.1877	1.16	0.0661
3.75	—	—	7.17	4.9426	3.25	0.7372	1.93	0.2121	1.25	0.0747
4.00	—	—	7.65	5.5526	3.47	0.8272	2.06	0.2379	1.33	0.0837
4.50	—	—	8.60	6.8690	3.90	1.0212	2.32	0.2934	1.50	0.1031
5.00	—	—	9.56	8.3126	4.33	1.2333	2.58	0.3539	1.66	0.1243
5.50	—	—	—	—	4.77	1.4634	2.83	0.4196	1.83	0.1473
6.00	—	—	—	—	5.20	1.7112	3.09	0.4902	2.00	0.1719
6.50	—	—	—	—	5.63	1.9764	3.35	0.5657	2.16	0.1983
7.00	—	—	—	—	6.07	2.2588	3.61	0.6460	2.33	0.2263
7.50	—	—	—	—	6.50	2.5583	3.86	0.7311	2.50	0.2560
8.00	—	—	—	—	6.93	2.8747	4.12	0.8209	2.66	0.2873
8.50	—	—	—	—	7.37	3.2078	4.38	0.9154	2.83	0.3202
9.00	—	—	—	—	7.80	3.5576	4.64	1.0146	3.00	0.3548
9.50	—	—	—	—	8.23	3.9239	4.89	1.1183	3.16	0.3909
10.00	—	—	—	—	8.67	4.3066	5.15	1.2267	3.33	0.4285
10.50	—	—	—	—	9.10	4.7056	5.41	1.3395	3.49	0.4678
11.00	—	—	—	—	9.53	5.1207	5.67	1.4569	3.66	0.5085
11.50	—	—	—	—	9.97	5.5520	5.93	1.5787	3.83	0.5509
12.00	—	—	—	—	—	—	6.18	1.7050	3.99	0.5947
12.50	—	—	—	—	—	—	6.44	1.8357	4.16	0.6401
13.00	—	—	—	—	—	—	6.70	1.9707	4.33	0.6869
13.50	—	—	—	—	—	—	6.96	2.1102	4.49	0.7353
14.00	—	—	—	—	—	—	7.21	2.2540	4.66	0.7851
14.50	—	—	—	—	—	—	7.47	2.4021	4.83	0.8364
15.00	—	—	—	—	—	—	7.73	2.5546	4.99	0.8892
16.00	—	—	—	—	—	—	8.24	2.8723	5.32	0.9992

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17.00	—	—	—	—	—	—	8.76	3.2070	5.66	1.1150
18.00	—	—	—	—	—	—	9.27	3.5587	5.99	1.2366
19.00	—	—	—	—	—	—	9.79	3.9271	6.32	1.3638
20.00	—	—	—	—	—	—	—	—	6.66	1.4968
21.00	—	—	—	—	—	—	—	—	6.99	1.6354
22.00	—	—	—	—	—	—	—	—	7.32	1.7796
23.00	—	—	—	—	—	—	—	—	7.65	1.9294
24.00	—	—	—	—	—	—	—	—	7.99	2.0847
25.00	—	—	—	—	—	—	—	—	8.32	2.2455
30.00	—	—	—	—	—	—	—	—	9.98	3.1313

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Table 27: Pressure loss for copper pipes in accordance with BS EN 1057, compressed air 10 bar, d42-108 mm

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
4.00	0.90	0.0331	—	—	—	—	—	—	—	—
4.50	1.01	0.0407	—	—	—	—	—	—	—	—
5.00	1.13	0.0491	—	—	—	—	—	—	—	—
5.50	1.24	0.0581	—	—	—	—	—	—	—	—
6.00	1.35	0.0678	—	—	—	—	—	—	—	—
6.50	1.47	0.0782	0.86	0.0221	—	—	—	—	—	—
7.00	1.58	0.0892	0.93	0.0252	—	—	—	—	—	—
7.50	1.69	0.1008	1.00	0.0284	—	—	—	—	—	—
8.00	1.80	0.1131	1.06	0.0319	—	—	—	—	—	—
8.50	1.92	0.1260	1.13	0.0355	—	—	—	—	—	—
9.00	2.03	0.1395	1.20	0.0393	—	—	—	—	—	—
9.50	2.14	0.1537	1.26	0.0433	—	—	—	—	—	—
10.00	2.26	0.1684	1.33	0.0474	0.86	0.0166	—	—	—	—
10.50	2.37	0.1838	1.39	0.0517	0.90	0.0180	—	—	—	—
11.00	2.48	0.1998	1.46	0.0562	0.94	0.0196	—	—	—	—
11.50	2.59	0.2163	1.53	0.0608	0.98	0.0212	—	—	—	—
12.00	2.71	0.2335	1.59	0.0656	1.03	0.0229	—	—	—	—
12.50	2.82	0.2512	1.66	0.0706	1.07	0.0246	—	—	—	—
13.00	2.93	0.2695	1.73	0.0757	1.11	0.0264	0.86	0.0143	—	—
13.50	3.04	0.2884	1.79	0.0810	1.15	0.0282	0.89	0.0153	—	—
14.00	3.16	0.3079	1.86	0.0864	1.20	0.0301	0.93	0.0163	—	—
14.50	3.27	0.3279	1.93	0.0920	1.24	0.0321	0.96	0.0174	—	—
15.00	3.38	0.3485	1.99	0.0978	1.28	0.0341	0.99	0.0184	—	—
16.00	3.61	0.3915	2.13	0.1097	1.37	0.0382	1.06	0.0207	—	—

d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17.00	3.83	0.4366	2.26	0.1223	1.45	0.0426	1.13	0.0230	—	—
18.00	4.06	0.4840	2.39	0.1355	1.54	0.0472	1.19	0.0255	—	—
19.00	4.29	0.5337	2.52	0.1494	1.63	0.0520	1.26	0.0281	—	—
20.00	4.51	0.5854	2.66	0.1638	1.71	0.0569	1.32	0.0308	—	—
21.00	4.74	0.6394	2.79	0.1788	1.80	0.0621	1.39	0.0336	—	—
22.00	4.96	0.6955	2.92	0.1944	1.88	0.0676	1.46	0.0365	—	—
23.00	5.19	0.7538	3.06	0.2106	1.97	0.0732	1.52	0.0395	—	—
24.00	5.41	0.8142	3.19	0.2274	2.05	0.0790	1.59	0.0427	—	—
25.00	5.64	0.8767	3.32	0.2448	2.14	0.0850	1.65	0.0459	—	—
30.00	6.77	1.2206	3.99	0.3402	2.57	0.1179	1.99	0.0637	0.98	0.0117
35.00	7.89	1.6159	4.65	0.4496	2.99	0.1557	2.32	0.0840	1.14	0.0155
40.00	9.02	2.0616	5.31	0.5728	3.42	0.1982	2.65	0.1069	1.31	0.0196
45.00	—	—	5.98	0.7095	3.85	0.2453	2.98	0.1322	1.47	0.0243
50.00	—	—	6.64	0.8594	4.28	0.2968	3.31	0.1599	1.63	0.0293
55.00	—	—	7.31	1.0224	4.70	0.3529	3.64	0.1901	1.80	0.0348
60.00	—	—	7.97	1.1984	5.13	0.4133	3.97	0.2225	1.96	0.0407
65.00	—	—	8.63	1.3871	5.56	0.4781	4.30	0.2573	2.13	0.0471
70.00	—	—	9.30	1.5886	5.99	0.5471	4.63	0.2944	2.29	0.0538
75.00	—	—	9.96	1.8025	6.42	0.6204	4.96	0.3337	2.45	0.0609
80.00	—	—	—	—	6.84	0.6980	5.29	0.3753	2.62	0.0685
85.00	—	—	—	—	7.27	0.7797	5.63	0.4191	2.78	0.0764
90.00	—	—	—	—	7.70	0.8655	5.96	0.4651	2.94	0.0848
95.00	—	—	—	—	8.13	0.9555	6.29	0.5133	3.11	0.0935
100.00	—	—	—	—	8.55	1.0495	6.62	0.5637	3.27	0.1026
105.00	—	—	—	—	8.98	1.1476	6.95	0.6162	3.43	0.1121
110.00	—	—	—	—	9.41	1.2498	7.28	0.6709	3.60	0.1220
115.00	—	—	—	—	9.84	1.3560	7.61	0.7277	3.76	0.1323
120.00	—	—	—	—	—	—	7.94	0.7867	3.92	0.1429
125.00	—	—	—	—	—	—	8.27	0.8478	4.09	0.1539
130.00	—	—	—	—	—	—	8.60	0.9109	4.25	0.1653
135.00	—	—	—	—	—	—	8.94	0.9762	4.41	0.1771
140.00	—	—	—	—	—	—	9.27	1.0435	4.58	0.1892
145.00	—	—	—	—	—	—	9.60	1.1130	4.74	0.2017
150.00	—	—	—	—	—	—	9.93	1.1845	4.90	0.2145
155.00	—	—	—	—	—	—	—	—	5.07	0.2278
160.00	—	—	—	—	—	—	—	—	5.23	0.2413
165.00	—	—	—	—	—	—	—	—	5.40	0.2553
170.00	—	—	—	—	—	—	—	—	5.56	0.2696
175.00	—	—	—	—	—	—	—	—	5.72	0.2843

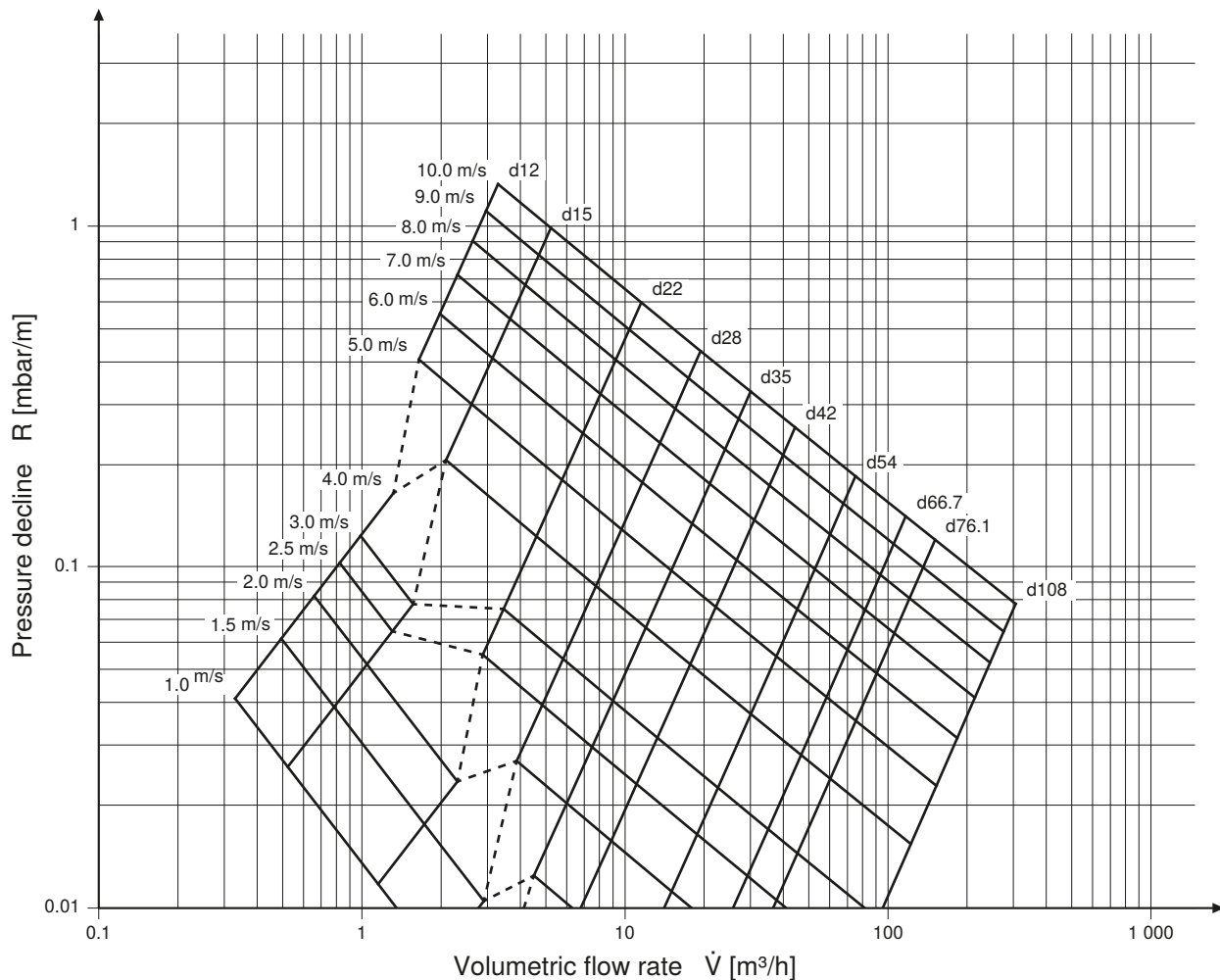
d [mm]	42		54		66.7		77.6		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
180.00	—	—	—	—	—	—	—	—	5.89	0.2993
185.00	—	—	—	—	—	—	—	—	6.05	0.3146
190.00	—	—	—	—	—	—	—	—	6.21	0.3304
195.00	—	—	—	—	—	—	—	—	6.38	0.3464
200.00	—	—	—	—	—	—	—	—	6.54	0.3629
205.00	—	—	—	—	—	—	—	—	6.70	0.3797
210.00	—	—	—	—	—	—	—	—	6.87	0.3968
215.00	—	—	—	—	—	—	—	—	7.03	0.4143
220.00	—	—	—	—	—	—	—	—	7.19	0.4321
225.00	—	—	—	—	—	—	—	—	7.36	0.4503
230.00	—	—	—	—	—	—	—	—	7.52	0.4688
235.00	—	—	—	—	—	—	—	—	7.68	0.4876
240.00	—	—	—	—	—	—	—	—	7.85	0.5069
245.00	—	—	—	—	—	—	—	—	8.01	0.5264
250.00	—	—	—	—	—	—	—	—	8.17	0.5463
255.00	—	—	—	—	—	—	—	—	8.34	0.5665
260.00	—	—	—	—	—	—	—	—	8.50	0.5871
265.00	—	—	—	—	—	—	—	—	8.67	0.6080
270.00	—	—	—	—	—	—	—	—	8.83	0.6292
275.00	—	—	—	—	—	—	—	—	8.99	0.6508
280.00	—	—	—	—	—	—	—	—	9.16	0.6728
285.00	—	—	—	—	—	—	—	—	9.32	0.6950
290.00	—	—	—	—	—	—	—	—	9.48	0.7176
295.00	—	—	—	—	—	—	—	—	9.65	0.7405
300.00	—	—	—	—	—	—	—	—	9.81	0.7638

