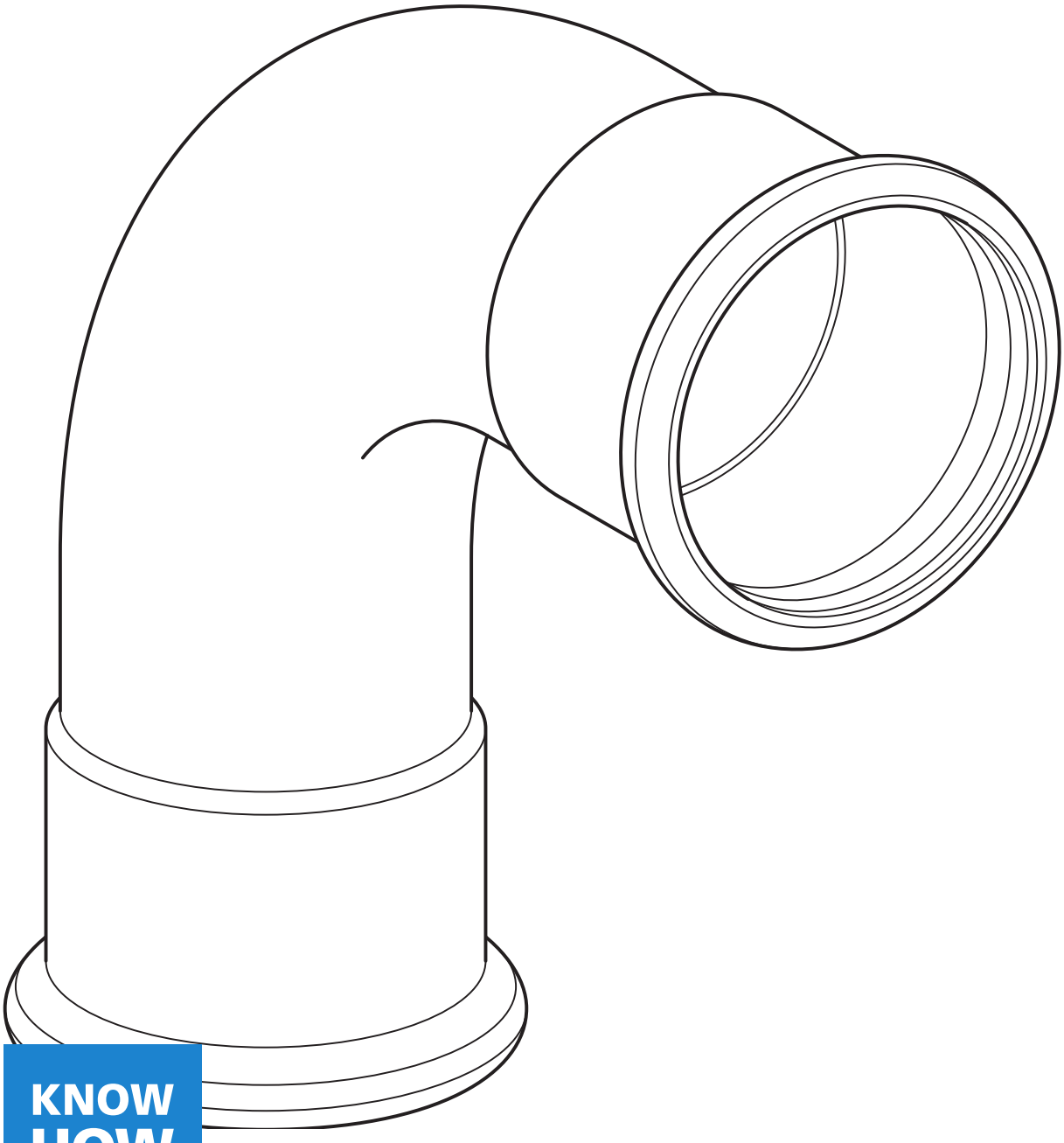
GEBERIT

GEBERIT MAPRESS COPPER
PRESSURE LOSS

VALID FROM 1 JANUARY 2026



KNOW HOW INSTALLED

1 TOTAL PRESSURE LOSS IN AN INSTALLATION

The total pressure loss in an installation is derived from the sum of the

- pressure losses through pipe friction in pipes
- pressure losses from the individual resistances of fittings

$$\Delta p_{tot} = \Delta p_R + \Delta p_E$$

Δp_{tot}	Total pressure loss
Δp_R	Pressure loss through pipe friction [Pa]
Δp_E	Pressure loss from individual resistances [Pa]

100,000 PA = 100 kPa = 1 bar = 1000 mbar

1.1 PRESSURE LOSS FROM INDIVIDUAL RESISTANCES

Changes in direction and/or velocity that occur in fittings such as bends and T-pieces cause pressure losses due to individual resistances.

The essential size for determining pressure losses from individual resistances is the pressure loss coefficient ζ (Zeta value), a dimensionless size which represents the resistance against the dynamic pressure of the water.

Since a theoretical determination of the flow losses of these individual resistances is only possible in certain cases, the pressure loss coefficients are determined in accordance with the procedures outlined in the Technical Test Specification W 575 of the DVGW.

The pressure loss from individual resistances Δp_E is derived from the sum of the pressure loss coefficients ζ (Zeta values) multiplied by the dynamic pressure:

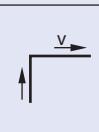
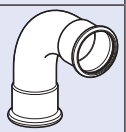
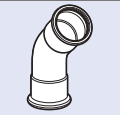
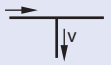
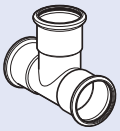
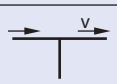
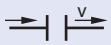
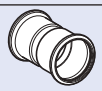
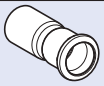
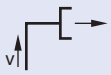
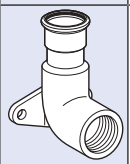
$$\Delta p_E = Z = \sum \zeta \cdot \frac{\rho}{2} \cdot v^2 \qquad \left[\frac{kg \cdot m^2}{m^3 \cdot s^2} = \frac{N}{m^2} = Pa \right]$$

Δp_E	Pressure loss from individual resistances [Pa]
$\sum \zeta$	Sum of the pressure loss coefficients [factor]
ρ	Density [kg/m^3]
v	Velocity in the pipe with the reference diameter [m/s]

1.1.1 Pressure loss coefficients

The pressure loss coefficients were calculated based on SVGW (SN EN 1267) and DVGW (W 575) specifications.

Table 1: Pressure loss coefficients ζ (Zeta values) for Geberit Mapress Copper fittings, d12–35 mm

			d [mm]					
			12	**15**	**18**	**22**	**28**	**35**
Bend 90° (W90)			0.44	0.45	0.42	0.39	0.34	0.34
Bend 45° (W45)			0.35	0.3	0.30	0.29	0.26	0.21
T-piece[1] Branch fitting (TA)			1.07	1.17	1.19	1.15	1.18	1.15
T-piece[1] Through-flow (TD)			0.22	0.20	0.16	0.16	0.12	0.13
Threaded socket (K)			0.20	0.17	0.14	0.14	0.10	0.11
Reducer (RED)			18/12 0.19	22/15 0.13	22/18 0.12	35/22 0.11	42/28 0.09	54/35 0.09
Elbow tap connector 90° (WS)			0.93	1.1	1.18	1.07	–	–

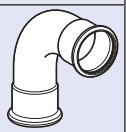
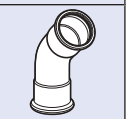
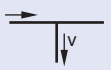
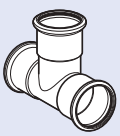
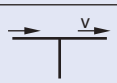
v The symbol v marks the reference cross-section.

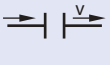
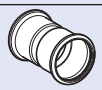
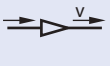
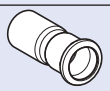
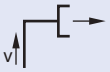
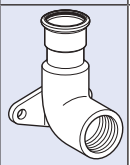
→ The arrow marks the cross-sections flowed through during the measurement.

– Flow situation does not apply to any application.

1) In the case of reduced T-pieces, the resistance value of the equal T-piece is set to the smallest dimension of the reduced T-piece for the flow path to be calculated.

Table 2: Pressure loss coefficients ζ (Zeta values) for Geberit Mapress Copper fittings, d42–108 mm

			d [mm]					
			42	**54**	**66.7**	**76.1**	**88.9**	**108**
Bend 90° (W90)			0.33	0.31	0.3	0.29	0.28	0.26
Bend 45° (W45)			0.20	0.19	0.19	0.18	0.17	0.16
T-piece[1] Branch fitting (TA)			1.17	1.20	1.27	1.35	1.35	1.35
T-piece[1] Through-flow (TD)			0.11	0.09	0.07	0.05	0.05	0.05

			d [mm]					
			42	**54**	**66.7**	**76.1**	**88.9**	**108**
Threaded socket (K)			0.09	0.07	0.13	0.03	0.03	0.03
Reducer (RED)			54/42 0.08	76.1/54 0.07	76.1/66.7 0.07	88.9/76.1 0.03	108/88.9 0.03	–
Elbow tap connector 90° (WS)			–	–	–	–	–	–

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v The symbol v marks the reference cross-section.

→ The arrow marks the cross-sections flowed through during the measurement.

– Flow situation does not apply to any application.

1) In the case of reduced T-pieces, the resistance value of the equal T-piece is set to the smallest dimension of the reduced T-piece for the flow path to be calculated.

1.2 EQUIVALENT PIPE LENGTH

The individual resistances can be taken into account in a simplified manner with the equivalent pipe length instead of the pressure loss coefficient (Zeta value). The equivalent pipe length indicates which length of a straight pipe corresponds to the pressure loss of a fitting or valve with a known individual resistance number.

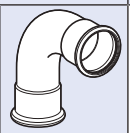
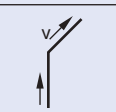
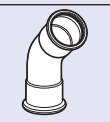
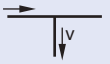
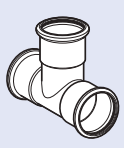
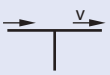
The equivalent pipe length must be added to the pipe length and multiplied by the corresponding pipe friction pressure drop.

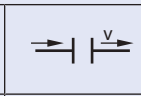
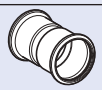
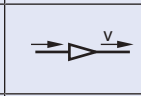
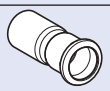
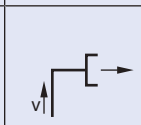
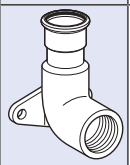
The equivalent pipe lengths corresponding to the individual resistances can be found in the tables entitled "Equivalent pipe lengths".

1.2.1 Equivalent pipe lengths

The equivalent pipe lengths were determined based on the guidelines of the SVGW (SN EN 1267) and DVGW (W 575).

Table 3: Equivalent pipe lengths [m] for Geberit Mapress Copper fittings, d12–35 mm

			d [mm]					
			12	**15**	**18**	**22**	**28**	**35**
Bend 90° (W90)			0.18	0.22	0.26	0.33	0.42	0.54
Bend 45° (W45)			0.14	0.2	0.19	0.25	0.30	0.40
T-piece[1)] Branch fitting (TA)			0.44	0.65	0.83	1.03	1.45	1.86
T-piece[1)] Through-flow (TD)			0.09	0.11	0.12	0.16	0.19	0.26

			d [mm]					
			12	**15**	**18**	**22**	**28**	**35**
Threaded socket (K)			0.08	0.09	0.09	0.12	0.12	0.17
Reducer (RED)			18/12 0.10	22/15 0.07	22/18 0.08	35/22 0.09	42/28 0.11	54/35 0.14
Elbow tap connector 90° (WS)			0.36	0.56	0.78	0.9	–	–

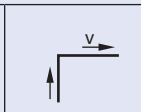
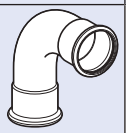
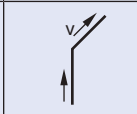
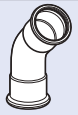
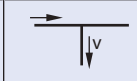
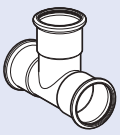
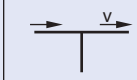
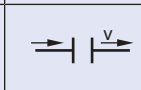
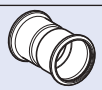
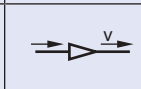
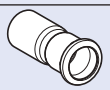
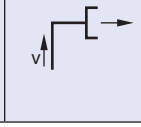
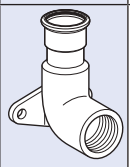
v The symbol v marks the reference cross-section.

→ The arrow marks the cross-sections flowed through during the measurement.

– Flow situation does not apply to any application.

1) In the case of reduced T-pieces, the equivalent pipe length of the equal T-piece is set to the smallest dimension of the reduced T-piece for the flow path to be calculated.

Table 4: Equivalent pipe lengths [m] for Geberit Mapress Copper fittings, d42–108 mm

			d [mm]					
			42	**54**	**66.7**	**76.1**	**88.9**	**108**
Bend 90° (W90)			0.66	0.86	1.1	1.11	1.33	1.68
Bend 45° (W45)			0.47	0.60	0.7	0.66	0.78	0.99
T-piece[1] Branch fitting (TA)			2.43	3.47	4.6	5.74	7.06	9.14
T-piece[1] Through-flow (TD)			0.30	0.37	0.35	0.33	0.39	0.47
Threaded socket (K)			0.18	0.19	0.49	0.12	0.15	0.19
Reducer (RED)			54/42 0.16	76.1/54 0.19	76.1/66.7 0.26	88.9/76.1 0.12	108/88.9 0.15	–
Elbow tap connector 90° (WS)			–	–	–	–	–	–

v The symbol v marks the reference cross-section.

→ The arrow marks the cross-sections flowed through during the measurement.

– Flow situation does not apply to any application.

1) In the case of reduced T-pieces, the equivalent pipe length of the equal T-piece is set to the smallest dimension of the reduced T-piece for the flow path to be calculated.

2 POTABLE WATER PRESSURE LOSS

2.1 POTABLE WATER 10 °C

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

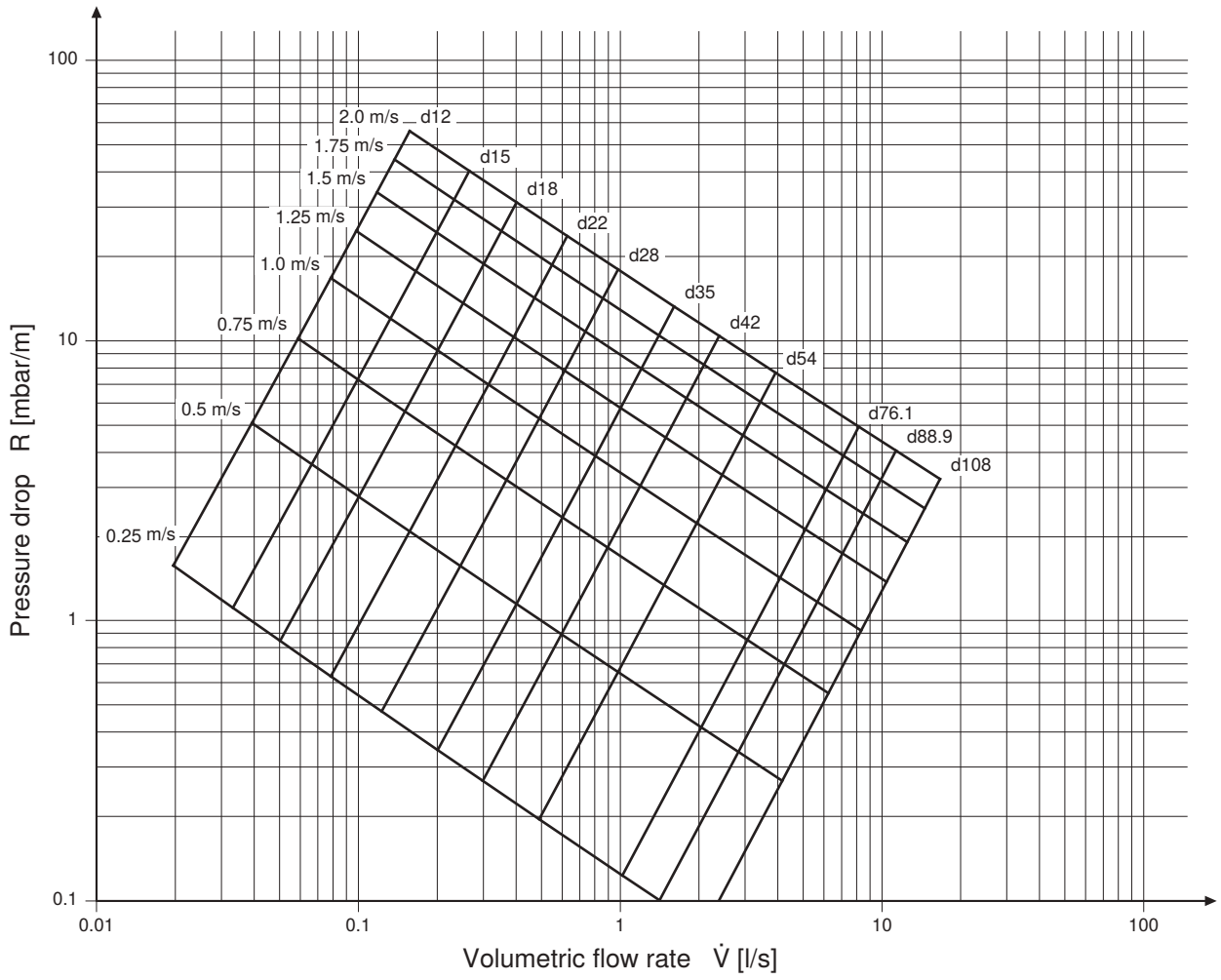


Table 5: Pressure loss for copper pipes in accordance with DVGW GW 392, drinking water 10 °C, d12–22 mm

d [mm]	12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0		22 x 1.0	
V̇ [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	0.12	0.45	0.13	0.53	–	–	–	–	–	–
0.02	0.24	0.91	0.25	1.06	0.15	0.37	0.10	0.16	–	–
0.03	0.35	2.67	0.38	3.21	0.23	0.56	0.15	0.24	–	–
0.04	0.47	4.36	0.51	5.24	0.30	1.53	0.20	0.58	0.11	0.09
0.05	0.59	6.38	0.64	7.68	0.38	2.23	0.25	0.84	0.13	0.11
0.06	0.71	8.72	0.76	10.50	0.45	3.04	0.30	1.14	0.16	0.26
0.07	0.82	11.38	0.89	13.70	0.53	3.96	0.35	1.49	0.18	0.33
0.08	0.94	14.33	1.02	17.25	0.60	4.99	0.40	1.87	0.21	0.42
0.09	1.06	17.57	1.15	21.16	0.68	6.11	0.45	2.29	0.24	0.51
0.10	1.18	21.10	1.27	25.41	0.75	7.33	0.50	2.74	0.26	0.61
0.15	1.77	42.81	1.91	51.60	1.13	14.82	0.75	5.53	0.39	1.23
0.20	–	–	–	–	1.51	24.50	0.99	9.13	0.53	2.01
0.25	–	–	–	–	1.88	36.25	1.24	13.48	0.66	2.97
0.30	–	–	–	–	–	–	1.49	18.56	0.79	4.08
0.35	–	–	–	–	–	–	1.74	24.35	0.92	5.34
0.40	–	–	–	–	–	–	1.99	30.82	1.05	6.75
0.45	–	–	–	–	–	–	–	–	1.18	8.31
0.50	–	–	–	–	–	–	–	–	1.32	10.00
0.55	–	–	–	–	–	–	–	–	1.45	11.83
0.60	–	–	–	–	–	–	–	–	1.58	13.79
0.65	–	–	–	–	–	–	–	–	1.71	15.89
0.70	–	–	–	–	–	–	–	–	1.84	18.12
0.75	–	–	–	–	–	–	–	–	1.97	20.48

Table 6: Pressure loss for copper pipes in accordance with DVGW GW 392, drinking water 10 °C, d28–35 mm

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
0.04	–	–	0.08	0.05	–	–	–	–
0.05	0.09	0.06	0.10	0.07	–	–	–	–
0.06	0.11	0.07	0.12	0.14	–	–	–	–
0.07	0.13	0.15	0.14	0.18	0.08	0.03	0.09	0.04
0.08	0.15	0.19	0.16	0.23	0.10	0.07	0.10	0.07
0.09	0.17	0.23	0.18	0.28	0.11	0.08	0.11	0.09
0.10	0.19	0.28	0.20	0.33	0.12	0.10	0.12	0.10
0.15	0.28	0.56	0.31	0.67	0.18	0.19	0.19	0.21
0.20	0.38	0.91	0.41	1.10	0.24	0.31	0.25	0.34
0.25	0.47	1.34	0.51	1.62	0.30	0.46	0.31	0.50
0.30	0.57	1.85	0.61	2.22	0.36	0.63	0.37	0.69
0.35	0.66	2.42	0.71	2.91	0.42	0.83	0.44	0.90
0.40	0.75	3.05	0.81	3.68	0.48	1.04	0.50	1.14
0.45	0.85	3.75	0.92	4.52	0.54	1.28	0.56	1.40
0.50	0.94	4.51	1.02	5.44	0.60	1.54	0.62	1.68
0.55	1.04	5.33	1.12	6.43	0.66	1.82	0.68	1.98
0.60	1.13	6.22	1.22	7.49	0.72	2.12	0.75	2.31
0.65	1.22	7.16	1.32	8.63	0.78	2.44	0.81	2.66
0.70	1.32	8.16	1.43	9.84	0.84	2.77	0.87	3.03

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
0.75	1.41	9.22	1.53	11.11	0.90	3.13	0.93	3.42
0.80	1.51	10.33	1.63	12.46	0.96	3.51	0.99	3.84
0.85	1.60	11.50	1.73	13.87	1.02	3.91	1.06	4.27
0.90	1.70	12.73	1.83	15.35	1.08	4.32	1.12	4.72
0.95	1.79	14.01	1.94	16.90	1.14	4.75	1.18	5.20
1.00	1.88	15.35	2.04	18.51	1.20	5.21	1.24	5.69
1.05	1.98	16.74	–	–	1.26	5.68	1.31	6.20
1.10	–	–	–	–	1.32	6.16	1.37	6.73
1.15	–	–	–	–	1.38	6.67	1.43	7.29
1.20	–	–	–	–	1.44	7.19	1.49	7.86
1.25	–	–	–	–	1.50	7.73	1.55	8.45
1.30	–	–	–	–	1.56	8.29	1.62	9.06
1.40	–	–	–	–	1.68	9.45	1.74	10.33
1.50	–	–	–	–	1.80	10.69	1.87	11.68
1.60	–	–	–	–	1.92	11.99	1.99	13.11
1.70	–	–	–	–	2.04	13.36	–	–

Table 7: Pressure loss for copper pipes in accordance with DVGW GW 392, drinking water 10 °C, d42–54 mm

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
0.10	0.08	0.04	0.08	0.04	–	–	–	–
0.15	0.12	0.08	0.13	0.08	–	–	–	–
0.20	0.16	0.13	0.17	0.13	0.10	0.04	0.10	0.04
0.25	0.20	0.18	0.21	0.20	0.12	0.06	0.13	0.06
0.30	0.24	0.25	0.25	0.27	0.15	0.08	0.15	0.08
0.35	0.28	0.33	0.29	0.35	0.17	0.10	0.18	0.11
0.40	0.32	0.41	0.33	0.45	0.20	0.13	0.20	0.14
0.45	0.37	0.51	0.38	0.55	0.22	0.15	0.23	0.17
0.50	0.41	0.61	0.42	0.66	0.24	0.18	0.25	0.20
0.55	0.45	0.72	0.46	0.78	0.27	0.22	0.28	0.24
0.60	0.49	0.84	0.50	0.90	0.29	0.25	0.31	0.28
0.65	0.53	0.97	0.54	1.04	0.32	0.29	0.33	0.32
0.70	0.57	1.10	0.59	1.18	0.34	0.33	0.36	0.36
0.75	0.61	1.24	0.63	1.33	0.37	0.37	0.38	0.41
0.80	0.65	1.39	0.67	1.49	0.39	0.42	0.41	0.46
0.85	0.69	1.55	0.71	1.66	0.42	0.46	0.43	0.51
0.90	0.73	1.71	0.75	1.84	0.44	0.51	0.46	0.56
0.95	0.77	1.88	0.80	2.02	0.47	0.56	0.48	0.62
1.00	0.81	2.06	0.84	2.21	0.49	0.62	0.51	0.68
1.05	0.85	2.24	0.88	2.41	0.51	0.67	0.53	0.74
1.10	0.89	2.44	0.92	2.62	0.54	0.73	0.56	0.80
1.15	0.93	2.63	0.96	2.83	0.56	0.79	0.59	0.87
1.20	0.97	2.84	1.00	3.05	0.59	0.85	0.61	0.93
1.25	1.01	3.05	1.05	3.28	0.61	0.91	0.64	1.00
1.30	1.06	3.27	1.09	3.52	0.64	0.98	0.66	1.08
1.40	1.14	3.73	1.17	4.01	0.69	1.12	0.71	1.23
1.50	1.22	4.22	1.26	4.54	0.73	1.26	0.76	1.38

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
1.60	1.30	4.73	1.34	5.09	0.78	1.41	0.81	1.55
1.70	1.38	5.27	1.42	5.66	0.83	1.57	0.87	1.73
1.80	1.46	5.83	1.51	6.27	0.88	1.74	0.92	1.91
1.90	1.54	6.42	1.59	6.90	0.93	1.91	0.97	2.10
2.00	1.62	7.03	1.67	7.56	0.98	2.10	1.02	2.30
2.10	1.71	7.67	1.76	8.25	1.03	2.29	1.07	2.51
2.20	1.79	8.33	1.84	8.97	1.08	2.48	1.12	2.73
2.30	1.87	9.02	1.93	9.71	1.13	2.69	1.17	2.95
2.40	1.95	9.73	2.01	10.47	1.17	2.90	1.22	3.19
2.50	2.03	10.47	–	–	1.22	3.12	1.27	3.43
2.60	–	–	–	–	1.27	3.34	1.32	3.67
2.70	–	–	–	–	1.32	3.57	1.38	3.93
2.80	–	–	–	–	1.37	3.81	1.43	4.19
2.90	–	–	–	–	1.42	4.06	1.48	4.46
3.00	–	–	–	–	1.47	4.31	1.53	4.74
3.10	–	–	–	–	1.52	4.57	1.58	5.03
3.20	–	–	–	–	1.57	4.84	1.63	5.32
3.30	–	–	–	–	1.62	5.11	1.68	5.62
3.40	–	–	–	–	1.66	5.39	1.73	5.93
3.50	–	–	–	–	1.71	5.68	1.78	6.25
3.60	–	–	–	–	1.76	5.97	1.83	6.57
3.70	–	–	–	–	1.81	6.27	1.88	6.90
3.80	–	–	–	–	1.86	6.58	1.94	7.24
3.90	–	–	–	–	1.91	6.89	1.99	7.58
4.00	–	–	–	–	1.96	7.21	2.04	7.93
4.10	–	–	–	–	2.01	7.54	–	–

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Table 8: Pressure loss for copper pipes in accordance with DVGW GW 392, drinking water 10 °C, d76.1–108 mm

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
V̇ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.35	0.09	0.02	–	–	–	–
0.40	0.10	0.02	–	–	–	–
0.45	0.11	0.03	–	–	–	–
0.50	0.12	0.04	0.09	0.02	–	–
0.55	0.13	0.04	0.10	0.02	–	–
0.60	0.15	0.05	0.11	0.02	–	–
0.65	0.16	0.06	0.11	0.03	–	–
0.70	0.17	0.06	0.12	0.03	0.08	0.01
0.75	0.18	0.07	0.13	0.03	0.09	0.01
0.80	0.20	0.08	0.14	0.04	0.10	0.01
0.85	0.21	0.09	0.15	0.04	0.10	0.02
0.90	0.22	0.10	0.16	0.05	0.11	0.02
0.95	0.23	0.11	0.17	0.05	0.11	0.02
1.00	0.24	0.12	0.18	0.05	0.12	0.02
1.05	0.26	0.13	0.19	0.06	0.13	0.02
1.10	0.27	0.14	0.19	0.06	0.13	0.03
1.15	0.28	0.15	0.20	0.07	0.14	0.03

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
V̇ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1.20	0.29	0.16	0.21	0.08	0.14	0.03
1.25	0.31	0.18	0.22	0.08	0.15	0.03
1.30	0.32	0.19	0.23	0.09	0.16	0.03
1.40	0.34	0.21	0.25	0.10	0.17	0.04
1.50	0.37	0.24	0.26	0.11	0.18	0.04
1.60	0.39	0.27	0.28	0.12	0.19	0.05
1.70	0.42	0.30	0.30	0.14	0.20	0.06
1.80	0.44	0.33	0.32	0.15	0.22	0.06
1.90	0.47	0.37	0.34	0.17	0.23	0.07
2.00	0.49	0.40	0.35	0.18	0.24	0.07
2.10	0.51	0.44	0.37	0.20	0.25	0.08
2.20	0.54	0.48	0.39	0.22	0.26	0.09
2.30	0.56	0.51	0.41	0.24	0.28	0.09
2.40	0.59	0.55	0.42	0.25	0.29	0.10
2.50	0.61	0.60	0.44	0.27	0.30	0.11
2.60	0.64	0.64	0.46	0.29	0.31	0.12
2.70	0.66	0.68	0.48	0.31	0.32	0.12
2.80	0.69	0.73	0.49	0.33	0.34	0.13
2.90	0.71	0.78	0.51	0.36	0.35	0.14
3.00	0.73	0.82	0.53	0.38	0.36	0.15
3.10	0.76	0.87	0.55	0.40	0.37	0.16
3.20	0.78	0.92	0.57	0.42	0.38	0.17
3.30	0.81	0.97	0.58	0.45	0.40	0.18
3.40	0.83	1.03	0.60	0.47	0.41	0.19
3.50	0.86	1.08	0.62	0.50	0.42	0.20
3.60	0.88	1.14	0.64	0.52	0.43	0.21
3.70	0.91	1.19	0.65	0.55	0.44	0.22
3.80	0.93	1.25	0.67	0.57	0.46	0.23
3.90	0.96	1.31	0.69	0.60	0.47	0.24
4.00	0.98	1.37	0.71	0.63	0.48	0.25
4.10	1.00	1.43	0.72	0.66	0.49	0.26
4.20	1.03	1.50	0.74	0.69	0.50	0.27
4.30	1.05	1.56	0.76	0.71	0.52	0.28
4.40	1.08	1.63	0.78	0.74	0.53	0.30
4.50	1.10	1.69	0.79	0.77	0.54	0.31
4.60	1.13	1.76	0.81	0.81	0.55	0.32
4.70	1.15	1.83	0.83	0.84	0.56	0.33
4.80	1.18	1.90	0.85	0.87	0.58	0.34
4.90	1.20	1.97	0.87	0.90	0.59	0.36
5.00	1.22	2.04	0.88	0.93	0.60	0.37
5.50	1.35	2.42	0.97	1.11	0.66	0.44
6.00	1.47	2.83	1.06	1.29	0.72	0.51
6.50	1.59	3.27	1.15	1.49	0.78	0.59
7.00	1.71	3.73	1.24	1.71	0.84	0.68
7.50	1.84	4.23	1.32	1.93	0.90	0.76
8.00	1.96	4.75	1.41	2.17	0.96	0.86
8.50	–	–	1.50	2.41	1.02	0.96
9.00	–	–	1.59	2.68	1.08	1.06
9.50	–	–	1.68	2.95	1.14	1.17

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
10.00	–	–	1.77	3.23	1.20	1.28
10.50	–	–	1.85	3.53	1.26	1.40
11.00	–	–	1.94	3.84	1.32	1.52
11.50	–	–	2.03	4.16	1.38	1.64
12.00	–	–	–	–	1.44	1.77
12.50	–	–	–	–	1.50	1.91
13.00	–	–	–	–	1.56	2.05
13.50	–	–	–	–	1.62	2.19
14.00	–	–	–	–	1.68	2.34
14.50	–	–	–	–	1.74	2.49
15.00	–	–	–	–	1.80	2.65
15.50	–	–	–	–	1.86	2.81
16.00	–	–	–	–	1.92	2.98
16.50	–	–	–	–	1.98	3.15

2.2 DRINKING WATER 60 °C

Medium:	Water	Viscosity:	0.000467 Pa•s
Temperature:	60 °C	Surface roughness:	0.0015 mm
Density:	983.2 kg/m^3		