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6 Pressure loss, gas

6.1 2nd gas family, natural gases

Medium:	2nd gas family, natural gases
Density:	0.79 kg/m ³
Viscosity:	0.000015 Pa•s
Surface roughness:	0.0015 mm



- Pure turbulent or laminar flow
- - - - Transition between turbulent and laminar flow

Table 28: Pressure loss for copper pipes in accordance with BSEN1057, 2nd gas family, d12–35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.25	0.76	0.0312	—	—	—	—	—	—	—	—
0.50	1.52	0.0624	0.96	0.0248	—	—	—	—	—	—
0.75	2.27	0.0936	1.43	0.0372	0.65	0.0076	—	—	—	—
1.00	3.03	0.1248	1.91	0.0496	0.87	0.0102	0.52	0.0036	—	—
1.25	3.79	0.1560	2.39	0.0620	1.08	0.0127	0.64	0.0045	—	—
1.50	4.55	0.3462	2.87	0.0744	1.30	0.0153	0.77	0.0054	—	—
1.75	5.31	0.4493	3.35	0.1523	1.52	0.0178	0.90	0.0063	0.58	0.0026
2.00	6.06	0.5637	3.82	0.1908	1.73	0.0204	1.03	0.0072	0.67	0.0030
2.25	6.82	0.6889	4.30	0.2329	1.95	0.0229	1.16	0.0081	0.75	0.0034
2.50	7.58	0.8246	4.78	0.2786	2.17	0.0435	1.29	0.0090	0.83	0.0038
2.75	8.34	0.9708	5.26	0.3276	2.38	0.0511	1.42	0.0099	0.92	0.0041
3.00	9.10	1.1270	5.74	0.3800	2.60	0.0592	1.55	0.0108	1.00	0.0045
3.25	9.85	1.2931	6.21	0.4357	2.82	0.0678	1.67	0.0200	1.08	0.0049
3.50	—	—	6.69	0.4947	3.03	0.0768	1.80	0.0227	1.16	0.0053
3.75	—	—	7.17	0.5568	3.25	0.0864	1.93	0.0255	1.25	0.0056
4.00	—	—	7.65	0.6220	3.47	0.0964	2.06	0.0284	1.33	0.0060
4.50	—	—	8.60	0.7617	3.90	0.1178	2.32	0.0347	1.50	0.0124
5.00	—	—	9.56	0.9135	4.33	0.1411	2.58	0.0415	1.66	0.0149
5.50	—	—	—	—	4.77	0.1661	2.83	0.0488	1.83	0.0175
6.00	—	—	—	—	5.20	0.1929	3.09	0.0566	2.00	0.0202
6.50	—	—	—	—	5.63	0.2213	3.35	0.0649	2.16	0.0232
7.00	—	—	—	—	6.07	0.2514	3.61	0.0737	2.33	0.0263
7.50	—	—	—	—	6.50	0.2832	3.86	0.0829	2.50	0.0296
8.00	—	—	—	—	6.93	0.3165	4.12	0.0926	2.66	0.0330
8.50	—	—	—	—	7.37	0.3515	4.38	0.1028	2.83	0.0367
9.00	—	—	—	—	7.80	0.3881	4.64	0.1134	3.00	0.0404
9.50	—	—	—	—	8.23	0.4262	4.89	0.1245	3.16	0.0444
10.00	—	—	—	—	8.67	0.4658	5.15	0.1360	3.33	0.0484
10.50	—	—	—	—	9.10	0.5070	5.41	0.1480	3.49	0.0527
11.00	—	—	—	—	9.53	0.5497	5.67	0.1604	3.66	0.0571
11.50	—	—	—	—	9.97	0.5939	5.93	0.1732	3.83	0.0616
12.00	—	—	—	—	10.40	0.6395	6.18	0.1864	3.99	0.0663
12.50	—	—	—	—	—	—	6.44	0.2001	4.16	0.0711
13.00	—	—	—	—	—	—	6.70	0.2142	4.33	0.0761
13.50	—	—	—	—	—	—	6.96	0.2287	4.49	0.0813
14.00	—	—	—	—	—	—	7.21	0.2436	4.66	0.0865
14.50	—	—	—	—	—	—	7.47	0.2589	4.83	0.0919
15.00	—	—	—	—	—	—	7.73	0.2746	4.99	0.0975

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
16.00	—	—	—	—	—	—	8.24	0.3072	5.32	0.1090
17.00	—	—	—	—	—	—	8.76	0.3415	5.66	0.1211
18.00	—	—	—	—	—	—	9.27	0.3773	5.99	0.1338
19.00	—	—	—	—	—	—	9.79	0.4146	6.32	0.1469
20.00	—	—	—	—	—	—	10.30	0.4535	6.66	0.1607
21.00	—	—	—	—	—	—	—	—	6.99	0.1749
22.00	—	—	—	—	—	—	—	—	7.32	0.1897
23.00	—	—	—	—	—	—	—	—	7.65	0.2050
24.00	—	—	—	—	—	—	—	—	7.99	0.2208
25.00	—	—	—	—	—	—	—	—	8.32	0.2371
30.00	—	—	—	—	—	—	—	—	9.98	0.3263

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Table 29: Pressure loss for copper pipes in accordance with BSEN1057, 2nd gas family, d42-108 mm

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2.25	0.51	0.0016	—	—	—	—	—	—	—	—
2.50	0.56	0.0017	—	—	—	—	—	—	—	—
2.75	0.62	0.0019	—	—	—	—	—	—	—	—
3.00	0.68	0.0021	—	—	—	—	—	—	—	—
3.25	0.73	0.0022	—	—	—	—	—	—	—	—
3.50	0.79	0.0024	—	—	—	—	—	—	—	—
3.75	0.85	0.0026	—	—	—	—	—	—	—	—
4.00	0.90	0.0028	0.53	0.0010	—	—	—	—	—	—
4.50	1.01	0.0031	0.60	0.0011	—	—	—	—	—	—
5.00	1.13	0.0060	0.66	0.0012	—	—	—	—	—	—
5.50	1.24	0.0070	0.73	0.0013	—	—	—	—	—	—
6.00	1.35	0.0081	0.80	0.0014	0.51	0.0006	—	—	—	—
6.50	1.47	0.0093	0.86	0.0027	0.56	0.0006	—	—	—	—
7.00	1.58	0.0105	0.93	0.0030	0.60	0.0007	—	—	—	—
7.50	1.69	0.0119	1.00	0.0034	0.64	0.0007	—	—	—	—
8.00	1.80	0.0132	1.06	0.0038	0.68	0.0014	0.53	0.0005	—	—
8.50	1.92	0.0147	1.13	0.0042	0.73	0.0015	0.56	0.0005	—	—
9.00	2.03	0.0162	1.20	0.0047	0.77	0.0017	0.60	0.0005	—	—
9.50	2.14	0.0177	1.26	0.0051	0.81	0.0018	0.63	0.0010	—	—
10.00	2.26	0.0194	1.33	0.0056	0.86	0.0020	0.66	0.0011	—	—
10.50	2.37	0.0210	1.39	0.0061	0.90	0.0022	0.69	0.0012	—	—
11.00	2.48	0.0228	1.46	0.0066	0.94	0.0023	0.73	0.0013	—	—
11.50	2.59	0.0246	1.53	0.0071	0.98	0.0025	0.76	0.0014	—	—

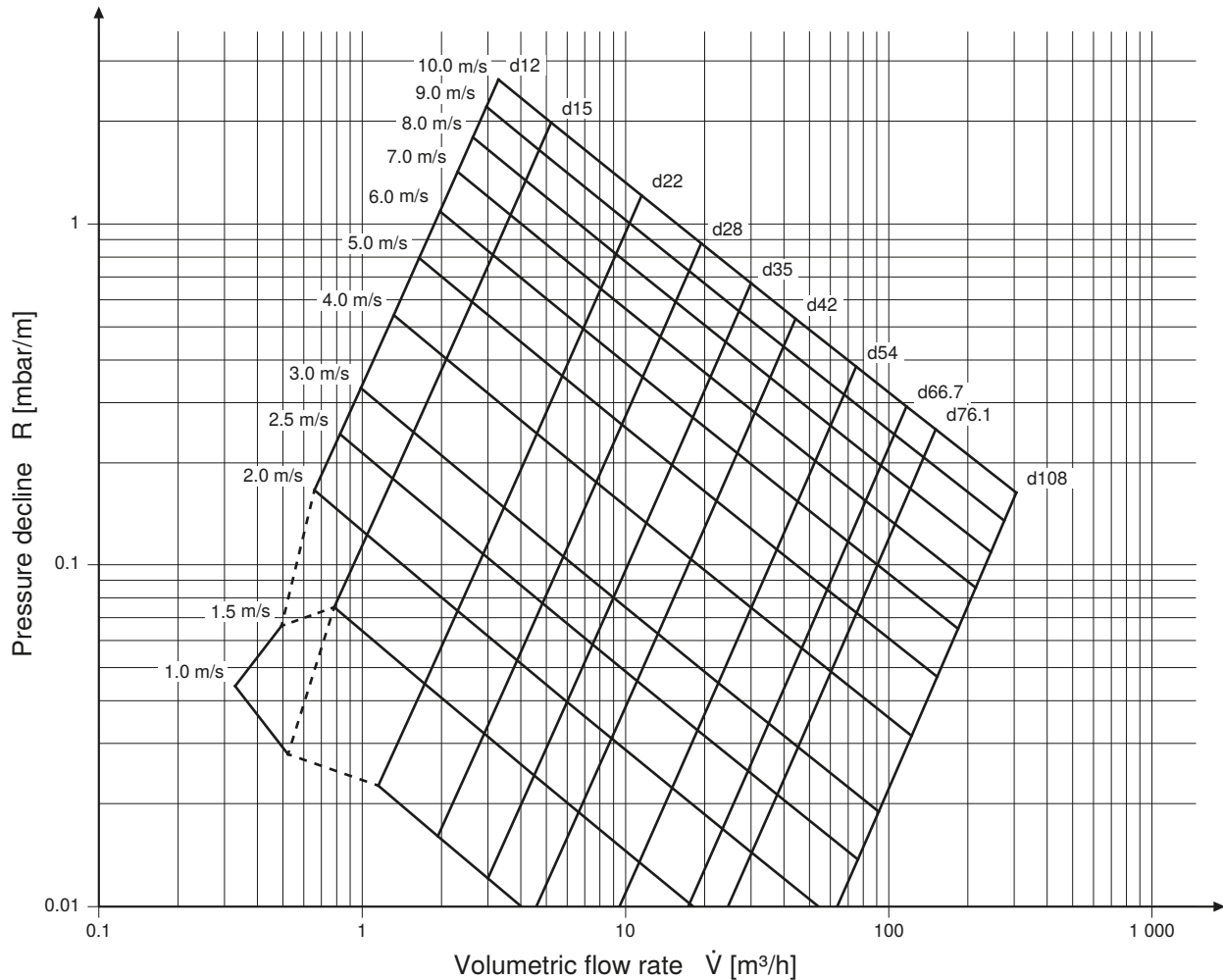
d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
12.00	2.71	0.0265	1.59	0.0076	1.03	0.0027	0.79	0.0015	—	—
12.50	2.82	0.0284	1.66	0.0081	1.07	0.0029	0.83	0.0016	—	—
13.00	2.93	0.0304	1.73	0.0087	1.11	0.0031	0.86	0.0017	—	—
13.50	3.04	0.0324	1.79	0.0093	1.15	0.0033	0.89	0.0018	—	—
14.00	3.16	0.0345	1.86	0.0099	1.20	0.0035	0.93	0.0019	—	—
14.50	3.27	0.0366	1.93	0.0105	1.24	0.0037	0.96	0.0020	—	—
15.00	3.38	0.0389	1.99	0.0111	1.28	0.0039	0.99	0.0022	—	—
16.00	3.61	0.0434	2.13	0.0124	1.37	0.0044	1.06	0.0024	0.52	0.0005
17.00	3.83	0.0482	2.26	0.0138	1.45	0.0049	1.13	0.0027	0.56	0.0005
18.00	4.06	0.0532	2.39	0.0152	1.54	0.0054	1.19	0.0029	0.59	0.0006
19.00	4.29	0.0585	2.52	0.0167	1.63	0.0059	1.26	0.0032	0.62	0.0006
20.00	4.51	0.0639	2.66	0.0183	1.71	0.0065	1.32	0.0035	0.65	0.0007
21.00	4.74	0.0695	2.79	0.0199	1.80	0.0070	1.39	0.0038	0.69	0.0007
22.00	4.96	0.0754	2.92	0.0215	1.88	0.0076	1.46	0.0042	0.72	0.0008
23.00	5.19	0.0815	3.06	0.0233	1.97	0.0082	1.52	0.0045	0.75	0.0009
24.00	5.41	0.0877	3.19	0.0250	2.05	0.0088	1.59	0.0048	0.78	0.0009
25.00	5.64	0.0942	3.32	0.0269	2.14	0.0095	1.65	0.0052	0.82	0.0010
30.00	6.77	0.1294	3.99	0.0369	2.57	0.0130	1.99	0.0071	0.98	0.0013
35.00	7.89	0.1695	4.65	0.0482	2.99	0.0170	2.32	0.0093	1.14	0.0017
40.00	9.02	0.2142	5.31	0.0609	3.42	0.0214	2.65	0.0117	1.31	0.0022
45.00	10.15	0.2635	5.98	0.0748	3.85	0.0263	2.98	0.0143	1.47	0.0027
50.00	—	—	6.64	0.0900	4.28	0.0316	3.31	0.0172	1.63	0.0032
55.00	—	—	7.31	0.1063	4.70	0.0373	3.64	0.0203	1.80	0.0038
60.00	—	—	7.97	0.1239	5.13	0.0435	3.97	0.0236	1.96	0.0044
65.00	—	—	8.63	0.1426	5.56	0.0500	4.30	0.0272	2.13	0.0051
70.00	—	—	9.30	0.1625	5.99	0.0570	4.63	0.0310	2.29	0.0058
75.00	—	—	9.96	0.1836	6.42	0.0644	4.96	0.0350	2.45	0.0065
80.00	—	—	—	—	6.84	0.0721	5.29	0.0391	2.62	0.0073
85.00	—	—	—	—	7.27	0.0802	5.63	0.0435	2.78	0.0081
90.00	—	—	—	—	7.70	0.0887	5.96	0.0482	2.94	0.0090
95.00	—	—	—	—	8.13	0.0976	6.29	0.0530	3.11	0.0099
100.00	—	—	—	—	8.55	0.1068	6.62	0.0580	3.27	0.0108
105.00	—	—	—	—	8.98	0.1165	6.95	0.0632	3.43	0.0118
110.00	—	—	—	—	9.41	0.1264	7.28	0.0686	3.60	0.0128
115.00	—	—	—	—	9.84	0.1368	7.61	0.0742	3.76	0.0138
120.00	—	—	—	—	10.27	0.1475	7.94	0.0800	3.92	0.0149
125.00	—	—	—	—	—	—	8.27	0.0860	4.09	0.0160
130.00	—	—	—	—	—	—	8.60	0.0921	4.25	0.0172
135.00	—	—	—	—	—	—	8.94	0.0985	4.41	0.0183

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
140.00	—	—	—	—	—	—	9.27	0.1050	4.58	0.0196
145.00	—	—	—	—	—	—	9.60	0.1118	4.74	0.0208
150.00	—	—	—	—	—	—	9.93	0.1187	4.90	0.0221
155.00	—	—	—	—	—	—	10.26	0.1258	5.07	0.0234
160.00	—	—	—	—	—	—	—	—	5.23	0.0247
165.00	—	—	—	—	—	—	—	—	5.40	0.0261
170.00	—	—	—	—	—	—	—	—	5.56	0.0275
175.00	—	—	—	—	—	—	—	—	5.72	0.0290
180.00	—	—	—	—	—	—	—	—	5.89	0.0305
185.00	—	—	—	—	—	—	—	—	6.05	0.0320
190.00	—	—	—	—	—	—	—	—	6.21	0.0335
195.00	—	—	—	—	—	—	—	—	6.38	0.0351
200.00	—	—	—	—	—	—	—	—	6.54	0.0367
205.00	—	—	—	—	—	—	—	—	6.70	0.0384
210.00	—	—	—	—	—	—	—	—	6.87	0.0400
215.00	—	—	—	—	—	—	—	—	7.03	0.0417
220.00	—	—	—	—	—	—	—	—	7.19	0.0435
225.00	—	—	—	—	—	—	—	—	7.36	0.0452
230.00	—	—	—	—	—	—	—	—	7.52	0.0470
235.00	—	—	—	—	—	—	—	—	7.68	0.0489
240.00	—	—	—	—	—	—	—	—	7.85	0.0507
245.00	—	—	—	—	—	—	—	—	8.01	0.0526
250.00	—	—	—	—	—	—	—	—	8.17	0.0545
255.00	—	—	—	—	—	—	—	—	8.34	0.0565
260.00	—	—	—	—	—	—	—	—	8.50	0.0585
265.00	—	—	—	—	—	—	—	—	8.67	0.0605
270.00	—	—	—	—	—	—	—	—	8.83	0.0625
275.00	—	—	—	—	—	—	—	—	8.99	0.0646
280.00	—	—	—	—	—	—	—	—	9.16	0.0667
285.00	—	—	—	—	—	—	—	—	9.32	0.0688
290.00	—	—	—	—	—	—	—	—	9.48	0.0710
295.00	—	—	—	—	—	—	—	—	9.65	0.0732
300.00	—	—	—	—	—	—	—	—	9.81	0.0754

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6.2 3rd gas family, liquid gases

Medium: 3rd gas family, liquid gases
 Density: 1.97 kg/m^3
 Viscosity: $0.000016154 \text{ Pa}\cdot\text{s}$
 Surface roughness: 0.0015 mm



— Pure turbulent or laminar flow
 - - - - - Transition between turbulent and laminar flow

Table 30: Pressure loss for copper pipes in accordance with BSEN1057, 3rd gas family, d12–35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.25	0.76	0.0336	–	–	–	–	–	–	–	–
0.50	1.52	0.0672	0.96	0.0267	–	–	–	–	–	–
0.75	2.27	0.2063	1.43	0.0699	0.65	0.0082	–	–	–	–
1.00	3.03	0.3365	1.91	0.1137	0.87	0.0110	0.52	0.0039	–	–
1.25	3.79	0.4929	2.39	0.1663	1.08	0.0259	0.64	0.0049	–	–
1.50	4.55	0.6743	2.87	0.2271	1.30	0.0353	0.77	0.0104	–	–
1.75	5.31	0.8796	3.35	0.2958	1.52	0.0458	0.90	0.0135	0.58	0.0048
2.00	6.06	1.1082	3.82	0.3722	1.73	0.0576	1.03	0.0169	0.67	0.0061
2.25	6.82	1.3594	4.30	0.4561	1.95	0.0704	1.16	0.0207	0.75	0.0074
2.50	7.58	1.6326	4.78	0.5473	2.17	0.0843	1.29	0.0248	0.83	0.0089
2.75	8.34	1.9273	5.26	0.6455	2.38	0.0993	1.42	0.0291	0.92	0.0104
3.00	9.10	2.2434	5.74	0.7508	2.60	0.1154	1.55	0.0338	1.00	0.0121
3.25	9.85	2.5802	6.21	0.8629	2.82	0.1325	1.67	0.0388	1.08	0.0138
3.50	–	–	6.69	0.9818	3.03	0.1506	1.80	0.0440	1.16	0.0157
3.75	–	–	7.17	1.1073	3.25	0.1696	1.93	0.0496	1.25	0.0177
4.00	–	–	7.65	1.2394	3.47	0.1897	2.06	0.0554	1.33	0.0198
4.50	–	–	8.60	1.5228	3.90	0.2327	2.32	0.0679	1.50	0.0242
5.00	–	–	9.56	1.8317	4.33	0.2795	2.58	0.0815	1.66	0.0290
5.50	–	–	–	–	4.77	0.3299	2.83	0.0961	1.83	0.0342
6.00	–	–	–	–	5.20	0.3840	3.09	0.1118	2.00	0.0397
6.50	–	–	–	–	5.63	0.4416	3.35	0.1285	2.16	0.0456
7.00	–	–	–	–	6.07	0.5027	3.61	0.1462	2.33	0.0519
7.50	–	–	–	–	6.50	0.5673	3.86	0.1648	2.50	0.0585
8.00	–	–	–	–	6.93	0.6353	4.12	0.1845	2.66	0.0654
8.50	–	–	–	–	7.37	0.7066	4.38	0.2051	2.83	0.0727
9.00	–	–	–	–	7.80	0.7813	4.64	0.2266	3.00	0.0803
9.50	–	–	–	–	8.23	0.8592	4.89	0.2491	3.16	0.0882
10.00	–	–	–	–	8.67	0.9405	5.15	0.2726	3.33	0.0965
10.50	–	–	–	–	9.10	1.0249	5.41	0.2969	3.49	0.1050
11.00	–	–	–	–	9.53	1.1125	5.67	0.3221	3.66	0.1139
11.50	–	–	–	–	9.97	1.2033	5.93	0.3483	3.83	0.1232
12.00	–	–	–	–	10.40	1.2972	6.18	0.3753	3.99	0.1327
12.50	–	–	–	–	–	–	6.44	0.4033	4.16	0.1425
13.00	–	–	–	–	–	–	6.70	0.4321	4.33	0.1527
13.50	–	–	–	–	–	–	6.96	0.4618	4.49	0.1631
14.00	–	–	–	–	–	–	7.21	0.4924	4.66	0.1738
14.50	–	–	–	–	–	–	7.47	0.5238	4.83	0.1849
15.00	–	–	–	–	–	–	7.73	0.5561	4.99	0.1962

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
16.00	—	—	—	—	—	—	8.24	0.6232	5.32	0.2198
17.00	—	—	—	—	—	—	8.76	0.6936	5.66	0.2446
18.00	—	—	—	—	—	—	9.27	0.7674	5.99	0.2705
19.00	—	—	—	—	—	—	9.79	0.8445	6.32	0.2975
20.00	—	—	—	—	—	—	10.30	0.9249	6.66	0.3257
21.00	—	—	—	—	—	—	—	—	6.99	0.3551
22.00	—	—	—	—	—	—	—	—	7.32	0.3855
23.00	—	—	—	—	—	—	—	—	7.65	0.4170
24.00	—	—	—	—	—	—	—	—	7.99	0.4496
25.00	—	—	—	—	—	—	—	—	8.32	0.4834
30.00	—	—	—	—	—	—	—	—	9.98	0.6680

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Table 31: Pressure loss for copper pipes in accordance with BSEN1057, 3rd gas family, d42-108 mm

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2.25	0.51	0.0030	—	—	—	—	—	—	—	—
2.50	0.56	0.0036	—	—	—	—	—	—	—	—
2.75	0.62	0.0042	—	—	—	—	—	—	—	—
3.00	0.68	0.0048	—	—	—	—	—	—	—	—
3.25	0.73	0.0055	—	—	—	—	—	—	—	—
3.50	0.79	0.0063	—	—	—	—	—	—	—	—
3.75	0.85	0.0071	—	—	—	—	—	—	—	—
4.00	0.90	0.0079	0.53	0.0023	—	—	—	—	—	—
4.50	1.01	0.0097	0.60	0.0028	—	—	—	—	—	—
5.00	1.13	0.0116	0.66	0.0033	—	—	—	—	—	—
5.50	1.24	0.0136	0.73	0.0039	—	—	—	—	—	—
6.00	1.35	0.0158	0.80	0.0045	0.51	0.0016	—	—	—	—
6.50	1.47	0.0182	0.86	0.0052	0.56	0.0018	—	—	—	—
7.00	1.58	0.0207	0.93	0.0059	0.60	0.0021	—	—	—	—
7.50	1.69	0.0233	1.00	0.0067	0.64	0.0024	—	—	—	—
8.00	1.80	0.0260	1.06	0.0074	0.68	0.0026	0.53	0.0014	—	—
8.50	1.92	0.0289	1.13	0.0083	0.73	0.0029	0.56	0.0016	—	—
9.00	2.03	0.0319	1.20	0.0091	0.77	0.0032	0.60	0.0018	—	—
9.50	2.14	0.0351	1.26	0.0100	0.81	0.0035	0.63	0.0019	—	—
10.00	2.26	0.0383	1.33	0.0109	0.86	0.0039	0.66	0.0021	—	—
10.50	2.37	0.0417	1.39	0.0119	0.90	0.0042	0.69	0.0023	—	—
11.00	2.48	0.0452	1.46	0.0129	0.94	0.0046	0.73	0.0025	—	—
11.50	2.59	0.0489	1.53	0.0139	0.98	0.0049	0.76	0.0027	—	—