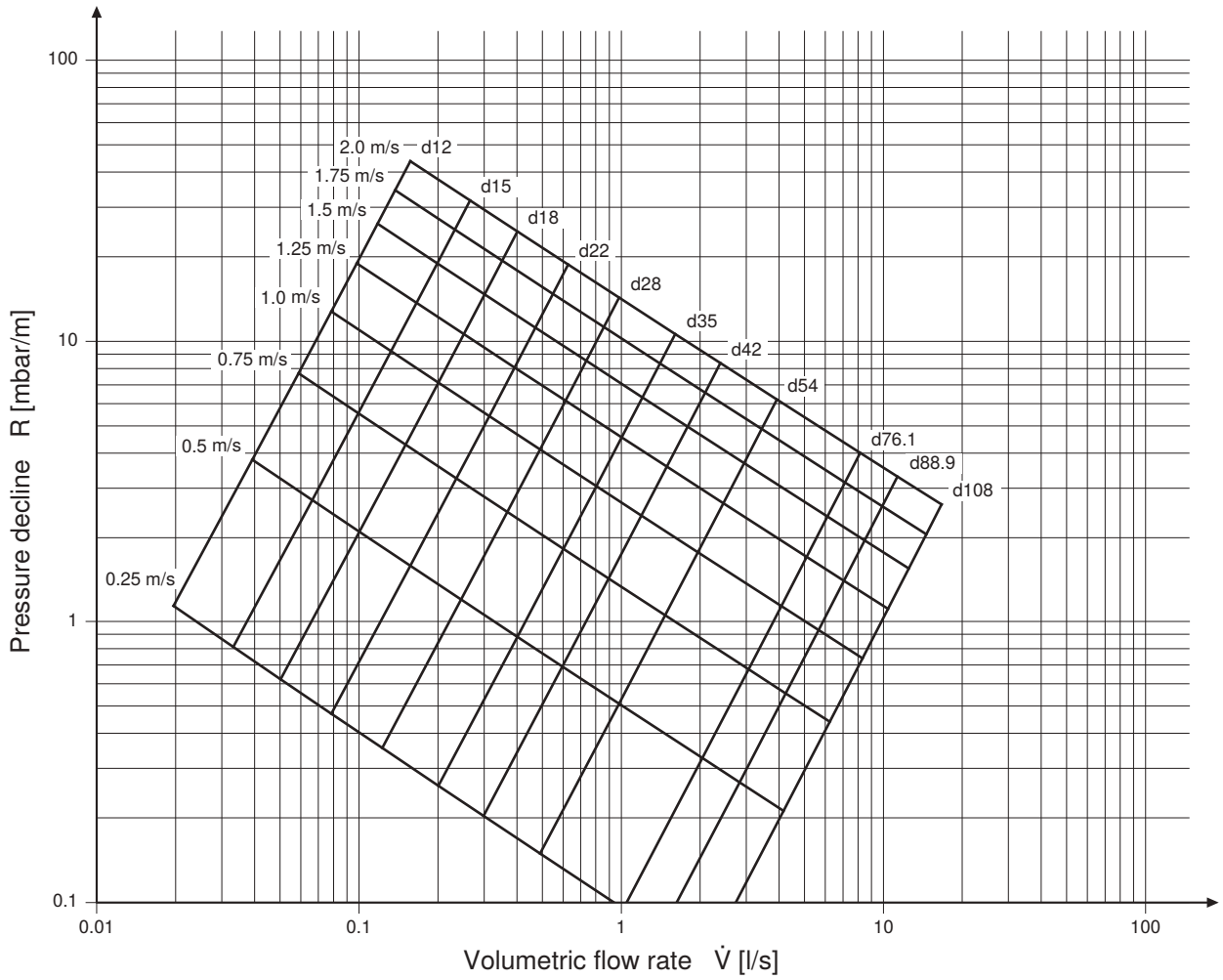

Table 9: Pressure loss for copper pipes in accordance with DVGW GW 392, drinking water 60 °C, d12–22 mm

d [mm]	**12 x 0.8**		**12 x 1.0**		**15 x 1.0**		**18 x 1.0**		**22 x 1.0**	
V̇ [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	0.12	0.30	0.13	0.36	–	–	–	–	–	–
0.02	0.24	0.98	0.25	1.18	0.15	0.34	0.10	0.13	–	–
0.03	0.35	1.96	0.38	2.37	0.23	0.68	0.15	0.26	–	–
0.04	0.47	3.24	0.51	3.90	0.30	1.12	0.20	0.42	0.11	0.09
0.05	0.59	4.78	0.64	5.76	0.38	1.66	0.25	0.62	0.13	0.14
0.06	0.71	6.58	0.76	7.93	0.45	2.27	0.30	0.85	0.16	0.19
0.07	0.82	8.63	0.89	10.40	0.53	2.98	0.35	1.11	0.18	0.25
0.08	0.94	10.91	1.02	13.16	0.60	3.76	0.40	1.40	0.21	0.31

d [mm]	12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0		22 x 1.0	
V̇ [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]
0.09	1.06	13.44	1.15	16.21	0.68	4.63	0.45	1.72	0.24	0.38
0.10	1.18	16.19	1.27	19.54	0.75	5.57	0.50	2.07	0.26	0.46
0.15	1.77	33.32	1.91	40.23	1.13	11.42	0.75	4.23	0.39	0.93
0.20	–	–	–	–	1.51	19.07	0.99	7.05	0.53	1.54
0.25	–	–	–	–	1.88	28.42	1.24	10.48	0.66	2.28
0.30	–	–	–	–	–	–	1.49	14.52	0.79	3.15
0.35	–	–	–	–	–	–	1.74	19.13	0.92	4.15
0.40	–	–	–	–	–	–	1.99	24.32	1.05	5.26
0.45	–	–	–	–	–	–	–	–	1.18	6.50
0.50	–	–	–	–	–	–	–	–	1.32	7.84
0.55	–	–	–	–	–	–	–	–	1.45	9.31
0.60	–	–	–	–	–	–	–	–	1.58	10.88
0.65	–	–	–	–	–	–	–	–	1.71	12.56
0.70	–	–	–	–	–	–	–	–	1.84	14.36
0.75	–	–	–	–	–	–	–	–	1.97	16.26

Table 10: Pressure loss for copper pipes in accordance with DVGW GW 392, drinking water 60 °C, d28–35 mm

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
0.04	–	–	0.08	0.05	–	–	–	–
0.05	0.09	0.06	0.10	0.08	–	–	–	–
0.06	0.11	0.09	0.12	0.10	–	–	–	–
0.07	0.13	0.11	0.14	0.13	0.08	0.04	0.09	0.04
0.08	0.15	0.14	0.16	0.17	0.10	0.05	0.10	0.05
0.09	0.17	0.17	0.18	0.21	0.11	0.06	0.11	0.06
0.10	0.19	0.21	0.20	0.25	0.12	0.07	0.12	0.08
0.15	0.28	0.42	0.31	0.50	0.18	0.14	0.19	0.16
0.20	0.38	0.69	0.41	0.84	0.24	0.24	0.25	0.26
0.25	0.47	1.03	0.51	1.24	0.30	0.35	0.31	0.38
0.30	0.57	1.42	0.61	1.71	0.36	0.48	0.37	0.53
0.35	0.66	1.86	0.71	2.25	0.42	0.63	0.44	0.69
0.40	0.75	2.36	0.81	2.85	0.48	0.80	0.50	0.88
0.45	0.85	2.92	0.92	3.52	0.54	0.99	0.56	1.08
0.50	0.94	3.52	1.02	4.25	0.60	1.19	0.62	1.30
0.55	1.04	4.17	1.12	5.03	0.66	1.41	0.68	1.54
0.60	1.13	4.87	1.22	5.88	0.72	1.65	0.75	1.80
0.65	1.22	5.63	1.32	6.79	0.78	1.90	0.81	2.08
0.70	1.32	6.42	1.43	7.76	0.84	2.17	0.87	2.37
0.75	1.41	7.27	1.53	8.78	0.90	2.45	0.93	2.68
0.80	1.51	8.17	1.63	9.86	0.96	2.75	0.99	3.01
0.85	1.60	9.11	1.73	11.00	1.02	3.07	1.06	3.36
0.90	1.70	10.10	1.83	12.20	1.08	3.40	1.12	3.72
0.95	1.79	11.13	1.94	13.45	1.14	3.75	1.18	4.10
1.00	1.88	12.21	2.04	14.75	1.20	4.11	1.24	4.49
1.05	1.98	13.33	–	–	1.26	4.48	1.31	4.90
1.10	–	–	–	–	1.32	4.88	1.37	5.33
1.15	–	–	–	–	1.38	5.28	1.43	5.78

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
1.20	–	–	–	–	1.44	5.70	1.49	6.24
1.25	–	–	–	–	1.50	6.14	1.55	6.71
1.30	–	–	–	–	1.56	6.59	1.62	7.21
1.40	–	–	–	–	1.68	7.53	1.74	8.24
1.50	–	–	–	–	1.80	8.53	1.87	9.33
1.60	–	–	–	–	1.92	9.59	1.99	10.49
1.70	–	–	–	–	2.04	10.70	–	–

Table 11: Pressure loss for copper pipes in accordance with DVGW GW 392, drinking water 60 °C, d42–54 mm

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
0.10	0.08	0.03	0.08	0.03	–	–	–	–
0.15	0.12	0.06	0.13	0.06	–	–	–	–
0.20	0.16	0.09	0.17	0.10	0.10	0.03	0.10	0.03
0.25	0.20	0.14	0.21	0.15	0.12	0.04	0.13	0.05
0.30	0.24	0.19	0.25	0.21	0.15	0.06	0.15	0.06
0.35	0.28	0.25	0.29	0.27	0.17	0.08	0.18	0.08
0.40	0.32	0.32	0.33	0.34	0.20	0.09	0.20	0.10
0.45	0.37	0.39	0.38	0.42	0.22	0.12	0.23	0.13
0.50	0.41	0.47	0.42	0.51	0.24	0.14	0.25	0.15
0.55	0.45	0.56	0.46	0.60	0.27	0.17	0.28	0.18
0.60	0.49	0.65	0.50	0.70	0.29	0.19	0.31	0.21
0.65	0.53	0.75	0.54	0.81	0.32	0.22	0.33	0.25
0.70	0.57	0.85	0.59	0.92	0.34	0.25	0.36	0.28
0.75	0.61	0.97	0.63	1.04	0.37	0.29	0.38	0.32
0.80	0.65	1.08	0.67	1.17	0.39	0.32	0.41	0.35
0.85	0.69	1.21	0.71	1.30	0.42	0.36	0.43	0.40
0.90	0.73	1.34	0.75	1.44	0.44	0.40	0.46	0.44
0.95	0.77	1.47	0.80	1.58	0.47	0.44	0.48	0.48
1.00	0.81	1.61	0.84	1.74	0.49	0.48	0.51	0.53
1.05	0.85	1.76	0.88	1.90	0.51	0.52	0.53	0.58
1.10	0.89	1.91	0.92	2.06	0.54	0.57	0.56	0.63
1.15	0.93	2.07	0.96	2.23	0.56	0.62	0.59	0.68
1.20	0.97	2.24	1.00	2.41	0.59	0.66	0.61	0.73
1.25	1.01	2.41	1.05	2.59	0.61	0.72	0.64	0.79
1.30	1.06	2.58	1.09	2.78	0.64	0.77	0.66	0.84
1.40	1.14	2.95	1.17	3.18	0.69	0.88	0.71	0.96
1.50	1.22	3.34	1.26	3.60	0.73	0.99	0.76	1.09
1.60	1.30	3.75	1.34	4.04	0.78	1.11	0.81	1.22
1.70	1.38	4.19	1.42	4.51	0.83	1.24	0.87	1.36
1.80	1.46	4.64	1.51	5.00	0.88	1.37	0.92	1.51
1.90	1.54	5.12	1.59	5.51	0.93	1.51	0.97	1.67
2.00	1.62	5.62	1.67	6.05	0.98	1.66	1.02	1.83
2.10	1.71	6.13	1.76	6.60	1.03	1.81	1.07	2.00
2.20	1.79	6.67	1.84	7.18	1.08	1.97	1.12	2.17
2.30	1.87	7.23	1.93	7.79	1.13	2.14	1.17	2.35
2.40	1.95	7.81	2.01	8.41	1.17	2.31	1.22	2.54

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
2.50	2.03	8.41	–	–	1.22	2.48	1.27	2.73
2.60	–	–	–	–	1.27	2.67	1.32	2.93
2.70	–	–	–	–	1.32	2.85	1.38	3.14
2.80	–	–	–	–	1.37	3.05	1.43	3.35
2.90	–	–	–	–	1.42	3.25	1.48	3.57
3.00	–	–	–	–	1.47	3.45	1.53	3.80
3.10	–	–	–	–	1.52	3.66	1.58	4.03
3.20	–	–	–	–	1.57	3.88	1.63	4.27
3.30	–	–	–	–	1.62	4.10	1.68	4.51
3.40	–	–	–	–	1.66	4.33	1.73	4.77
3.50	–	–	–	–	1.71	4.57	1.78	5.02
3.60	–	–	–	–	1.76	4.80	1.83	5.29
3.70	–	–	–	–	1.81	5.05	1.88	5.56
3.80	–	–	–	–	1.86	5.30	1.94	5.83
3.90	–	–	–	–	1.91	5.56	1.99	6.11
4.00	–	–	–	–	1.96	5.82	2.04	6.40
4.10	–	–	–	–	2.01	6.08	–	–

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Table 12: Pressure loss for copper pipes in accordance with DVGW GW 392, drinking water 60 °C, d76.1–108 mm

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
V̇ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
0.35	0.09	0.01	–	–	–	–
0.40	0.10	0.02	–	–	–	–
0.45	0.11	0.02	–	–	–	–
0.50	0.12	0.03	0.09	0.01	–	–
0.55	0.13	0.03	0.10	0.01	–	–
0.60	0.15	0.04	0.11	0.02	–	–
0.65	0.16	0.04	0.11	0.02	–	–
0.70	0.17	0.05	0.12	0.02	0.08	0.01
0.75	0.18	0.06	0.13	0.03	0.09	0.01
0.80	0.20	0.06	0.14	0.03	0.10	0.01
0.85	0.21	0.07	0.15	0.03	0.10	0.01
0.90	0.22	0.08	0.16	0.03	0.11	0.01
0.95	0.23	0.08	0.17	0.04	0.11	0.02
1.00	0.24	0.09	0.18	0.04	0.12	0.02
1.05	0.26	0.10	0.19	0.05	0.13	0.02
1.10	0.27	0.11	0.19	0.05	0.13	0.02
1.15	0.28	0.12	0.20	0.05	0.14	0.02
1.20	0.29	0.13	0.21	0.06	0.14	0.02
1.25	0.31	0.14	0.22	0.06	0.15	0.02
1.30	0.32	0.15	0.23	0.07	0.16	0.03
1.40	0.34	0.17	0.25	0.08	0.17	0.03
1.50	0.37	0.19	0.26	0.09	0.18	0.03
1.60	0.39	0.21	0.28	0.10	0.19	0.04
1.70	0.42	0.24	0.30	0.11	0.20	0.04
1.80	0.44	0.26	0.32	0.12	0.22	0.05
1.90	0.47	0.29	0.34	0.13	0.23	0.05

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
V̇ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2.00	0.49	0.32	0.35	0.14	0.24	0.06
2.10	0.51	0.34	0.37	0.16	0.25	0.06
2.20	0.54	0.37	0.39	0.17	0.26	0.07
2.30	0.56	0.40	0.41	0.18	0.28	0.07
2.40	0.59	0.44	0.42	0.20	0.29	0.08
2.50	0.61	0.47	0.44	0.21	0.30	0.09
2.60	0.64	0.50	0.46	0.23	0.31	0.09
2.70	0.66	0.54	0.48	0.25	0.32	0.10
2.80	0.69	0.58	0.49	0.26	0.34	0.10
2.90	0.71	0.61	0.51	0.28	0.35	0.11
3.00	0.73	0.65	0.53	0.30	0.36	0.12
3.10	0.76	0.69	0.55	0.32	0.37	0.12
3.20	0.78	0.73	0.57	0.33	0.38	0.13
3.30	0.81	0.77	0.58	0.35	0.40	0.14
3.40	0.83	0.82	0.60	0.37	0.41	0.15
3.50	0.86	0.86	0.62	0.39	0.42	0.16
3.60	0.88	0.91	0.64	0.41	0.43	0.16
3.70	0.91	0.95	0.65	0.43	0.44	0.17
3.80	0.93	1.00	0.67	0.46	0.46	0.18
3.90	0.96	1.05	0.69	0.48	0.47	0.19
4.00	0.98	1.10	0.71	0.50	0.48	0.20
4.10	1.00	1.15	0.72	0.52	0.49	0.21
4.20	1.03	1.20	0.74	0.54	0.50	0.22
4.30	1.05	1.25	0.76	0.57	0.52	0.22
4.40	1.08	1.30	0.78	0.59	0.53	0.23
4.50	1.10	1.36	0.79	0.62	0.54	0.24
4.60	1.13	1.41	0.81	0.64	0.55	0.25
4.70	1.15	1.47	0.83	0.67	0.56	0.26
4.80	1.18	1.52	0.85	0.69	0.58	0.27
4.90	1.20	1.58	0.87	0.72	0.59	0.28
5.00	1.22	1.64	0.88	0.75	0.60	0.29
5.50	1.35	1.95	0.97	0.89	0.66	0.35
6.00	1.47	2.28	1.06	1.04	0.72	0.41
6.50	1.59	2.64	1.15	1.20	0.78	0.47
7.00	1.71	3.02	1.24	1.37	0.84	0.54
7.50	1.84	3.42	1.32	1.56	0.90	0.61
8.00	1.96	3.85	1.41	1.75	0.96	0.69
8.50	–	–	1.50	1.95	1.02	0.77
9.00	–	–	1.59	2.17	1.08	0.85
9.50	–	–	1.68	2.39	1.14	0.94
10.00	–	–	1.77	2.62	1.20	1.03
10.50	–	–	1.85	2.87	1.26	1.13
11.00	–	–	1.94	3.12	1.32	1.23
11.50	–	–	2.03	3.39	1.38	1.33
12.00	–	–	–	–	1.44	1.44
12.50	–	–	–	–	1.50	1.55
13.00	–	–	–	–	1.56	1.66
13.50	–	–	–	–	1.62	1.78
14.00	–	–	–	–	1.68	1.90

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [l/s]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
14.50	–	–	–	–	1.74	2.03
15.00	–	–	–	–	1.80	2.16
15.50	–	–	–	–	1.86	2.29
16.00	–	–	–	–	1.92	2.43
16.50	–	–	–	–	1.98	2.57

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

Table 13: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 10 °C / return flow 11 °C, d12–18 mm

d [mm]		**12 x 0.8**		**12 x 1.0**		**15 x 1.0**		**18 x 1.0**	
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	0.14	0.54	0.15	0.63	0.09	0.22	0.06	0.10
100	86.0	0.28	1.07	0.30	2.18	0.18	0.44	0.12	0.19
150	129.0	0.42	3.60	0.46	4.33	0.27	1.26	0.18	0.29
200	171.9	0.56	5.88	0.61	7.07	0.36	2.06	0.24	0.77
250	214.9	0.70	8.62	0.76	10.38	0.45	3.01	0.30	1.13
300	257.9	0.84	11.80	0.91	14.21	0.54	4.11	0.36	1.54
350	300.9	0.98	15.41	1.06	18.56	0.63	5.36	0.42	2.01
400	343.9	1.12	19.43	1.22	23.40	0.72	6.75	0.48	2.53
450	386.9	1.27	23.84	1.37	28.72	0.81	8.27	0.53	3.10
500	429.8	1.41	28.65	1.52	34.52	0.90	9.93	0.59	3.72
550	472.8	1.55	33.84	1.67	40.78	0.99	11.72	0.65	4.38
600	515.8	1.69	39.40	1.82	47.49	1.08	13.64	0.71	5.09
700	601.8	1.97	51.63	–	–	1.26	17.85	0.83	6.66

d [mm]		12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0	
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]
800	687.7	–	–	–	–	1.44	22.55	0.95	8.40
900	773.7	–	–	–	–	1.62	27.72	1.07	10.32
1,000	859.7	–	–	–	–	1.80	33.35	1.19	12.41
1,100	945.6	–	–	–	–	1.98	39.45	1.31	14.66
1,200	1,031.6	–	–	–	–	–	–	1.43	17.08
1,300	1,117.6	–	–	–	–	–	–	1.54	19.67
1,400	1,203.6	–	–	–	–	–	–	1.66	22.41
1,500	1,289.5	–	–	–	–	–	–	1.78	25.30
1,600	1,375.5	–	–	–	–	–	–	1.90	28.36

Table 14: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 10 °C / return flow 11 °C, d22–28 mm

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
100	86.0	0.08	0.08	–	–	–	–
150	129.0	0.11	0.12	0.07	0.04	0.07	0.05
200	171.9	0.15	0.27	0.09	0.05	0.10	0.06
250	214.9	0.19	0.40	0.11	0.07	0.12	0.14
300	257.9	0.23	0.54	0.13	0.16	0.15	0.19
350	300.9	0.27	0.70	0.16	0.20	0.17	0.25
400	343.9	0.30	0.88	0.18	0.26	0.19	0.31
450	386.9	0.34	1.08	0.20	0.31	0.22	0.38
500	429.8	0.38	1.29	0.22	0.38	0.24	0.45
550	472.8	0.42	1.52	0.25	0.44	0.27	0.53
600	515.8	0.46	1.77	0.27	0.51	0.29	0.62
700	601.8	0.53	2.31	0.31	0.67	0.34	0.80
800	687.7	0.61	2.91	0.36	0.84	0.39	1.01
900	773.7	0.68	3.58	0.40	1.03	0.44	1.24
1,000	859.7	0.76	4.30	0.45	1.24	0.49	1.49
1,100	945.6	0.84	5.07	0.49	1.46	0.54	1.76
1,200	1,031.6	0.91	5.91	0.54	1.70	0.58	2.05
1,300	1,117.6	0.99	6.80	0.58	1.95	0.63	2.35
1,400	1,203.6	1.06	7.74	0.63	2.22	0.68	2.68
1,500	1,289.5	1.14	8.73	0.67	2.51	0.73	3.02
1,600	1,375.5	1.22	9.78	0.72	2.81	0.78	3.38
1,700	1,461.5	1.29	10.88	0.76	3.12	0.83	3.76
1,800	1,547.4	1.37	12.04	0.81	3.45	0.88	4.16
1,900	1,633.4	1.44	13.24	0.85	3.79	0.92	4.57
2,000	1,719.4	1.52	14.49	0.90	4.15	0.97	5.00
2,500	2,149.2	1.90	21.50	1.12	6.15	1.22	7.41
3,000	2,579.0	–	–	1.35	8.48	1.46	10.22
3,500	3,008.9	–	–	1.57	11.14	1.70	13.43
4,000	3,438.7	–	–	1.80	14.11	1.95	17.03

Table 15: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 10 °C / return flow 11 °C, d35–42 mm

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
$\dot{Q}$ [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]
200	171.9	0.06	0.02	0.06	0.02	–	–	–	–
250	214.9	0.07	0.03	0.07	0.03	–	–	–	–
300	257.9	0.09	0.03	0.09	0.04	0.06	0.02	0.06	0.02
350	300.9	0.10	0.07	0.10	0.08	0.07	0.02	0.07	0.02
400	343.9	0.11	0.09	0.12	0.10	0.08	0.04	0.08	0.04
450	386.9	0.13	0.11	0.13	0.12	0.09	0.04	0.09	0.05
500	429.8	0.14	0.13	0.15	0.14	0.10	0.05	0.10	0.06
550	472.8	0.16	0.15	0.16	0.17	0.11	0.06	0.11	0.07
600	515.8	0.17	0.18	0.18	0.19	0.12	0.07	0.12	0.08
700	601.8	0.20	0.23	0.21	0.25	0.14	0.09	0.14	0.10
800	687.7	0.23	0.29	0.24	0.32	0.16	0.12	0.16	0.12
900	773.7	0.26	0.35	0.27	0.39	0.17	0.14	0.18	0.15
1,000	859.7	0.29	0.42	0.30	0.46	0.19	0.17	0.20	0.18
1,100	945.6	0.31	0.50	0.33	0.55	0.21	0.20	0.22	0.21
1,200	1,031.6	0.34	0.58	0.36	0.64	0.23	0.23	0.24	0.25
1,300	1,117.6	0.37	0.67	0.39	0.73	0.25	0.27	0.26	0.29
1,400	1,203.6	0.40	0.76	0.42	0.83	0.27	0.30	0.28	0.33
1,500	1,289.5	0.43	0.86	0.45	0.94	0.29	0.34	0.30	0.37
1,600	1,375.5	0.46	0.96	0.48	1.05	0.31	0.38	0.32	0.41
1,700	1,461.5	0.49	1.07	0.50	1.16	0.33	0.42	0.34	0.46
1,800	1,547.4	0.52	1.18	0.53	1.29	0.35	0.47	0.36	0.50
1,900	1,633.4	0.54	1.29	0.56	1.41	0.37	0.51	0.38	0.55
2,000	1,719.4	0.57	1.42	0.59	1.55	0.39	0.56	0.40	0.60
2,500	2,149.2	0.72	2.09	0.74	2.29	0.48	0.83	0.50	0.89
3,000	2,579.0	0.86	2.88	0.89	3.15	0.58	1.14	0.60	1.23
3,500	3,008.9	1.00	3.78	1.04	4.13	0.68	1.50	0.70	1.61
4,000	3,438.7	1.14	4.79	1.19	5.23	0.78	1.89	0.80	2.04
4,500	3,868.6	1.29	5.90	1.34	6.45	0.87	2.33	0.90	2.51
5,000	4,298.4	1.43	7.11	1.49	7.77	0.97	2.81	1.00	3.02
5,500	4,728.2	1.57	8.42	1.63	9.20	1.07	3.32	1.10	3.57
6,000	5,158.1	1.72	9.83	1.78	10.74	1.16	3.88	1.20	4.17
6,500	5,587.9	1.86	11.33	1.93	12.39	1.26	4.47	1.30	4.81
7,000	6,017.8	–	–	–	–	1.36	5.10	1.40	5.48
7,500	6,447.6	–	–	–	–	1.45	5.76	1.50	6.20
8,000	6,877.4	–	–	–	–	1.55	6.46	1.60	6.96
8,500	7,307.3	–	–	–	–	1.65	7.20	1.70	7.75
9,000	7,737.1	–	–	–	–	1.75	7.97	1.80	8.58
9,500	8,167.0	–	–	–	–	1.84	8.78	1.90	9.45
10,000	8,596.8	–	–	–	–	1.94	9.62	2.00	10.36

Table 16: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 10 °C / return flow 11 °C, d54–76.1 mm

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
450	386.9	0.05	0.01	0.05	0.01	–	–
500	429.8	0.06	0.02	0.06	0.02	–	–
550	472.8	0.06	0.02	0.07	0.02	–	–
600	515.8	0.07	0.02	0.07	0.02	–	–
700	601.8	0.08	0.03	0.09	0.03	–	–
800	687.7	0.09	0.04	0.10	0.04	–	–
900	773.7	0.11	0.04	0.11	0.05	0.05	0.01
1,000	859.7	0.12	0.05	0.12	0.06	0.06	0.01
1,100	945.6	0.13	0.06	0.13	0.07	0.06	0.01
1,200	1,031.6	0.14	0.07	0.15	0.08	0.07	0.01
1,300	1,117.6	0.15	0.08	0.16	0.09	0.08	0.02
1,400	1,203.6	0.16	0.09	0.17	0.10	0.08	0.02
1,500	1,289.5	0.18	0.10	0.18	0.11	0.09	0.02
1,600	1,375.5	0.19	0.12	0.19	0.13	0.09	0.02
1,700	1,461.5	0.20	0.13	0.21	0.14	0.10	0.02
1,800	1,547.4	0.21	0.14	0.22	0.16	0.11	0.03
1,900	1,633.4	0.22	0.16	0.23	0.17	0.11	0.03
2,000	1,719.4	0.23	0.17	0.24	0.19	0.12	0.03
2,500	2,149.2	0.29	0.25	0.30	0.27	0.15	0.05
3,000	2,579.0	0.35	0.34	0.36	0.38	0.18	0.07
3,500	3,008.9	0.41	0.45	0.43	0.49	0.20	0.09
4,000	3,438.7	0.47	0.57	0.49	0.62	0.23	0.11
4,500	3,868.6	0.53	0.70	0.55	0.77	0.26	0.13
5,000	4,298.4	0.58	0.84	0.61	0.92	0.29	0.16
5,500	4,728.2	0.64	0.99	0.67	1.09	0.32	0.19
6,000	5,158.1	0.70	1.16	0.73	1.27	0.35	0.22
6,500	5,587.9	0.76	1.34	0.79	1.47	0.38	0.26
7,000	6,017.8	0.82	1.52	0.85	1.67	0.41	0.29
7,500	6,447.6	0.88	1.72	0.91	1.89	0.44	0.33
8,000	6,877.4	0.94	1.93	0.97	2.12	0.47	0.37
8,500	7,307.3	0.99	2.15	1.03	2.36	0.50	0.41
9,000	7,737.1	1.05	2.38	1.09	2.61	0.53	0.46
9,500	8,167.0	1.11	2.62	1.16	2.88	0.56	0.50
10,000	8,596.8	1.17	2.87	1.22	3.15	0.59	0.55
10,500	9,026.7	1.23	3.13	1.28	3.44	0.61	0.60
11,000	9,456.5	1.29	3.40	1.34	3.73	0.64	0.65
11,500	9,886.3	1.34	3.68	1.40	4.04	0.67	0.70
12,000	10,316.2	1.40	3.97	1.46	4.36	0.70	0.76
12,500	10,746.0	1.46	4.26	1.52	4.69	0.73	0.81
13,000	11,175.9	1.52	4.57	1.58	5.03	0.76	0.87
13,500	11,605.7	1.58	4.89	1.64	5.38	0.79	0.93
14,000	12,035.5	1.64	5.22	1.70	5.74	0.82	1.00
14,500	12,465.4	1.70	5.56	1.76	6.11	0.85	1.06
15,000	12,895.2	1.75	5.91	1.82	6.50	0.88	1.13
15,500	13,325.1	1.81	6.26	1.89	6.89	0.91	1.19
16,000	13,754.9	1.87	6.63	1.95	7.29	0.94	1.26
16,500	14,184.7	1.93	7.01	–	–	0.97	1.33
17,000	14,614.6	1.99	7.39	–	–	0.99	1.41

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17,500	15,044.4	–	–	–	–	1.02	1.48
18,000	15,474.3	–	–	–	–	1.05	1.56
18,500	15,904.1	–	–	–	–	1.08	1.64
19,000	16,333.9	–	–	–	–	1.11	1.72
19,500	16,763.8	–	–	–	–	1.14	1.80
20,000	17,193.6	–	–	–	–	1.17	1.88
20,500	17,623.5	–	–	–	–	1.20	1.96
21,000	18,053.3	–	–	–	–	1.23	2.05
21,500	18,483.1	–	–	–	–	1.26	2.14
22,000	18,913.0	–	–	–	–	1.29	2.23
22,500	19,342.8	–	–	–	–	1.32	2.32
23,000	19,772.7	–	–	–	–	1.35	2.41
23,500	20,202.5	–	–	–	–	1.37	2.51
24,000	20,632.3	–	–	–	–	1.40	2.60
24,500	21,062.2	–	–	–	–	1.43	2.70
25,000	21,492.0	–	–	–	–	1.46	2.80
25,500	21,921.9	–	–	–	–	1.49	2.90
26,000	22,351.7	–	–	–	–	1.52	3.01
26,500	22,781.5	–	–	–	–	1.55	3.11
27,000	23,211.4	–	–	–	–	1.58	3.22
27,500	23,641.2	–	–	–	–	1.61	3.32
28,000	24,071.1	–	–	–	–	1.64	3.43
28,500	24,500.9	–	–	–	–	1.67	3.54
29,000	24,930.7	–	–	–	–	1.70	3.66
29,500	25,360.6	–	–	–	–	1.73	3.77
30,000	25,790.4	–	–	–	–	1.76	3.89
32,500	27,939.6	–	–	–	–	1.90	4.49

Table 17: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 10 °C / return flow 11 °C, d88.9–108 mm

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,200	1,031.6	0.05	0.01	–	–
1,300	1,117.6	0.05	0.01	–	–
1,400	1,203.6	0.06	0.01	–	–
1,500	1,289.5	0.06	0.01	–	–
1,600	1,375.5	0.07	0.01	–	–
1,700	1,461.5	0.07	0.01	–	–
1,800	1,547.4	0.08	0.01	0.05	0.01
1,900	1,633.4	0.08	0.01	0.05	0.01
2,000	1,719.4	0.08	0.02	0.06	0.01
2,500	2,149.2	0.11	0.02	0.07	0.01
3,000	2,579.0	0.13	0.03	0.09	0.01
3,500	3,008.9	0.15	0.04	0.10	0.02
4,000	3,438.7	0.17	0.05	0.11	0.02
4,500	3,868.6	0.19	0.06	0.13	0.02
5,000	4,298.4	0.21	0.07	0.14	0.03
5,500	4,728.2	0.23	0.09	0.16	0.04

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
6,000	5,158.1	0.25	0.10	0.17	0.04
6,500	5,587.9	0.27	0.12	0.19	0.05
7,000	6,017.8	0.30	0.13	0.20	0.05
7,500	6,447.6	0.32	0.15	0.22	0.06
8,000	6,877.4	0.34	0.17	0.23	0.07
8,500	7,307.3	0.36	0.19	0.24	0.08
9,000	7,737.1	0.38	0.21	0.26	0.08
9,500	8,167.0	0.40	0.23	0.27	0.09
10,000	8,596.8	0.42	0.25	0.29	0.10
10,500	9,026.7	0.44	0.27	0.30	0.11
11,000	9,456.5	0.46	0.30	0.32	0.12
11,500	9,886.3	0.49	0.32	0.33	0.13
12,000	10,316.2	0.51	0.35	0.34	0.14
12,500	10,746.0	0.53	0.37	0.36	0.15
13,000	11,175.9	0.55	0.40	0.37	0.16
13,500	11,605.7	0.57	0.43	0.39	0.17
14,000	12,035.5	0.59	0.46	0.40	0.18
14,500	12,465.4	0.61	0.49	0.42	0.19
15,000	12,895.2	0.63	0.52	0.43	0.20
15,500	13,325.1	0.65	0.55	0.44	0.22
16,000	13,754.9	0.68	0.58	0.46	0.23
16,500	14,184.7	0.70	0.61	0.47	0.24
17,000	14,614.6	0.72	0.64	0.49	0.26
17,500	15,044.4	0.74	0.68	0.50	0.27
18,000	15,474.3	0.76	0.71	0.52	0.28
18,500	15,904.1	0.78	0.75	0.53	0.30
19,000	16,333.9	0.80	0.78	0.54	0.31
19,500	16,763.8	0.82	0.82	0.56	0.33
20,000	17,193.6	0.84	0.86	0.57	0.34
20,500	17,623.5	0.87	0.90	0.59	0.36
21,000	18,053.3	0.89	0.94	0.60	0.37
21,500	18,483.1	0.91	0.98	0.62	0.39
22,000	18,913.0	0.93	1.02	0.63	0.40
22,500	19,342.8	0.95	1.06	0.65	0.42
23,000	19,772.7	0.97	1.10	0.66	0.44
23,500	20,202.5	0.99	1.15	0.67	0.45
24,000	20,632.3	1.01	1.19	0.69	0.47
24,500	21,062.2	1.03	1.23	0.70	0.49
25,000	21,492.0	1.05	1.28	0.72	0.51
25,500	21,921.9	1.08	1.33	0.73	0.53
26,000	22,351.7	1.10	1.37	0.75	0.54
26,500	22,781.5	1.12	1.42	0.76	0.56
27,000	23,211.4	1.14	1.47	0.77	0.58
27,500	23,641.2	1.16	1.52	0.79	0.60
28,000	24,071.1	1.18	1.57	0.80	0.62
28,500	24,500.9	1.20	1.62	0.82	0.64
29,000	24,930.7	1.22	1.67	0.83	0.66
29,500	25,360.6	1.24	1.72	0.85	0.68
30,000	25,790.4	1.27	1.77	0.86	0.70

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
32,500	27,939.6	1.37	2.05	0.93	0.81
35,000	30,088.8	1.48	2.34	1.00	0.93
37,500	32,238.0	1.58	2.65	1.08	1.05
40,000	34,387.2	1.69	2.97	1.15	1.18
42,500	36,536.4	1.79	3.31	1.22	1.31
45,000	38,685.6	1.90	3.67	1.29	1.45
47,500	40,834.8	–	–	1.36	1.60
50,000	42,984.0	–	–	1.43	1.75
52,500	45,133.3	–	–	1.51	1.92
55,000	47,282.5	–	–	1.58	2.08
57,500	49,431.7	–	–	1.65	2.26
60,000	51,580.9	–	–	1.72	2.44
62,500	53,730.1	–	–	1.79	2.62
65,000	55,879.3	–	–	1.86	2.81
67,500	58,028.5	–	–	1.94	3.01

3.3 COOLING, INLET FLOW 8 °C / RETURN FLOW 12 °C

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

Table 18: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 8 °C / return flow 12 °C, d12–18 mm

d [mm]		12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0	
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	0.272	0.08	0.318	–	–	–	–
150	32.2	0.11	0.407	0.11	0.477	0.07	0.167	–	–
200	43.0	0.14	0.543	0.15	0.635	0.09	0.222	0.06	0.097
250	53.7	0.18	0.679	0.19	0.794	0.11	0.278	0.07	0.121
300	64.5	0.21	0.815	0.23	0.953	0.13	0.334	0.09	0.145
350	75.2	0.25	0.951	0.27	1.112	0.16	0.389	0.10	0.170
400	86.0	0.28	1.086	0.30	2.187	0.18	0.445	0.12	0.194
450	96.7	0.32	2.219	0.34	2.667	0.20	0.501	0.13	0.218
500	107.4	0.35	2.651	0.38	3.188	0.22	0.556	0.15	0.242
550	118.2	0.39	3.116	0.42	3.747	0.25	1.093	0.16	0.267
600	128.9	0.42	3.612	0.46	4.344	0.27	1.266	0.18	0.291
700	150.4	0.49	4.696	0.53	5.649	0.31	1.644	0.21	0.620
800	171.9	0.56	5.900	0.61	7.099	0.36	2.063	0.24	0.777

d [mm]		12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0	
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]
900	193.4	0.63	7.219	0.68	8.687	0.40	2.521	0.27	0.949
1,000	214.9	0.70	8.651	0.76	10.413	0.45	3.018	0.30	1.135
1,100	236.4	0.77	10.194	0.84	12.271	0.49	3.553	0.33	1.336
1,200	257.9	0.84	11.844	0.91	14.259	0.54	4.126	0.36	1.549
1,300	279.4	0.91	13.600	0.99	16.376	0.58	4.734	0.39	1.777
1,400	300.9	0.98	15.461	1.06	18.619	0.63	5.378	0.42	2.017
1,500	322.3	1.05	17.425	1.14	20.986	0.67	6.058	0.45	2.271
1,600	343.8	1.12	19.490	1.22	23.476	0.72	6.772	0.48	2.537
1,700	365.3	1.19	21.655	1.29	26.086	0.76	7.520	0.50	2.816
1,800	386.8	1.27	23.919	1.37	28.815	0.81	8.302	0.53	3.108
1,900	408.3	1.34	26.280	1.44	31.663	0.85	9.117	0.56	3.412
2,000	429.8	1.41	28.739	1.52	34.628	0.90	9.966	0.59	3.728
2,500	537.2	1.76	42.448	1.90	51.165	1.12	14.692	0.74	5.486
3,000	644.7	–	–	–	–	1.35	20.199	0.89	7.532
3,500	752.1	–	–	–	–	1.57	26.460	1.04	9.854
4,000	859.6	–	–	–	–	1.80	33.453	1.19	12.446
4,500	967.0	–	–	–	–	–	–	1.34	15.299
5,000	1,074.5	–	–	–	–	–	–	1.48	18.409
5,500	1,181.9	–	–	–	–	–	–	1.63	21.769
6,000	1,289.4	–	–	–	–	–	–	1.78	25.376
6,500	1,396.8	–	–	–	–	–	–	1.93	29.225

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Table 19: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 8 °C / return flow 12 °C, d22–28 mm

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
300	64.5	0.06	0.060	–	–	–	–
350	75.2	0.07	0.070	–	–	–	–
400	86.0	0.08	0.079	–	–	–	–
450	96.7	0.09	0.089	0.05	0.031	0.05	0.037
500	107.4	0.10	0.099	0.06	0.035	0.06	0.041
550	118.2	0.10	0.109	0.06	0.038	0.07	0.045
600	128.9	0.11	0.119	0.07	0.042	0.07	0.049
700	150.4	0.13	0.139	0.08	0.049	0.09	0.057
800	171.9	0.15	0.273	0.09	0.056	0.10	0.065
900	193.4	0.17	0.333	0.10	0.063	0.11	0.073
1,000	214.9	0.19	0.398	0.11	0.070	0.12	0.140
1,100	236.4	0.21	0.468	0.12	0.137	0.13	0.164
1,200	257.9	0.23	0.542	0.13	0.158	0.15	0.190
1,300	279.4	0.25	0.621	0.15	0.181	0.16	0.218
1,400	300.9	0.27	0.705	0.16	0.205	0.17	0.247
1,500	322.3	0.29	0.793	0.17	0.231	0.18	0.277
1,600	343.8	0.30	0.885	0.18	0.257	0.19	0.310
1,700	365.3	0.32	0.982	0.19	0.285	0.21	0.343
1,800	386.8	0.34	1.083	0.20	0.315	0.22	0.378
1,900	408.3	0.36	1.189	0.21	0.345	0.23	0.415
2,000	429.8	0.38	1.298	0.22	0.377	0.24	0.453
2,500	537.2	0.48	1.907	0.28	0.552	0.30	0.664

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
3,000	644.7	0.57	2.615	0.34	0.756	0.36	0.910
3,500	752.1	0.67	3.417	0.39	0.986	0.43	1.187
4,000	859.6	0.76	4.311	0.45	1.242	0.49	1.496
4,500	967.0	0.86	5.294	0.51	1.524	0.55	1.836
5,000	1,074.5	0.95	6.365	0.56	1.831	0.61	2.205
5,500	1,181.9	1.05	7.521	0.62	2.161	0.67	2.604
6,000	1,289.4	1.14	8.761	0.67	2.516	0.73	3.031
6,500	1,396.8	1.24	10.083	0.73	2.894	0.79	3.487
7,000	1,504.3	1.33	11.487	0.79	3.294	0.85	3.970
7,500	1,611.7	1.43	12.971	0.84	3.718	0.91	4.480
8,000	1,719.2	1.52	14.534	0.90	4.163	0.97	5.018
8,500	1,826.6	1.62	16.175	0.96	4.631	1.03	5.582
9,000	1,934.1	1.71	17.894	1.01	5.120	1.09	6.172
9,500	2,041.5	1.81	19.689	1.07	5.631	1.16	6.789
10,000	2,149.0	1.90	21.560	1.12	6.164	1.22	7.431
10,500	2,256.4	2.00	23.506	1.18	6.717	1.28	8.099
11,000	2,363.9	–	–	1.24	7.291	1.34	8.792
11,500	2,471.3	–	–	1.29	7.887	1.40	9.510
12,000	2,578.8	–	–	1.35	8.502	1.46	10.253
12,500	2,686.2	–	–	1.41	9.138	1.52	11.021
13,000	2,793.7	–	–	1.46	9.795	1.58	11.813
13,500	2,901.1	–	–	1.52	10.471	1.64	12.629
14,000	3,008.6	–	–	1.57	11.168	1.70	13.470
14,500	3,116.0	–	–	1.63	11.884	1.76	14.335
15,000	3,223.5	–	–	1.69	12.620	1.82	15.223
15,500	3,330.9	–	–	1.74	13.376	1.89	16.136
16,000	3,438.4	–	–	1.80	14.151	1.95	17.072
16,500	3,545.8	–	–	1.86	14.946	–	–
17,000	3,653.3	–	–	1.91	15.760	–	–
17,500	3,760.7	–	–	1.97	16.593	–	–

Table 20: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 8 °C / return flow 12 °C, d35–42 mm

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
700	150.4	0.05	0.020	0.05	0.021	–	–	–	–
800	171.9	0.06	0.023	0.06	0.024	–	–	–	–
900	193.4	0.06	0.025	0.07	0.027	–	–	–	–
1,000	214.9	0.07	0.028	0.07	0.030	–	–	–	–
1,100	236.4	0.08	0.031	0.08	0.033	0.05	0.014	0.05	0.015
1,200	257.9	0.09	0.034	0.09	0.036	0.06	0.016	0.06	0.016
1,300	279.4	0.09	0.063	0.10	0.068	0.06	0.017	0.06	0.018
1,400	300.9	0.10	0.071	0.10	0.077	0.07	0.018	0.07	0.019
1,500	322.3	0.11	0.080	0.11	0.087	0.07	0.019	0.07	0.021
1,600	343.8	0.11	0.089	0.12	0.097	0.08	0.036	0.08	0.038
1,700	365.3	0.12	0.099	0.13	0.108	0.08	0.040	0.08	0.043
1,800	386.8	0.13	0.109	0.13	0.119	0.09	0.044	0.09	0.047
1,900	408.3	0.14	0.119	0.14	0.130	0.09	0.048	0.09	0.051

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
2,000	429.8	0.14	0.130	0.15	0.142	0.10	0.052	0.10	0.056
2,500	537.2	0.18	0.190	0.19	0.207	0.12	0.076	0.12	0.082
3,000	644.7	0.21	0.260	0.22	0.283	0.15	0.104	0.15	0.112
3,500	752.1	0.25	0.338	0.26	0.369	0.17	0.135	0.17	0.145
4,000	859.6	0.29	0.426	0.30	0.465	0.19	0.170	0.20	0.183
4,500	967.0	0.32	0.522	0.33	0.570	0.22	0.208	0.22	0.224
5,000	1,074.5	0.36	0.627	0.37	0.684	0.24	0.250	0.25	0.268
5,500	1,181.9	0.39	0.739	0.41	0.807	0.27	0.294	0.27	0.316
6,000	1,289.4	0.43	0.860	0.45	0.939	0.29	0.342	0.30	0.368
6,500	1,396.8	0.46	0.988	0.48	1.080	0.32	0.393	0.32	0.423
7,000	1,504.3	0.50	1.125	0.52	1.228	0.34	0.447	0.35	0.481
7,500	1,611.7	0.54	1.269	0.56	1.386	0.36	0.504	0.37	0.542
8,000	1,719.2	0.57	1.420	0.59	1.551	0.39	0.564	0.40	0.606
8,500	1,826.6	0.61	1.579	0.63	1.724	0.41	0.627	0.42	0.674
9,000	1,934.1	0.64	1.745	0.67	1.906	0.44	0.693	0.45	0.745
9,500	2,041.5	0.68	1.918	0.71	2.095	0.46	0.761	0.47	0.818
10,000	2,149.0	0.72	2.099	0.74	2.293	0.48	0.832	0.50	0.895
10,500	2,256.4	0.75	2.286	0.78	2.498	0.51	0.907	0.52	0.975
11,000	2,363.9	0.79	2.481	0.82	2.711	0.53	0.983	0.55	1.058
11,500	2,471.3	0.82	2.683	0.85	2.931	0.56	1.063	0.57	1.143
12,000	2,578.8	0.86	2.891	0.89	3.159	0.58	1.145	0.60	1.232
12,500	2,686.2	0.89	3.107	0.93	3.394	0.61	1.230	0.62	1.323
13,000	2,793.7	0.93	3.329	0.97	3.637	0.63	1.318	0.65	1.418
13,500	2,901.1	0.97	3.558	1.00	3.887	0.65	1.408	0.67	1.515
14,000	3,008.6	1.00	3.793	1.04	4.145	0.68	1.501	0.70	1.615
14,500	3,116.0	1.04	4.036	1.08	4.410	0.70	1.597	0.72	1.717
15,000	3,223.5	1.07	4.285	1.11	4.682	0.73	1.695	0.75	1.823
15,500	3,330.9	1.11	4.540	1.15	4.961	0.75	1.796	0.77	1.931
16,000	3,438.4	1.14	4.802	1.19	5.247	0.78	1.899	0.80	2.043
16,500	3,545.8	1.18	5.071	1.23	5.541	0.80	2.005	0.82	2.156
17,000	3,653.3	1.22	5.346	1.26	5.841	0.82	2.113	0.85	2.273
17,500	3,760.7	1.25	5.627	1.30	6.149	0.85	2.224	0.87	2.392
18,000	3,868.2	1.29	5.915	1.34	6.464	0.87	2.338	0.90	2.514
18,500	3,975.6	1.32	6.209	1.37	6.785	0.90	2.453	0.92	2.639
19,000	4,083.1	1.36	6.509	1.41	7.114	0.92	2.572	0.95	2.766
19,500	4,190.5	1.39	6.816	1.45	7.449	0.95	2.692	0.97	2.896
20,000	4,298.0	1.43	7.129	1.48	7.791	0.97	2.816	1.00	3.029
20,500	4,405.4	1.47	7.448	1.52	8.140	0.99	2.941	1.02	3.164
21,000	4,512.9	1.50	7.774	1.56	8.496	1.02	3.069	1.05	3.301
21,500	4,620.3	1.54	8.105	1.60	8.859	1.04	3.200	1.07	3.442
22,000	4,727.8	1.57	8.443	1.63	9.228	1.07	3.333	1.10	3.585
22,500	4,835.2	1.61	8.787	1.67	9.604	1.09	3.468	1.12	3.730
23,000	4,942.7	1.65	9.137	1.71	9.987	1.12	3.606	1.15	3.879
23,500	5,050.1	1.68	9.493	1.74	10.376	1.14	3.746	1.17	4.029
24,000	5,157.6	1.72	9.856	1.78	10.772	1.16	3.888	1.20	4.182
24,500	5,265.0	1.75	10.224	1.82	11.175	1.19	4.033	1.22	4.338
25,000	5,372.5	1.79	10.598	1.86	11.584	1.21	4.180	1.25	4.497
25,500	5,479.9	1.82	10.978	1.89	12.000	1.24	4.330	1.27	4.657
26,000	5,587.4	1.86	11.365	1.93	12.422	1.26	4.481	1.30	4.821

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
26,500	5,694.8	1.90	11.757	1.97	12.851	1.28	4.636	1.32	4.986
27,000	5,802.3	1.93	12.155	–	–	1.31	4.792	1.35	5.155
27,500	5,909.7	1.97	12.559	–	–	1.33	4.951	1.37	5.326
28,000	6,017.2	–	–	–	–	1.36	5.112	1.40	5.499
28,500	6,124.6	–	–	–	–	1.38	5.275	1.42	5.675
29,000	6,232.1	–	–	–	–	1.41	5.441	1.45	5.853
29,500	6,339.5	–	–	–	–	1.43	5.608	1.47	6.034
30,000	6,447.0	–	–	–	–	1.45	5.779	1.50	6.217
32,500	6,984.2	–	–	–	–	1.58	6.663	1.62	7.169
35,000	7,521.5	–	–	–	–	1.70	7.604	1.75	8.181
37,500	8,058.7	–	–	–	–	1.82	8.599	1.87	9.252
40,000	8,596.0	–	–	–	–	1.94	9.650	2.00	10.382

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Table 21: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 8 °C / return flow 12 °C, d54–76.1 mm

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,700	365.3	–	–	0.05	0.009	–	–
1,800	386.8	0.05	0.008	0.05	0.009	–	–
1,900	408.3	0.06	0.009	0.06	0.010	–	–
2,000	429.8	0.06	0.009	0.06	0.017	–	–
2,500	537.2	0.07	0.023	0.08	0.025	–	–
3,000	644.7	0.09	0.032	0.09	0.035	–	–
3,500	752.1	0.10	0.041	0.11	0.045	0.05	0.008
4,000	859.6	0.12	0.052	0.12	0.057	0.06	0.010
4,500	967.0	0.13	0.063	0.14	0.069	0.07	0.012
5,000	1,074.5	0.15	0.076	0.15	0.083	0.07	0.015
5,500	1,181.9	0.16	0.089	0.17	0.098	0.08	0.017
6,000	1,289.4	0.18	0.103	0.18	0.114	0.09	0.020
6,500	1,396.8	0.19	0.119	0.20	0.130	0.10	0.023
7,000	1,504.3	0.20	0.135	0.21	0.148	0.10	0.026
7,500	1,611.7	0.22	0.152	0.23	0.167	0.11	0.030
8,000	1,719.2	0.23	0.170	0.24	0.187	0.12	0.033
8,500	1,826.6	0.25	0.189	0.26	0.207	0.12	0.037
9,000	1,934.1	0.26	0.209	0.27	0.229	0.13	0.041
9,500	2,041.5	0.28	0.229	0.29	0.252	0.14	0.044
10,000	2,149.0	0.29	0.251	0.30	0.275	0.15	0.049
10,500	2,256.4	0.31	0.273	0.32	0.300	0.15	0.053
11,000	2,363.9	0.32	0.296	0.33	0.325	0.16	0.057
11,500	2,471.3	0.34	0.320	0.35	0.351	0.17	0.062
12,000	2,578.8	0.35	0.344	0.36	0.378	0.18	0.067
12,500	2,686.2	0.37	0.370	0.38	0.406	0.18	0.072
13,000	2,793.7	0.38	0.396	0.40	0.435	0.19	0.077
13,500	2,901.1	0.39	0.423	0.41	0.465	0.20	0.082
14,000	3,008.6	0.41	0.451	0.43	0.495	0.20	0.087
14,500	3,116.0	0.42	0.479	0.44	0.527	0.21	0.093
15,000	3,223.5	0.44	0.509	0.46	0.559	0.22	0.098
15,500	3,330.9	0.45	0.539	0.47	0.592	0.23	0.104

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
16,000	3,438.4	0.47	0.569	0.49	0.626	0.23	0.110
16,500	3,545.8	0.48	0.601	0.50	0.660	0.24	0.116
17,000	3,653.3	0.50	0.633	0.52	0.696	0.25	0.122
17,500	3,760.7	0.51	0.666	0.53	0.732	0.26	0.129
18,000	3,868.2	0.53	0.700	0.55	0.770	0.26	0.135
18,500	3,975.6	0.54	0.735	0.56	0.808	0.27	0.142
19,000	4,083.1	0.56	0.770	0.58	0.846	0.28	0.148
19,500	4,190.5	0.57	0.806	0.59	0.886	0.29	0.155
20,000	4,298.0	0.58	0.843	0.61	0.926	0.29	0.162
20,500	4,405.4	0.60	0.880	0.62	0.967	0.30	0.170
21,000	4,512.9	0.61	0.919	0.64	1.009	0.31	0.177
21,500	4,620.3	0.63	0.957	0.65	1.052	0.31	0.184
22,000	4,727.8	0.64	0.997	0.67	1.096	0.32	0.192
22,500	4,835.2	0.66	1.037	0.68	1.140	0.33	0.200
23,000	4,942.7	0.67	1.078	0.70	1.185	0.34	0.207
23,500	5,050.1	0.69	1.120	0.71	1.231	0.34	0.215
24,000	5,157.6	0.70	1.162	0.73	1.277	0.35	0.223
24,500	5,265.0	0.72	1.205	0.75	1.325	0.36	0.232
25,000	5,372.5	0.73	1.249	0.76	1.373	0.37	0.240
25,500	5,479.9	0.75	1.294	0.78	1.422	0.37	0.249
26,000	5,587.4	0.76	1.339	0.79	1.472	0.38	0.257
26,500	5,694.8	0.77	1.385	0.81	1.522	0.39	0.266
27,000	5,802.3	0.79	1.431	0.82	1.573	0.39	0.275
27,500	5,909.7	0.80	1.478	0.84	1.625	0.40	0.284
28,000	6,017.2	0.82	1.526	0.85	1.678	0.41	0.293
28,500	6,124.6	0.83	1.575	0.87	1.731	0.42	0.302
29,000	6,232.1	0.85	1.624	0.88	1.785	0.42	0.312
29,500	6,339.5	0.86	1.674	0.90	1.840	0.43	0.321
30,000	6,447.0	0.88	1.725	0.91	1.896	0.44	0.331
32,500	6,984.2	0.95	1.987	0.99	2.185	0.48	0.381
35,000	7,521.5	1.02	2.267	1.06	2.492	0.51	0.434
37,500	8,058.7	1.10	2.562	1.14	2.817	0.55	0.490
40,000	8,596.0	1.17	2.874	1.22	3.159	0.59	0.550
42,500	9,133.2	1.24	3.201	1.29	3.519	0.62	0.612
45,000	9,670.5	1.32	3.544	1.37	3.896	0.66	0.677
47,500	10,207.7	1.39	3.902	1.44	4.290	0.69	0.745
50,000	10,745.0	1.46	4.276	1.52	4.701	0.73	0.816
52,500	11,282.2	1.53	4.665	1.60	5.129	0.77	0.890
55,000	11,819.5	1.61	5.069	1.67	5.574	0.80	0.967
57,500	12,356.7	1.68	5.488	1.75	6.035	0.84	1.046
60,000	12,894.0	1.75	5.922	1.82	6.512	0.88	1.128
62,500	13,431.2	1.83	6.371	1.90	7.006	0.91	1.213
65,000	13,968.5	1.90	6.834	1.98	7.516	0.95	1.301
67,500	14,505.7	1.97	7.312	–	–	0.99	1.392
70,000	15,043.0	–	–	–	–	1.02	1.485
72,500	15,580.2	–	–	–	–	1.06	1.581
75,000	16,117.5	–	–	–	–	1.10	1.679
77,500	16,654.7	–	–	–	–	1.13	1.780
80,000	17,192.0	–	–	–	–	1.17	1.884

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
82,500	17,729.2	–	–	–	–	1.21	1.991
85,000	18,266.5	–	–	–	–	1.24	2.100
87,500	18,803.7	–	–	–	–	1.28	2.212
90,000	19,341.0	–	–	–	–	1.32	2.326
92,500	19,878.2	–	–	–	–	1.35	2.443
95,000	20,415.5	–	–	–	–	1.39	2.562
97,500	20,952.7	–	–	–	–	1.43	2.684
100,000	21,490.0	–	–	–	–	1.46	2.808
105,000	22,564.5	–	–	–	–	1.54	3.065
110,000	23,639.0	–	–	–	–	1.61	3.332
115,000	24,713.5	–	–	–	–	1.68	3.608
120,000	25,788.0	–	–	–	–	1.76	3.895
125,000	26,862.5	–	–	–	–	1.83	4.191
130,000	27,937.0	–	–	–	–	1.90	4.497
135,000	29,011.5	–	–	–	–	1.97	4.812

Table 22: Pressure loss for copper pipes in accordance with DVGW GW 392, cooling, inlet flow 8 °C / return flow 12 °C, d88.9–108 mm

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
5,000	1,074.5	0.05	0.007	–	–
5,500	1,181.9	0.06	0.008	–	–
6,000	1,289.4	0.06	0.009	–	–
6,500	1,396.8	0.07	0.011	–	–
7,000	1,504.3	0.07	0.012	0.05	0.005
7,500	1,611.7	0.08	0.014	0.05	0.006
8,000	1,719.2	0.08	0.015	0.06	0.006
8,500	1,826.6	0.09	0.017	0.06	0.007
9,000	1,934.1	0.09	0.019	0.06	0.008
9,500	2,041.5	0.10	0.021	0.07	0.008
10,000	2,149.0	0.11	0.022	0.07	0.009
10,500	2,256.4	0.11	0.024	0.08	0.010
11,000	2,363.9	0.12	0.026	0.08	0.011
11,500	2,471.3	0.12	0.029	0.08	0.011
12,000	2,578.8	0.13	0.031	0.09	0.012
12,500	2,686.2	0.13	0.033	0.09	0.013
13,000	2,793.7	0.14	0.035	0.09	0.014
13,500	2,901.1	0.14	0.038	0.10	0.015
14,000	3,008.6	0.15	0.040	0.10	0.016
14,500	3,116.0	0.15	0.043	0.10	0.017
15,000	3,223.5	0.16	0.045	0.11	0.018
15,500	3,330.9	0.16	0.048	0.11	0.019
16,000	3,438.4	0.17	0.051	0.11	0.020
16,500	3,545.8	0.17	0.053	0.12	0.021
17,000	3,653.3	0.18	0.056	0.12	0.023
17,500	3,760.7	0.18	0.059	0.13	0.024
18,000	3,868.2	0.19	0.062	0.13	0.025
18,500	3,975.6	0.20	0.065	0.13	0.026

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
19,000	4,083.1	0.20	0.068	0.14	0.027
19,500	4,190.5	0.21	0.071	0.14	0.029
20,000	4,298.0	0.21	0.075	0.14	0.030
20,500	4,405.4	0.22	0.078	0.15	0.031
21,000	4,512.9	0.22	0.081	0.15	0.033
21,500	4,620.3	0.23	0.085	0.15	0.034
22,000	4,727.8	0.23	0.088	0.16	0.035
22,500	4,835.2	0.24	0.092	0.16	0.037
23,000	4,942.7	0.24	0.095	0.16	0.038
23,500	5,050.1	0.25	0.099	0.17	0.040
24,000	5,157.6	0.25	0.103	0.17	0.041
24,500	5,265.0	0.26	0.107	0.18	0.043
25,000	5,372.5	0.26	0.110	0.18	0.044
25,500	5,479.9	0.27	0.114	0.18	0.046
26,000	5,587.4	0.27	0.118	0.19	0.047
26,500	5,694.8	0.28	0.122	0.19	0.049
27,000	5,802.3	0.28	0.126	0.19	0.050
27,500	5,909.7	0.29	0.130	0.20	0.052
28,000	6,017.2	0.30	0.135	0.20	0.054
28,500	6,124.6	0.30	0.139	0.20	0.055
29,000	6,232.1	0.31	0.143	0.21	0.057
29,500	6,339.5	0.31	0.148	0.21	0.059
30,000	6,447.0	0.32	0.152	0.21	0.061
32,500	6,984.2	0.34	0.175	0.23	0.070
35,000	7,521.5	0.37	0.199	0.25	0.079
37,500	8,058.7	0.40	0.225	0.27	0.090
40,000	8,596.0	0.42	0.252	0.29	0.100
42,500	9,133.2	0.45	0.281	0.30	0.112
45,000	9,670.5	0.47	0.310	0.32	0.124
47,500	10,207.7	0.50	0.342	0.34	0.136
50,000	10,745.0	0.53	0.374	0.36	0.149
52,500	11,282.2	0.55	0.408	0.38	0.162
55,000	11,819.5	0.58	0.443	0.39	0.176
57,500	12,356.7	0.61	0.479	0.41	0.190
60,000	12,894.0	0.63	0.517	0.43	0.205
62,500	13,431.2	0.66	0.556	0.45	0.221
65,000	13,968.5	0.69	0.596	0.47	0.237
67,500	14,505.7	0.71	0.637	0.48	0.253
70,000	15,043.0	0.74	0.679	0.50	0.270
72,500	15,580.2	0.76	0.723	0.52	0.287
75,000	16,117.5	0.79	0.768	0.54	0.305
77,500	16,654.7	0.82	0.814	0.56	0.323
80,000	17,192.0	0.84	0.862	0.57	0.342
82,500	17,729.2	0.87	0.910	0.59	0.361
85,000	18,266.5	0.90	0.960	0.61	0.381
87,500	18,803.7	0.92	1.011	0.63	0.401
90,000	19,341.0	0.95	1.063	0.64	0.422
92,500	19,878.2	0.98	1.116	0.66	0.443
95,000	20,415.5	1.00	1.171	0.68	0.464

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
97,500	20,952.7	1.03	1.226	0.70	0.486
100,000	21,490.0	1.05	1.283	0.72	0.509
105,000	22,564.5	1.11	1.400	0.75	0.555
110,000	23,639.0	1.16	1.522	0.79	0.603
115,000	24,713.5	1.21	1.647	0.82	0.653
120,000	25,788.0	1.27	1.778	0.86	0.704
125,000	26,862.5	1.32	1.913	0.90	0.758
130,000	27,937.0	1.37	2.052	0.93	0.813
135,000	29,011.5	1.42	2.196	0.97	0.869
140,000	30,086.0	1.48	2.344	1.00	0.928
145,000	31,160.5	1.53	2.496	1.04	0.988
150,000	32,235.0	1.58	2.653	1.07	1.050
160,000	34,384.0	1.69	2.979	1.15	1.178
170,000	36,533.0	1.79	3.322	1.22	1.314
180,000	38,681.9	1.90	3.682	1.29	1.455
190,000	40,830.9	–	–	1.36	1.604
200,000	42,979.9	–	–	1.43	1.759