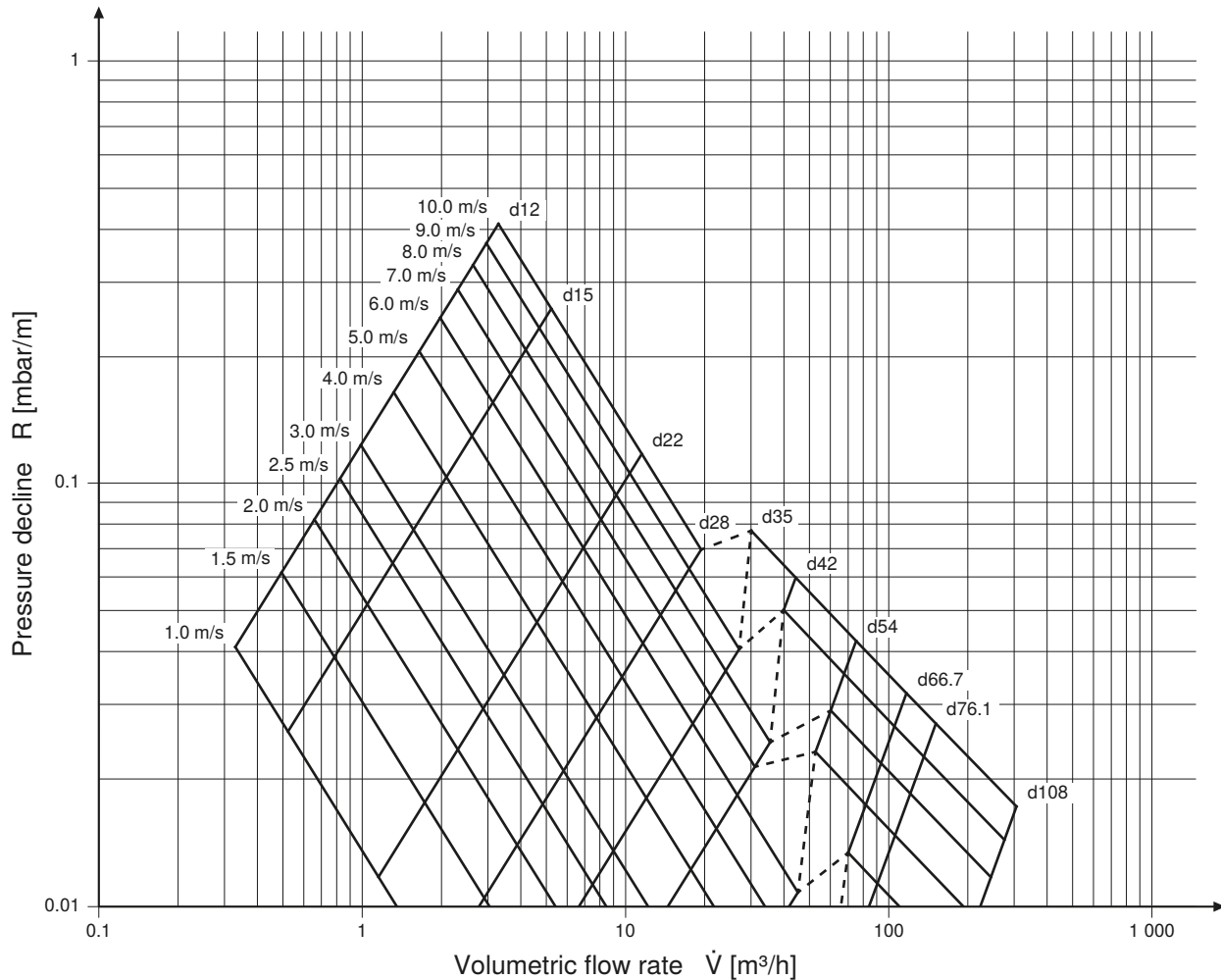
d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
12.00	2.71	0.0527	1.59	0.0150	1.03	0.0053	0.79	0.0029	—	—
12.50	2.82	0.0565	1.66	0.0161	1.07	0.0057	0.83	0.0031	—	—
13.00	2.93	0.0606	1.73	0.0172	1.11	0.0061	0.86	0.0033	—	—
13.50	3.04	0.0647	1.79	0.0184	1.15	0.0065	0.89	0.0035	—	—
14.00	3.16	0.0689	1.86	0.0196	1.20	0.0069	0.93	0.0038	—	—
14.50	3.27	0.0733	1.93	0.0209	1.24	0.0074	0.96	0.0040	—	—
15.00	3.38	0.0778	1.99	0.0221	1.28	0.0078	0.99	0.0042	—	—
16.00	3.61	0.0871	2.13	0.0248	1.37	0.0087	1.06	0.0047	0.52	0.0009
17.00	3.83	0.0969	2.26	0.0275	1.45	0.0097	1.13	0.0053	0.56	0.0010
18.00	4.06	0.1071	2.39	0.0304	1.54	0.0107	1.19	0.0058	0.59	0.0011
19.00	4.29	0.1178	2.52	0.0334	1.63	0.0118	1.26	0.0064	0.62	0.0012
20.00	4.51	0.1289	2.66	0.0366	1.71	0.0129	1.32	0.0070	0.65	0.0013
21.00	4.74	0.1404	2.79	0.0398	1.80	0.0140	1.39	0.0076	0.69	0.0014
22.00	4.96	0.1524	2.92	0.0432	1.88	0.0152	1.46	0.0083	0.72	0.0016
23.00	5.19	0.1649	3.06	0.0467	1.97	0.0164	1.52	0.0089	0.75	0.0017
24.00	5.41	0.1777	3.19	0.0504	2.05	0.0177	1.59	0.0096	0.78	0.0018
25.00	5.64	0.1910	3.32	0.0541	2.14	0.0190	1.65	0.0103	0.82	0.0019
30.00	6.77	0.2636	3.99	0.0746	2.57	0.0262	1.99	0.0142	0.98	0.0027
35.00	7.89	0.3465	4.65	0.0979	2.99	0.0343	2.32	0.0186	1.14	0.0035
40.00	9.02	0.4393	5.31	0.1240	3.42	0.0434	2.65	0.0236	1.31	0.0044
45.00	10.15	0.5417	5.98	0.1528	3.85	0.0534	2.98	0.0290	1.47	0.0054
50.00	—	—	6.64	0.1842	4.28	0.0644	3.31	0.0349	1.63	0.0065
55.00	—	—	7.31	0.2182	4.70	0.0762	3.64	0.0413	1.80	0.0077
60.00	—	—	7.97	0.2547	5.13	0.0889	3.97	0.0482	1.96	0.0090
65.00	—	—	8.63	0.2937	5.56	0.1025	4.30	0.0555	2.13	0.0103
70.00	—	—	9.30	0.3353	5.99	0.1170	4.63	0.0633	2.29	0.0118
75.00	—	—	9.96	0.3792	6.42	0.1322	4.96	0.0716	2.45	0.0133
80.00	—	—	—	—	6.84	0.1483	5.29	0.0803	2.62	0.0149
85.00	—	—	—	—	7.27	0.1653	5.63	0.0895	2.78	0.0166
90.00	—	—	—	—	7.70	0.1830	5.96	0.0990	2.94	0.0184
95.00	—	—	—	—	8.13	0.2015	6.29	0.1090	3.11	0.0202
100.00	—	—	—	—	8.55	0.2209	6.62	0.1195	3.27	0.0221
105.00	—	—	—	—	8.98	0.2410	6.95	0.1304	3.43	0.0241
110.00	—	—	—	—	9.41	0.2619	7.28	0.1416	3.60	0.0262
115.00	—	—	—	—	9.84	0.2836	7.61	0.1534	3.76	0.0284
120.00	—	—	—	—	10.27	0.3061	7.94	0.1655	3.92	0.0306
125.00	—	—	—	—	—	—	8.27	0.1780	4.09	0.0329
130.00	—	—	—	—	—	—	8.60	0.1910	4.25	0.0353
135.00	—	—	—	—	—	—	8.94	0.2043	4.41	0.0377

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
140.00	—	—	—	—	—	—	9.27	0.2180	4.58	0.0403
145.00	—	—	—	—	—	—	9.60	0.2322	4.74	0.0429
150.00	—	—	—	—	—	—	9.93	0.2468	4.90	0.0455
155.00	—	—	—	—	—	—	10.26	0.2617	5.07	0.0483
160.00	—	—	—	—	—	—	—	—	5.23	0.0511
165.00	—	—	—	—	—	—	—	—	5.40	0.0540
170.00	—	—	—	—	—	—	—	—	5.56	0.0570
175.00	—	—	—	—	—	—	—	—	5.72	0.0600
180.00	—	—	—	—	—	—	—	—	5.89	0.0631
185.00	—	—	—	—	—	—	—	—	6.05	0.0662
190.00	—	—	—	—	—	—	—	—	6.21	0.0695
195.00	—	—	—	—	—	—	—	—	6.38	0.0728
200.00	—	—	—	—	—	—	—	—	6.54	0.0762
205.00	—	—	—	—	—	—	—	—	6.70	0.0796
210.00	—	—	—	—	—	—	—	—	6.87	0.0831
215.00	—	—	—	—	—	—	—	—	7.03	0.0867
220.00	—	—	—	—	—	—	—	—	7.19	0.0903
225.00	—	—	—	—	—	—	—	—	7.36	0.0941
230.00	—	—	—	—	—	—	—	—	7.52	0.0978
235.00	—	—	—	—	—	—	—	—	7.68	0.1017
240.00	—	—	—	—	—	—	—	—	7.85	0.1056
245.00	—	—	—	—	—	—	—	—	8.01	0.1096
250.00	—	—	—	—	—	—	—	—	8.17	0.1136
255.00	—	—	—	—	—	—	—	—	8.34	0.1177
260.00	—	—	—	—	—	—	—	—	8.50	0.1219
265.00	—	—	—	—	—	—	—	—	8.67	0.1262
270.00	—	—	—	—	—	—	—	—	8.83	0.1305
275.00	—	—	—	—	—	—	—	—	8.99	0.1348
280.00	—	—	—	—	—	—	—	—	9.16	0.1393
285.00	—	—	—	—	—	—	—	—	9.32	0.1438
290.00	—	—	—	—	—	—	—	—	9.48	0.1484
295.00	—	—	—	—	—	—	—	—	9.65	0.1530
300.00	—	—	—	—	—	—	—	—	9.81	0.1577

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6.3 5th gas family, group A, hydrogen, purity $\geq 98\%$

Medium: 5th gas family, group A, hydrogen, purity $\geq 98\%$
 Density: 0.107 kg/m^3
 Viscosity: $0.000015 \text{ Pa}\cdot\text{s}$
 Surface roughness: 0.0015 mm



- Pure turbulent or laminar flow
- - - - Transition between turbulent and laminar flow

Table 32: Pressure loss for copper pipes in accordance with BSEN1057, 5th gas family, group A, d12-35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.25	0.76	0.0312	—	—	—	—	—	—	—	—
0.50	1.52	0.0624	0.96	0.0248	—	—	—	—	—	—
0.75	2.27	0.0936	1.43	0.0372	0.65	0.0076	—	—	—	—
1.00	3.03	0.1248	1.91	0.0496	0.87	0.0102	0.52	0.0036	—	—
1.25	3.79	0.1560	2.39	0.0620	1.08	0.0127	0.64	0.0045	—	—
1.50	4.55	0.1872	2.87	0.0744	1.30	0.0153	0.77	0.0054	—	—
1.75	5.31	0.2184	3.35	0.0868	1.52	0.0178	0.90	0.0063	0.58	0.0026
2.00	6.06	0.2496	3.82	0.0992	1.73	0.0204	1.03	0.0072	0.67	0.0030
2.25	6.82	0.2808	4.30	0.1117	1.95	0.0229	1.16	0.0081	0.75	0.0034
2.50	7.58	0.3120	4.78	0.1241	2.17	0.0255	1.29	0.0090	0.83	0.0038
2.75	8.34	0.3432	5.26	0.1365	2.38	0.0280	1.42	0.0099	0.92	0.0041
3.00	9.10	0.3743	5.74	0.1489	2.60	0.0306	1.55	0.0108	1.00	0.0045
3.25	9.85	0.4055	6.21	0.1613	2.82	0.0331	1.67	0.0117	1.08	0.0049
3.50	—	—	6.69	0.1737	3.03	0.0357	1.80	0.0126	1.16	0.0053
3.75	—	—	7.17	0.1861	3.25	0.0382	1.93	0.0135	1.25	0.0056
4.00	—	—	7.65	0.1985	3.47	0.0408	2.06	0.0144	1.33	0.0060
4.50	—	—	8.60	0.2233	3.90	0.0459	2.32	0.0162	1.50	0.0068
5.00	—	—	9.56	0.2481	4.33	0.0510	2.58	0.0180	1.66	0.0075
5.50	—	—	—	—	4.77	0.0561	2.83	0.0198	1.83	0.0083
6.00	—	—	—	—	5.20	0.0612	3.09	0.0216	2.00	0.0090
6.50	—	—	—	—	5.63	0.0663	3.35	0.0234	2.16	0.0098
7.00	—	—	—	—	6.07	0.0714	3.61	0.0252	2.33	0.0105
7.50	—	—	—	—	6.50	0.0765	3.86	0.0270	2.50	0.0113
8.00	—	—	—	—	6.93	0.0816	4.12	0.0288	2.66	0.0120
8.50	—	—	—	—	7.37	0.0867	4.38	0.0306	2.83	0.0128
9.00	—	—	—	—	7.80	0.0918	4.64	0.0324	3.00	0.0135
9.50	—	—	—	—	8.23	0.0969	4.89	0.0342	3.16	0.0143
10.00	—	—	—	—	8.67	0.1020	5.15	0.0360	3.33	0.0150
10.50	—	—	—	—	9.10	0.1071	5.41	0.0378	3.49	0.0158
11.00	—	—	—	—	9.53	0.1122	5.67	0.0396	3.66	0.0165
11.50	—	—	—	—	9.97	0.1173	5.93	0.0414	3.83	0.0173
12.00	—	—	—	—	10.40	0.1224	6.18	0.0432	3.99	0.0180
12.50	—	—	—	—	—	—	6.44	0.0450	4.16	0.0188
13.00	—	—	—	—	—	—	6.70	0.0468	4.33	0.0195
13.50	—	—	—	—	—	—	6.96	0.0486	4.49	0.0203
14.00	—	—	—	—	—	—	7.21	0.0504	4.66	0.0210
14.50	—	—	—	—	—	—	7.47	0.0522	4.83	0.0218
15.00	—	—	—	—	—	—	7.73	0.0540	4.99	0.0225

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
16.00	—	—	—	—	—	—	8.24	0.0576	5.32	0.0240
17.00	—	—	—	—	—	—	8.76	0.0612	5.66	0.0256
18.00	—	—	—	—	—	—	9.27	0.0649	5.99	0.0271
19.00	—	—	—	—	—	—	9.79	0.0685	6.32	0.0286
20.00	—	—	—	—	—	—	10.30	0.0721	6.66	0.0301
21.00	—	—	—	—	—	—	—	—	6.99	0.0316
22.00	—	—	—	—	—	—	—	—	7.32	0.0331
23.00	—	—	—	—	—	—	—	—	7.65	0.0346
24.00	—	—	—	—	—	—	—	—	7.99	0.0361
25.00	—	—	—	—	—	—	—	—	8.32	0.0376
30.00	—	—	—	—	—	—	—	—	9.98	0.0773

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Table 33: Pressure loss for copper pipes in accordance with BSEN1057, 5th gas family, group A, d42-108 mm