4 HEATING PRESSURE LOSS

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

Table 23: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 61 °C / return flow 60 °C, d12–18 mm

d [mm]		**12 x 0.8**		**12 x 1.0**		**15 x 1.0**		**18 x 1.0**	
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	0.14	0.417	0.15	0.501	0.09	0.146	0.06	0.035
100	86.1	0.29	1.364	0.31	1.642	0.18	0.476	0.12	0.179
150	129.1	0.43	2.753	0.46	3.316	0.27	0.956	0.18	0.358
200	172.1	0.57	4.546	0.62	5.478	0.37	1.575	0.24	0.588
250	215.1	0.72	6.721	0.77	8.102	0.46	2.324	0.30	0.867
300	258.2	0.86	9.261	0.93	11.169	0.55	3.197	0.36	1.191
350	301.2	1.00	12.156	1.08	14.663	0.64	4.190	0.42	1.559
400	344.2	1.15	15.396	1.24	18.575	0.73	5.301	0.48	1.970
450	387.3	1.29	18.972	1.39	22.895	0.82	6.525	0.54	2.423
500	430.3	1.43	22.879	1.55	27.615	0.92	7.860	0.60	2.917
550	473.3	1.57	27.111	1.70	32.729	1.01	9.306	0.67	3.450
600	516.4	1.72	31.663	1.86	38.230	1.10	10.859	0.73	4.023
700	602.4	–	–	–	–	1.28	14.282	0.85	5.285
800	688.5	–	–	–	–	1.47	18.120	0.97	6.697
900	774.5	–	–	–	–	1.65	22.364	1.09	8.257
1,000	860.6	–	–	–	–	1.83	27.006	1.21	9.961
1,100	946.6	–	–	–	–	–	–	1.33	11.808
1,200	1,032.7	–	–	–	–	–	–	1.45	13.795
1,300	1,118.8	–	–	–	–	–	–	1.57	15.919
1,400	1,204.8	–	–	–	–	–	–	1.69	18.180
1,500	1,290.9	–	–	–	–	–	–	1.81	20.576
1,600	1,376.9	–	–	–	–	–	–	1.94	23.106

Table 24: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 61 °C / return flow 60 °C, d22–28 mm

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
$\dot{Q}$ [W]	$\dot{m}$ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
100	86.1	0.08	0.063	–	–	–	–
150	129.1	0.12	0.125	0.07	0.036	0.07	0.044
200	172.1	0.15	0.205	0.09	0.059	0.10	0.071
250	215.1	0.19	0.301	0.11	0.087	0.12	0.105
300	258.2	0.23	0.413	0.14	0.119	0.15	0.144
350	301.2	0.27	0.540	0.16	0.156	0.17	0.187
400	344.2	0.31	0.682	0.18	0.196	0.20	0.236
450	387.3	0.35	0.838	0.21	0.241	0.22	0.290
500	430.3	0.39	1.007	0.23	0.289	0.25	0.349
550	473.3	0.43	1.191	0.25	0.342	0.27	0.412
600	516.4	0.46	1.388	0.27	0.398	0.30	0.480
700	602.4	0.54	1.820	0.32	0.522	0.35	0.629
800	688.5	0.62	2.304	0.37	0.659	0.40	0.795
900	774.5	0.70	2.838	0.41	0.811	0.45	0.978
1,000	860.6	0.77	3.421	0.46	0.977	0.50	1.178
1,100	946.6	0.85	4.052	0.50	1.156	0.54	1.394
1,200	1,032.7	0.93	4.730	0.55	1.349	0.59	1.626
1,300	1,118.8	1.01	5.455	0.60	1.554	0.64	1.874
1,400	1,204.8	1.08	6.225	0.64	1.772	0.69	2.138
1,500	1,290.9	1.16	7.041	0.69	2.003	0.74	2.417
1,600	1,376.9	1.24	7.902	0.73	2.247	0.79	2.711
1,700	1,463.0	1.32	8.807	0.78	2.503	0.84	3.020
1,800	1,549.1	1.39	9.756	0.82	2.771	0.89	3.344
1,900	1,635.1	1.47	10.749	0.87	3.051	0.94	3.682
2,000	1,721.2	1.55	11.785	0.92	3.343	0.99	4.035
2,500	2,151.5	1.94	17.604	1.15	4.983	1.24	6.016
3,000	2,581.8	–	–	1.37	6.910	1.49	8.345
3,500	3,012.0	–	–	1.60	9.117	1.73	11.013
4,000	3,442.3	–	–	1.83	11.599	1.98	14.014

Table 25: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 61 °C / return flow 60 °C, d35–42 mm

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
$\dot{Q}$ [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]
200	172.1	0.06	0.020	0.06	0.022	–	–	–	–
250	215.1	0.07	0.030	0.08	0.033	–	–	0.05	0.013
300	258.2	0.09	0.041	0.09	0.045	0.06	0.016	0.06	0.018
350	301.2	0.10	0.053	0.11	0.058	0.07	0.021	0.07	0.023
400	344.2	0.12	0.067	0.12	0.073	0.08	0.027	0.08	0.029
450	387.3	0.13	0.082	0.14	0.090	0.09	0.033	0.09	0.035
500	430.3	0.15	0.099	0.15	0.108	0.10	0.039	0.10	0.042
550	473.3	0.16	0.117	0.17	0.128	0.11	0.046	0.11	0.050
600	516.4	0.17	0.136	0.18	0.148	0.12	0.054	0.12	0.058
700	602.4	0.20	0.178	0.21	0.194	0.14	0.071	0.14	0.076
800	688.5	0.23	0.225	0.24	0.245	0.16	0.089	0.16	0.096
900	774.5	0.26	0.276	0.27	0.302	0.18	0.110	0.18	0.118
1,000	860.6	0.29	0.332	0.30	0.363	0.20	0.132	0.20	0.142

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
1,100	946.6	0.32	0.393	0.33	0.429	0.22	0.156	0.22	0.167
1,200	1,032.7	0.35	0.458	0.36	0.501	0.24	0.181	0.24	0.195
1,300	1,118.8	0.38	0.528	0.39	0.577	0.26	0.209	0.26	0.225
1,400	1,204.8	0.41	0.601	0.42	0.657	0.28	0.238	0.29	0.256
1,500	1,290.9	0.44	0.679	0.45	0.743	0.30	0.269	0.31	0.289
1,600	1,376.9	0.47	0.762	0.48	0.832	0.32	0.301	0.33	0.324
1,700	1,463.0	0.50	0.848	0.51	0.927	0.34	0.335	0.35	0.360
1,800	1,549.1	0.52	0.939	0.54	1.026	0.36	0.371	0.37	0.399
1,900	1,635.1	0.55	1.033	0.57	1.129	0.38	0.408	0.39	0.439
2,000	1,721.2	0.58	1.132	0.60	1.237	0.39	0.447	0.41	0.480
2,500	2,151.5	0.73	1.684	0.76	1.840	0.49	0.664	0.51	0.714
3,000	2,581.8	0.87	2.331	0.91	2.549	0.59	0.918	0.61	0.987
3,500	3,012.0	1.02	3.072	1.06	3.359	0.69	1.208	0.71	1.300
4,000	3,442.3	1.17	3.904	1.21	4.268	0.79	1.534	0.81	1.651
4,500	3,872.6	1.31	4.824	1.36	5.275	0.89	1.894	0.92	2.038
5,000	4,302.9	1.46	5.832	1.51	6.378	0.99	2.288	1.02	2.462
5,500	4,733.2	1.60	6.926	1.66	7.574	1.09	2.716	1.12	2.922
6,000	5,163.5	1.75	8.104	1.81	8.863	1.18	3.176	1.22	3.418
6,500	5,593.8	1.89	9.366	1.97	10.244	1.28	3.668	1.32	3.948
7,000	6,024.1	–	–	–	–	1.38	4.192	1.43	4.512
7,500	6,454.4	–	–	–	–	1.48	4.748	1.53	5.111
8,000	6,884.7	–	–	–	–	1.58	5.335	1.63	5.743
8,500	7,315.0	–	–	–	–	1.68	5.954	1.73	6.409
9,000	7,745.3	–	–	–	–	1.78	6.603	1.83	7.107
9,500	8,175.6	–	–	–	–	1.88	7.282	1.93	7.839
10,000	8,605.9	–	–	–	–	1.97	7.992	–	–

Table 26: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 61 °C / return flow 60 °C, d54–76.1 mm

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
450	387.3	0.05	0.010	0.06	0.011	–	–
500	430.3	0.06	0.012	0.06	0.013	–	–
550	473.3	0.07	0.014	0.07	0.015	–	–
600	516.4	0.07	0.016	0.07	0.018	–	–
700	602.4	0.08	0.021	0.09	0.023	–	–
800	688.5	0.10	0.027	0.10	0.030	–	–
900	774.5	0.11	0.033	0.11	0.036	0.05	0.006
1,000	860.6	0.12	0.040	0.12	0.044	0.06	0.008
1,100	946.6	0.13	0.047	0.14	0.051	0.07	0.009
1,200	1,032.7	0.14	0.054	0.15	0.060	0.07	0.011
1,300	1,118.8	0.15	0.063	0.16	0.069	0.08	0.012
1,400	1,204.8	0.17	0.071	0.17	0.078	0.08	0.014
1,500	1,290.9	0.18	0.081	0.19	0.088	0.09	0.016
1,600	1,376.9	0.19	0.090	0.20	0.099	0.10	0.017
1,700	1,463.0	0.20	0.100	0.21	0.110	0.10	0.019
1,800	1,549.1	0.21	0.111	0.22	0.122	0.11	0.021
1,900	1,635.1	0.23	0.122	0.24	0.134	0.11	0.023

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2,000	1,721.2	0.24	0.134	0.25	0.147	0.12	0.026
2,500	2,151.5	0.30	0.198	0.31	0.218	0.15	0.038
3,000	2,581.8	0.36	0.274	0.37	0.301	0.18	0.052
3,500	3,012.0	0.42	0.360	0.43	0.396	0.21	0.069
4,000	3,442.3	0.48	0.456	0.50	0.502	0.24	0.087
4,500	3,872.6	0.54	0.563	0.56	0.619	0.27	0.107
5,000	4,302.9	0.60	0.680	0.62	0.747	0.30	0.130
5,500	4,733.2	0.65	0.806	0.68	0.886	0.33	0.154
6,000	5,163.5	0.71	0.942	0.74	1.036	0.36	0.179
6,500	5,593.8	0.77	1.087	0.81	1.195	0.39	0.207
7,000	6,024.1	0.83	1.242	0.87	1.366	0.42	0.236
7,500	6,454.4	0.89	1.406	0.93	1.546	0.45	0.267
8,000	6,884.7	0.95	1.578	0.99	1.736	0.48	0.300
8,500	7,315.0	1.01	1.760	1.05	1.936	0.51	0.334
9,000	7,745.3	1.07	1.951	1.11	2.146	0.54	0.370
9,500	8,175.6	1.13	2.151	1.18	2.366	0.57	0.407
10,000	8,605.9	1.19	2.360	1.24	2.596	0.60	0.447
10,500	9,036.1	1.25	2.577	1.30	2.835	0.63	0.488
11,000	9,466.4	1.31	2.803	1.36	3.083	0.66	0.530
11,500	9,896.7	1.37	3.037	1.42	3.341	0.69	0.574
12,000	10,327.0	1.43	3.280	1.49	3.609	0.71	0.620
12,500	10,757.3	1.49	3.532	1.55	3.885	0.74	0.667
13,000	11,187.6	1.55	3.791	1.61	4.172	0.77	0.716
13,500	11,617.9	1.61	4.060	1.67	4.467	0.80	0.766
14,000	12,048.2	1.67	4.336	1.73	4.771	0.83	0.818
14,500	12,478.5	1.73	4.621	1.80	5.085	0.86	0.871
15,000	12,908.8	1.79	4.915	1.86	5.408	0.89	0.926
15,500	13,339.1	1.85	5.216	1.92	5.740	0.92	0.983
16,000	13,769.4	1.90	5.526	1.98	6.080	0.95	1.041
16,500	14,199.7	1.96	5.843	–	–	0.98	1.100
17,000	14,629.9	–	–	–	–	1.01	1.161
17,500	15,060.2	–	–	–	–	1.04	1.224
18,000	15,490.5	–	–	–	–	1.07	1.287
18,500	15,920.8	–	–	–	–	1.10	1.353
19,000	16,351.1	–	–	–	–	1.13	1.420
19,500	16,781.4	–	–	–	–	1.16	1.488
20,000	17,211.7	–	–	–	–	1.19	1.558
20,500	17,642.0	–	–	–	–	1.22	1.629
21,000	18,072.3	–	–	–	–	1.25	1.702
21,500	18,502.6	–	–	–	–	1.28	1.776
22,000	18,932.9	–	–	–	–	1.31	1.851
22,500	19,363.2	–	–	–	–	1.34	1.928
23,000	19,793.5	–	–	–	–	1.37	2.007
23,500	20,223.8	–	–	–	–	1.40	2.087
24,000	20,654.0	–	–	–	–	1.43	2.168
24,500	21,084.3	–	–	–	–	1.46	2.250
25,000	21,514.6	–	–	–	–	1.49	2.335
25,500	21,944.9	–	–	–	–	1.52	2.420
26,000	22,375.2	–	–	–	–	1.55	2.507

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
26,500	22,805.5	–	–	–	–	1.58	2.595
27,000	23,235.8	–	–	–	–	1.61	2.685
27,500	23,666.1	–	–	–	–	1.64	2.776
28,000	24,096.4	–	–	–	–	1.67	2.868
28,500	24,526.7	–	–	–	–	1.70	2.962
29,000	24,957.0	–	–	–	–	1.73	3.057
29,500	25,387.3	–	–	–	–	1.76	3.154
30,000	25,817.6	–	–	–	–	1.79	3.252
32,500	27,969.0	–	–	–	–	1.94	3.762

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Table 27: Pressure loss for copper pipes in accordance with DVGW GW 392, heating, inlet flow 61 °C / return flow 60 °C, d88.9–108 mm

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,200	1,032.7	0.05	0.005	–	–
1,300	1,118.8	0.06	0.006	–	–
1,400	1,204.8	0.06	0.006	–	–
1,500	1,290.9	0.06	0.007	–	–
1,600	1,376.9	0.07	0.008	–	–
1,700	1,463.0	0.07	0.009	–	–
1,800	1,549.1	0.08	0.010	0.05	0.004
1,900	1,635.1	0.08	0.011	0.06	0.004
2,000	1,721.2	0.09	0.012	0.06	0.005
2,500	2,151.5	0.11	0.017	0.07	0.007
3,000	2,581.8	0.13	0.024	0.09	0.010
3,500	3,012.0	0.15	0.032	0.10	0.013
4,000	3,442.3	0.17	0.040	0.12	0.016
4,500	3,872.6	0.19	0.049	0.13	0.020
5,000	4,302.9	0.21	0.059	0.15	0.024
5,500	4,733.2	0.24	0.070	0.16	0.028
6,000	5,163.5	0.26	0.082	0.18	0.033
6,500	5,593.8	0.28	0.095	0.19	0.038
7,000	6,024.1	0.30	0.108	0.20	0.043
7,500	6,454.4	0.32	0.122	0.22	0.048
8,000	6,884.7	0.34	0.137	0.23	0.054
8,500	7,315.0	0.37	0.153	0.25	0.060
9,000	7,745.3	0.39	0.169	0.26	0.067
9,500	8,175.6	0.41	0.186	0.28	0.074
10,000	8,605.9	0.43	0.204	0.29	0.081
10,500	9,036.1	0.45	0.223	0.31	0.088
11,000	9,466.4	0.47	0.242	0.32	0.096
11,500	9,896.7	0.49	0.262	0.34	0.104
12,000	10,327.0	0.52	0.283	0.35	0.112
12,500	10,757.3	0.54	0.304	0.36	0.120
13,000	11,187.6	0.56	0.326	0.38	0.129
13,500	11,617.9	0.58	0.349	0.39	0.138
14,000	12,048.2	0.60	0.373	0.41	0.148
14,500	12,478.5	0.62	0.397	0.42	0.157

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
15,000	12,908.8	0.64	0.422	0.44	0.167
15,500	13,339.1	0.67	0.448	0.45	0.177
16,000	13,769.4	0.69	0.474	0.47	0.187
16,500	14,199.7	0.71	0.501	0.48	0.198
17,000	14,629.9	0.73	0.529	0.50	0.209
17,500	15,060.2	0.75	0.557	0.51	0.220
18,000	15,490.5	0.77	0.586	0.53	0.232
18,500	15,920.8	0.79	0.616	0.54	0.243
19,000	16,351.1	0.82	0.646	0.55	0.255
19,500	16,781.4	0.84	0.677	0.57	0.267
20,000	17,211.7	0.86	0.709	0.58	0.280
20,500	17,642.0	0.88	0.741	0.60	0.293
21,000	18,072.3	0.90	0.774	0.61	0.306
21,500	18,502.6	0.92	0.808	0.63	0.319
22,000	18,932.9	0.95	0.842	0.64	0.332
22,500	19,363.2	0.97	0.877	0.66	0.346
23,000	19,793.5	0.99	0.913	0.67	0.360
23,500	20,223.8	1.01	0.949	0.69	0.374
24,000	20,654.0	1.03	0.986	0.70	0.389
24,500	21,084.3	1.05	1.023	0.72	0.404
25,000	21,514.6	1.07	1.061	0.73	0.419
25,500	21,944.9	1.10	1.100	0.74	0.434
26,000	22,375.2	1.12	1.140	0.76	0.449
26,500	22,805.5	1.14	1.180	0.77	0.465
27,000	23,235.8	1.16	1.220	0.79	0.481
27,500	23,666.1	1.18	1.261	0.80	0.497
28,000	24,096.4	1.20	1.303	0.82	0.514
28,500	24,526.7	1.22	1.346	0.83	0.530
29,000	24,957.0	1.25	1.389	0.85	0.547
29,500	25,387.3	1.27	1.433	0.86	0.564
30,000	25,817.6	1.29	1.477	0.88	0.582
32,500	27,969.0	1.40	1.708	0.95	0.673
35,000	30,120.5	1.50	1.954	1.02	0.769
37,500	32,271.9	1.61	2.216	1.09	0.872
40,000	34,423.4	1.72	2.492	1.17	0.980
42,500	36,574.9	1.83	2.783	1.24	1.094
45,000	38,726.3	1.93	3.089	1.31	1.214
47,500	40,877.8	–	–	1.39	1.339
50,000	43,029.3	–	–	1.46	1.470
52,500	45,180.7	–	–	1.53	1.607
55,000	47,332.2	–	–	1.61	1.749
57,500	49,483.6	–	–	1.68	1.897
60,000	51,635.1	–	–	1.75	2.050
62,500	53,786.6	–	–	1.82	2.209
65,000	55,938.0	–	–	1.90	2.373
67,500	58,089.5	–	–	1.97	2.542

4.3 HEATING, INLET FLOW 70 °C / RETURN FLOW 55 °C

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

Table 28: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 70 °C / return flow 55 °C, d12–18 mm

d [mm]		**12 x 0.8**		**12 x 1.0**		**15 x 1.0**		**18 x 1.0**	
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	0.06	0.076	0.06	0.089	–	–	–	–
400	22.9	0.08	0.102	0.08	0.119	–	–	–	–
500	28.7	0.10	0.127	0.10	0.149	0.06	0.052	–	–
600	34.4	0.11	0.283	0.12	0.341	0.07	0.063	–	–
700	40.2	0.13	0.368	0.14	0.442	0.09	0.129	0.06	0.032
800	45.9	0.15	0.462	0.17	0.555	0.10	0.162	0.06	0.036
900	51.6	0.17	0.564	0.19	0.679	0.11	0.197	0.07	0.075
1,000	57.4	0.19	0.675	0.21	0.813	0.12	0.236	0.08	0.089
1,100	63.1	0.21	0.795	0.23	0.957	0.13	0.278	0.09	0.105
1,200	68.8	0.23	0.923	0.25	1.111	0.15	0.322	0.10	0.121
1,300	74.6	0.25	1.059	0.27	1.275	0.16	0.370	0.10	0.139
1,400	80.3	0.27	1.203	0.29	1.448	0.17	0.419	0.11	0.158
1,500	86.0	0.29	1.355	0.31	1.631	0.18	0.472	0.12	0.177
1,600	91.8	0.31	1.515	0.33	1.824	0.20	0.528	0.13	0.198
1,700	97.5	0.32	1.682	0.35	2.026	0.21	0.585	0.14	0.220
1,800	103.3	0.34	1.857	0.37	2.236	0.22	0.646	0.15	0.242
1,900	109.0	0.36	2.039	0.39	2.456	0.23	0.709	0.15	0.266
2,000	114.7	0.38	2.229	0.41	2.685	0.24	0.775	0.16	0.290
2,500	143.4	0.48	3.286	0.52	3.959	0.31	1.140	0.20	0.426
3,000	172.1	0.57	4.518	0.62	5.445	0.37	1.565	0.24	0.585
3,500	200.8	0.67	5.919	0.72	7.135	0.43	2.047	0.28	0.764
4,000	229.4	0.76	7.483	0.83	9.023	0.49	2.585	0.32	0.964
4,500	258.1	0.86	9.208	0.93	11.105	0.55	3.178	0.36	1.184
5,000	286.8	0.96	11.089	1.03	13.376	0.61	3.823	0.40	1.423
5,500	315.5	1.05	13.125	1.14	15.833	0.67	4.521	0.44	1.681
6,000	344.2	1.15	15.311	1.24	18.474	0.73	5.270	0.48	1.958
6,500	372.8	1.24	17.647	1.34	21.295	0.79	6.070	0.52	2.254
7,000	401.5	1.34	20.130	1.45	24.295	0.86	6.919	0.56	2.568
7,500	430.2	1.43	22.758	1.55	27.471	0.92	7.817	0.61	2.900
8,000	458.9	1.53	25.530	1.65	30.821	0.98	8.763	0.65	3.249
8,500	487.6	1.62	28.445	1.76	34.343	1.04	9.758	0.69	3.616
9,000	516.3	1.72	31.501	1.86	38.037	1.10	10.800	0.73	4.001
9,500	544.9	1.81	34.696	1.96	41.900	1.16	11.889	0.77	4.402
10,000	573.6	1.91	38.031	–	–	1.22	13.025	0.81	4.820
10,500	602.3	–	–	–	–	1.28	14.207	0.85	5.256
11,000	631.0	–	–	–	–	1.34	15.435	0.89	5.708

d [mm]		12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0	
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]
11,500	659.7	–	–	–	–	1.41	16.708	0.93	6.176
12,000	688.3	–	–	–	–	1.47	18.027	0.97	6.661
12,500	717.0	–	–	–	–	1.53	19.390	1.01	7.162
13,000	745.7	–	–	–	–	1.59	20.798	1.05	7.680
13,500	774.4	–	–	–	–	1.65	22.251	1.09	8.213
14,000	803.1	–	–	–	–	1.71	23.747	1.13	8.763
14,500	831.7	–	–	–	–	1.77	25.288	1.17	9.328
15,000	860.4	–	–	–	–	1.83	26.872	1.21	9.910
15,500	889.1	–	–	–	–	1.90	28.500	1.25	10.507
16,000	917.8	–	–	–	–	1.96	30.170	1.29	11.119
16,500	946.5	–	–	–	–	–	–	1.33	11.748
17,000	975.1	–	–	–	–	–	–	1.37	12.391
17,500	1,003.8	–	–	–	–	–	–	1.41	13.050
18,000	1,032.5	–	–	–	–	–	–	1.45	13.725
18,500	1,061.2	–	–	–	–	–	–	1.49	14.415
19,000	1,089.9	–	–	–	–	–	–	1.53	15.120
19,500	1,118.5	–	–	–	–	–	–	1.57	15.840
20,000	1,147.2	–	–	–	–	–	–	1.61	16.575
20,500	1,175.9	–	–	–	–	–	–	1.65	17.326
21,000	1,204.6	–	–	–	–	–	–	1.69	18.091
21,500	1,233.3	–	–	–	–	–	–	1.74	18.871
22,000	1,262.0	–	–	–	–	–	–	1.78	19.667
22,500	1,290.6	–	–	–	–	–	–	1.82	20.477
23,000	1,319.3	–	–	–	–	–	–	1.86	21.301
23,500	1,348.0	–	–	–	–	–	–	1.90	22.141
24,000	1,376.7	–	–	–	–	–	–	1.94	22.995
24,500	1,405.4	–	–	–	–	–	–	1.98	23.864

Table 29: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 70 °C / return flow 55 °C, d22–28 mm

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,000	57.4	0.05	0.019	–	–	–	–
1,100	63.1	0.06	0.037	–	–	–	–
1,200	68.8	0.06	0.043	–	–	–	–
1,300	74.6	0.07	0.049	–	–	–	–
1,400	80.3	0.07	0.055	–	–	–	–
1,500	86.0	0.08	0.062	–	–	–	–
1,600	91.8	0.08	0.069	–	–	0.05	0.024
1,700	97.5	0.09	0.077	0.05	0.022	0.06	0.027
1,800	103.3	0.09	0.085	0.06	0.025	0.06	0.030
1,900	109.0	0.10	0.093	0.06	0.027	0.06	0.032
2,000	114.7	0.10	0.101	0.06	0.029	0.07	0.035
2,500	143.4	0.13	0.149	0.08	0.043	0.08	0.052
3,000	172.1	0.15	0.203	0.09	0.059	0.10	0.071
3,500	200.8	0.18	0.265	0.11	0.077	0.12	0.092
4,000	229.4	0.21	0.334	0.12	0.097	0.13	0.116
4,500	258.1	0.23	0.410	0.14	0.118	0.15	0.143

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
5,000	286.8	0.26	0.493	0.15	0.142	0.17	0.171
5,500	315.5	0.28	0.582	0.17	0.168	0.18	0.202
6,000	344.2	0.31	0.678	0.18	0.195	0.20	0.235
6,500	372.8	0.34	0.779	0.20	0.224	0.21	0.270
7,000	401.5	0.36	0.887	0.21	0.255	0.23	0.307
7,500	430.2	0.39	1.001	0.23	0.288	0.25	0.347
8,000	458.9	0.41	1.121	0.24	0.322	0.26	0.388
8,500	487.6	0.44	1.248	0.26	0.358	0.28	0.431
9,000	516.3	0.46	1.379	0.28	0.396	0.30	0.477
9,500	544.9	0.49	1.517	0.29	0.435	0.31	0.524
10,000	573.6	0.52	1.661	0.31	0.476	0.33	0.574
10,500	602.3	0.54	1.810	0.32	0.518	0.35	0.625
11,000	631.0	0.57	1.965	0.34	0.563	0.36	0.678
11,500	659.7	0.59	2.125	0.35	0.608	0.38	0.733
12,000	688.3	0.62	2.291	0.37	0.656	0.40	0.790
12,500	717.0	0.65	2.463	0.38	0.704	0.41	0.849
13,000	745.7	0.67	2.640	0.40	0.755	0.43	0.910
13,500	774.4	0.70	2.823	0.41	0.807	0.45	0.973
14,000	803.1	0.72	3.011	0.43	0.860	0.46	1.037
14,500	831.7	0.75	3.204	0.44	0.915	0.48	1.103
15,000	860.4	0.77	3.403	0.46	0.971	0.50	1.171
15,500	889.1	0.80	3.607	0.47	1.029	0.51	1.241
16,000	917.8	0.83	3.816	0.49	1.089	0.53	1.313
16,500	946.5	0.85	4.030	0.50	1.150	0.55	1.386
17,000	975.1	0.88	4.250	0.52	1.212	0.56	1.462
17,500	1,003.8	0.90	4.475	0.53	1.276	0.58	1.539
18,000	1,032.5	0.93	4.705	0.55	1.341	0.60	1.617
18,500	1,061.2	0.96	4.940	0.57	1.408	0.61	1.698
19,000	1,089.9	0.98	5.181	0.58	1.476	0.63	1.780
19,500	1,118.5	1.01	5.426	0.60	1.545	0.64	1.864
20,000	1,147.2	1.03	5.677	0.61	1.616	0.66	1.950
20,500	1,175.9	1.06	5.932	0.63	1.689	0.68	2.037
21,000	1,204.6	1.08	6.193	0.64	1.763	0.69	2.126
21,500	1,233.3	1.11	6.459	0.66	1.838	0.71	2.217
22,000	1,262.0	1.14	6.730	0.67	1.914	0.73	2.310
22,500	1,290.6	1.16	7.005	0.69	1.992	0.74	2.404
23,000	1,319.3	1.19	7.286	0.70	2.072	0.76	2.500
23,500	1,348.0	1.21	7.571	0.72	2.153	0.78	2.597
24,000	1,376.7	1.24	7.862	0.73	2.235	0.79	2.696
24,500	1,405.4	1.27	8.157	0.75	2.318	0.81	2.797
25,000	1,434.0	1.29	8.458	0.76	2.403	0.83	2.900
25,500	1,462.7	1.32	8.763	0.78	2.489	0.84	3.004
26,000	1,491.4	1.34	9.073	0.79	2.577	0.86	3.110
26,500	1,520.1	1.37	9.388	0.81	2.666	0.88	3.217
27,000	1,548.8	1.39	9.708	0.83	2.756	0.89	3.326
27,500	1,577.4	1.42	10.033	0.84	2.848	0.91	3.437
28,000	1,606.1	1.45	10.362	0.86	2.941	0.93	3.549
28,500	1,634.8	1.47	10.696	0.87	3.035	0.94	3.663
29,000	1,663.5	1.50	11.035	0.89	3.131	0.96	3.779

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
Q̇ [W]	ṁ [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	1.52	11.379	0.90	3.228	0.98	3.896
30,000	1,720.8	1.55	11.728	0.92	3.326	0.99	4.015
32,500	1,864.2	1.68	13.542	0.99	3.838	1.07	4.632
35,000	2,007.6	1.81	15.474	1.07	4.382	1.16	5.290
37,500	2,151.1	1.94	17.521	1.15	4.958	1.24	5.986
40,000	2,294.5	–	–	1.22	5.566	1.32	6.721
42,500	2,437.9	–	–	1.30	6.206	1.40	7.494
45,000	2,581.3	–	–	1.38	6.877	1.49	8.305
47,500	2,724.7	–	–	1.45	7.579	1.57	9.153
50,000	2,868.1	–	–	1.53	8.311	1.65	10.039
52,500	3,011.5	–	–	1.60	9.074	1.74	10.962
55,000	3,154.9	–	–	1.68	9.868	1.82	11.921
57,500	3,298.3	–	–	1.76	10.692	1.90	12.917
60,000	3,441.7	–	–	1.83	11.545	1.98	13.950
62,500	3,585.1	–	–	1.91	12.429	–	–
65,000	3,728.5	–	–	1.99	13.341	–	–

Table 30: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 70 °C / return flow 55 °C, d35–42 mm

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
2,500	143.4	–	–	0.05	0.016	–	–	–	–
3,000	172.1	0.06	0.020	0.06	0.022	–	–	–	–
3,500	200.8	0.07	0.026	0.07	0.029	–	–	–	–
4,000	229.4	0.08	0.033	0.08	0.036	0.05	0.013	0.05	0.014
4,500	258.1	0.09	0.041	0.09	0.044	0.06	0.016	0.06	0.017
5,000	286.8	0.10	0.049	0.10	0.053	0.07	0.019	0.07	0.021
5,500	315.5	0.11	0.057	0.11	0.063	0.07	0.023	0.07	0.025
6,000	344.2	0.12	0.067	0.12	0.073	0.08	0.027	0.08	0.029
6,500	372.8	0.13	0.077	0.13	0.084	0.09	0.031	0.09	0.033
7,000	401.5	0.14	0.087	0.14	0.095	0.09	0.035	0.10	0.037
7,500	430.2	0.15	0.098	0.15	0.107	0.10	0.039	0.10	0.042
8,000	458.9	0.16	0.110	0.16	0.120	0.11	0.044	0.11	0.047
8,500	487.6	0.17	0.122	0.17	0.134	0.11	0.049	0.12	0.052
9,000	516.3	0.17	0.135	0.18	0.148	0.12	0.054	0.12	0.058
9,500	544.9	0.18	0.148	0.19	0.162	0.13	0.059	0.13	0.063
10,000	573.6	0.19	0.162	0.20	0.177	0.13	0.064	0.14	0.069
10,500	602.3	0.20	0.177	0.21	0.193	0.14	0.070	0.14	0.075
11,000	631.0	0.21	0.192	0.22	0.209	0.14	0.076	0.15	0.082
11,500	659.7	0.22	0.207	0.23	0.226	0.15	0.082	0.16	0.088
12,000	688.3	0.23	0.223	0.24	0.244	0.16	0.089	0.16	0.095
12,500	717.0	0.24	0.240	0.25	0.262	0.16	0.095	0.17	0.102
13,000	745.7	0.25	0.257	0.26	0.281	0.17	0.102	0.18	0.110
13,500	774.4	0.26	0.275	0.27	0.300	0.18	0.109	0.18	0.117
14,000	803.1	0.27	0.293	0.28	0.320	0.18	0.116	0.19	0.125
14,500	831.7	0.28	0.311	0.29	0.340	0.19	0.123	0.20	0.133
15,000	860.4	0.29	0.330	0.30	0.361	0.20	0.131	0.20	0.141
15,500	889.1	0.30	0.350	0.31	0.382	0.20	0.139	0.21	0.149