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2.25	0.51	0.0016	—	—	—	—	—	—	—	—
2.50	0.56	0.0017	—	—	—	—	—	—	—	—
2.75	0.62	0.0019	—	—	—	—	—	—	—	—
3.00	0.68	0.0021	—	—	—	—	—	—	—	—
3.25	0.73	0.0022	—	—	—	—	—	—	—	—
3.50	0.79	0.0024	—	—	—	—	—	—	—	—
3.75	0.85	0.0026	—	—	—	—	—	—	—	—
4.00	0.90	0.0028	0.53	0.0010	—	—	—	—	—	—
4.50	1.01	0.0031	0.60	0.0011	—	—	—	—	—	—
5.00	1.13	0.0035	0.66	0.0012	—	—	—	—	—	—
5.50	1.24	0.0038	0.73	0.0013	—	—	—	—	—	—
6.00	1.35	0.0041	0.80	0.0014	0.51	0.0006	—	—	—	—
6.50	1.47	0.0045	0.86	0.0016	0.56	0.0006	—	—	—	—
7.00	1.58	0.0048	0.93	0.0017	0.60	0.0007	—	—	—	—
7.50	1.69	0.0052	1.00	0.0018	0.64	0.0007	—	—	—	—
8.00	1.80	0.0055	1.06	0.0019	0.68	0.0008	0.53	0.0005	—	—
8.50	1.92	0.0059	1.13	0.0020	0.73	0.0008	0.56	0.0005	—	—
9.00	2.03	0.0062	1.20	0.0022	0.77	0.0009	0.60	0.0005	—	—
9.50	2.14	0.0066	1.26	0.0023	0.81	0.0009	0.63	0.0006	—	—
10.00	2.26	0.0069	1.33	0.0024	0.86	0.0010	0.66	0.0006	—	—
10.50	2.37	0.0072	1.39	0.0025	0.90	0.0010	0.69	0.0006	—	—
11.00	2.48	0.0076	1.46	0.0026	0.94	0.0011	0.73	0.0007	—	—
11.50	2.59	0.0079	1.53	0.0028	0.98	0.0011	0.76	0.0007	—	—

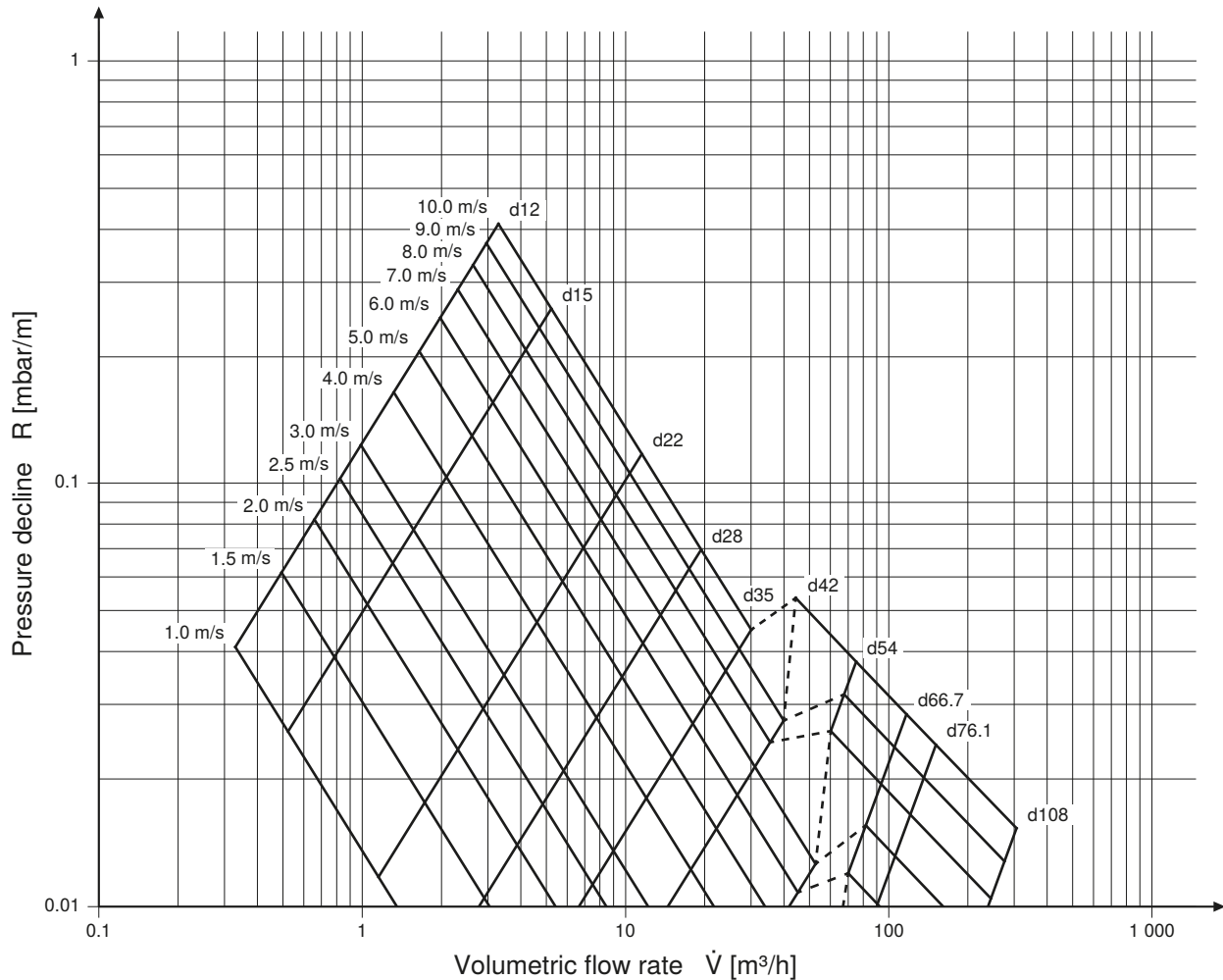
d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
12.00	2.71	0.0083	1.59	0.0029	1.03	0.0012	0.79	0.0007	—	—
12.50	2.82	0.0086	1.66	0.0030	1.07	0.0012	0.83	0.0007	—	—
13.00	2.93	0.0090	1.73	0.0031	1.11	0.0013	0.86	0.0008	—	—
13.50	3.04	0.0093	1.79	0.0032	1.15	0.0013	0.89	0.0008	—	—
14.00	3.16	0.0097	1.86	0.0034	1.20	0.0014	0.93	0.0008	—	—
14.50	3.27	0.0100	1.93	0.0035	1.24	0.0014	0.96	0.0009	—	—
15.00	3.38	0.0104	1.99	0.0036	1.28	0.0015	0.99	0.0009	—	—
16.00	3.61	0.0110	2.13	0.0038	1.37	0.0016	1.06	0.0010	0.52	0.0002
17.00	3.83	0.0117	2.26	0.0041	1.45	0.0017	1.13	0.0010	0.56	0.0002
18.00	4.06	0.0124	2.39	0.0043	1.54	0.0018	1.19	0.0011	0.59	0.0003
19.00	4.29	0.0131	2.52	0.0045	1.63	0.0019	1.26	0.0011	0.62	0.0003
20.00	4.51	0.0138	2.66	0.0048	1.71	0.0020	1.32	0.0012	0.65	0.0003
21.00	4.74	0.0145	2.79	0.0050	1.80	0.0021	1.39	0.0012	0.69	0.0003
22.00	4.96	0.0152	2.92	0.0053	1.88	0.0022	1.46	0.0013	0.72	0.0003
23.00	5.19	0.0159	3.06	0.0055	1.97	0.0023	1.52	0.0014	0.75	0.0003
24.00	5.41	0.0166	3.19	0.0057	2.05	0.0024	1.59	0.0014	0.78	0.0003
25.00	5.64	0.0173	3.32	0.0060	2.14	0.0025	1.65	0.0015	0.82	0.0004
30.00	6.77	0.0207	3.99	0.0072	2.57	0.0030	1.99	0.0018	0.98	0.0004
35.00	7.89	0.0242	4.65	0.0084	2.99	0.0035	2.32	0.0021	1.14	0.0005
40.00	9.02	0.0504	5.31	0.0096	3.42	0.0040	2.65	0.0024	1.31	0.0006
45.00	10.15	0.0616	5.98	0.0108	3.85	0.0045	2.98	0.0027	1.47	0.0007
50.00	—	—	6.64	0.0213	4.28	0.0050	3.31	0.0030	1.63	0.0007
55.00	—	—	7.31	0.0250	4.70	0.0055	3.64	0.0033	1.80	0.0008
60.00	—	—	7.97	0.0289	5.13	0.0103	3.97	0.0036	1.96	0.0009
65.00	—	—	8.63	0.0331	5.56	0.0118	4.30	0.0039	2.13	0.0009
70.00	—	—	9.30	0.0376	5.99	0.0134	4.63	0.0073	2.29	0.0010
75.00	—	—	9.96	0.0422	6.42	0.0150	4.96	0.0082	2.45	0.0011
80.00	—	—	—	—	6.84	0.0168	5.29	0.0092	2.62	0.0012
85.00	—	—	—	—	7.27	0.0186	5.63	0.0102	2.78	0.0012
90.00	—	—	—	—	7.70	0.0205	5.96	0.0112	2.94	0.0013
95.00	—	—	—	—	8.13	0.0224	6.29	0.0123	3.11	0.0024
100.00	—	—	—	—	8.55	0.0245	6.62	0.0134	3.27	0.0026
105.00	—	—	—	—	8.98	0.0266	6.95	0.0146	3.43	0.0028
110.00	—	—	—	—	9.41	0.0288	7.28	0.0158	3.60	0.0030
115.00	—	—	—	—	9.84	0.0311	7.61	0.0170	3.76	0.0032
120.00	—	—	—	—	10.27	0.0334	7.94	0.0183	3.92	0.0035
125.00	—	—	—	—	—	—	8.27	0.0196	4.09	0.0037
130.00	—	—	—	—	—	—	8.60	0.0209	4.25	0.0040
135.00	—	—	—	—	—	—	8.94	0.0223	4.41	0.0043

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m ³ /h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
140.00	—	—	—	—	—	—	9.27	0.0238	4.58	0.0045
145.00	—	—	—	—	—	—	9.60	0.0253	4.74	0.0048
150.00	—	—	—	—	—	—	9.93	0.0268	4.90	0.0051
155.00	—	—	—	—	—	—	10.26	0.0283	5.07	0.0054
160.00	—	—	—	—	—	—	—	—	5.23	0.0057
165.00	—	—	—	—	—	—	—	—	5.40	0.0060
170.00	—	—	—	—	—	—	—	—	5.56	0.0063
175.00	—	—	—	—	—	—	—	—	5.72	0.0066
180.00	—	—	—	—	—	—	—	—	5.89	0.0069
185.00	—	—	—	—	—	—	—	—	6.05	0.0073
190.00	—	—	—	—	—	—	—	—	6.21	0.0076
195.00	—	—	—	—	—	—	—	—	6.38	0.0080
200.00	—	—	—	—	—	—	—	—	6.54	0.0083
205.00	—	—	—	—	—	—	—	—	6.70	0.0087
210.00	—	—	—	—	—	—	—	—	6.87	0.0090
215.00	—	—	—	—	—	—	—	—	7.03	0.0094
220.00	—	—	—	—	—	—	—	—	7.19	0.0098
225.00	—	—	—	—	—	—	—	—	7.36	0.0102
230.00	—	—	—	—	—	—	—	—	7.52	0.0106
235.00	—	—	—	—	—	—	—	—	7.68	0.0110
240.00	—	—	—	—	—	—	—	—	7.85	0.0114
245.00	—	—	—	—	—	—	—	—	8.01	0.0118
250.00	—	—	—	—	—	—	—	—	8.17	0.0122
255.00	—	—	—	—	—	—	—	—	8.34	0.0126
260.00	—	—	—	—	—	—	—	—	8.50	0.0130
265.00	—	—	—	—	—	—	—	—	8.67	0.0135
270.00	—	—	—	—	—	—	—	—	8.83	0.0139
275.00	—	—	—	—	—	—	—	—	8.99	0.0144
280.00	—	—	—	—	—	—	—	—	9.16	0.0148
285.00	—	—	—	—	—	—	—	—	9.32	0.0153
290.00	—	—	—	—	—	—	—	—	9.48	0.0157
295.00	—	—	—	—	—	—	—	—	9.65	0.0162
300.00	—	—	—	—	—	—	—	—	9.81	0.0167

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6.4 5th gas family, group D, hydrogen, purity $\geq 99.97\%$

Medium: 5th gas family, group D, hydrogen, purity $\geq 99.97\%$
 Density: 0.091 kg/m^3
 Viscosity: $0.000015 \text{ Pa}\cdot\text{s}$
 Surface roughness: 0.0015 mm



- Pure turbulent or laminar flow
- - - - Transition between turbulent and laminar flow