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
16,000	917.8	0.31	0.370	0.32	0.404	0.21	0.147	0.22	0.158
16,500	946.5	0.32	0.391	0.33	0.427	0.22	0.155	0.22	0.166
17,000	975.1	0.33	0.412	0.34	0.450	0.22	0.163	0.23	0.175
17,500	1,003.8	0.34	0.433	0.35	0.474	0.23	0.172	0.24	0.185
18,000	1,032.5	0.35	0.456	0.36	0.498	0.24	0.180	0.24	0.194
18,500	1,061.2	0.36	0.478	0.37	0.522	0.24	0.189	0.25	0.203
19,000	1,089.9	0.37	0.501	0.38	0.548	0.25	0.198	0.26	0.213
19,500	1,118.5	0.38	0.525	0.39	0.573	0.26	0.208	0.26	0.223
20,000	1,147.2	0.39	0.549	0.40	0.600	0.26	0.217	0.27	0.233
20,500	1,175.9	0.40	0.573	0.41	0.626	0.27	0.227	0.28	0.244
21,000	1,204.6	0.41	0.598	0.42	0.654	0.28	0.237	0.29	0.254
21,500	1,233.3	0.42	0.623	0.43	0.681	0.28	0.247	0.29	0.265
22,000	1,262.0	0.43	0.649	0.44	0.710	0.29	0.257	0.30	0.276
22,500	1,290.6	0.44	0.676	0.45	0.738	0.30	0.267	0.31	0.287
23,000	1,319.3	0.45	0.703	0.46	0.768	0.30	0.278	0.31	0.299
23,500	1,348.0	0.46	0.730	0.47	0.798	0.31	0.288	0.32	0.310
24,000	1,376.7	0.47	0.758	0.48	0.828	0.32	0.299	0.33	0.322
24,500	1,405.4	0.48	0.786	0.49	0.859	0.32	0.310	0.33	0.334
25,000	1,434.0	0.49	0.814	0.50	0.890	0.33	0.322	0.34	0.346
25,500	1,462.7	0.50	0.843	0.51	0.922	0.34	0.333	0.35	0.358
26,000	1,491.4	0.51	0.873	0.52	0.954	0.34	0.345	0.35	0.371
26,500	1,520.1	0.52	0.903	0.53	0.987	0.35	0.357	0.36	0.384
27,000	1,548.8	0.52	0.933	0.54	1.020	0.36	0.369	0.37	0.396
27,500	1,577.4	0.53	0.964	0.55	1.054	0.36	0.381	0.37	0.410
28,000	1,606.1	0.54	0.996	0.56	1.088	0.37	0.393	0.38	0.423
28,500	1,634.8	0.55	1.028	0.58	1.123	0.38	0.406	0.39	0.436
29,000	1,663.5	0.56	1.060	0.59	1.158	0.38	0.418	0.39	0.450
29,500	1,692.2	0.57	1.092	0.60	1.194	0.39	0.431	0.40	0.464
30,000	1,720.8	0.58	1.126	0.61	1.230	0.40	0.444	0.41	0.478
32,500	1,864.2	0.63	1.298	0.66	1.419	0.43	0.512	0.44	0.551
35,000	2,007.6	0.68	1.481	0.71	1.619	0.46	0.584	0.48	0.628
37,500	2,151.1	0.73	1.675	0.76	1.831	0.49	0.660	0.51	0.710
40,000	2,294.5	0.78	1.879	0.81	2.054	0.53	0.740	0.54	0.796
42,500	2,437.9	0.83	2.094	0.86	2.289	0.56	0.825	0.58	0.887
45,000	2,581.3	0.87	2.320	0.91	2.536	0.59	0.913	0.61	0.982
47,500	2,724.7	0.92	2.555	0.96	2.794	0.63	1.005	0.65	1.082
50,000	2,868.1	0.97	2.801	1.01	3.062	0.66	1.102	0.68	1.185
52,500	3,011.5	1.02	3.057	1.06	3.342	0.69	1.202	0.71	1.293
55,000	3,154.9	1.07	3.323	1.11	3.633	0.72	1.306	0.75	1.406
57,500	3,298.3	1.12	3.599	1.16	3.935	0.76	1.414	0.78	1.522
60,000	3,441.7	1.17	3.885	1.21	4.248	0.79	1.526	0.82	1.642
62,500	3,585.1	1.22	4.181	1.26	4.571	0.82	1.642	0.85	1.767
65,000	3,728.5	1.26	4.486	1.31	4.905	0.86	1.762	0.88	1.896
67,500	3,871.9	1.31	4.801	1.36	5.250	0.89	1.885	0.92	2.028
70,000	4,015.3	1.36	5.126	1.41	5.606	0.92	2.012	0.95	2.165
72,500	4,158.7	1.41	5.461	1.46	5.972	0.96	2.143	0.98	2.306
75,000	4,302.1	1.46	5.805	1.51	6.348	0.99	2.277	1.02	2.450
77,500	4,445.5	1.51	6.158	1.56	6.735	1.02	2.415	1.05	2.599
80,000	4,588.9	1.56	6.521	1.61	7.132	1.05	2.557	1.09	2.752

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
82,500	4,732.3	1.60	6.894	1.66	7.540	1.09	2.703	1.12	2.908
85,000	4,875.7	1.65	7.276	1.72	7.957	1.12	2.852	1.15	3.069
87,500	5,019.1	1.70	7.667	1.77	8.385	1.15	3.004	1.19	3.233
90,000	5,162.5	1.75	8.067	1.82	8.823	1.19	3.161	1.22	3.402
92,500	5,305.9	1.80	8.477	1.87	9.272	1.22	3.320	1.26	3.574
95,000	5,449.3	1.85	8.896	1.92	9.730	1.25	3.484	1.29	3.750
97,500	5,592.7	1.90	9.324	1.97	10.199	1.28	3.651	1.32	3.929
100,000	5,736.1	1.94	9.761	–	–	1.32	3.821	1.36	4.113
105,000	6,022.9	–	–	–	–	1.38	4.173	1.43	4.491
110,000	6,309.8	–	–	–	–	1.45	4.539	1.49	4.885
115,000	6,596.6	–	–	–	–	1.52	4.918	1.56	5.294
120,000	6,883.4	–	–	–	–	1.58	5.311	1.63	5.717
125,000	7,170.2	–	–	–	–	1.65	5.718	1.70	6.155
130,000	7,457.0	–	–	–	–	1.71	6.139	1.77	6.608
135,000	7,743.8	–	–	–	–	1.78	6.573	1.83	7.076
140,000	8,030.6	–	–	–	–	1.84	7.021	1.90	7.558
145,000	8,317.4	–	–	–	–	1.91	7.482	1.97	8.055
150,000	8,604.2	–	–	–	–	1.98	7.957	–	–

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Table 31: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 70 °C / return flow 55 °C, d54–76.1 mm

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
6,500	372.8	0.05	0.009	0.05	0.010	–	–
7,000	401.5	0.06	0.011	0.06	0.012	–	–
7,500	430.2	0.06	0.012	0.06	0.013	–	–
8,000	458.9	0.06	0.013	0.07	0.015	–	–
8,500	487.6	0.07	0.015	0.07	0.016	–	–
9,000	516.3	0.07	0.016	0.07	0.018	–	–
9,500	544.9	0.08	0.018	0.08	0.020	–	–
10,000	573.6	0.08	0.019	0.08	0.021	–	–
10,500	602.3	0.08	0.021	0.09	0.023	–	–
11,000	631.0	0.09	0.023	0.09	0.025	–	–
11,500	659.7	0.09	0.025	0.10	0.027	–	–
12,000	688.3	0.10	0.027	0.10	0.029	–	–
12,500	717.0	0.10	0.029	0.10	0.031	–	–
13,000	745.7	0.10	0.031	0.11	0.034	0.05	0.006
13,500	774.4	0.11	0.033	0.11	0.036	0.05	0.006
14,000	803.1	0.11	0.035	0.12	0.038	0.06	0.007
14,500	831.7	0.12	0.037	0.12	0.041	0.06	0.007
15,000	860.4	0.12	0.039	0.12	0.043	0.06	0.008
15,500	889.1	0.12	0.042	0.13	0.046	0.06	0.008
16,000	917.8	0.13	0.044	0.13	0.048	0.06	0.009
16,500	946.5	0.13	0.046	0.14	0.051	0.07	0.009
17,000	975.1	0.14	0.049	0.14	0.054	0.07	0.009
17,500	1,003.8	0.14	0.052	0.14	0.057	0.07	0.010
18,000	1,032.5	0.14	0.054	0.15	0.059	0.07	0.010
18,500	1,061.2	0.15	0.057	0.15	0.062	0.07	0.011

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
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	1,089.9	0.15	0.060	0.16	0.065	0.08	0.011
19,500	1,118.5	0.15	0.062	0.16	0.068	0.08	0.012
20,000	1,147.2	0.16	0.065	0.17	0.072	0.08	0.013
20,500	1,175.9	0.16	0.068	0.17	0.075	0.08	0.013
21,000	1,204.6	0.17	0.071	0.17	0.078	0.08	0.014
21,500	1,233.3	0.17	0.074	0.18	0.081	0.09	0.014
22,000	1,262.0	0.17	0.077	0.18	0.085	0.09	0.015
22,500	1,290.6	0.18	0.080	0.19	0.088	0.09	0.015
23,000	1,319.3	0.18	0.083	0.19	0.091	0.09	0.016
23,500	1,348.0	0.19	0.086	0.19	0.095	0.09	0.017
24,000	1,376.7	0.19	0.090	0.20	0.099	0.10	0.017
24,500	1,405.4	0.19	0.093	0.20	0.102	0.10	0.018
25,000	1,434.0	0.20	0.096	0.21	0.106	0.10	0.019
25,500	1,462.7	0.20	0.100	0.21	0.110	0.10	0.019
26,000	1,491.4	0.21	0.103	0.21	0.113	0.10	0.020
26,500	1,520.1	0.21	0.107	0.22	0.117	0.11	0.021
27,000	1,548.8	0.21	0.110	0.22	0.121	0.11	0.021
27,500	1,577.4	0.22	0.114	0.23	0.125	0.11	0.022
28,000	1,606.1	0.22	0.118	0.23	0.129	0.11	0.023
28,500	1,634.8	0.23	0.121	0.24	0.133	0.11	0.023
29,000	1,663.5	0.23	0.125	0.24	0.137	0.12	0.024
29,500	1,692.2	0.23	0.129	0.24	0.142	0.12	0.025
30,000	1,720.8	0.24	0.133	0.25	0.146	0.12	0.026
32,500	1,864.2	0.26	0.153	0.27	0.168	0.13	0.029
35,000	2,007.6	0.28	0.174	0.29	0.192	0.14	0.033
37,500	2,151.1	0.30	0.197	0.31	0.217	0.15	0.038
40,000	2,294.5	0.32	0.221	0.33	0.243	0.16	0.042
42,500	2,437.9	0.34	0.246	0.35	0.270	0.17	0.047
45,000	2,581.3	0.36	0.272	0.37	0.299	0.18	0.052
47,500	2,724.7	0.38	0.300	0.39	0.329	0.19	0.057
50,000	2,868.1	0.40	0.328	0.41	0.361	0.20	0.063
52,500	3,011.5	0.42	0.358	0.43	0.394	0.21	0.068
55,000	3,154.9	0.44	0.389	0.45	0.427	0.22	0.074
57,500	3,298.3	0.46	0.421	0.48	0.463	0.23	0.080
60,000	3,441.7	0.48	0.454	0.50	0.499	0.24	0.087
62,500	3,585.1	0.50	0.488	0.52	0.537	0.25	0.093
65,000	3,728.5	0.52	0.524	0.54	0.576	0.26	0.100
67,500	3,871.9	0.54	0.560	0.56	0.616	0.27	0.107
70,000	4,015.3	0.56	0.598	0.58	0.657	0.28	0.114
72,500	4,158.7	0.58	0.636	0.60	0.700	0.29	0.121
75,000	4,302.1	0.60	0.676	0.62	0.743	0.30	0.129
77,500	4,445.5	0.62	0.717	0.64	0.788	0.31	0.137
80,000	4,588.9	0.64	0.759	0.66	0.834	0.32	0.145
82,500	4,732.3	0.66	0.802	0.68	0.882	0.33	0.153
85,000	4,875.7	0.68	0.846	0.70	0.930	0.34	0.161
87,500	5,019.1	0.70	0.891	0.72	0.980	0.35	0.170
90,000	5,162.5	0.71	0.937	0.74	1.031	0.36	0.178
92,500	5,305.9	0.73	0.984	0.76	1.082	0.37	0.187
95,000	5,449.3	0.75	1.032	0.79	1.135	0.38	0.196

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
97,500	5,592.7	0.77	1.082	0.81	1.190	0.39	0.206
100,000	5,736.1	0.79	1.132	0.83	1.245	0.40	0.215
105,000	6,022.9	0.83	1.236	0.87	1.359	0.42	0.235
110,000	6,309.8	0.87	1.343	0.91	1.478	0.44	0.255
115,000	6,596.6	0.91	1.455	0.95	1.600	0.46	0.276
120,000	6,883.4	0.95	1.571	0.99	1.728	0.48	0.298
125,000	7,170.2	0.99	1.691	1.03	1.860	0.50	0.321
130,000	7,457.0	1.03	1.814	1.07	1.996	0.52	0.344
135,000	7,743.8	1.07	1.942	1.12	2.136	0.54	0.368
140,000	8,030.6	1.11	2.074	1.16	2.281	0.56	0.393
145,000	8,317.4	1.15	2.209	1.20	2.430	0.58	0.418
150,000	8,604.2	1.19	2.349	1.24	2.584	0.60	0.445
155,000	8,891.0	1.23	2.492	1.28	2.741	0.62	0.471
160,000	9,177.8	1.27	2.639	1.32	2.903	0.64	0.499
165,000	9,464.6	1.31	2.790	1.36	3.069	0.66	0.528
170,000	9,751.4	1.35	2.945	1.40	3.240	0.68	0.557
175,000	10,038.2	1.39	3.103	1.45	3.414	0.70	0.586
180,000	10,325.0	1.43	3.265	1.49	3.593	0.72	0.617
185,000	10,611.9	1.47	3.431	1.53	3.775	0.74	0.648
190,000	10,898.7	1.51	3.601	1.57	3.962	0.76	0.680
195,000	11,185.5	1.55	3.775	1.61	4.153	0.78	0.712
200,000	11,472.3	1.59	3.952	1.65	4.348	0.79	0.746
205,000	11,759.1	1.63	4.133	1.69	4.547	0.81	0.780
210,000	12,045.9	1.67	4.317	1.74	4.751	0.83	0.814
215,000	12,332.7	1.71	4.506	1.78	4.958	0.85	0.849
220,000	12,619.5	1.75	4.698	1.82	5.169	0.87	0.885
225,000	12,906.3	1.79	4.893	1.86	5.384	0.89	0.922
230,000	13,193.1	1.83	5.093	1.90	5.604	0.91	0.959
235,000	13,479.9	1.87	5.295	1.94	5.827	0.93	0.997
240,000	13,766.7	1.91	5.502	1.98	6.054	0.95	1.036
245,000	14,053.5	1.95	5.712	–	–	0.97	1.075
250,000	14,340.3	1.99	5.926	–	–	0.99	1.115
255,000	14,627.2	–	–	–	–	1.01	1.156
260,000	14,914.0	–	–	–	–	1.03	1.197
265,000	15,200.8	–	–	–	–	1.05	1.239
270,000	15,487.6	–	–	–	–	1.07	1.282
275,000	15,774.4	–	–	–	–	1.09	1.325
280,000	16,061.2	–	–	–	–	1.11	1.369
285,000	16,348.0	–	–	–	–	1.13	1.413
290,000	16,634.8	–	–	–	–	1.15	1.459
295,000	16,921.6	–	–	–	–	1.17	1.504
300,000	17,208.4	–	–	–	–	1.19	1.551
310,000	17,782.0	–	–	–	–	1.23	1.646
320,000	18,355.6	–	–	–	–	1.27	1.743
330,000	18,929.3	–	–	–	–	1.31	1.843
340,000	19,502.9	–	–	–	–	1.35	1.946
350,000	20,076.5	–	–	–	–	1.39	2.051
360,000	20,650.1	–	–	–	–	1.43	2.158
370,000	21,223.7	–	–	–	–	1.47	2.269

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
380,000	21,797.3	–	–	–	–	1.51	2.381
390,000	22,370.9	–	–	–	–	1.55	2.496
400,000	22,944.6	–	–	–	–	1.59	2.614
410,000	23,518.2	–	–	–	–	1.63	2.734
420,000	24,091.8	–	–	–	–	1.67	2.856
430,000	24,665.4	–	–	–	–	1.71	2.981
440,000	25,239.0	–	–	–	–	1.75	3.109
450,000	25,812.6	–	–	–	–	1.79	3.238
460,000	26,386.2	–	–	–	–	1.83	3.371
470,000	26,959.8	–	–	–	–	1.87	3.505
480,000	27,533.5	–	–	–	–	1.91	3.642
490,000	28,107.1	–	–	–	–	1.95	3.782
500,000	28,680.7	–	–	–	–	1.99	3.924

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Table 32: Pressure loss for copper pipes in accordance with DVGW GW 392, heating, inlet flow 70 °C / return flow 55 °C, d88.9–108 mm

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
17,500	1,003.8	0.05	0.005	–	–
18,000	1,032.5	0.05	0.005	–	–
18,500	1,061.2	0.05	0.005	–	–
19,000	1,089.9	0.05	0.005	–	–
19,500	1,118.5	0.06	0.006	–	–
20,000	1,147.2	0.06	0.006	–	–
20,500	1,175.9	0.06	0.006	–	–
21,000	1,204.6	0.06	0.006	–	–
21,500	1,233.3	0.06	0.007	–	–
22,000	1,262.0	0.06	0.007	–	–
22,500	1,290.6	0.06	0.007	–	–
23,000	1,319.3	0.07	0.007	–	–
23,500	1,348.0	0.07	0.008	–	–
24,000	1,376.7	0.07	0.008	–	–
24,500	1,405.4	0.07	0.008	–	–
25,000	1,434.0	0.07	0.009	–	–
25,500	1,462.7	0.07	0.009	–	–
26,000	1,491.4	0.07	0.009	0.05	0.004
26,500	1,520.1	0.08	0.009	0.05	0.004
27,000	1,548.8	0.08	0.010	0.05	0.004
27,500	1,577.4	0.08	0.010	0.05	0.004
28,000	1,606.1	0.08	0.010	0.05	0.004
28,500	1,634.8	0.08	0.011	0.06	0.004
29,000	1,663.5	0.08	0.011	0.06	0.004
29,500	1,692.2	0.08	0.011	0.06	0.005
30,000	1,720.8	0.09	0.012	0.06	0.005
32,500	1,864.2	0.09	0.014	0.06	0.005
35,000	2,007.6	0.10	0.015	0.07	0.006
37,500	2,151.1	0.11	0.017	0.07	0.007
40,000	2,294.5	0.11	0.019	0.08	0.008

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
42,500	2,437.9	0.12	0.022	0.08	0.009
45,000	2,581.3	0.13	0.024	0.09	0.010
47,500	2,724.7	0.14	0.026	0.09	0.010
50,000	2,868.1	0.14	0.029	0.10	0.011
52,500	3,011.5	0.15	0.031	0.10	0.013
55,000	3,154.9	0.16	0.034	0.11	0.014
57,500	3,298.3	0.16	0.037	0.11	0.015
60,000	3,441.7	0.17	0.040	0.12	0.016
62,500	3,585.1	0.18	0.043	0.12	0.017
65,000	3,728.5	0.19	0.046	0.13	0.018
67,500	3,871.9	0.19	0.049	0.13	0.019
70,000	4,015.3	0.20	0.052	0.14	0.021
72,500	4,158.7	0.21	0.056	0.14	0.022
75,000	4,302.1	0.21	0.059	0.15	0.023
77,500	4,445.5	0.22	0.063	0.15	0.025
80,000	4,588.9	0.23	0.066	0.16	0.026
82,500	4,732.3	0.24	0.070	0.16	0.028
85,000	4,875.7	0.24	0.074	0.17	0.029
87,500	5,019.1	0.25	0.078	0.17	0.031
90,000	5,162.5	0.26	0.082	0.18	0.032
92,500	5,305.9	0.27	0.086	0.18	0.034
95,000	5,449.3	0.27	0.090	0.19	0.036
97,500	5,592.7	0.28	0.094	0.19	0.037
100,000	5,736.1	0.29	0.098	0.19	0.039
105,000	6,022.9	0.30	0.107	0.20	0.043
110,000	6,309.8	0.32	0.117	0.21	0.046
115,000	6,596.6	0.33	0.126	0.22	0.050
120,000	6,883.4	0.34	0.136	0.23	0.054
125,000	7,170.2	0.36	0.147	0.24	0.058
130,000	7,457.0	0.37	0.157	0.25	0.062
135,000	7,743.8	0.39	0.168	0.26	0.067
140,000	8,030.6	0.40	0.179	0.27	0.071
145,000	8,317.4	0.42	0.191	0.28	0.076
150,000	8,604.2	0.43	0.203	0.29	0.080
155,000	8,891.0	0.44	0.215	0.30	0.085
160,000	9,177.8	0.46	0.228	0.31	0.090
165,000	9,464.6	0.47	0.241	0.32	0.095
170,000	9,751.4	0.49	0.254	0.33	0.101
175,000	10,038.2	0.50	0.268	0.34	0.106
180,000	10,325.0	0.52	0.281	0.35	0.111
185,000	10,611.9	0.53	0.296	0.36	0.117
190,000	10,898.7	0.54	0.310	0.37	0.123
195,000	11,185.5	0.56	0.325	0.38	0.129
200,000	11,472.3	0.57	0.340	0.39	0.135
205,000	11,759.1	0.59	0.355	0.40	0.141
210,000	12,045.9	0.60	0.371	0.41	0.147
215,000	12,332.7	0.62	0.387	0.42	0.153
220,000	12,619.5	0.63	0.404	0.43	0.160
225,000	12,906.3	0.64	0.420	0.44	0.166

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
230,000	13,193.1	0.66	0.437	0.45	0.173
235,000	13,479.9	0.67	0.454	0.46	0.180
240,000	13,766.7	0.69	0.472	0.47	0.187
245,000	14,053.5	0.70	0.490	0.48	0.194
250,000	14,340.3	0.72	0.508	0.49	0.201
255,000	14,627.2	0.73	0.526	0.50	0.208
260,000	14,914.0	0.75	0.545	0.51	0.215
265,000	15,200.8	0.76	0.564	0.52	0.223
270,000	15,487.6	0.77	0.584	0.53	0.231
275,000	15,774.4	0.79	0.603	0.54	0.238
280,000	16,061.2	0.80	0.623	0.55	0.246
285,000	16,348.0	0.82	0.643	0.56	0.254
290,000	16,634.8	0.83	0.664	0.56	0.262
295,000	16,921.6	0.85	0.685	0.57	0.270
300,000	17,208.4	0.86	0.706	0.58	0.279
310,000	17,782.0	0.89	0.749	0.60	0.296
320,000	18,355.6	0.92	0.793	0.62	0.313
330,000	18,929.3	0.95	0.838	0.64	0.331
340,000	19,502.9	0.97	0.885	0.66	0.349
350,000	20,076.5	1.00	0.933	0.68	0.368
360,000	20,650.1	1.03	0.981	0.70	0.387
370,000	21,223.7	1.06	1.031	0.72	0.407
380,000	21,797.3	1.09	1.082	0.74	0.427
390,000	22,370.9	1.12	1.135	0.76	0.447
400,000	22,944.6	1.15	1.188	0.78	0.468
410,000	23,518.2	1.18	1.242	0.80	0.490
420,000	24,091.8	1.20	1.298	0.82	0.511
430,000	24,665.4	1.23	1.354	0.84	0.534
440,000	25,239.0	1.26	1.412	0.86	0.556
450,000	25,812.6	1.29	1.471	0.88	0.579
460,000	26,386.2	1.32	1.531	0.90	0.603
470,000	26,959.8	1.35	1.592	0.92	0.627
480,000	27,533.5	1.38	1.654	0.93	0.651
490,000	28,107.1	1.40	1.717	0.95	0.676
500,000	28,680.7	1.43	1.781	0.97	0.701
550,000	31,548.8	1.58	2.118	1.07	0.833
600,000	34,416.8	1.72	2.482	1.17	0.976
650,000	37,284.9	1.86	2.872	1.27	1.129
700,000	40,153.0	–	–	1.36	1.291
750,000	43,021.0	–	–	1.46	1.464
800,000	45,889.1	–	–	1.56	1.647
850,000	48,757.2	–	–	1.66	1.840
900,000	51,625.2	–	–	1.75	2.042
950,000	54,493.3	–	–	1.85	2.254
1,000,000	57,361.4	–	–	1.95	2.475

4.4 HEATING, INLET FLOW 45 °C / RETURN FLOW 35 °C

Medium:	Water	Density:	992.2 kg/m^3
Inlet flow temperature:	45 °C	Viscosity:	0.0006533 Pa•s
Return temperature:	35 °C	Specific thermal capacity:	4,182 J/(kg•K)
Range:	10 K	Surface roughness:	0.0015 mm
Average temperature:	30 °C		

Table 33: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 45 °C / return flow 35 °C, d12–18 mm

d [mm]		**12 x 0.8**		**12 x 1.0**		**15 x 1.0**		**18 x 1.0**	
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	0.06	0.110	0.06	0.128	–	–	–	–
300	25.8	0.09	0.165	0.09	0.192	0.05	0.067	–	–
400	34.4	0.11	0.219	0.12	0.257	0.07	0.090	–	–
500	43.0	0.14	0.274	0.15	0.552	0.09	0.112	0.06	0.049
600	51.6	0.17	0.625	0.18	0.751	0.11	0.135	0.07	0.059
700	60.3	0.20	0.811	0.21	0.976	0.13	0.285	0.08	0.069
800	68.9	0.23	1.018	0.25	1.224	0.15	0.357	0.10	0.135
900	77.5	0.26	1.244	0.28	1.497	0.16	0.435	0.11	0.164
1,000	86.1	0.28	1.490	0.31	1.793	0.18	0.521	0.12	0.196
1,100	94.7	0.31	1.754	0.34	2.111	0.20	0.613	0.13	0.231
1,200	103.3	0.34	2.037	0.37	2.451	0.22	0.711	0.14	0.267
1,300	111.9	0.37	2.337	0.40	2.813	0.24	0.815	0.16	0.307
1,400	120.5	0.40	2.655	0.43	3.197	0.25	0.926	0.17	0.348
1,500	129.1	0.43	2.991	0.46	3.601	0.27	1.042	0.18	0.391
1,600	137.7	0.45	3.344	0.49	4.026	0.29	1.164	0.19	0.437
1,700	146.3	0.48	3.714	0.52	4.472	0.31	1.292	0.20	0.485
1,800	154.9	0.51	4.100	0.55	4.938	0.33	1.426	0.22	0.535
1,900	163.6	0.54	4.503	0.58	5.423	0.34	1.565	0.23	0.587
2,000	172.2	0.57	4.922	0.61	5.929	0.36	1.710	0.24	0.641
2,500	215.2	0.71	7.258	0.77	8.745	0.45	2.517	0.30	0.941
3,000	258.2	0.85	9.981	0.92	12.029	0.54	3.456	0.36	1.291
3,500	301.3	0.99	13.077	1.07	15.766	0.64	4.522	0.42	1.687
4,000	344.3	1.13	16.537	1.23	19.941	0.73	5.711	0.48	2.128
4,500	387.4	1.28	20.351	1.38	24.545	0.82	7.021	0.54	2.614
5,000	430.4	1.42	24.512	1.53	29.569	0.91	8.449	0.60	3.143
5,500	473.5	1.56	29.014	1.69	35.005	1.00	9.992	0.66	3.714
6,000	516.5	1.70	33.852	1.84	40.848	1.09	11.648	0.72	4.327
6,500	559.5	1.84	39.020	1.99	47.090	1.18	13.416	0.78	4.981
7,000	602.6	1.99	44.514	–	–	1.27	15.294	0.84	5.675
7,500	645.6	–	–	–	–	1.36	17.281	0.90	6.409
8,000	688.7	–	–	–	–	1.45	19.375	0.96	7.182
8,500	731.7	–	–	–	–	1.54	21.576	1.02	7.993
9,000	774.7	–	–	–	–	1.63	23.882	1.08	8.843
9,500	817.8	–	–	–	–	1.72	26.292	1.14	9.731
10,000	860.8	–	–	–	–	1.82	28.805	1.20	10.657
10,500	903.9	–	–	–	–	1.91	31.420	1.26	11.620

d [mm]		12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0	
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]
11,000	946.9	–	–	–	–	2.00	34.138	1.32	12.620
11,500	990.0	–	–	–	–	–	–	1.38	13.656
12,000	1,033.0	–	–	–	–	–	–	1.44	14.729
12,500	1,076.0	–	–	–	–	–	–	1.50	15.838
13,000	1,119.1	–	–	–	–	–	–	1.56	16.983
13,500	1,162.1	–	–	–	–	–	–	1.62	18.164
14,000	1,205.2	–	–	–	–	–	–	1.68	19.380
14,500	1,248.2	–	–	–	–	–	–	1.74	20.632
15,000	1,291.2	–	–	–	–	–	–	1.80	21.918
15,500	1,334.3	–	–	–	–	–	–	1.86	23.239
16,000	1,377.3	–	–	–	–	–	–	1.92	24.595
16,500	1,420.4	–	–	–	–	–	–	1.98	25.986

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Table 34: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 45 °C / return flow 35 °C, d22–28 mm

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
700	60.3	0.05	0.028	–	–	–	–
800	68.9	0.06	0.032	–	–	–	–
900	77.5	0.07	0.036	–	–	–	–
1,000	86.1	0.08	0.069	–	–	–	–
1,100	94.7	0.08	0.081	–	–	0.05	0.018
1,200	103.3	0.09	0.094	0.05	0.017	0.06	0.020
1,300	111.9	0.10	0.107	0.06	0.031	0.06	0.038
1,400	120.5	0.11	0.122	0.06	0.036	0.07	0.043
1,500	129.1	0.12	0.137	0.07	0.040	0.07	0.048
1,600	137.7	0.12	0.153	0.07	0.045	0.08	0.054
1,700	146.3	0.13	0.169	0.08	0.049	0.08	0.059
1,800	154.9	0.14	0.187	0.08	0.054	0.09	0.065
1,900	163.6	0.15	0.205	0.09	0.060	0.09	0.072
2,000	172.2	0.15	0.224	0.09	0.065	0.10	0.078
2,500	215.2	0.19	0.328	0.11	0.095	0.12	0.114
3,000	258.2	0.23	0.449	0.14	0.130	0.15	0.156
3,500	301.3	0.27	0.586	0.16	0.169	0.17	0.204
4,000	344.3	0.31	0.738	0.18	0.213	0.20	0.257
4,500	387.4	0.35	0.906	0.20	0.261	0.22	0.315
5,000	430.4	0.38	1.089	0.23	0.314	0.25	0.378
5,500	473.5	0.42	1.286	0.25	0.370	0.27	0.446
6,000	516.5	0.46	1.497	0.27	0.431	0.29	0.519
6,500	559.5	0.50	1.722	0.30	0.495	0.32	0.596
7,000	602.6	0.54	1.960	0.32	0.563	0.34	0.679
7,500	645.6	0.58	2.212	0.34	0.635	0.37	0.766
8,000	688.7	0.61	2.478	0.36	0.711	0.39	0.857
8,500	731.7	0.65	2.757	0.39	0.791	0.42	0.953
9,000	774.7	0.69	3.049	0.41	0.874	0.44	1.053
9,500	817.8	0.73	3.353	0.43	0.961	0.47	1.158
10,000	860.8	0.77	3.671	0.45	1.051	0.49	1.267
10,500	903.9	0.81	4.001	0.48	1.145	0.52	1.381