Table 34: Pressure loss for copper pipes in accordance with BSEN1057, 5th gas family, group D, d12-35 mm

d [mm]	12		15		22		28		35	
$\dot{V}$ [m ³ /h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.25	0.76	0.0312	—	—	—	—	—	—	—	—
0.50	1.52	0.0624	0.96	0.0248	—	—	—	—	—	—
0.75	2.27	0.0936	1.43	0.0372	0.65	0.0076	—	—	—	—
1.00	3.03	0.1248	1.91	0.0496	0.87	0.0102	0.52	0.0036	—	—
1.25	3.79	0.1560	2.39	0.0620	1.08	0.0127	0.64	0.0045	—	—
1.50	4.55	0.1872	2.87	0.0744	1.30	0.0153	0.77	0.0054	—	—
1.75	5.31	0.2184	3.35	0.0868	1.52	0.0178	0.90	0.0063	0.58	0.0026
2.00	6.06	0.2496	3.82	0.0992	1.73	0.0204	1.03	0.0072	0.67	0.0030
2.25	6.82	0.2808	4.30	0.1117	1.95	0.0229	1.16	0.0081	0.75	0.0034
2.50	7.58	0.3120	4.78	0.1241	2.17	0.0255	1.29	0.0090	0.83	0.0038
2.75	8.34	0.3432	5.26	0.1365	2.38	0.0280	1.42	0.0099	0.92	0.0041
3.00	9.10	0.3743	5.74	0.1489	2.60	0.0306	1.55	0.0108	1.00	0.0045
3.25	9.85	0.4055	6.21	0.1613	2.82	0.0331	1.67	0.0117	1.08	0.0049
3.50	—	—	6.69	0.1737	3.03	0.0357	1.80	0.0126	1.16	0.0053
3.75	—	—	7.17	0.1861	3.25	0.0382	1.93	0.0135	1.25	0.0056
4.00	—	—	7.65	0.1985	3.47	0.0408	2.06	0.0144	1.33	0.0060
4.50	—	—	8.60	0.2233	3.90	0.0459	2.32	0.0162	1.50	0.0068
5.00	—	—	9.56	0.2481	4.33	0.0510	2.58	0.0180	1.66	0.0075
5.50	—	—	—	—	4.77	0.0561	2.83	0.0198	1.83	0.0083
6.00	—	—	—	—	5.20	0.0612	3.09	0.0216	2.00	0.0090
6.50	—	—	—	—	5.63	0.0663	3.35	0.0234	2.16	0.0098
7.00	—	—	—	—	6.07	0.0714	3.61	0.0252	2.33	0.0105
7.50	—	—	—	—	6.50	0.0765	3.86	0.0270	2.50	0.0113
8.00	—	—	—	—	6.93	0.0816	4.12	0.0288	2.66	0.0120
8.50	—	—	—	—	7.37	0.0867	4.38	0.0306	2.83	0.0128
9.00	—	—	—	—	7.80	0.0918	4.64	0.0324	3.00	0.0135
9.50	—	—	—	—	8.23	0.0969	4.89	0.0342	3.16	0.0143
10.00	—	—	—	—	8.67	0.1020	5.15	0.0360	3.33	0.0150
10.50	—	—	—	—	9.10	0.1071	5.41	0.0378	3.49	0.0158
11.00	—	—	—	—	9.53	0.1122	5.67	0.0396	3.66	0.0165
11.50	—	—	—	—	9.97	0.1173	5.93	0.0414	3.83	0.0173
12.00	—	—	—	—	10.40	0.1224	6.18	0.0432	3.99	0.0180
12.50	—	—	—	—	—	—	6.44	0.0450	4.16	0.0188
13.00	—	—	—	—	—	—	6.70	0.0468	4.33	0.0195
13.50	—	—	—	—	—	—	6.96	0.0486	4.49	0.0203
14.00	—	—	—	—	—	—	7.21	0.0504	4.66	0.0210
14.50	—	—	—	—	—	—	7.47	0.0522	4.83	0.0218
15.00	—	—	—	—	—	—	7.73	0.0540	4.99	0.0225

d [mm]	12		15		22		28		35	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
16.00	—	—	—	—	—	—	8.24	0.0576	5.32	0.0240
17.00	—	—	—	—	—	—	8.76	0.0612	5.66	0.0256
18.00	—	—	—	—	—	—	9.27	0.0649	5.99	0.0271
19.00	—	—	—	—	—	—	9.79	0.0685	6.32	0.0286
20.00	—	—	—	—	—	—	10.30	0.0721	6.66	0.0301
21.00	—	—	—	—	—	—	—	—	6.99	0.0316
22.00	—	—	—	—	—	—	—	—	7.32	0.0331
23.00	—	—	—	—	—	—	—	—	7.65	0.0346
24.00	—	—	—	—	—	—	—	—	7.99	0.0361
25.00	—	—	—	—	—	—	—	—	8.32	0.0376
30.00	—	—	—	—	—	—	—	—	9.98	0.0451

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Table 35: Pressure loss for copper pipes in accordance with BSEN1057, 5th gas family, group D, d42-108 mm

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2.25	0.51	0.0016	—	—	—	—	—	—	—	—
2.50	0.56	0.0017	—	—	—	—	—	—	—	—
2.75	0.62	0.0019	—	—	—	—	—	—	—	—
3.00	0.68	0.0021	—	—	—	—	—	—	—	—
3.25	0.73	0.0022	—	—	—	—	—	—	—	—
3.50	0.79	0.0024	—	—	—	—	—	—	—	—
3.75	0.85	0.0026	—	—	—	—	—	—	—	—
4.00	0.90	0.0028	0.53	0.0010	—	—	—	—	—	—
4.50	1.01	0.0031	0.60	0.0011	—	—	—	—	—	—
5.00	1.13	0.0035	0.66	0.0012	—	—	—	—	—	—
5.50	1.24	0.0038	0.73	0.0013	—	—	—	—	—	—
6.00	1.35	0.0041	0.80	0.0014	0.51	0.0006	—	—	—	—
6.50	1.47	0.0045	0.86	0.0016	0.56	0.0006	—	—	—	—
7.00	1.58	0.0048	0.93	0.0017	0.60	0.0007	—	—	—	—
7.50	1.69	0.0052	1.00	0.0018	0.64	0.0007	—	—	—	—
8.00	1.80	0.0055	1.06	0.0019	0.68	0.0008	0.53	0.0005	—	—
8.50	1.92	0.0059	1.13	0.0020	0.73	0.0008	0.56	0.0005	—	—
9.00	2.03	0.0062	1.20	0.0022	0.77	0.0009	0.60	0.0005	—	—
9.50	2.14	0.0066	1.26	0.0023	0.81	0.0009	0.63	0.0006	—	—
10.00	2.26	0.0069	1.33	0.0024	0.86	0.0010	0.66	0.0006	—	—
10.50	2.37	0.0072	1.39	0.0025	0.90	0.0010	0.69	0.0006	—	—
11.00	2.48	0.0076	1.46	0.0026	0.94	0.0011	0.73	0.0007	—	—
11.50	2.59	0.0079	1.53	0.0028	0.98	0.0011	0.76	0.0007	—	—

d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
12.00	2.71	0.0083	1.59	0.0029	1.03	0.0012	0.79	0.0007	—	—
12.50	2.82	0.0086	1.66	0.0030	1.07	0.0012	0.83	0.0007	—	—
13.00	2.93	0.0090	1.73	0.0031	1.11	0.0013	0.86	0.0008	—	—
13.50	3.04	0.0093	1.79	0.0032	1.15	0.0013	0.89	0.0008	—	—
14.00	3.16	0.0097	1.86	0.0034	1.20	0.0014	0.93	0.0008	—	—
14.50	3.27	0.0100	1.93	0.0035	1.24	0.0014	0.96	0.0009	—	—
15.00	3.38	0.0104	1.99	0.0036	1.28	0.0015	0.99	0.0009	—	—
16.00	3.61	0.0110	2.13	0.0038	1.37	0.0016	1.06	0.0010	0.52	0.0002
17.00	3.83	0.0117	2.26	0.0041	1.45	0.0017	1.13	0.0010	0.56	0.0002
18.00	4.06	0.0124	2.39	0.0043	1.54	0.0018	1.19	0.0011	0.59	0.0003
19.00	4.29	0.0131	2.52	0.0045	1.63	0.0019	1.26	0.0011	0.62	0.0003
20.00	4.51	0.0138	2.66	0.0048	1.71	0.0020	1.32	0.0012	0.65	0.0003
21.00	4.74	0.0145	2.79	0.0050	1.80	0.0021	1.39	0.0012	0.69	0.0003
22.00	4.96	0.0152	2.92	0.0053	1.88	0.0022	1.46	0.0013	0.72	0.0003
23.00	5.19	0.0159	3.06	0.0055	1.97	0.0023	1.52	0.0014	0.75	0.0003
24.00	5.41	0.0166	3.19	0.0057	2.05	0.0024	1.59	0.0014	0.78	0.0003
25.00	5.64	0.0173	3.32	0.0060	2.14	0.0025	1.65	0.0015	0.82	0.0004
30.00	6.77	0.0207	3.99	0.0072	2.57	0.0030	1.99	0.0018	0.98	0.0004
35.00	7.89	0.0242	4.65	0.0084	2.99	0.0035	2.32	0.0021	1.14	0.0005
40.00	9.02	0.0276	5.31	0.0096	3.42	0.0040	2.65	0.0024	1.31	0.0006
45.00	10.15	0.0551	5.98	0.0108	3.85	0.0045	2.98	0.0027	1.47	0.0007
50.00	—	—	6.64	0.0120	4.28	0.0050	3.31	0.0030	1.63	0.0007
55.00	—	—	7.31	0.0132	4.70	0.0055	3.64	0.0033	1.80	0.0008
60.00	—	—	7.97	0.0259	5.13	0.0060	3.97	0.0036	1.96	0.0009
65.00	—	—	8.63	0.0296	5.56	0.0065	4.30	0.0039	2.13	0.0009
70.00	—	—	9.30	0.0336	5.99	0.0120	4.63	0.0042	2.29	0.0010
75.00	—	—	9.96	0.0377	6.42	0.0134	4.96	0.0045	2.45	0.0011
80.00	—	—	—	—	6.84	0.0150	5.29	0.0082	2.62	0.0012
85.00	—	—	—	—	7.27	0.0166	5.63	0.0091	2.78	0.0012
90.00	—	—	—	—	7.70	0.0183	5.96	0.0100	2.94	0.0013
95.00	—	—	—	—	8.13	0.0200	6.29	0.0110	3.11	0.0014
100.00	—	—	—	—	8.55	0.0219	6.62	0.0120	3.27	0.0015
105.00	—	—	—	—	8.98	0.0237	6.95	0.0130	3.43	0.0015
110.00	—	—	—	—	9.41	0.0257	7.28	0.0141	3.60	0.0016
115.00	—	—	—	—	9.84	0.0277	7.61	0.0152	3.76	0.0029
120.00	—	—	—	—	10.27	0.0298	7.94	0.0163	3.92	0.0031
125.00	—	—	—	—	—	—	8.27	0.0175	4.09	0.0033
130.00	—	—	—	—	—	—	8.60	0.0187	4.25	0.0036
135.00	—	—	—	—	—	—	8.94	0.0199	4.41	0.0038

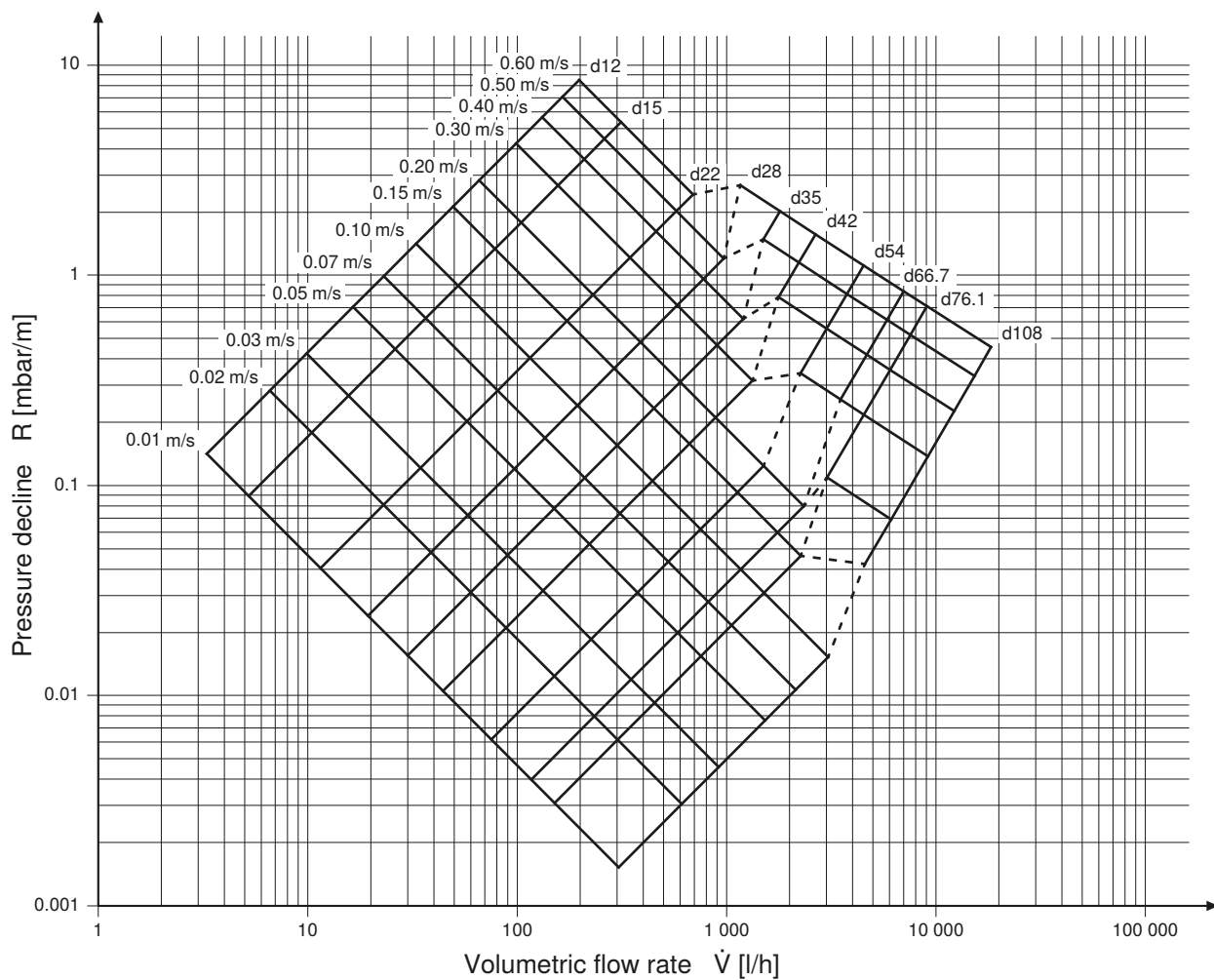
d [mm]	42		54		66.7		76.1		108	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
140.00	—	—	—	—	—	—	9.27	0.0212	4.58	0.0040
145.00	—	—	—	—	—	—	9.60	0.0225	4.74	0.0043
150.00	—	—	—	—	—	—	9.93	0.0239	4.90	0.0045
155.00	—	—	—	—	—	—	10.26	0.0252	5.07	0.0048
160.00	—	—	—	—	—	—	—	—	5.23	0.0051
165.00	—	—	—	—	—	—	—	—	5.40	0.0053
170.00	—	—	—	—	—	—	—	—	5.56	0.0056
175.00	—	—	—	—	—	—	—	—	5.72	0.0059
180.00	—	—	—	—	—	—	—	—	5.89	0.0062
185.00	—	—	—	—	—	—	—	—	6.05	0.0065
190.00	—	—	—	—	—	—	—	—	6.21	0.0068
195.00	—	—	—	—	—	—	—	—	6.38	0.0071
200.00	—	—	—	—	—	—	—	—	6.54	0.0074
205.00	—	—	—	—	—	—	—	—	6.70	0.0077
210.00	—	—	—	—	—	—	—	—	6.87	0.0081
215.00	—	—	—	—	—	—	—	—	7.03	0.0084
220.00	—	—	—	—	—	—	—	—	7.19	0.0087
225.00	—	—	—	—	—	—	—	—	7.36	0.0091
230.00	—	—	—	—	—	—	—	—	7.52	0.0094
235.00	—	—	—	—	—	—	—	—	7.68	0.0098
240.00	—	—	—	—	—	—	—	—	7.85	0.0101
245.00	—	—	—	—	—	—	—	—	8.01	0.0105
250.00	—	—	—	—	—	—	—	—	8.17	0.0109
255.00	—	—	—	—	—	—	—	—	8.34	0.0112
260.00	—	—	—	—	—	—	—	—	8.50	0.0116
265.00	—	—	—	—	—	—	—	—	8.67	0.0120
270.00	—	—	—	—	—	—	—	—	8.83	0.0124
275.00	—	—	—	—	—	—	—	—	8.99	0.0128
280.00	—	—	—	—	—	—	—	—	9.16	0.0132
285.00	—	—	—	—	—	—	—	—	9.32	0.0136
290.00	—	—	—	—	—	—	—	—	9.48	0.0140
295.00	—	—	—	—	—	—	—	—	9.65	0.0144
300.00	—	—	—	—	—	—	—	—	9.81	0.0148

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7 Pressure loss, heating oil EL

7.1 Heating oil EL, 20 °C

Medium:	Heating oil EL
Temperature:	20 °C
Density:	860 kg/m ³
Viscosity:	0.00516 Pa•s
Kinematic viscosity:	0.000006 m ² /s
Surface roughness:	0.0015 mm



- Pure turbulent or laminar flow
- - - - Transition between turbulent and laminar flow

Table 36: Pressure loss for copper pipes in accordance with BS EN 1057, heating oil EL 20 °C, d12–28 mm

d [mm]		12		15		22		28	
$\dot{m}$ [kg/h]	$\dot{V}$ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.50	0.6	0.002	0.0250	0.001	0.0099	—	—	—	—
0.75	0.9	0.003	0.0374	0.002	0.0149	—	—	—	—
1.00	1.2	0.004	0.0499	0.002	0.0198	0.001	0.0041	—	—
1.25	1.5	0.004	0.0624	0.003	0.0248	0.001	0.0051	—	—
1.50	1.7	0.005	0.0749	0.003	0.0298	0.002	0.0061	—	—
1.75	2.0	0.006	0.0873	0.004	0.0347	0.002	0.0071	0.001	0.0025
2.00	2.3	0.007	0.0998	0.004	0.0397	0.002	0.0082	0.001	0.0029
2.25	2.6	0.008	0.1123	0.005	0.0447	0.002	0.0092	0.001	0.0032
2.50	2.9	0.009	0.1248	0.006	0.0496	0.003	0.0102	0.001	0.0036
2.75	3.2	0.010	0.1373	0.006	0.0546	0.003	0.0112	0.002	0.0040
3.00	3.5	0.011	0.1497	0.007	0.0595	0.003	0.0122	0.002	0.0043
3.25	3.8	0.011	0.1622	0.007	0.0645	0.003	0.0133	0.002	0.0047
3.50	4.1	0.012	0.1747	0.008	0.0695	0.004	0.0143	0.002	0.0050
3.75	4.4	0.013	0.1872	0.008	0.0744	0.004	0.0153	0.002	0.0054
4.00	4.7	0.014	0.1997	0.009	0.0794	0.004	0.0163	0.002	0.0058
4.25	4.9	0.015	0.2121	0.009	0.0844	0.004	0.0173	0.003	0.0061
4.50	5.2	0.016	0.2246	0.010	0.0893	0.005	0.0184	0.003	0.0065
4.75	5.5	0.017	0.2371	0.011	0.0943	0.005	0.0194	0.003	0.0068
5.00	5.8	0.018	0.2496	0.011	0.0992	0.005	0.0204	0.003	0.0072
5.50	6.4	0.019	0.2745	0.012	0.1092	0.006	0.0224	0.003	0.0079
6.00	7.0	0.021	0.2995	0.013	0.1191	0.006	0.0245	0.004	0.0086
6.50	7.6	0.023	0.3244	0.014	0.1290	0.007	0.0265	0.004	0.0094
7.00	8.1	0.025	0.3494	0.016	0.1389	0.007	0.0285	0.004	0.0101
7.50	8.7	0.026	0.3743	0.017	0.1489	0.008	0.0306	0.004	0.0108
8.00	9.3	0.028	0.3993	0.018	0.1588	0.008	0.0326	0.005	0.0115
8.50	9.9	0.030	0.4243	0.019	0.1687	0.009	0.0347	0.005	0.0122
9.00	10.5	0.032	0.4492	0.020	0.1786	0.009	0.0367	0.005	0.0130
9.50	11.0	0.033	0.4742	0.021	0.1886	0.010	0.0387	0.006	0.0137
10	11.6	0.035	0.4991	0.022	0.1985	0.010	0.0408	0.006	0.0144
15	17.4	0.053	0.7487	0.033	0.2977	0.015	0.0612	0.009	0.0216
20	23.3	0.071	0.9983	0.044	0.3970	0.020	0.0816	0.012	0.0288
25	29.1	0.088	1.2478	0.056	0.4962	0.025	0.1020	0.015	0.0360
30	34.9	0.106	1.4974	0.067	0.5955	0.030	0.1224	0.018	0.0432
35	40.7	0.123	1.7470	0.078	0.6947	0.035	0.1427	0.021	0.0504
40	46.5	0.141	1.9965	0.089	0.7940	0.040	0.1631	0.024	0.0576
45	52.3	0.159	2.2461	0.100	0.8932	0.045	0.1835	0.027	0.0649
50	58.1	0.176	2.4957	0.111	0.9925	0.050	0.2039	0.030	0.0721
55	64.0	0.194	2.7452	0.122	1.0917	0.055	0.2243	0.033	0.0793

d [mm]		12		15		22		28	
$\dot{m}$ [kg/h]	$\dot{V}$ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
60	69.8	0.212	2.9948	0.133	1.1910	0.060	0.2447	0.036	0.0865
65	75.6	0.229	3.2443	0.145	1.2902	0.066	0.2651	0.039	0.0937
70	81.4	0.247	3.4939	0.156	1.3895	0.071	0.2855	0.042	0.1009
75	87.2	0.264	3.7435	0.167	1.4887	0.076	0.3059	0.045	0.1081
80	93.0	0.282	3.9930	0.178	1.5880	0.081	0.3263	0.048	0.1153
85	98.8	0.300	4.2426	0.189	1.6872	0.086	0.3467	0.051	0.1225
90	104.7	0.317	4.4922	0.200	1.7865	0.091	0.3671	0.054	0.1297
95	110.5	0.335	4.7417	0.211	1.8857	0.096	0.3875	0.057	0.1369
100	116.3	0.353	4.9913	0.222	1.9850	0.101	0.4079	0.060	0.1441
125	145.3	0.441	6.2391	0.278	2.4812	0.126	0.5098	0.075	0.1801
150	174.4	—	—	0.334	2.9774	0.151	0.6118	0.090	0.2162
175	203.5	—	—	0.389	3.4737	0.176	0.7137	0.105	0.2522
200	232.6	—	—	0.445	3.9699	0.202	0.8157	0.120	0.2882
250	290.7	—	—	—	—	0.252	1.0196	0.150	0.3603
300	348.8	—	—	—	—	0.302	1.2236	0.180	0.4323
350	407.0	—	—	—	—	0.353	1.4275	0.210	0.5044
400	465.1	—	—	—	—	0.403	1.6314	0.240	0.5765
450	523.3	—	—	—	—	0.454	1.8353	0.270	0.6485
500	581.4	—	—	—	—	0.504	2.0393	0.300	0.7206
550	639.5	—	—	—	—	—	—	0.330	0.7926
600	697.7	—	—	—	—	—	—	0.359	0.8647
650	755.8	—	—	—	—	—	—	0.389	0.9367
700	814.0	—	—	—	—	—	—	0.419	1.0088
750	872.1	—	—	—	—	—	—	0.449	1.0808
800	930.2	—	—	—	—	—	—	0.479	1.1529
850	988.4	—	—	—	—	—	—	0.509	1.2250

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Table 37: Pressure loss for copper pipes in accordance with BS EN 1057, heating oil EL 20 °C, d35-54 mm

d [mm]		35		42		54	
$\dot{m}$ [kg/h]	$\dot{V}$ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2.75	3.2	0.001	0.0017	—	—	—	—
3.00	3.5	0.001	0.0018	—	—	—	—
3.25	3.8	0.001	0.0020	—	—	—	—
3.50	4.1	0.001	0.0021	—	—	—	—
3.75	4.4	0.001	0.0023	—	—	—	—
4.00	4.7	0.002	0.0024	0.001	0.0011	—	—
4.25	4.9	0.002	0.0026	0.001	0.0012	—	—
4.50	5.2	0.002	0.0027	0.001	0.0012	—	—

d [mm]		35		42		54	
m [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
4.75	5.5	0.002	0.0029	0.001	0.0013	—	—
5.00	5.8	0.002	0.0030	0.001	0.0014	—	—
5.50	6.4	0.002	0.0033	0.001	0.0015	—	—
6.00	7.0	0.002	0.0036	0.002	0.0017	—	—
6.50	7.6	0.003	0.0039	0.002	0.0018	0.001	0.0006
7.00	8.1	0.003	0.0042	0.002	0.0019	0.001	0.0007
7.50	8.7	0.003	0.0045	0.002	0.0021	0.001	0.0007
8.00	9.3	0.003	0.0048	0.002	0.0022	0.001	0.0008
8.50	9.9	0.003	0.0051	0.002	0.0023	0.001	0.0008
9.00	10.5	0.003	0.0054	0.002	0.0025	0.001	0.0009
9.50	11.0	0.004	0.0057	0.002	0.0026	0.001	0.0009
10	11.6	0.004	0.0060	0.003	0.0028	0.002	0.0010
15	17.4	0.006	0.0090	0.004	0.0041	0.002	0.0014
20	23.3	0.008	0.0120	0.005	0.0055	0.003	0.0019
25	29.1	0.010	0.0150	0.007	0.0069	0.004	0.0024
30	34.9	0.012	0.0180	0.008	0.0083	0.005	0.0029
35	40.7	0.014	0.0210	0.009	0.0097	0.005	0.0034
40	46.5	0.015	0.0240	0.010	0.0110	0.006	0.0038
45	52.3	0.017	0.0271	0.012	0.0124	0.007	0.0043
50	58.1	0.019	0.0301	0.013	0.0138	0.008	0.0048
55	64.0	0.021	0.0331	0.014	0.0152	0.008	0.0053
60	69.8	0.023	0.0361	0.016	0.0166	0.009	0.0057
65	75.6	0.025	0.0391	0.017	0.0179	0.010	0.0062
70	81.4	0.027	0.0421	0.018	0.0193	0.011	0.0067
75	87.2	0.029	0.0451	0.020	0.0207	0.012	0.0072
80	93.0	0.031	0.0481	0.021	0.0221	0.012	0.0077
85	98.8	0.033	0.0511	0.022	0.0235	0.013	0.0081
90	104.7	0.035	0.0541	0.024	0.0249	0.014	0.0086
95	110.5	0.037	0.0571	0.025	0.0262	0.015	0.0091
100	116.3	0.039	0.0601	0.026	0.0276	0.015	0.0096
125	145.3	0.048	0.0752	0.033	0.0345	0.019	0.0120
150	174.4	0.058	0.0902	0.039	0.0414	0.023	0.0144
175	203.5	0.068	0.1052	0.046	0.0483	0.027	0.0168
200	232.6	0.077	0.1202	0.052	0.0552	0.031	0.0192
250	290.7	0.097	0.1503	0.066	0.0690	0.039	0.0239
300	348.8	0.116	0.1804	0.079	0.0828	0.046	0.0287
350	407.0	0.135	0.2104	0.092	0.0966	0.054	0.0335
400	465.1	0.155	0.2405	0.105	0.1105	0.062	0.0383
450	523.3	0.174	0.2706	0.118	0.1243	0.070	0.0431