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
11,000	946.9	0.84	4.343	0.50	1.243	0.54	1.498
11,500	990.0	0.88	4.698	0.52	1.344	0.56	1.620
12,000	1,033.0	0.92	5.066	0.54	1.449	0.59	1.746
12,500	1,076.0	0.96	5.445	0.57	1.557	0.61	1.877
13,000	1,119.1	1.00	5.837	0.59	1.668	0.64	2.011
13,500	1,162.1	1.04	6.241	0.61	1.783	0.66	2.150
14,000	1,205.2	1.07	6.656	0.64	1.901	0.69	2.292
14,500	1,248.2	1.11	7.084	0.66	2.022	0.71	2.439
15,000	1,291.2	1.15	7.524	0.68	2.147	0.74	2.589
15,500	1,334.3	1.19	7.975	0.70	2.275	0.76	2.744
16,000	1,377.3	1.23	8.438	0.73	2.407	0.79	2.903
16,500	1,420.4	1.27	8.912	0.75	2.541	0.81	3.065
17,000	1,463.4	1.30	9.399	0.77	2.679	0.83	3.232
17,500	1,506.5	1.34	9.896	0.79	2.820	0.86	3.402
18,000	1,549.5	1.38	10.405	0.82	2.965	0.88	3.576
18,500	1,592.5	1.42	10.926	0.84	3.112	0.91	3.754
19,000	1,635.6	1.46	11.458	0.86	3.263	0.93	3.936
19,500	1,678.6	1.50	12.001	0.89	3.417	0.96	4.122
20,000	1,721.7	1.53	12.556	0.91	3.574	0.98	4.312
20,500	1,764.7	1.57	13.122	0.93	3.734	1.01	4.505
21,000	1,807.7	1.61	13.699	0.95	3.897	1.03	4.702
21,500	1,850.8	1.65	14.287	0.98	4.064	1.06	4.903
22,000	1,893.8	1.69	14.886	1.00	4.233	1.08	5.108
22,500	1,936.9	1.73	15.496	1.02	4.406	1.10	5.316
23,000	1,979.9	1.76	16.117	1.04	4.582	1.13	5.528
23,500	2,023.0	1.80	16.749	1.07	4.760	1.15	5.744
24,000	2,066.0	1.84	17.393	1.09	4.942	1.18	5.963
24,500	2,109.0	1.88	18.046	1.11	5.127	1.20	6.187
25,000	2,152.1	1.92	18.711	1.13	5.315	1.23	6.413
25,500	2,195.1	1.96	19.387	1.16	5.506	1.25	6.644
26,000	2,238.2	1.99	20.074	1.18	5.699	1.28	6.878
26,500	2,281.2	–	–	1.20	5.896	1.30	7.116
27,000	2,324.2	–	–	1.23	6.096	1.33	7.357
27,500	2,367.3	–	–	1.25	6.299	1.35	7.602
28,000	2,410.3	–	–	1.27	6.505	1.37	7.851
28,500	2,453.4	–	–	1.29	6.713	1.40	8.103
29,000	2,496.4	–	–	1.32	6.925	1.42	8.359
29,500	2,539.5	–	–	1.34	7.140	1.45	8.618
30,000	2,582.5	–	–	1.36	7.357	1.47	8.881
32,500	2,797.7	–	–	1.48	8.489	1.60	10.248
35,000	3,012.9	–	–	1.59	9.693	1.72	11.703
37,500	3,228.1	–	–	1.70	10.969	1.84	13.244
40,000	3,443.3	–	–	1.82	12.315	1.96	14.871
42,500	3,658.5	–	–	1.93	13.731	–	–

Table 35: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 45 °C / return flow 35 °C, d35–42 mm

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
1,700	146.3	–	–	0.05	0.019	–	–	–	–
1,800	154.9	0.05	0.019	0.05	0.021	–	–	–	–
1,900	163.6	0.05	0.021	0.06	0.022	–	–	–	–
2,000	172.2	0.06	0.022	0.06	0.025	–	–	–	–
2,500	215.2	0.07	0.033	0.07	0.036	–	–	0.05	0.014
3,000	258.2	0.09	0.045	0.09	0.049	0.06	0.018	0.06	0.019
3,500	301.3	0.10	0.058	0.10	0.064	0.07	0.023	0.07	0.025
4,000	344.3	0.12	0.073	0.12	0.080	0.08	0.029	0.08	0.031
4,500	387.4	0.13	0.090	0.13	0.098	0.09	0.036	0.09	0.038
5,000	430.4	0.14	0.108	0.15	0.117	0.10	0.043	0.10	0.046
5,500	473.5	0.16	0.127	0.16	0.138	0.11	0.051	0.11	0.054
6,000	516.5	0.17	0.147	0.18	0.161	0.12	0.059	0.12	0.063
6,500	559.5	0.19	0.169	0.19	0.185	0.13	0.067	0.13	0.073
7,000	602.6	0.20	0.193	0.21	0.210	0.14	0.077	0.14	0.082
7,500	645.6	0.22	0.217	0.22	0.237	0.15	0.086	0.15	0.093
8,000	688.7	0.23	0.243	0.24	0.265	0.16	0.097	0.16	0.104
8,500	731.7	0.25	0.270	0.25	0.295	0.17	0.107	0.17	0.115
9,000	774.7	0.26	0.298	0.27	0.326	0.18	0.119	0.18	0.127
9,500	817.8	0.27	0.328	0.28	0.358	0.19	0.130	0.19	0.140
10,000	860.8	0.29	0.359	0.30	0.392	0.20	0.142	0.20	0.153
10,500	903.9	0.30	0.391	0.31	0.427	0.21	0.155	0.21	0.167
11,000	946.9	0.32	0.424	0.33	0.463	0.22	0.168	0.22	0.181
11,500	990.0	0.33	0.458	0.34	0.500	0.23	0.182	0.23	0.195
12,000	1,033.0	0.35	0.493	0.36	0.539	0.23	0.196	0.24	0.210
12,500	1,076.0	0.36	0.530	0.37	0.579	0.24	0.210	0.25	0.226
13,000	1,119.1	0.38	0.568	0.39	0.620	0.25	0.225	0.26	0.242
13,500	1,162.1	0.39	0.607	0.40	0.663	0.26	0.241	0.27	0.259
14,000	1,205.2	0.40	0.647	0.42	0.707	0.27	0.256	0.28	0.276
14,500	1,248.2	0.42	0.688	0.43	0.752	0.28	0.273	0.29	0.293
15,000	1,291.2	0.43	0.730	0.45	0.798	0.29	0.289	0.30	0.311
15,500	1,334.3	0.45	0.774	0.46	0.845	0.30	0.306	0.31	0.329
16,000	1,377.3	0.46	0.818	0.48	0.894	0.31	0.324	0.32	0.348
16,500	1,420.4	0.48	0.864	0.49	0.944	0.32	0.342	0.33	0.368
17,000	1,463.4	0.49	0.910	0.51	0.995	0.33	0.360	0.34	0.388
17,500	1,506.5	0.51	0.958	0.52	1.047	0.34	0.379	0.35	0.408
18,000	1,549.5	0.52	1.007	0.54	1.100	0.35	0.398	0.36	0.429
18,500	1,592.5	0.53	1.057	0.55	1.155	0.36	0.418	0.37	0.450
19,000	1,635.6	0.55	1.108	0.57	1.210	0.37	0.438	0.38	0.471
19,500	1,678.6	0.56	1.160	0.58	1.267	0.38	0.459	0.39	0.493
20,000	1,721.7	0.58	1.213	0.60	1.325	0.39	0.480	0.40	0.516
20,500	1,764.7	0.59	1.267	0.61	1.384	0.40	0.501	0.41	0.539
21,000	1,807.7	0.61	1.322	0.63	1.445	0.41	0.523	0.42	0.562
21,500	1,850.8	0.62	1.378	0.64	1.506	0.42	0.545	0.43	0.586
22,000	1,893.8	0.64	1.436	0.66	1.569	0.43	0.567	0.44	0.610
22,500	1,936.9	0.65	1.494	0.67	1.632	0.44	0.590	0.45	0.635
23,000	1,979.9	0.66	1.553	0.69	1.697	0.45	0.614	0.46	0.660
23,500	2,023.0	0.68	1.613	0.70	1.763	0.46	0.637	0.47	0.686
24,000	2,066.0	0.69	1.675	0.72	1.830	0.47	0.662	0.48	0.712

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
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]
24,500	2,109.0	0.71	1.737	0.73	1.898	0.48	0.686	0.49	0.738
25,000	2,152.1	0.72	1.800	0.75	1.968	0.49	0.711	0.50	0.765
25,500	2,195.1	0.74	1.865	0.76	2.038	0.50	0.736	0.51	0.792
26,000	2,238.2	0.75	1.930	0.78	2.110	0.51	0.762	0.52	0.820
26,500	2,281.2	0.77	1.997	0.79	2.182	0.52	0.788	0.53	0.848
27,000	2,324.2	0.78	2.064	0.81	2.256	0.53	0.815	0.54	0.876
27,500	2,367.3	0.79	2.132	0.82	2.331	0.54	0.842	0.55	0.905
28,000	2,410.3	0.81	2.202	0.84	2.406	0.55	0.869	0.56	0.935
28,500	2,453.4	0.82	2.272	0.85	2.483	0.56	0.897	0.57	0.964
29,000	2,496.4	0.84	2.343	0.87	2.561	0.57	0.925	0.59	0.995
29,500	2,539.5	0.85	2.416	0.88	2.640	0.58	0.953	0.60	1.025
30,000	2,582.5	0.87	2.489	0.90	2.721	0.59	0.982	0.61	1.056
32,500	2,797.7	0.94	2.870	0.97	3.137	0.64	1.132	0.66	1.217
35,000	3,012.9	1.01	3.275	1.05	3.580	0.68	1.291	0.71	1.389
37,500	3,228.1	1.08	3.704	1.12	4.049	0.73	1.459	0.76	1.570
40,000	3,443.3	1.15	4.157	1.20	4.544	0.78	1.637	0.81	1.761
42,500	3,658.5	1.23	4.633	1.27	5.064	0.83	1.824	0.86	1.962
45,000	3,873.7	1.30	5.131	1.35	5.610	0.88	2.019	0.91	2.173
47,500	4,089.0	1.37	5.653	1.42	6.180	0.93	2.224	0.96	2.393
50,000	4,304.2	1.44	6.197	1.50	6.775	0.98	2.437	1.01	2.622
52,500	4,519.4	1.52	6.764	1.57	7.395	1.03	2.659	1.06	2.861
55,000	4,734.6	1.59	7.353	1.65	8.039	1.08	2.890	1.11	3.109
57,500	4,949.8	1.66	7.964	1.72	8.708	1.13	3.129	1.16	3.367
60,000	5,165.0	1.73	8.597	1.80	9.400	1.17	3.377	1.21	3.633
62,500	5,380.2	1.80	9.251	1.87	10.116	1.22	3.633	1.26	3.909
65,000	5,595.4	1.88	9.928	1.95	10.856	1.27	3.897	1.31	4.194
67,500	5,810.6	1.95	10.626	–	–	1.32	4.170	1.36	4.488
70,000	6,025.8	–	–	–	–	1.37	4.452	1.41	4.790
72,500	6,241.0	–	–	–	–	1.42	4.741	1.46	5.102
75,000	6,456.2	–	–	–	–	1.47	5.039	1.51	5.422
77,500	6,671.4	–	–	–	–	1.52	5.345	1.56	5.752
80,000	6,886.7	–	–	–	–	1.57	5.658	1.61	6.090
82,500	7,101.9	–	–	–	–	1.61	5.980	1.66	6.436
85,000	7,317.1	–	–	–	–	1.66	6.311	1.71	6.792
87,500	7,532.3	–	–	–	–	1.71	6.649	1.77	7.156
90,000	7,747.5	–	–	–	–	1.76	6.995	1.82	7.528
92,500	7,962.7	–	–	–	–	1.81	7.349	1.87	7.909
95,000	8,177.9	–	–	–	–	1.86	7.711	1.92	8.299
97,500	8,393.1	–	–	–	–	1.91	8.080	1.97	8.697
100,000	8,608.3	–	–	–	–	1.96	8.458	–	–

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Table 36: Pressure loss in copper pipes in accordance with DVGW GW 392, heating, inlet flow 45 °C / return flow 35 °C, d54–76.1 mm

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
4,500	387.4	0.05	0.011	0.06	0.012	–	–
5,000	430.4	0.06	0.013	0.06	0.014	–	–
5,500	473.5	0.06	0.015	0.07	0.017	–	–

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
6,000	516.5	0.07	0.018	0.07	0.020	–	–
6,500	559.5	0.08	0.020	0.08	0.022	–	–
7,000	602.6	0.08	0.023	0.09	0.025	–	–
7,500	645.6	0.09	0.026	0.09	0.029	–	–
8,000	688.7	0.09	0.029	0.10	0.032	–	–
8,500	731.7	0.10	0.032	0.10	0.036	0.05	0.006
9,000	774.7	0.11	0.036	0.11	0.039	0.05	0.007
9,500	817.8	0.11	0.039	0.12	0.043	0.06	0.008
10,000	860.8	0.12	0.043	0.12	0.047	0.06	0.008
10,500	903.9	0.12	0.047	0.13	0.051	0.06	0.009
11,000	946.9	0.13	0.051	0.14	0.056	0.06	0.010
11,500	990.0	0.14	0.055	0.14	0.060	0.07	0.011
12,000	1,033.0	0.14	0.059	0.15	0.065	0.07	0.011
12,500	1,076.0	0.15	0.063	0.15	0.069	0.07	0.012
13,000	1,119.1	0.15	0.068	0.16	0.074	0.08	0.013
13,500	1,162.1	0.16	0.072	0.17	0.079	0.08	0.014
14,000	1,205.2	0.17	0.077	0.17	0.085	0.08	0.015
14,500	1,248.2	0.17	0.082	0.18	0.090	0.09	0.016
15,000	1,291.2	0.18	0.087	0.18	0.096	0.09	0.017
15,500	1,334.3	0.18	0.092	0.19	0.101	0.09	0.018
16,000	1,377.3	0.19	0.097	0.20	0.107	0.09	0.019
16,500	1,420.4	0.19	0.103	0.20	0.113	0.10	0.020
17,000	1,463.4	0.20	0.108	0.21	0.119	0.10	0.021
17,500	1,506.5	0.21	0.114	0.21	0.125	0.10	0.022
18,000	1,549.5	0.21	0.120	0.22	0.131	0.11	0.023
18,500	1,592.5	0.22	0.125	0.23	0.138	0.11	0.024
19,000	1,635.6	0.22	0.131	0.23	0.144	0.11	0.025
19,500	1,678.6	0.23	0.138	0.24	0.151	0.12	0.027
20,000	1,721.7	0.24	0.144	0.25	0.158	0.12	0.028
20,500	1,764.7	0.24	0.150	0.25	0.165	0.12	0.029
21,000	1,807.7	0.25	0.157	0.26	0.172	0.12	0.030
21,500	1,850.8	0.25	0.163	0.26	0.179	0.13	0.032
22,000	1,893.8	0.26	0.170	0.27	0.187	0.13	0.033
22,500	1,936.9	0.27	0.177	0.28	0.194	0.13	0.034
23,000	1,979.9	0.27	0.184	0.28	0.202	0.14	0.035
23,500	2,023.0	0.28	0.191	0.29	0.210	0.14	0.037
24,000	2,066.0	0.28	0.198	0.29	0.218	0.14	0.038
24,500	2,109.0	0.29	0.205	0.30	0.226	0.14	0.040
25,000	2,152.1	0.29	0.213	0.31	0.234	0.15	0.041
25,500	2,195.1	0.30	0.220	0.31	0.242	0.15	0.042
26,000	2,238.2	0.31	0.228	0.32	0.251	0.15	0.044
26,500	2,281.2	0.31	0.236	0.33	0.259	0.16	0.045
27,000	2,324.2	0.32	0.244	0.33	0.268	0.16	0.047
27,500	2,367.3	0.32	0.252	0.34	0.277	0.16	0.048
28,000	2,410.3	0.33	0.260	0.34	0.286	0.17	0.050
28,500	2,453.4	0.34	0.268	0.35	0.295	0.17	0.052
29,000	2,496.4	0.34	0.277	0.36	0.304	0.17	0.053
29,500	2,539.5	0.35	0.285	0.36	0.313	0.17	0.055
30,000	2,582.5	0.35	0.294	0.37	0.323	0.18	0.056

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
32,500	2,797.7	0.38	0.338	0.40	0.372	0.19	0.065
35,000	3,012.9	0.41	0.385	0.43	0.424	0.21	0.074
37,500	3,228.1	0.44	0.436	0.46	0.479	0.22	0.084
40,000	3,443.3	0.47	0.488	0.49	0.537	0.24	0.094
42,500	3,658.5	0.50	0.544	0.52	0.598	0.25	0.104
45,000	3,873.7	0.53	0.602	0.55	0.662	0.27	0.115
47,500	4,089.0	0.56	0.662	0.58	0.728	0.28	0.127
50,000	4,304.2	0.59	0.726	0.61	0.798	0.30	0.139
52,500	4,519.4	0.62	0.792	0.64	0.870	0.31	0.151
55,000	4,734.6	0.65	0.860	0.68	0.945	0.32	0.164
57,500	4,949.8	0.68	0.931	0.71	1.023	0.34	0.178
60,000	5,165.0	0.71	1.004	0.74	1.104	0.35	0.192
62,500	5,380.2	0.74	1.080	0.77	1.187	0.37	0.206
65,000	5,595.4	0.77	1.158	0.80	1.274	0.38	0.221
67,500	5,810.6	0.80	1.239	0.83	1.362	0.40	0.236
70,000	6,025.8	0.83	1.322	0.86	1.454	0.41	0.252
72,500	6,241.0	0.86	1.408	0.89	1.548	0.43	0.268
75,000	6,456.2	0.88	1.496	0.92	1.645	0.44	0.285
77,500	6,671.4	0.91	1.586	0.95	1.744	0.46	0.302
80,000	6,886.7	0.94	1.679	0.98	1.846	0.47	0.320
82,500	7,101.9	0.97	1.774	1.01	1.951	0.49	0.338
85,000	7,317.1	1.00	1.871	1.04	2.058	0.50	0.356
87,500	7,532.3	1.03	1.971	1.07	2.168	0.52	0.375
90,000	7,747.5	1.06	2.073	1.10	2.280	0.53	0.394
92,500	7,962.7	1.09	2.178	1.14	2.395	0.55	0.414
95,000	8,177.9	1.12	2.284	1.17	2.512	0.56	0.434
97,500	8,393.1	1.15	2.393	1.20	2.632	0.58	0.455
100,000	8,608.3	1.18	2.505	1.23	2.755	0.59	0.476
105,000	9,038.7	1.24	2.734	1.29	3.007	0.62	0.519
110,000	9,469.2	1.30	2.973	1.35	3.270	0.65	0.564
115,000	9,899.6	1.36	3.220	1.41	3.542	0.68	0.611
120,000	10,330.0	1.42	3.477	1.47	3.824	0.71	0.659
125,000	10,760.4	1.47	3.742	1.53	4.116	0.74	0.709
130,000	11,190.8	1.53	4.016	1.60	4.417	0.77	0.761
135,000	11,621.2	1.59	4.298	1.66	4.728	0.80	0.814
140,000	12,051.6	1.65	4.590	1.72	5.049	0.83	0.869
145,000	12,482.1	1.71	4.890	1.78	5.379	0.86	0.926
150,000	12,912.5	1.77	5.199	1.84	5.719	0.89	0.984
155,000	13,342.9	1.83	5.516	1.90	6.068	0.91	1.043
160,000	13,773.3	1.89	5.842	1.96	6.427	0.94	1.105
165,000	14,203.7	1.95	6.176	–	–	0.97	1.167
170,000	14,634.1	–	–	–	–	1.00	1.232
175,000	15,064.6	–	–	–	–	1.03	1.298
180,000	15,495.0	–	–	–	–	1.06	1.365
185,000	15,925.4	–	–	–	–	1.09	1.434
190,000	16,355.8	–	–	–	–	1.12	1.505
195,000	16,786.2	–	–	–	–	1.15	1.577
200,000	17,216.6	–	–	–	–	1.18	1.650
205,000	17,647.1	–	–	–	–	1.21	1.725

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
210,000	18,077.5	–	–	–	–	1.24	1.802
215,000	18,507.9	–	–	–	–	1.27	1.880
220,000	18,938.3	–	–	–	–	1.30	1.960
225,000	19,368.7	–	–	–	–	1.33	2.041
230,000	19,799.1	–	–	–	–	1.36	2.123
235,000	20,229.6	–	–	–	–	1.39	2.208
240,000	20,660.0	–	–	–	–	1.42	2.293
245,000	21,090.4	–	–	–	–	1.45	2.380
250,000	21,520.8	–	–	–	–	1.48	2.469
255,000	21,951.2	–	–	–	–	1.51	2.559
260,000	22,381.6	–	–	–	–	1.53	2.650
265,000	22,812.1	–	–	–	–	1.56	2.743
270,000	23,242.5	–	–	–	–	1.59	2.837
275,000	23,672.9	–	–	–	–	1.62	2.933
280,000	24,103.3	–	–	–	–	1.65	3.030
285,000	24,533.7	–	–	–	–	1.68	3.129
290,000	24,964.1	–	–	–	–	1.71	3.229
295,000	25,394.5	–	–	–	–	1.74	3.331
300,000	25,825.0	–	–	–	–	1.77	3.434
310,000	26,685.8	–	–	–	–	1.83	3.644
320,000	27,546.6	–	–	–	–	1.89	3.860
330,000	28,407.5	–	–	–	–	1.95	4.081

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Table 37: Pressure loss for copper pipes in accordance with DVGW GW 392, heating, inlet flow 45 °C / return flow 35 °C, d88.9–108 mm

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
12,000	1,033.0	0.05	0.005	–	–
12,500	1,076.0	0.05	0.006	–	–
13,000	1,119.1	0.06	0.006	–	–
13,500	1,162.1	0.06	0.006	–	–
14,000	1,205.2	0.06	0.007	–	–
14,500	1,248.2	0.06	0.007	–	–
15,000	1,291.2	0.06	0.008	–	–
15,500	1,334.3	0.07	0.008	–	–
16,000	1,377.3	0.07	0.009	–	–
16,500	1,420.4	0.07	0.009	–	–
17,000	1,463.4	0.07	0.010	–	–
17,500	1,506.5	0.07	0.010	0.05	0.004
18,000	1,549.5	0.08	0.011	0.05	0.004
18,500	1,592.5	0.08	0.011	0.05	0.004
19,000	1,635.6	0.08	0.012	0.05	0.005
19,500	1,678.6	0.08	0.012	0.06	0.005
20,000	1,721.7	0.09	0.013	0.06	0.005
20,500	1,764.7	0.09	0.013	0.06	0.005
21,000	1,807.7	0.09	0.014	0.06	0.006
21,500	1,850.8	0.09	0.015	0.06	0.006
22,000	1,893.8	0.09	0.015	0.06	0.006

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
22,500	1,936.9	0.10	0.016	0.07	0.006
23,000	1,979.9	0.10	0.016	0.07	0.007
23,500	2,023.0	0.10	0.017	0.07	0.007
24,000	2,066.0	0.10	0.018	0.07	0.007
24,500	2,109.0	0.10	0.018	0.07	0.007
25,000	2,152.1	0.11	0.019	0.07	0.008
25,500	2,195.1	0.11	0.020	0.07	0.008
26,000	2,238.2	0.11	0.020	0.08	0.008
26,500	2,281.2	0.11	0.021	0.08	0.008
27,000	2,324.2	0.11	0.022	0.08	0.009
27,500	2,367.3	0.12	0.022	0.08	0.009
28,000	2,410.3	0.12	0.023	0.08	0.009
28,500	2,453.4	0.12	0.024	0.08	0.009
29,000	2,496.4	0.12	0.024	0.08	0.010
29,500	2,539.5	0.13	0.025	0.09	0.010
30,000	2,582.5	0.13	0.026	0.09	0.010
32,500	2,797.7	0.14	0.030	0.09	0.012
35,000	3,012.9	0.15	0.034	0.10	0.014
37,500	3,228.1	0.16	0.038	0.11	0.015
40,000	3,443.3	0.17	0.043	0.12	0.017
42,500	3,658.5	0.18	0.048	0.12	0.019
45,000	3,873.7	0.19	0.053	0.13	0.021
47,500	4,089.0	0.20	0.058	0.14	0.023
50,000	4,304.2	0.21	0.064	0.14	0.025
52,500	4,519.4	0.22	0.069	0.15	0.028
55,000	4,734.6	0.23	0.075	0.16	0.030
57,500	4,949.8	0.24	0.082	0.17	0.032
60,000	5,165.0	0.26	0.088	0.17	0.035
62,500	5,380.2	0.27	0.094	0.18	0.038
65,000	5,595.4	0.28	0.101	0.19	0.040
67,500	5,810.6	0.29	0.108	0.20	0.043
70,000	6,025.8	0.30	0.115	0.20	0.046
72,500	6,241.0	0.31	0.123	0.21	0.049
75,000	6,456.2	0.32	0.130	0.22	0.052
77,500	6,671.4	0.33	0.138	0.22	0.055
80,000	6,886.7	0.34	0.146	0.23	0.058
82,500	7,101.9	0.35	0.155	0.24	0.061
85,000	7,317.1	0.36	0.163	0.25	0.065
87,500	7,532.3	0.37	0.172	0.25	0.068
90,000	7,747.5	0.38	0.180	0.26	0.072
92,500	7,962.7	0.39	0.189	0.27	0.075
95,000	8,177.9	0.40	0.199	0.27	0.079
97,500	8,393.1	0.42	0.208	0.28	0.083
100,000	8,608.3	0.43	0.218	0.29	0.086
105,000	9,038.7	0.45	0.237	0.30	0.094
110,000	9,469.2	0.47	0.258	0.32	0.102
115,000	9,899.6	0.49	0.279	0.33	0.111
120,000	10,330.0	0.51	0.301	0.35	0.119
125,000	10,760.4	0.53	0.324	0.36	0.128

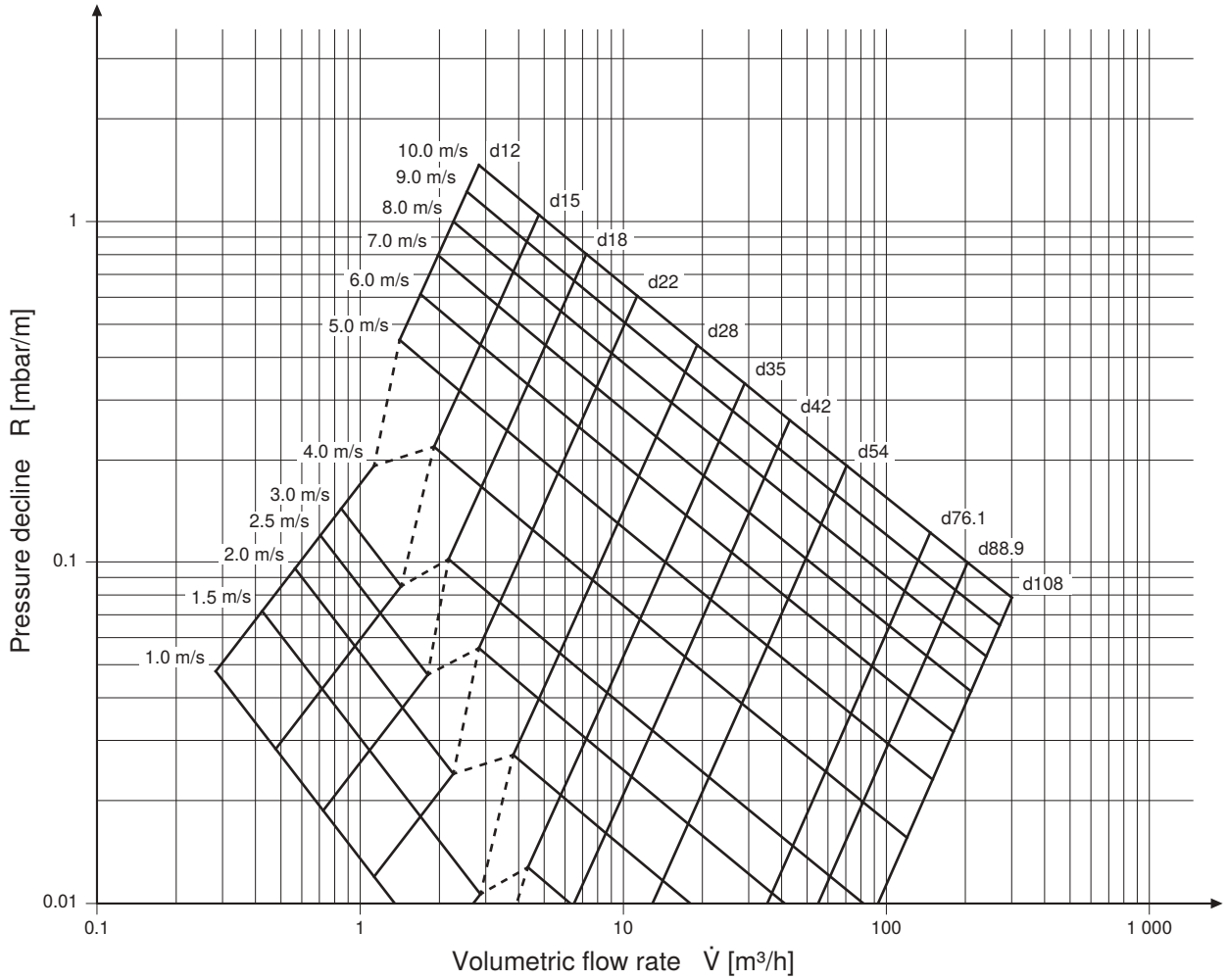
d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
130,000	11,190.8	0.55	0.348	0.38	0.138
135,000	11,621.2	0.57	0.372	0.39	0.147
140,000	12,051.6	0.60	0.397	0.40	0.157
145,000	12,482.1	0.62	0.423	0.42	0.167
150,000	12,912.5	0.64	0.449	0.43	0.178
155,000	13,342.9	0.66	0.476	0.45	0.189
160,000	13,773.3	0.68	0.504	0.46	0.200
165,000	14,203.7	0.70	0.533	0.48	0.211
170,000	14,634.1	0.72	0.562	0.49	0.222
175,000	15,064.6	0.74	0.592	0.51	0.234
180,000	15,495.0	0.77	0.623	0.52	0.246
185,000	15,925.4	0.79	0.654	0.54	0.259
190,000	16,355.8	0.81	0.686	0.55	0.271
195,000	16,786.2	0.83	0.719	0.56	0.284
200,000	17,216.6	0.85	0.752	0.58	0.298
205,000	17,647.1	0.87	0.787	0.59	0.311
210,000	18,077.5	0.89	0.821	0.61	0.325
215,000	18,507.9	0.92	0.857	0.62	0.339
220,000	18,938.3	0.94	0.893	0.64	0.353
225,000	19,368.7	0.96	0.930	0.65	0.368
230,000	19,799.1	0.98	0.967	0.67	0.382
235,000	20,229.6	1.00	1.006	0.68	0.397
240,000	20,660.0	1.02	1.045	0.69	0.413
245,000	21,090.4	1.04	1.084	0.71	0.428
250,000	21,520.8	1.06	1.124	0.72	0.444
255,000	21,951.2	1.09	1.165	0.74	0.460
260,000	22,381.6	1.11	1.207	0.75	0.477
265,000	22,812.1	1.13	1.249	0.77	0.493
270,000	23,242.5	1.15	1.292	0.78	0.510
275,000	23,672.9	1.17	1.335	0.80	0.527
280,000	24,103.3	1.19	1.379	0.81	0.545
285,000	24,533.7	1.21	1.424	0.82	0.562
290,000	24,964.1	1.23	1.470	0.84	0.580
295,000	25,394.5	1.26	1.516	0.85	0.598
300,000	25,825.0	1.28	1.562	0.87	0.617
310,000	26,685.8	1.32	1.658	0.90	0.654
320,000	27,546.6	1.36	1.756	0.93	0.693
330,000	28,407.5	1.40	1.856	0.95	0.732
340,000	29,268.3	1.45	1.959	0.98	0.773
350,000	30,129.1	1.49	2.065	1.01	0.814
360,000	30,990.0	1.53	2.173	1.04	0.857
370,000	31,850.8	1.58	2.283	1.07	0.900
380,000	32,711.6	1.62	2.396	1.10	0.945
390,000	33,572.5	1.66	2.512	1.13	0.990
400,000	34,433.3	1.70	2.630	1.16	1.036
410,000	35,294.1	1.75	2.750	1.19	1.084
420,000	36,154.9	1.79	2.873	1.21	1.132
430,000	37,015.8	1.83	2.999	1.24	1.181
440,000	37,876.6	1.87	3.126	1.27	1.231

d [mm]		88.9 x 2.0		108 x 2.5	
Q̇ [W]	ṁ [kg/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
450,000	38,737.4	1.92	3.257	1.30	1.282
460,000	39,598.3	1.96	3.389	1.33	1.335
470,000	40,459.1	–	–	1.36	1.388
480,000	41,319.9	–	–	1.39	1.441
490,000	42,180.8	–	–	1.42	1.496
500,000	43,041.6	–	–	1.45	1.552
550,000	47,345.8	–	–	1.59	1.845
600,000	51,649.9	–	–	1.74	2.161
650,000	55,954.1	–	–	1.88	2.499

5 PRESSURE LOSS GAS

5.1 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 38: Pressure loss for copper pipes in accordance with DVGWGW392 2nd gas family, d12–22 mm

d [mm]	12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0		22 x 1.0	
V̇ [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	0.82	0.0363	0.88	0.0424	0.52	0.0149	–	–	–	–
0.50	1.63	0.0726	1.77	0.0849	1.05	0.0297	0.69	0.0130	–	–
0.75	2.45	0.1088	2.65	0.1273	1.57	0.0446	1.04	0.0194	0.66	0.0080
1.00	3.27	0.1451	3.54	0.1698	2.09	0.0594	1.38	0.0259	0.88	0.0106
1.25	4.09	0.1814	4.42	0.3651	2.62	0.0743	1.73	0.0324	1.11	0.0133
1.50	4.90	0.4132	5.31	0.4968	3.14	0.0892	2.07	0.0389	1.33	0.0159
1.75	5.72	0.5365	6.19	0.6451	3.66	0.1882	2.42	0.0453	1.55	0.0186
2.00	6.54	0.6732	7.07	0.8097	4.19	0.2358	2.76	0.0891	1.77	0.0212
2.25	7.36	0.8229	7.96	0.9899	4.71	0.2880	3.11	0.1086	1.99	0.0239
2.50	8.17	0.9852	8.84	1.1854	5.23	0.3444	3.45	0.1298	2.21	0.0456
2.75	8.99	1.1599	9.73	1.3958	5.76	0.4052	3.80	0.1526	2.43	0.0535
3.00	9.81	1.3468	–	–	6.28	0.4701	4.14	0.1769	2.65	0.0620
3.25	–	–	–	–	6.80	0.5390	4.49	0.2027	2.87	0.0710
3.50	–	–	–	–	7.32	0.6120	4.84	0.2300	3.09	0.0805
3.75	–	–	–	–	7.85	0.6889	5.18	0.2587	3.32	0.0905
4.00	–	–	–	–	8.37	0.7698	5.53	0.2889	3.54	0.1010
4.50	–	–	–	–	9.42	0.9428	6.22	0.3536	3.98	0.1235
5.00	–	–	–	–	10.46	1.1308	6.91	0.4237	4.42	0.1479
5.50	–	–	–	–	–	–	7.60	0.4993	4.86	0.1741
6.00	–	–	–	–	–	–	8.29	0.5801	5.31	0.2021
6.50	–	–	–	–	–	–	8.98	0.6662	5.75	0.2319
7.00	–	–	–	–	–	–	9.67	0.7573	6.19	0.2635
7.50	–	–	–	–	–	–	10.36	0.8535	6.63	0.2968
8.00	–	–	–	–	–	–	–	–	7.07	0.3318
8.50	–	–	–	–	–	–	–	–	7.52	0.3685
9.00	–	–	–	–	–	–	–	–	7.96	0.4068
9.50	–	–	–	–	–	–	–	–	8.40	0.4468
10.00	–	–	–	–	–	–	–	–	8.84	0.4883
10.50	–	–	–	–	–	–	–	–	9.28	0.5315
11.00	–	–	–	–	–	–	–	–	9.73	0.5762
11.50	–	–	–	–	–	–	–	–	10.17	0.6226

Table 39: Pressure loss for copper pipes in accordance with DVGWGW392 2nd gas family, d28–35 mm

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
1.00	0.52	0.0037	0.57	0.0043	–	–	–	–
1.25	0.65	0.0046	0.71	0.0054	–	–	–	–
1.50	0.78	0.0056	0.85	0.0065	–	–	0.52	0.0024
1.75	0.92	0.0065	0.99	0.0076	0.58	0.0026	0.60	0.0028
2.00	1.05	0.0074	1.13	0.0087	0.67	0.0030	0.69	0.0032
2.25	1.18	0.0084	1.27	0.0098	0.75	0.0034	0.78	0.0036
2.50	1.31	0.0093	1.41	0.0109	0.83	0.0038	0.86	0.0040
2.75	1.44	0.0102	1.56	0.0120	0.92	0.0041	0.95	0.0045
3.00	1.57	0.0111	1.70	0.0130	1.00	0.0045	1.04	0.0049
3.25	1.70	0.0207	1.84	0.0249	1.08	0.0049	1.12	0.0053
3.50	1.83	0.0235	1.98	0.0282	1.16	0.0053	1.21	0.0057

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
3.75	1.96	0.0264	2.12	0.0317	1.25	0.0056	1.30	0.0061
4.00	2.09	0.0294	2.26	0.0354	1.33	0.0060	1.38	0.0111
4.50	2.35	0.0360	2.55	0.0432	1.50	0.0124	1.55	0.0136
5.00	2.62	0.0430	2.83	0.0517	1.66	0.0149	1.73	0.0162
5.50	2.88	0.0506	3.11	0.0608	1.83	0.0175	1.90	0.0191
6.00	3.14	0.0587	3.40	0.0706	2.00	0.0202	2.07	0.0221
6.50	3.40	0.0673	3.68	0.0809	2.16	0.0232	2.25	0.0253
7.00	3.66	0.0764	3.96	0.0919	2.33	0.0263	2.42	0.0287
7.50	3.92	0.0860	4.24	0.1034	2.50	0.0296	2.59	0.0323
8.00	4.19	0.0960	4.53	0.1156	2.66	0.0330	2.76	0.0361
8.50	4.45	0.1066	4.81	0.1283	2.83	0.0367	2.94	0.0400
9.00	4.71	0.1176	5.09	0.1416	3.00	0.0404	3.11	0.0441
9.50	4.97	0.1291	5.38	0.1554	3.16	0.0444	3.28	0.0484
10.00	5.23	0.1410	5.66	0.1698	3.33	0.0484	3.45	0.0529
10.50	5.49	0.1534	5.94	0.1847	3.49	0.0527	3.63	0.0575
11.00	5.76	0.1663	6.22	0.2002	3.66	0.0571	3.80	0.0623
11.50	6.02	0.1796	6.51	0.2162	3.83	0.0616	3.97	0.0673
12.00	6.28	0.1933	6.79	0.2328	3.99	0.0663	4.14	0.0724
12.50	6.54	0.2075	7.07	0.2498	4.16	0.0711	4.32	0.0777
13.00	6.80	0.2221	7.36	0.2674	4.33	0.0761	4.49	0.0831
13.50	7.06	0.2371	7.64	0.2856	4.49	0.0813	4.66	0.0887
14.00	7.32	0.2526	7.92	0.3042	4.66	0.0865	4.84	0.0945
14.50	7.59	0.2685	8.21	0.3233	4.83	0.0919	5.01	0.1004
15.00	7.85	0.2848	8.49	0.3430	4.99	0.0975	5.18	0.1065
16.00	8.37	0.3186	9.05	0.3838	5.32	0.1090	5.53	0.1191
17.00	8.89	0.3541	9.62	0.4266	5.66	0.1211	5.87	0.1323
18.00	9.42	0.3912	10.19	0.4714	5.99	0.1338	6.22	0.1461
19.00	9.94	0.4300	–	–	6.32	0.1469	6.56	0.1605
20.00	10.46	0.4703	–	–	6.66	0.1607	6.91	0.1755
21.00	–	–	–	–	6.99	0.1749	7.25	0.1910
22.00	–	–	–	–	7.32	0.1897	7.60	0.2072
23.00	–	–	–	–	7.65	0.2050	7.94	0.2239
24.00	–	–	–	–	7.99	0.2208	8.29	0.2412
25.00	–	–	–	–	8.32	0.2371	8.63	0.2590
30.00	–	–	–	–	9.98	0.3263	10.36	0.3564

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Table 40: Pressure loss for copper pipes in accordance with DVGWGW392 2nd gas family, d42–54 mm

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
2.25	0.51	0.0016	0.52	0.0017	–	–	–	–
2.50	0.56	0.0017	0.58	0.0018	–	–	–	–
2.75	0.62	0.0019	0.64	0.0020	–	–	–	–
3.00	0.68	0.0021	0.70	0.0022	–	–	–	–
3.25	0.73	0.0022	0.76	0.0024	–	–	–	–
3.50	0.79	0.0024	0.81	0.0026	–	–	–	–

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
3.75	0.85	0.0026	0.87	0.0028	0.51	0.0009	0.53	0.0010
4.00	0.90	0.0028	0.93	0.0029	0.54	0.0010	0.57	0.0011
4.50	1.01	0.0031	1.05	0.0033	0.61	0.0011	0.64	0.0012
5.00	1.13	0.0060	1.16	0.0064	0.68	0.0013	0.71	0.0014
5.50	1.24	0.0070	1.28	0.0075	0.75	0.0014	0.78	0.0015
6.00	1.35	0.0081	1.40	0.0087	0.82	0.0015	0.85	0.0016
6.50	1.47	0.0093	1.51	0.0100	0.88	0.0028	0.92	0.0031
7.00	1.58	0.0105	1.63	0.0113	0.95	0.0032	0.99	0.0035
7.50	1.69	0.0119	1.74	0.0127	1.02	0.0036	1.06	0.0040
8.00	1.80	0.0132	1.86	0.0142	1.09	0.0040	1.13	0.0044
8.50	1.92	0.0147	1.98	0.0158	1.16	0.0045	1.20	0.0049
9.00	2.03	0.0162	2.09	0.0174	1.22	0.0049	1.27	0.0054
9.50	2.14	0.0177	2.21	0.0191	1.29	0.0054	1.34	0.0059
10.00	2.26	0.0194	2.33	0.0208	1.36	0.0059	1.41	0.0065
10.50	2.37	0.0210	2.44	0.0226	1.43	0.0064	1.49	0.0070
11.00	2.48	0.0228	2.56	0.0245	1.50	0.0069	1.56	0.0076
11.50	2.59	0.0246	2.67	0.0264	1.56	0.0075	1.63	0.0082
12.00	2.71	0.0265	2.79	0.0284	1.63	0.0080	1.70	0.0088
12.50	2.82	0.0284	2.91	0.0305	1.70	0.0086	1.77	0.0095
13.00	2.93	0.0304	3.02	0.0326	1.77	0.0092	1.84	0.0101
13.50	3.04	0.0324	3.14	0.0348	1.84	0.0098	1.91	0.0108
14.00	3.16	0.0345	3.26	0.0371	1.90	0.0105	1.98	0.0115
14.50	3.27	0.0366	3.37	0.0394	1.97	0.0111	2.05	0.0122
15.00	3.38	0.0389	3.49	0.0418	2.04	0.0118	2.12	0.0129
16.00	3.61	0.0434	3.72	0.0467	2.18	0.0131	2.26	0.0144
17.00	3.83	0.0482	3.95	0.0518	2.31	0.0146	2.41	0.0160
18.00	4.06	0.0532	4.19	0.0572	2.45	0.0161	2.55	0.0177
19.00	4.29	0.0585	4.42	0.0628	2.58	0.0177	2.69	0.0194
20.00	4.51	0.0639	4.65	0.0687	2.72	0.0193	2.83	0.0212
21.00	4.74	0.0695	4.88	0.0748	2.86	0.0210	2.97	0.0231
22.00	4.96	0.0754	5.12	0.0811	2.99	0.0228	3.11	0.0250
23.00	5.19	0.0815	5.35	0.0876	3.13	0.0246	3.25	0.0270
24.00	5.41	0.0877	5.58	0.0943	3.26	0.0265	3.40	0.0291
25.00	5.64	0.0942	5.81	0.1013	3.40	0.0284	3.54	0.0312
30.00	6.77	0.1294	6.98	0.1392	4.08	0.0390	4.24	0.0428
35.00	7.89	0.1695	8.14	0.1823	4.76	0.0510	4.95	0.0560
40.00	9.02	0.2142	9.30	0.2304	5.44	0.0643	5.66	0.0707
45.00	10.15	0.2635	10.46	0.2833	6.12	0.0791	6.37	0.0869
50.00	–	–	–	–	6.80	0.0951	7.07	0.1045
55.00	–	–	–	–	7.48	0.1124	7.78	0.1235
60.00	–	–	–	–	8.16	0.1310	8.49	0.1440
65.00	–	–	–	–	8.84	0.1508	9.20	0.1657
70.00	–	–	–	–	9.52	0.1719	9.90	0.1889
75.00	–	–	–	–	10.20	0.1941	–	–

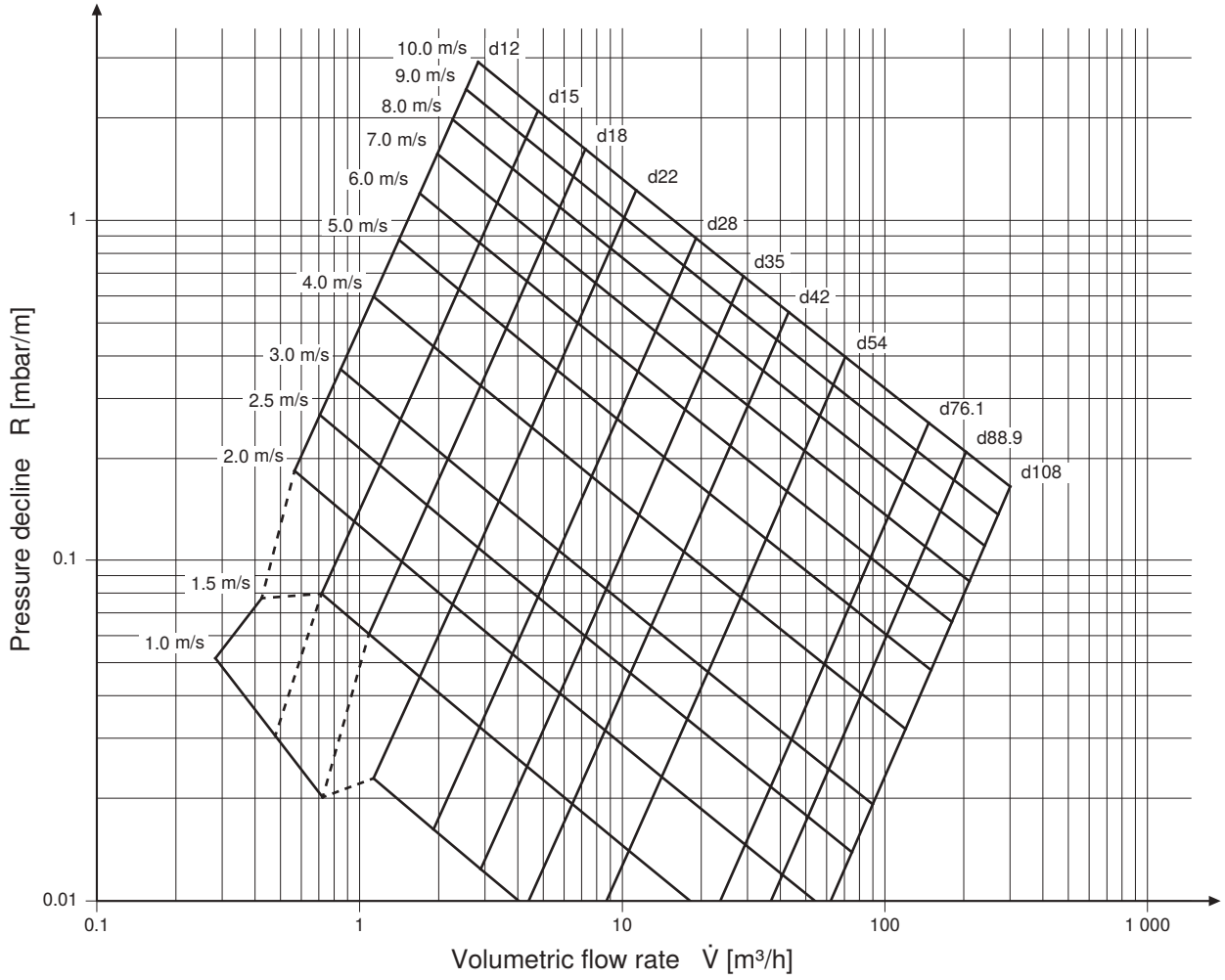
Table 41: Pressure loss for copper pipes in accordance with DVGWGW392 2nd gas family, d76.1–108 mm

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
7.50	0.51	0.0005	–	–	–	–
8.00	0.54	0.0005	–	–	–	–
8.50	0.58	0.0005	–	–	–	–
9.00	0.61	0.0010	–	–	–	–
9.50	0.65	0.0011	–	–	–	–
10.00	0.68	0.0012	–	–	–	–
10.50	0.71	0.0013	0.52	0.0006	–	–
11.00	0.75	0.0014	0.54	0.0006	–	–
11.50	0.78	0.0015	0.56	0.0007	–	–
12.00	0.82	0.0016	0.59	0.0007	–	–
12.50	0.85	0.0017	0.61	0.0008	–	–
13.00	0.88	0.0018	0.64	0.0008	–	–
13.50	0.92	0.0019	0.66	0.0009	–	–
14.00	0.95	0.0020	0.69	0.0010	–	–
14.50	0.99	0.0022	0.71	0.0010	–	–
15.00	1.02	0.0023	0.74	0.0011	0.50	0.0004
16.00	1.09	0.0026	0.79	0.0012	0.53	0.0005
17.00	1.16	0.0029	0.83	0.0013	0.57	0.0005
18.00	1.22	0.0031	0.88	0.0015	0.60	0.0006
19.00	1.29	0.0034	0.93	0.0016	0.63	0.0006
20.00	1.36	0.0038	0.98	0.0017	0.67	0.0007
21.00	1.43	0.0041	1.03	0.0019	0.70	0.0008
22.00	1.50	0.0044	1.08	0.0021	0.73	0.0008
23.00	1.56	0.0048	1.13	0.0022	0.77	0.0009
24.00	1.63	0.0051	1.18	0.0024	0.80	0.0010
25.00	1.70	0.0055	1.23	0.0026	0.83	0.0010
30.00	2.04	0.0076	1.47	0.0035	1.00	0.0014
35.00	2.38	0.0099	1.72	0.0046	1.17	0.0018
40.00	2.72	0.0125	1.96	0.0057	1.33	0.0023
45.00	3.06	0.0153	2.21	0.0070	1.50	0.0028
50.00	3.40	0.0184	2.45	0.0085	1.67	0.0034
55.00	3.74	0.0217	2.70	0.0100	1.83	0.0040
60.00	4.08	0.0252	2.94	0.0116	2.00	0.0046
65.00	4.42	0.0290	3.19	0.0134	2.17	0.0053
70.00	4.76	0.0331	3.43	0.0152	2.33	0.0061
75.00	5.10	0.0373	3.68	0.0172	2.50	0.0069
80.00	5.44	0.0418	3.93	0.0192	2.67	0.0077
85.00	5.78	0.0465	4.17	0.0214	2.83	0.0085
90.00	6.12	0.0514	4.42	0.0236	3.00	0.0094
95.00	6.46	0.0566	4.66	0.0260	3.17	0.0104
100.00	6.80	0.0619	4.91	0.0284	3.33	0.0113
105.00	7.14	0.0675	5.15	0.0310	3.50	0.0123
110.00	7.48	0.0732	5.40	0.0336	3.67	0.0134
115.00	7.82	0.0792	5.64	0.0364	3.83	0.0145
120.00	8.16	0.0854	5.89	0.0392	4.00	0.0156
125.00	8.50	0.0918	6.13	0.0421	4.17	0.0168
130.00	8.84	0.0984	6.38	0.0451	4.33	0.0180
135.00	9.18	0.1052	6.62	0.0482	4.50	0.0192

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
140.00	9.53	0.1122	6.87	0.0514	4.67	0.0205
145.00	9.87	0.1194	7.11	0.0547	4.83	0.0218
150.00	10.21	0.1268	7.36	0.0581	5.00	0.0231
155.00	–	–	7.61	0.0616	5.17	0.0245
160.00	–	–	7.85	0.0651	5.33	0.0259
165.00	–	–	8.10	0.0688	5.50	0.0274
170.00	–	–	8.34	0.0725	5.67	0.0288
175.00	–	–	8.59	0.0764	5.83	0.0304
180.00	–	–	8.83	0.0803	6.00	0.0319
185.00	–	–	9.08	0.0843	6.17	0.0335
190.00	–	–	9.32	0.0883	6.33	0.0351
195.00	–	–	9.57	0.0925	6.50	0.0368
200.00	–	–	9.81	0.0968	6.67	0.0384
205.00	–	–	10.06	0.1011	6.83	0.0402
210.00	–	–	10.30	0.1055	7.00	0.0419
215.00	–	–	–	–	7.17	0.0437
220.00	–	–	–	–	7.33	0.0455
225.00	–	–	–	–	7.50	0.0474
230.00	–	–	–	–	7.67	0.0493
235.00	–	–	–	–	7.83	0.0512
240.00	–	–	–	–	8.00	0.0531
245.00	–	–	–	–	8.17	0.0551
250.00	–	–	–	–	8.33	0.0571
255.00	–	–	–	–	8.50	0.0592
260.00	–	–	–	–	8.67	0.0612
265.00	–	–	–	–	8.83	0.0633
270.00	–	–	–	–	9.00	0.0655
275.00	–	–	–	–	9.17	0.0677
280.00	–	–	–	–	9.33	0.0699
285.00	–	–	–	–	9.50	0.0721
290.00	–	–	–	–	9.67	0.0744
295.00	–	–	–	–	9.83	0.0767
300.00	–	–	–	–	10.00	0.0790

5.2 3RD GAS FAMILY, LIQUID GASES

Medium:	3rd gas family, liquid gases
Density:	1.97 kg/m^3
Viscosity:	0.000016154 Pa•s
Surface roughness:	0.0015 mm



——— Pure turbulent or laminar flow

- - - - - Transition between turbulent and laminar flow

Table 42: Pressure loss for copper pipes in accordance with DVGWGW392 3rd gas family, d12–22 mm

d [mm]	12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0		22 x 1.0	
V̇ [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	0.82	0.0391	0.88	0.0457	0.52	0.0160	–	–	–	–
0.50	1.63	0.0781	1.77	0.0914	1.05	0.0320	0.69	0.0139	–	–
0.75	2.45	0.2463	2.65	0.2962	1.57	0.0864	1.04	0.0209	0.66	0.0086
1.00	3.27	0.4019	3.54	0.4835	2.09	0.1406	1.38	0.0530	0.88	0.0114
1.25	4.09	0.5890	4.42	0.7088	2.62	0.2056	1.73	0.0774	1.11	0.0271
1.50	4.90	0.8060	5.31	0.9702	3.14	0.2809	2.07	0.1056	1.33	0.0370
1.75	5.72	1.0517	6.19	1.2663	3.66	0.3661	2.42	0.1374	1.55	0.0480
2.00	6.54	1.3252	7.07	1.5960	4.19	0.4607	2.76	0.1728	1.77	0.0603
2.25	7.36	1.6258	7.96	1.9585	4.71	0.5647	3.11	0.2115	1.99	0.0738
2.50	8.17	1.9529	8.84	2.3528	5.23	0.6777	3.45	0.2536	2.21	0.0884
2.75	8.99	2.3059	9.73	2.7785	5.76	0.7995	3.80	0.2990	2.43	0.1041
3.00	9.81	2.6843	–	–	6.28	0.9300	4.14	0.3476	2.65	0.1210
3.25	–	–	–	–	6.80	1.0690	4.49	0.3993	2.87	0.1389
3.50	–	–	–	–	7.32	1.2164	4.84	0.4541	3.09	0.1578
3.75	–	–	–	–	7.85	1.3721	5.18	0.5119	3.32	0.1778
4.00	–	–	–	–	8.37	1.5359	5.53	0.5727	3.54	0.1988
4.50	–	–	–	–	9.42	1.8876	6.22	0.7033	3.98	0.2439
5.00	–	–	–	–	10.46	2.2708	6.91	0.8453	4.42	0.2930
5.50	–	–	–	–	–	–	7.60	0.9987	4.86	0.3459
6.00	–	–	–	–	–	–	8.29	1.1633	5.31	0.4026
6.50	–	–	–	–	–	–	8.98	1.3388	5.75	0.4630
7.00	–	–	–	–	–	–	9.67	1.5250	6.19	0.5271
7.50	–	–	–	–	–	–	10.36	1.7219	6.63	0.5948
8.00	–	–	–	–	–	–	–	–	7.07	0.6661
8.50	–	–	–	–	–	–	–	–	7.52	0.7409
9.00	–	–	–	–	–	–	–	–	7.96	0.8192
9.50	–	–	–	–	–	–	–	–	8.40	0.9010
10.00	–	–	–	–	–	–	–	–	8.84	0.9861
10.50	–	–	–	–	–	–	–	–	9.28	1.0747
11.00	–	–	–	–	–	–	–	–	9.73	1.1666
11.50	–	–	–	–	–	–	–	–	10.17	1.2618

Table 43: Pressure loss for copper pipes in accordance with DVGWGW392 3rd gas family, d28–35 mm

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
1.00	0.52	0.0040	0.57	0.0047	–	–	–	–
1.25	0.65	0.0050	0.71	0.0059	–	–	–	–
1.50	0.78	0.0108	0.85	0.0130	–	–	0.52	0.0026
1.75	0.92	0.0140	0.99	0.0168	0.58	0.0048	0.60	0.0053
2.00	1.05	0.0176	1.13	0.0211	0.67	0.0061	0.69	0.0066
2.25	1.18	0.0214	1.27	0.0258	0.75	0.0074	0.78	0.0081
2.50	1.31	0.0257	1.41	0.0309	0.83	0.0089	0.86	0.0097
2.75	1.44	0.0302	1.56	0.0363	0.92	0.0104	0.95	0.0114
3.00	1.57	0.0351	1.70	0.0422	1.00	0.0121	1.04	0.0132
3.25	1.70	0.0402	1.84	0.0484	1.08	0.0138	1.12	0.0151
3.50	1.83	0.0457	1.98	0.0550	1.16	0.0157	1.21	0.0172

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
$\dot{V}$ [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]
3.75	1.96	0.0514	2.12	0.0619	1.25	0.0177	1.30	0.0193
4.00	2.09	0.0575	2.26	0.0692	1.33	0.0198	1.38	0.0216
4.50	2.35	0.0704	2.55	0.0848	1.50	0.0242	1.55	0.0264
5.00	2.62	0.0845	2.83	0.1017	1.66	0.0290	1.73	0.0316
5.50	2.88	0.0997	3.11	0.1200	1.83	0.0342	1.90	0.0373
6.00	3.14	0.1159	3.40	0.1396	2.00	0.0397	2.07	0.0434
6.50	3.40	0.1332	3.68	0.1605	2.16	0.0456	2.25	0.0498
7.00	3.66	0.1516	3.96	0.1826	2.33	0.0519	2.42	0.0566
7.50	3.92	0.1709	4.24	0.2059	2.50	0.0585	2.59	0.0638
8.00	4.19	0.1913	4.53	0.2305	2.66	0.0654	2.76	0.0714
8.50	4.45	0.2127	4.81	0.2563	2.83	0.0727	2.94	0.0794
9.00	4.71	0.2350	5.09	0.2832	3.00	0.0803	3.11	0.0877
9.50	4.97	0.2584	5.38	0.3114	3.16	0.0882	3.28	0.0963
10.00	5.23	0.2827	5.66	0.3407	3.33	0.0965	3.45	0.1054
10.50	5.49	0.3079	5.94	0.3711	3.49	0.1050	3.63	0.1147
11.00	5.76	0.3341	6.22	0.4027	3.66	0.1139	3.80	0.1245
11.50	6.02	0.3612	6.51	0.4354	3.83	0.1232	3.97	0.1345
12.00	6.28	0.3893	6.79	0.4693	3.99	0.1327	4.14	0.1449
12.50	6.54	0.4183	7.07	0.5042	4.16	0.1425	4.32	0.1557
13.00	6.80	0.4482	7.36	0.5403	4.33	0.1527	4.49	0.1668
13.50	7.06	0.4790	7.64	0.5775	4.49	0.1631	4.66	0.1782
14.00	7.32	0.5107	7.92	0.6157	4.66	0.1738	4.84	0.1899
14.50	7.59	0.5433	8.21	0.6550	4.83	0.1849	5.01	0.2020
15.00	7.85	0.5768	8.49	0.6954	4.99	0.1962	5.18	0.2144
16.00	8.37	0.6464	9.05	0.7795	5.32	0.2198	5.53	0.2402
17.00	8.89	0.7195	9.62	0.8677	5.66	0.2446	5.87	0.2672
18.00	9.42	0.7960	10.19	0.9601	5.99	0.2705	6.22	0.2955
19.00	9.94	0.8760	–	–	6.32	0.2975	6.56	0.3251
20.00	10.46	0.9594	–	–	6.66	0.3257	6.91	0.3559
21.00	–	–	–	–	6.99	0.3551	7.25	0.3880
22.00	–	–	–	–	7.32	0.3855	7.60	0.4212
23.00	–	–	–	–	7.65	0.4170	7.94	0.4557
24.00	–	–	–	–	7.99	0.4496	8.29	0.4914
25.00	–	–	–	–	8.32	0.4834	8.63	0.5282
30.00	–	–	–	–	9.98	0.6680	10.36	0.7300

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Table 44: Pressure loss for copper pipes in accordance with DVGWGW392 3rd gas family, d42–54 mm

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
$\dot{V}$ [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]
2.25	0.51	0.0030	0.52	0.0032	–	–	–	–
2.50	0.56	0.0036	0.58	0.0038	–	–	–	–
2.75	0.62	0.0042	0.64	0.0045	–	–	–	–
3.00	0.68	0.0048	0.70	0.0052	–	–	–	–
3.25	0.73	0.0055	0.76	0.0060	–	–	–	–
3.50	0.79	0.0063	0.81	0.0068	–	–	–	–