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d [mm]		35		42		54	
m [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
500	581.4	0.193	0.3006	0.131	0.1381	0.077	0.0479
550	639.5	0.213	0.3307	0.144	0.1519	0.085	0.0527
600	697.7	0.232	0.3607	0.157	0.1657	0.093	0.0575
650	755.8	0.252	0.3908	0.170	0.1795	0.100	0.0623
700	814.0	0.271	0.4209	0.184	0.1933	0.108	0.0671
750	872.1	0.290	0.4509	0.197	0.2071	0.116	0.0718
800	930.2	0.310	0.4810	0.210	0.2209	0.124	0.0766
850	988.4	0.329	0.5110	0.223	0.2347	0.131	0.0814
900	1,046.5	0.348	0.5411	0.236	0.2485	0.139	0.0862
950	1,104.7	0.368	0.5712	0.249	0.2623	0.147	0.0910
1,000	1,162.8	0.387	0.6012	0.262	0.2761	0.154	0.0958
1,050	1,220.9	0.406	0.6313	0.275	0.2899	0.162	0.1006
1,100	1,279.1	0.426	1.1307	0.288	0.3038	0.170	0.1054
1,150	1,337.2	0.445	1.2186	0.302	0.3176	0.178	0.1102
1,200	1,395.3	0.464	1.3092	0.315	0.3314	0.185	0.1149
1,250	1,453.5	0.484	1.4026	0.328	0.3452	0.193	0.1197
1,300	1,511.6	0.503	1.4987	0.341	0.3590	0.201	0.1245
1,350	1,569.8	—	—	0.354	0.6418	0.209	0.1293
1,400	1,627.9	—	—	0.367	0.6823	0.216	0.1341
1,450	1,686.0	—	—	0.380	0.7239	0.224	0.1389
1,500	1,744.2	—	—	0.393	0.7665	0.232	0.1437
1,550	1,802.3	—	—	0.406	0.8101	0.239	0.1485
1,600	1,860.5	—	—	0.420	0.8547	0.247	0.1533
1,650	1,918.6	—	—	0.433	0.9004	0.255	0.1580
1,700	1,976.7	—	—	0.446	0.9471	0.263	0.1628
1,750	2,034.9	—	—	0.459	0.9947	0.270	0.2875
1,800	2,093.0	—	—	0.472	1.0433	0.278	0.3015
1,850	2,151.2	—	—	0.485	1.0929	0.286	0.3157
1,900	2,209.3	—	—	0.498	1.1435	0.293	0.3302
1,950	2,267.4	—	—	0.511	1.1951	0.301	0.3450
2,000	2,325.6	—	—	—	—	0.309	0.3601
2,050	2,383.7	—	—	—	—	0.317	0.3754
2,100	2,441.9	—	—	—	—	0.324	0.3910
2,150	2,500.0	—	—	—	—	0.332	0.4069
2,200	2,558.1	—	—	—	—	0.340	0.4230
2,250	2,616.3	—	—	—	—	0.348	0.4395
2,300	2,674.4	—	—	—	—	0.355	0.4561
2,350	2,732.6	—	—	—	—	0.363	0.4730
2,400	2,790.7	—	—	—	—	0.371	0.4902

d [mm]		35		42		54	
$\dot{m}$ [kg/h]	$\dot{V}$ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2,450	2,848.8	—	—	—	—	0.378	0.5077
2,500	2,907.0	—	—	—	—	0.386	0.5254
2,550	2,965.1	—	—	—	—	0.394	0.5434
2,600	3,023.3	—	—	—	—	0.402	0.5616
2,650	3,081.4	—	—	—	—	0.409	0.5801
2,700	3,139.5	—	—	—	—	0.417	0.5988
2,750	3,197.7	—	—	—	—	0.425	0.6178
2,800	3,255.8	—	—	—	—	0.432	0.6370
2,850	3,314.0	—	—	—	—	0.440	0.6565
2,900	3,372.1	—	—	—	—	0.448	0.6762
2,950	3,430.2	—	—	—	—	0.456	0.6962
3,000	3,488.4	—	—	—	—	0.463	0.7164
3,100	3,604.7	—	—	—	—	0.479	0.7576
3,200	3,720.9	—	—	—	—	0.494	0.7998
3,300	3,837.2	—	—	—	—	0.510	0.8429

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Table 38: Pressure loss for copper pipes in accordance with BS EN 1057, heating oil EL 20 °C, d66.7–108 mm

d [mm]		66.7		76.1		108	
$\dot{m}$ [kg/h]	$\dot{V}$ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
15	17.4	0.001	0.0006	0.001	0.0004	—	—
20	23.3	0.002	0.0008	0.002	0.0005	—	—
25	29.1	0.002	0.0010	0.002	0.0006	—	—
30	34.9	0.003	0.0012	0.002	0.0007	0.001	0.0002
35	40.7	0.003	0.0014	0.003	0.0008	0.001	0.0002
40	46.5	0.004	0.0016	0.003	0.0010	0.001	0.0002
45	52.3	0.004	0.0018	0.003	0.0011	0.002	0.0003
50	58.1	0.005	0.0020	0.004	0.0012	0.002	0.0003
55	64.0	0.005	0.0022	0.004	0.0013	0.002	0.0003
60	69.8	0.006	0.0024	0.005	0.0014	0.002	0.0003
65	75.6	0.006	0.0026	0.005	0.0015	0.002	0.0004
70	81.4	0.007	0.0028	0.005	0.0017	0.003	0.0004
75	87.2	0.007	0.0030	0.006	0.0018	0.003	0.0004
80	93.0	0.008	0.0032	0.006	0.0019	0.003	0.0004
85	98.8	0.008	0.0034	0.007	0.0020	0.003	0.0005
90	104.7	0.009	0.0036	0.007	0.0021	0.003	0.0005
95	110.5	0.009	0.0038	0.007	0.0023	0.004	0.0005
100	116.3	0.010	0.0040	0.008	0.0024	0.004	0.0006
125	145.3	0.012	0.0050	0.010	0.0030	0.005	0.0007

d [mm]		66.7		76.1		108	
m [kg/h]	Ḃ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
150	174.4	0.015	0.0060	0.012	0.0036	0.006	0.0008
175	203.5	0.017	0.0070	0.013	0.0042	0.007	0.0010
200	232.6	0.020	0.0079	0.015	0.0048	0.007	0.0011
250	290.7	0.025	0.0099	0.019	0.0059	0.009	0.0014
300	348.8	0.030	0.0119	0.023	0.0071	0.011	0.0017
350	407.0	0.035	0.0139	0.027	0.0083	0.013	0.0020
400	465.1	0.040	0.0159	0.031	0.0095	0.015	0.0022
450	523.3	0.045	0.0179	0.035	0.0107	0.017	0.0025
500	581.4	0.050	0.0199	0.038	0.0119	0.019	0.0028
550	639.5	0.055	0.0218	0.042	0.0131	0.021	0.0031
600	697.7	0.060	0.0238	0.046	0.0143	0.022	0.0034
650	755.8	0.065	0.0258	0.050	0.0155	0.024	0.0036
700	814.0	0.070	0.0278	0.054	0.0166	0.026	0.0039
750	872.1	0.075	0.0298	0.058	0.0178	0.028	0.0042
800	930.2	0.080	0.0318	0.062	0.0190	0.030	0.0045
850	988.4	0.085	0.0338	0.065	0.0202	0.032	0.0047
900	1,046.5	0.090	0.0358	0.069	0.0214	0.034	0.0050
950	1,104.7	0.094	0.0377	0.073	0.0226	0.035	0.0053
1,000	1,162.8	0.099	0.0397	0.077	0.0238	0.037	0.0056
1,050	1,220.9	0.104	0.0417	0.081	0.0250	0.039	0.0059
1,100	1,279.1	0.109	0.0437	0.085	0.0262	0.041	0.0061
1,150	1,337.2	0.114	0.0457	0.089	0.0273	0.043	0.0064
1,200	1,395.3	0.119	0.0477	0.092	0.0285	0.045	0.0067
1,250	1,453.5	0.124	0.0497	0.096	0.0297	0.047	0.0070
1,300	1,511.6	0.129	0.0516	0.100	0.0309	0.048	0.0073
1,350	1,569.8	0.134	0.0536	0.104	0.0321	0.050	0.0075
1,400	1,627.9	0.139	0.0556	0.108	0.0333	0.052	0.0078
1,450	1,686.0	0.144	0.0576	0.112	0.0345	0.054	0.0081
1,500	1,744.2	0.149	0.0596	0.115	0.0357	0.056	0.0084
1,550	1,802.3	0.154	0.0616	0.119	0.0369	0.058	0.0087
1,600	1,860.5	0.159	0.0636	0.123	0.0381	0.060	0.0089
1,650	1,918.6	0.164	0.0655	0.127	0.0392	0.062	0.0092
1,700	1,976.7	0.169	0.0675	0.131	0.0404	0.063	0.0095
1,750	2,034.9	0.174	0.0695	0.135	0.0416	0.065	0.0098
1,800	2,093.0	0.179	0.0715	0.139	0.0428	0.067	0.0101
1,850	2,151.2	0.184	0.0735	0.142	0.0440	0.069	0.0103
1,900	2,209.3	0.189	0.0755	0.146	0.0452	0.071	0.0106
1,950	2,267.4	0.194	0.0775	0.150	0.0464	0.073	0.0109
2,000	2,325.6	0.199	0.0795	0.154	0.0476	0.075	0.0112

d [mm]		66.7		76.1		108	
m [kg/h]	$\dot{V}$ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2,050	2,383.7	0.204	0.0814	0.158	0.0488	0.076	0.0115
2,100	2,441.9	0.209	0.0834	0.162	0.0499	0.078	0.0117
2,150	2,500.0	0.214	0.0854	0.165	0.0511	0.080	0.0120
2,200	2,558.1	0.219	0.1508	0.169	0.0523	0.082	0.0123
2,250	2,616.3	0.224	0.1566	0.173	0.0535	0.084	0.0126
2,300	2,674.4	0.229	0.1625	0.177	0.0547	0.086	0.0128
2,350	2,732.6	0.234	0.1685	0.181	0.0559	0.088	0.0131
2,400	2,790.7	0.239	0.1746	0.185	0.0571	0.090	0.0134
2,450	2,848.8	0.244	0.1808	0.189	0.0583	0.091	0.0137
2,500	2,907.0	0.249	0.1871	0.192	0.1025	0.093	0.0140
2,550	2,965.1	0.254	0.1934	0.196	0.1060	0.095	0.0142
2,600	3,023.3	0.259	0.1999	0.200	0.1095	0.097	0.0145
2,650	3,081.4	0.264	0.2064	0.204	0.1131	0.099	0.0148
2,700	3,139.5	0.269	0.2130	0.208	0.1167	0.101	0.0151
2,750	3,197.7	0.274	0.2198	0.212	0.1204	0.103	0.0154
2,800	3,255.8	0.279	0.2266	0.215	0.1241	0.104	0.0156
2,850	3,314.0	0.283	0.2335	0.219	0.1279	0.106	0.0159
2,900	3,372.1	0.288	0.2404	0.223	0.1317	0.108	0.0162
2,950	3,430.2	0.293	0.2475	0.227	0.1356	0.110	0.0165
3,000	3,488.4	0.298	0.2547	0.231	0.1395	0.112	0.0168
3,100	3,604.7	0.308	0.2692	0.239	0.1474	0.116	0.0173
3,200	3,720.9	0.318	0.2841	0.246	0.1556	0.119	0.0179
3,300	3,837.2	0.328	0.2994	0.254	0.1639	0.123	0.0184
3,400	3,953.5	0.338	0.3150	0.262	0.1724	0.127	0.0190
3,500	4,069.8	0.348	0.3309	0.269	0.1811	0.131	0.0196
3,600	4,186.0	0.358	0.3472	0.277	0.1900	0.134	0.0347
3,700	4,302.3	0.368	0.3637	0.285	0.1990	0.138	0.0364
3,800	4,418.6	0.378	0.3807	0.292	0.2082	0.142	0.0381
3,900	4,534.9	0.388	0.3979	0.300	0.2176	0.145	0.0398
4,000	4,651.2	0.398	0.4155	0.308	0.2272	0.149	0.0415
4,100	4,767.4	0.408	0.4334	0.316	0.2370	0.153	0.0433
4,200	4,883.7	0.418	0.4516	0.323	0.2469	0.157	0.0451
4,300	5,000.0	0.428	0.4701	0.331	0.2570	0.160	0.0469
4,400	5,116.3	0.438	0.4889	0.339	0.2673	0.164	0.0487
4,500	5,232.6	0.448	0.5081	0.346	0.2777	0.168	0.0506
4,600	5,348.8	0.458	0.5276	0.354	0.2883	0.172	0.0526
4,700	5,465.1	0.468	0.5474	0.362	0.2991	0.175	0.0545
4,800	5,581.4	0.477	0.5675	0.369	0.3101	0.179	0.0565
4,900	5,697.7	0.487	0.5879	0.377	0.3212	0.183	0.0585

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d [mm]		66.7		76.1		108	
m [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
5,000	5,814.0	0.497	0.6086	0.385	0.3325	0.187	0.0605
5,100	5,930.2	0.507	0.6296	0.393	0.3439	0.190	0.0626
5,200	6,046.5	0.517	0.6510	0.400	0.3556	0.194	0.0647
5,300	6,162.8	—	—	0.408	0.3674	0.198	0.0668
5,400	6,279.1	—	—	0.416	0.3793	0.201	0.0690
5,500	6,395.3	—	—	0.423	0.3914	0.205	0.0712
5,600	6,511.6	—	—	0.431	0.4037	0.209	0.0734
5,700	6,627.9	—	—	0.439	0.4161	0.213	0.0756
5,800	6,744.2	—	—	0.446	0.4287	0.216	0.0779
5,900	6,860.5	—	—	0.454	0.4415	0.220	0.0802
6,000	6,976.7	—	—	0.462	0.4544	0.224	0.0825
6,100	7,093.0	—	—	0.469	0.4675	0.228	0.0849
6,200	7,209.3	—	—	0.477	0.4808	0.231	0.0873
6,300	7,325.6	—	—	0.485	0.4942	0.235	0.0897
6,400	7,441.9	—	—	0.493	0.5077	0.239	0.0921
6,500	7,558.1	—	—	0.500	0.5214	0.242	0.0946
7,000	8,139.5	—	—	—	—	0.261	0.1074
7,500	8,720.9	—	—	—	—	0.280	0.1208
8,000	9,302.3	—	—	—	—	0.298	0.1349
8,500	9,883.7	—	—	—	—	0.317	0.1497
9,000	10,465.1	—	—	—	—	0.336	0.1652
9,500	11,046.5	—	—	—	—	0.354	0.1812
10,000	11,627.9	—	—	—	—	0.373	0.1980
10,500	12,209.3	—	—	—	—	0.392	0.2153
11,000	12,790.7	—	—	—	—	0.410	0.2333
11,500	13,372.1	—	—	—	—	0.429	0.2519
12,000	13,953.5	—	—	—	—	0.448	0.2711
12,500	14,534.9	—	—	—	—	0.466	0.2909
13,000	15,116.3	—	—	—	—	0.485	0.3114
13,500	15,697.7	—	—	—	—	0.504	0.3324

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