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
$\dot{V}$ [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]
3.75	0.85	0.0071	0.87	0.0076	0.51	0.0022	0.53	0.0024
4.00	0.90	0.0079	0.93	0.0085	0.54	0.0024	0.57	0.0026
4.50	1.01	0.0097	1.05	0.0104	0.61	0.0029	0.64	0.0032
5.00	1.13	0.0116	1.16	0.0124	0.68	0.0035	0.71	0.0039
5.50	1.24	0.0136	1.28	0.0146	0.75	0.0041	0.78	0.0045
6.00	1.35	0.0158	1.40	0.0170	0.82	0.0048	0.85	0.0053
6.50	1.47	0.0182	1.51	0.0195	0.88	0.0055	0.92	0.0060
7.00	1.58	0.0207	1.63	0.0222	0.95	0.0063	0.99	0.0069
7.50	1.69	0.0233	1.74	0.0250	1.02	0.0070	1.06	0.0077
8.00	1.80	0.0260	1.86	0.0280	1.09	0.0079	1.13	0.0086
8.50	1.92	0.0289	1.98	0.0311	1.16	0.0087	1.20	0.0096
9.00	2.03	0.0319	2.09	0.0343	1.22	0.0096	1.27	0.0106
9.50	2.14	0.0351	2.21	0.0377	1.29	0.0106	1.34	0.0116
10.00	2.26	0.0383	2.33	0.0412	1.36	0.0116	1.41	0.0127
10.50	2.37	0.0417	2.44	0.0449	1.43	0.0126	1.49	0.0138
11.00	2.48	0.0452	2.56	0.0486	1.50	0.0136	1.56	0.0150
11.50	2.59	0.0489	2.67	0.0526	1.56	0.0147	1.63	0.0162
12.00	2.71	0.0527	2.79	0.0566	1.63	0.0159	1.70	0.0174
12.50	2.82	0.0565	2.91	0.0608	1.70	0.0170	1.77	0.0187
13.00	2.93	0.0606	3.02	0.0651	1.77	0.0182	1.84	0.0200
13.50	3.04	0.0647	3.14	0.0696	1.84	0.0195	1.91	0.0214
14.00	3.16	0.0689	3.26	0.0741	1.90	0.0207	1.98	0.0228
14.50	3.27	0.0733	3.37	0.0788	1.97	0.0220	2.05	0.0242
15.00	3.38	0.0778	3.49	0.0836	2.04	0.0234	2.12	0.0257
16.00	3.61	0.0871	3.72	0.0937	2.18	0.0262	2.26	0.0288
17.00	3.83	0.0969	3.95	0.1042	2.31	0.0291	2.41	0.0320
18.00	4.06	0.1071	4.19	0.1152	2.45	0.0322	2.55	0.0353
19.00	4.29	0.1178	4.42	0.1266	2.58	0.0353	2.69	0.0388
20.00	4.51	0.1289	4.65	0.1386	2.72	0.0387	2.83	0.0425
21.00	4.74	0.1404	4.88	0.1510	2.86	0.0421	2.97	0.0463
22.00	4.96	0.1524	5.12	0.1639	2.99	0.0457	3.11	0.0502
23.00	5.19	0.1649	5.35	0.1773	3.13	0.0494	3.25	0.0543
24.00	5.41	0.1777	5.58	0.1911	3.26	0.0532	3.40	0.0585
25.00	5.64	0.1910	5.81	0.2054	3.40	0.0572	3.54	0.0629
30.00	6.77	0.2636	6.98	0.2836	4.08	0.0789	4.24	0.0867
35.00	7.89	0.3465	8.14	0.3727	4.76	0.1035	4.95	0.1138
40.00	9.02	0.4393	9.30	0.4725	5.44	0.1311	5.66	0.1441
45.00	10.15	0.5417	10.46	0.5828	6.12	0.1615	6.37	0.1776
50.00	–	–	–	–	6.80	0.1948	7.07	0.2141
55.00	–	–	–	–	7.48	0.2307	7.78	0.2536
60.00	–	–	–	–	8.16	0.2694	8.49	0.2961
65.00	–	–	–	–	8.84	0.3107	9.20	0.3416
70.00	–	–	–	–	9.52	0.3546	9.90	0.3899
75.00	–	–	–	–	10.20	0.4011	–	–

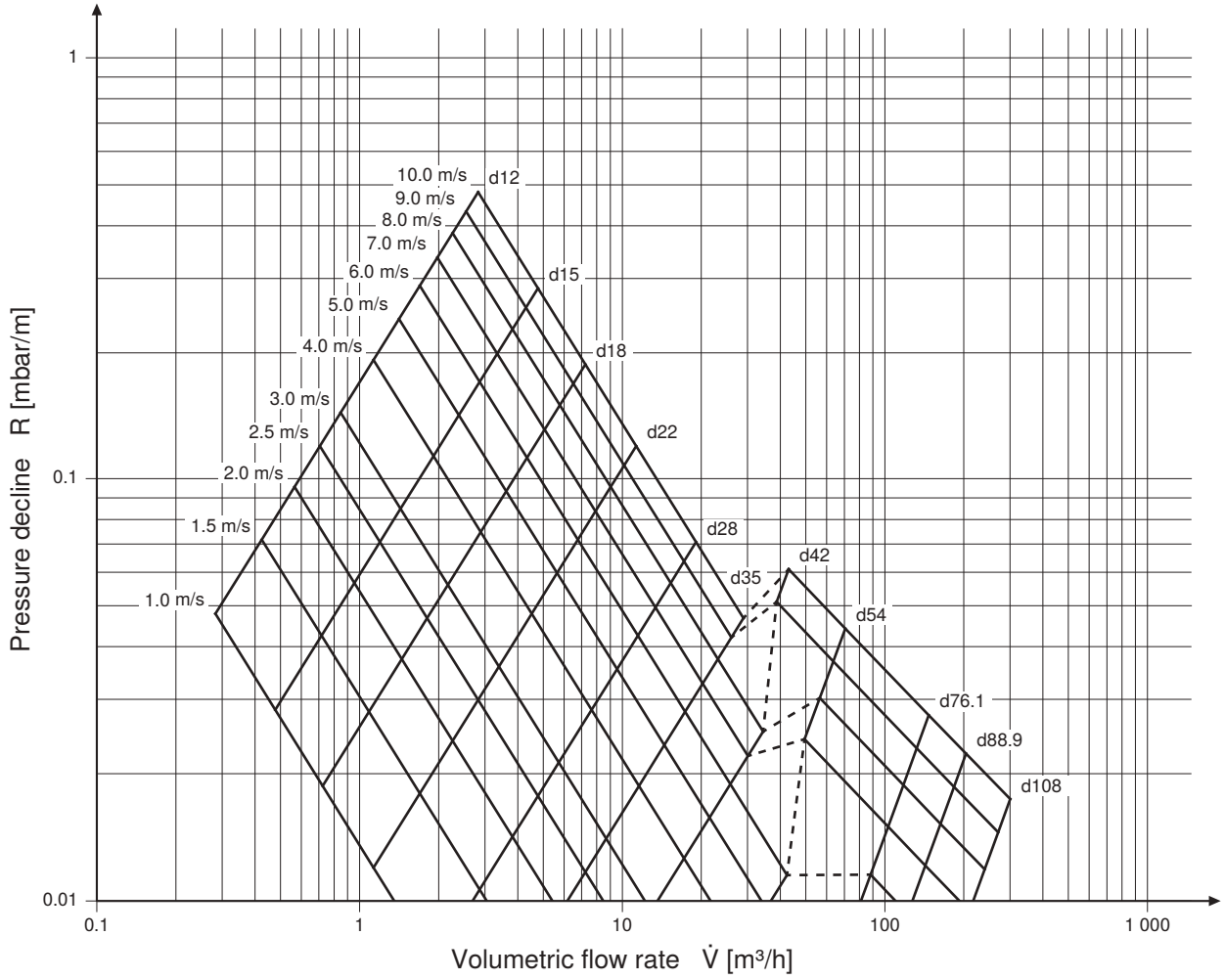
Table 45: Pressure loss for copper pipes in accordance with DVGWGW392 3rd gas family, d76.1–108 mm

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
7.50	0.51	0.0014	–	–	–	–
8.00	0.54	0.0015	–	–	–	–
8.50	0.58	0.0017	–	–	–	–
9.00	0.61	0.0019	–	–	–	–
9.50	0.65	0.0021	–	–	–	–
10.00	0.68	0.0023	–	–	–	–
10.50	0.71	0.0024	0.52	0.0011	–	–
11.00	0.75	0.0027	0.54	0.0012	–	–
11.50	0.78	0.0029	0.56	0.0013	–	–
12.00	0.82	0.0031	0.59	0.0014	–	–
12.50	0.85	0.0033	0.61	0.0015	–	–
13.00	0.88	0.0035	0.64	0.0016	–	–
13.50	0.92	0.0038	0.66	0.0017	–	–
14.00	0.95	0.0040	0.69	0.0019	–	–
14.50	0.99	0.0043	0.71	0.0020	–	–
15.00	1.02	0.0045	0.74	0.0021	0.50	0.0008
16.00	1.09	0.0051	0.79	0.0023	0.53	0.0009
17.00	1.16	0.0056	0.83	0.0026	0.57	0.0010
18.00	1.22	0.0062	0.88	0.0029	0.60	0.0011
19.00	1.29	0.0068	0.93	0.0032	0.63	0.0013
20.00	1.36	0.0075	0.98	0.0034	0.67	0.0014
21.00	1.43	0.0081	1.03	0.0037	0.70	0.0015
22.00	1.50	0.0088	1.08	0.0041	0.73	0.0016
23.00	1.56	0.0095	1.13	0.0044	0.77	0.0018
24.00	1.63	0.0103	1.18	0.0047	0.80	0.0019
25.00	1.70	0.0110	1.23	0.0051	0.83	0.0020
30.00	2.04	0.0152	1.47	0.0070	1.00	0.0028
35.00	2.38	0.0199	1.72	0.0091	1.17	0.0036
40.00	2.72	0.0252	1.96	0.0116	1.33	0.0046
45.00	3.06	0.0310	2.21	0.0142	1.50	0.0057
50.00	3.40	0.0373	2.45	0.0171	1.67	0.0068
55.00	3.74	0.0441	2.70	0.0202	1.83	0.0081
60.00	4.08	0.0515	2.94	0.0236	2.00	0.0094
65.00	4.42	0.0593	3.19	0.0272	2.17	0.0108
70.00	4.76	0.0677	3.43	0.0310	2.33	0.0123
75.00	5.10	0.0765	3.68	0.0350	2.50	0.0139
80.00	5.44	0.0858	3.93	0.0393	2.67	0.0156
85.00	5.78	0.0955	4.17	0.0437	2.83	0.0174
90.00	6.12	0.1058	4.42	0.0484	3.00	0.0192
95.00	6.46	0.1165	4.66	0.0533	3.17	0.0212
100.00	6.80	0.1276	4.91	0.0584	3.33	0.0232
105.00	7.14	0.1393	5.15	0.0637	3.50	0.0253
110.00	7.48	0.1513	5.40	0.0692	3.67	0.0275
115.00	7.82	0.1638	5.64	0.0749	3.83	0.0297
120.00	8.16	0.1768	5.89	0.0808	4.00	0.0321
125.00	8.50	0.1902	6.13	0.0869	4.17	0.0345
130.00	8.84	0.2040	6.38	0.0932	4.33	0.0370
135.00	9.18	0.2183	6.62	0.0997	4.50	0.0395

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
V̇ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
140.00	9.53	0.2329	6.87	0.1064	4.67	0.0422
145.00	9.87	0.2481	7.11	0.1133	4.83	0.0449
150.00	10.21	0.2636	7.36	0.1204	5.00	0.0477
155.00	–	–	7.61	0.1277	5.17	0.0506
160.00	–	–	7.85	0.1351	5.33	0.0535
165.00	–	–	8.10	0.1428	5.50	0.0565
170.00	–	–	8.34	0.1506	5.67	0.0596
175.00	–	–	8.59	0.1587	5.83	0.0628
180.00	–	–	8.83	0.1669	6.00	0.0661
185.00	–	–	9.08	0.1753	6.17	0.0694
190.00	–	–	9.32	0.1839	6.33	0.0728
195.00	–	–	9.57	0.1927	6.50	0.0762
200.00	–	–	9.81	0.2016	6.67	0.0798
205.00	–	–	10.06	0.2108	6.83	0.0834
210.00	–	–	10.30	0.2201	7.00	0.0871
215.00	–	–	–	–	7.17	0.0908
220.00	–	–	–	–	7.33	0.0946
225.00	–	–	–	–	7.50	0.0985
230.00	–	–	–	–	7.67	0.1025
235.00	–	–	–	–	7.83	0.1065
240.00	–	–	–	–	8.00	0.1106
245.00	–	–	–	–	8.17	0.1148
250.00	–	–	–	–	8.33	0.1190
255.00	–	–	–	–	8.50	0.1233
260.00	–	–	–	–	8.67	0.1277
265.00	–	–	–	–	8.83	0.1322
270.00	–	–	–	–	9.00	0.1367
275.00	–	–	–	–	9.17	0.1413
280.00	–	–	–	–	9.33	0.1459
285.00	–	–	–	–	9.50	0.1506
290.00	–	–	–	–	9.67	0.1554
295.00	–	–	–	–	9.83	0.1603
300.00	–	–	–	–	10.00	0.1652

5.3 5TH GAS FAMILY, GROUP A, HYDROGEN, PURITY ≥ 98 %

Medium:	5th gas family, group A, hydrogen, purity ≥ 98 %
Density:	0.107 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 46: Pressure loss for copper pipes in accordance with DVGWGW392 5th gas family, group A, d12–22 mm

d [mm]	12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0		22 x 1.0	
V̇ [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	0.82	0.0363	0.88	0.0424	0.52	0.0149	–	–	–	–
0.50	1.63	0.0726	1.77	0.0849	1.05	0.0297	0.69	0.0130	–	–
0.75	2.45	0.1088	2.65	0.1273	1.57	0.0446	1.04	0.0194	0.66	0.0080
1.00	3.27	0.1451	3.54	0.1698	2.09	0.0594	1.38	0.0259	0.88	0.0106
1.25	4.09	0.1814	4.42	0.2122	2.62	0.0743	1.73	0.0324	1.11	0.0133
1.50	4.90	0.2177	5.31	0.2546	3.14	0.0892	2.07	0.0389	1.33	0.0159
1.75	5.72	0.2540	6.19	0.2971	3.66	0.1040	2.42	0.0453	1.55	0.0186
2.00	6.54	0.2902	7.07	0.3395	4.19	0.1189	2.76	0.0518	1.77	0.0212
2.25	7.36	0.3265	7.96	0.3820	4.71	0.1337	3.11	0.0583	1.99	0.0239
2.50	8.17	0.3628	8.84	0.4244	5.23	0.1486	3.45	0.0648	2.21	0.0265
2.75	8.99	0.3991	9.73	0.4669	5.76	0.1635	3.80	0.0712	2.43	0.0292
3.00	9.81	0.4353	–	–	6.28	0.1783	4.14	0.0777	2.65	0.0318
3.25	–	–	–	–	6.80	0.1932	4.49	0.0842	2.87	0.0345
3.50	–	–	–	–	7.32	0.2080	4.84	0.0907	3.09	0.0371
3.75	–	–	–	–	7.85	0.2229	5.18	0.0971	3.32	0.0398
4.00	–	–	–	–	8.37	0.2378	5.53	0.1036	3.54	0.0424
4.50	–	–	–	–	9.42	0.2675	6.22	0.1166	3.98	0.0477
5.00	–	–	–	–	10.46	0.2972	6.91	0.1295	4.42	0.0531
5.50	–	–	–	–	–	–	7.60	0.1425	4.86	0.0584
6.00	–	–	–	–	–	–	8.29	0.1554	5.31	0.0637
6.50	–	–	–	–	–	–	8.98	0.1684	5.75	0.0690
7.00	–	–	–	–	–	–	9.67	0.1813	6.19	0.0743
7.50	–	–	–	–	–	–	10.36	0.1943	6.63	0.0796
8.00	–	–	–	–	–	–	–	–	7.07	0.0849
8.50	–	–	–	–	–	–	–	–	7.52	0.0902
9.00	–	–	–	–	–	–	–	–	7.96	0.0955
9.50	–	–	–	–	–	–	–	–	8.40	0.1008
10.00	–	–	–	–	–	–	–	–	8.84	0.1061
10.50	–	–	–	–	–	–	–	–	9.28	0.1114
11.00	–	–	–	–	–	–	–	–	9.73	0.1167
11.50	–	–	–	–	–	–	–	–	10.17	0.1220

Table 47: Pressure loss for copper pipes in accordance with DVGWGW392 5th gas family, group A, d28–35 mm

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
1.00	0.52	0.0037	0.57	0.0043	–	–	–	–
1.25	0.65	0.0046	0.71	0.0054	–	–	–	–
1.50	0.78	0.0056	0.85	0.0065	–	–	0.52	0.0024
1.75	0.92	0.0065	0.99	0.0076	0.58	0.0026	0.60	0.0028
2.00	1.05	0.0074	1.13	0.0087	0.67	0.0030	0.69	0.0032
2.25	1.18	0.0084	1.27	0.0098	0.75	0.0034	0.78	0.0036
2.50	1.31	0.0093	1.41	0.0109	0.83	0.0038	0.86	0.0040
2.75	1.44	0.0102	1.56	0.0120	0.92	0.0041	0.95	0.0045
3.00	1.57	0.0111	1.70	0.0130	1.00	0.0045	1.04	0.0049
3.25	1.70	0.0121	1.84	0.0141	1.08	0.0049	1.12	0.0053
3.50	1.83	0.0130	1.98	0.0152	1.16	0.0053	1.21	0.0057

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
3.75	1.96	0.0139	2.12	0.0163	1.25	0.0056	1.30	0.0061
4.00	2.09	0.0149	2.26	0.0174	1.33	0.0060	1.38	0.0065
4.50	2.35	0.0167	2.55	0.0196	1.50	0.0068	1.55	0.0073
5.00	2.62	0.0186	2.83	0.0217	1.66	0.0075	1.73	0.0081
5.50	2.88	0.0204	3.11	0.0239	1.83	0.0083	1.90	0.0089
6.00	3.14	0.0223	3.40	0.0261	2.00	0.0090	2.07	0.0097
6.50	3.40	0.0241	3.68	0.0282	2.16	0.0098	2.25	0.0105
7.00	3.66	0.0260	3.96	0.0304	2.33	0.0105	2.42	0.0113
7.50	3.92	0.0279	4.24	0.0326	2.50	0.0113	2.59	0.0121
8.00	4.19	0.0297	4.53	0.0348	2.66	0.0120	2.76	0.0130
8.50	4.45	0.0316	4.81	0.0369	2.83	0.0128	2.94	0.0138
9.00	4.71	0.0334	5.09	0.0391	3.00	0.0135	3.11	0.0146
9.50	4.97	0.0353	5.38	0.0413	3.16	0.0143	3.28	0.0154
10.00	5.23	0.0371	5.66	0.0435	3.33	0.0150	3.45	0.0162
10.50	5.49	0.0390	5.94	0.0456	3.49	0.0158	3.63	0.0170
11.00	5.76	0.0409	6.22	0.0478	3.66	0.0165	3.80	0.0178
11.50	6.02	0.0427	6.51	0.0500	3.83	0.0173	3.97	0.0186
12.00	6.28	0.0446	6.79	0.0522	3.99	0.0180	4.14	0.0194
12.50	6.54	0.0464	7.07	0.0543	4.16	0.0188	4.32	0.0202
13.00	6.80	0.0483	7.36	0.0565	4.33	0.0195	4.49	0.0210
13.50	7.06	0.0502	7.64	0.0587	4.49	0.0203	4.66	0.0219
14.00	7.32	0.0520	7.92	0.0608	4.66	0.0210	4.84	0.0227
14.50	7.59	0.0539	8.21	0.0630	4.83	0.0218	5.01	0.0235
15.00	7.85	0.0557	8.49	0.0652	4.99	0.0225	5.18	0.0243
16.00	8.37	0.0594	9.05	0.0695	5.32	0.0240	5.53	0.0259
17.00	8.89	0.0632	9.62	0.0739	5.66	0.0256	5.87	0.0275
18.00	9.42	0.0669	10.19	0.0782	5.99	0.0271	6.22	0.0291
19.00	9.94	0.0706	–	–	6.32	0.0286	6.56	0.0308
20.00	10.46	0.0743	–	–	6.66	0.0301	6.91	0.0324
21.00	–	–	–	–	6.99	0.0316	7.25	0.0340
22.00	–	–	–	–	7.32	0.0331	7.60	0.0356
23.00	–	–	–	–	7.65	0.0346	7.94	0.0372
24.00	–	–	–	–	7.99	0.0361	8.29	0.0389
25.00	–	–	–	–	8.32	0.0376	8.63	0.0405
30.00	–	–	–	–	9.98	0.0773	10.36	0.0843

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Table 48: Pressure loss for copper pipes in accordance with DVGWGW392 5th gas family, group A, d42–54 mm

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
2.25	0.51	0.0016	0.52	0.0017	–	–	–	–
2.50	0.56	0.0017	0.58	0.0018	–	–	–	–
2.75	0.62	0.0019	0.64	0.0020	–	–	–	–
3.00	0.68	0.0021	0.70	0.0022	–	–	–	–
3.25	0.73	0.0022	0.76	0.0024	–	–	–	–
3.50	0.79	0.0024	0.81	0.0026	–	–	–	–

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
$\dot{V}$ [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]
3.75	0.85	0.0026	0.87	0.0028	0.51	0.0009	0.53	0.0010
4.00	0.90	0.0028	0.93	0.0029	0.54	0.0010	0.57	0.0011
4.50	1.01	0.0031	1.05	0.0033	0.61	0.0011	0.64	0.0012
5.00	1.13	0.0035	1.16	0.0037	0.68	0.0013	0.71	0.0014
5.50	1.24	0.0038	1.28	0.0040	0.75	0.0014	0.78	0.0015
6.00	1.35	0.0041	1.40	0.0044	0.82	0.0015	0.85	0.0016
6.50	1.47	0.0045	1.51	0.0048	0.88	0.0016	0.92	0.0018
7.00	1.58	0.0048	1.63	0.0051	0.95	0.0018	0.99	0.0019
7.50	1.69	0.0052	1.74	0.0055	1.02	0.0019	1.06	0.0020
8.00	1.80	0.0055	1.86	0.0059	1.09	0.0020	1.13	0.0022
8.50	1.92	0.0059	1.98	0.0062	1.16	0.0021	1.20	0.0023
9.00	2.03	0.0062	2.09	0.0066	1.22	0.0023	1.27	0.0024
9.50	2.14	0.0066	2.21	0.0070	1.29	0.0024	1.34	0.0026
10.00	2.26	0.0069	2.33	0.0073	1.36	0.0025	1.41	0.0027
10.50	2.37	0.0072	2.44	0.0077	1.43	0.0026	1.49	0.0029
11.00	2.48	0.0076	2.56	0.0081	1.50	0.0028	1.56	0.0030
11.50	2.59	0.0079	2.67	0.0084	1.56	0.0029	1.63	0.0031
12.00	2.71	0.0083	2.79	0.0088	1.63	0.0030	1.70	0.0033
12.50	2.82	0.0086	2.91	0.0092	1.70	0.0031	1.77	0.0034
13.00	2.93	0.0090	3.02	0.0095	1.77	0.0033	1.84	0.0035
13.50	3.04	0.0093	3.14	0.0099	1.84	0.0034	1.91	0.0037
14.00	3.16	0.0097	3.26	0.0103	1.90	0.0035	1.98	0.0038
14.50	3.27	0.0100	3.37	0.0106	1.97	0.0036	2.05	0.0039
15.00	3.38	0.0104	3.49	0.0110	2.04	0.0038	2.12	0.0041
16.00	3.61	0.0110	3.72	0.0117	2.18	0.0040	2.26	0.0043
17.00	3.83	0.0117	3.95	0.0125	2.31	0.0043	2.41	0.0046
18.00	4.06	0.0124	4.19	0.0132	2.45	0.0045	2.55	0.0049
19.00	4.29	0.0131	4.42	0.0139	2.58	0.0048	2.69	0.0052
20.00	4.51	0.0138	4.65	0.0147	2.72	0.0050	2.83	0.0054
21.00	4.74	0.0145	4.88	0.0154	2.86	0.0053	2.97	0.0057
22.00	4.96	0.0152	5.12	0.0161	2.99	0.0055	3.11	0.0060
23.00	5.19	0.0159	5.35	0.0169	3.13	0.0058	3.25	0.0062
24.00	5.41	0.0166	5.58	0.0176	3.26	0.0060	3.40	0.0065
25.00	5.64	0.0173	5.81	0.0183	3.40	0.0063	3.54	0.0068
30.00	6.77	0.0207	6.98	0.0220	4.08	0.0075	4.24	0.0081
35.00	7.89	0.0242	8.14	0.0257	4.76	0.0088	4.95	0.0095
40.00	9.02	0.0504	9.30	0.0542	5.44	0.0100	5.66	0.0109
45.00	10.15	0.0616	10.46	0.0661	6.12	0.0113	6.37	0.0122
50.00	–	–	–	–	6.80	0.0225	7.07	0.0246
55.00	–	–	–	–	7.48	0.0264	7.78	0.0289
60.00	–	–	–	–	8.16	0.0306	8.49	0.0335
65.00	–	–	–	–	8.84	0.0350	9.20	0.0384
70.00	–	–	–	–	9.52	0.0397	9.90	0.0436
75.00	–	–	–	–	10.20	0.0446	–	–

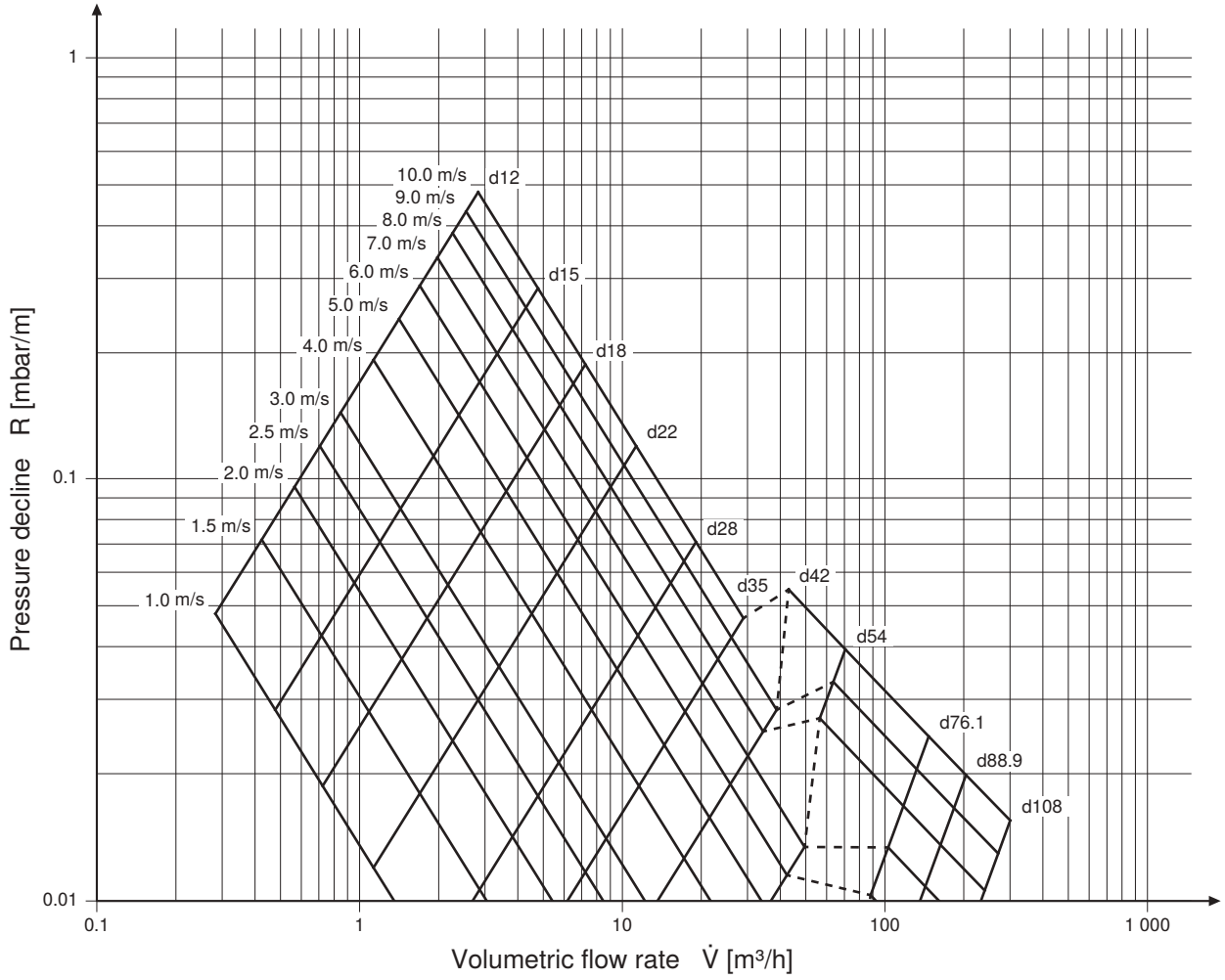
Table 49: Pressure loss for copper pipes in accordance with DVGWGW392 5th gas family, group A, d76.1–108 mm

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
7.50	0.51	0.0005	–	–	–	–
8.00	0.54	0.0005	–	–	–	–
8.50	0.58	0.0005	–	–	–	–
9.00	0.61	0.0006	–	–	–	–
9.50	0.65	0.0006	–	–	–	–
10.00	0.68	0.0006	–	–	–	–
10.50	0.71	0.0007	0.52	0.0003	–	–
11.00	0.75	0.0007	0.54	0.0004	–	–
11.50	0.78	0.0007	0.56	0.0004	–	–
12.00	0.82	0.0008	0.59	0.0004	–	–
12.50	0.85	0.0008	0.61	0.0004	–	–
13.00	0.88	0.0008	0.64	0.0004	–	–
13.50	0.92	0.0008	0.66	0.0004	–	–
14.00	0.95	0.0009	0.69	0.0005	–	–
14.50	0.99	0.0009	0.71	0.0005	–	–
15.00	1.02	0.0009	0.74	0.0005	0.50	0.0002
16.00	1.09	0.0010	0.79	0.0005	0.53	0.0002
17.00	1.16	0.0011	0.83	0.0006	0.57	0.0003
18.00	1.22	0.0011	0.88	0.0006	0.60	0.0003
19.00	1.29	0.0012	0.93	0.0006	0.63	0.0003
20.00	1.36	0.0013	0.98	0.0007	0.67	0.0003
21.00	1.43	0.0013	1.03	0.0007	0.70	0.0003
22.00	1.50	0.0014	1.08	0.0007	0.73	0.0003
23.00	1.56	0.0014	1.13	0.0008	0.77	0.0003
24.00	1.63	0.0015	1.18	0.0008	0.80	0.0004
25.00	1.70	0.0016	1.23	0.0008	0.83	0.0004
30.00	2.04	0.0019	1.47	0.0010	1.00	0.0005
35.00	2.38	0.0022	1.72	0.0011	1.17	0.0005
40.00	2.72	0.0025	1.96	0.0013	1.33	0.0006
45.00	3.06	0.0028	2.21	0.0015	1.50	0.0007
50.00	3.40	0.0031	2.45	0.0016	1.67	0.0008
55.00	3.74	0.0035	2.70	0.0018	1.83	0.0008
60.00	4.08	0.0038	2.94	0.0020	2.00	0.0009
65.00	4.42	0.0041	3.19	0.0021	2.17	0.0010
70.00	4.76	0.0078	3.43	0.0023	2.33	0.0011
75.00	5.10	0.0088	3.68	0.0025	2.50	0.0011
80.00	5.44	0.0098	3.93	0.0046	2.67	0.0012
85.00	5.78	0.0108	4.17	0.0050	2.83	0.0013
90.00	6.12	0.0120	4.42	0.0056	3.00	0.0014
95.00	6.46	0.0131	4.66	0.0061	3.17	0.0025
100.00	6.80	0.0143	4.91	0.0066	3.33	0.0027
105.00	7.14	0.0155	5.15	0.0072	3.50	0.0029
110.00	7.48	0.0168	5.40	0.0078	3.67	0.0031
115.00	7.82	0.0181	5.64	0.0084	3.83	0.0034
120.00	8.16	0.0195	5.89	0.0090	4.00	0.0036
125.00	8.50	0.0209	6.13	0.0097	4.17	0.0039
130.00	8.84	0.0224	6.38	0.0104	4.33	0.0042
135.00	9.18	0.0238	6.62	0.0110	4.50	0.0045

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
140.00	9.53	0.0254	6.87	0.0118	4.67	0.0047
145.00	9.87	0.0269	7.11	0.0125	4.83	0.0050
150.00	10.21	0.0286	7.36	0.0132	5.00	0.0053
155.00	–	–	7.61	0.0140	5.17	0.0056
160.00	–	–	7.85	0.0148	5.33	0.0059
165.00	–	–	8.10	0.0156	5.50	0.0063
170.00	–	–	8.34	0.0164	5.67	0.0066
175.00	–	–	8.59	0.0172	5.83	0.0069
180.00	–	–	8.83	0.0181	6.00	0.0073
185.00	–	–	9.08	0.0189	6.17	0.0076
190.00	–	–	9.32	0.0198	6.33	0.0080
195.00	–	–	9.57	0.0207	6.50	0.0083
200.00	–	–	9.81	0.0216	6.67	0.0087
205.00	–	–	10.06	0.0226	6.83	0.0091
210.00	–	–	10.30	0.0235	7.00	0.0095
215.00	–	–	–	–	7.17	0.0098
220.00	–	–	–	–	7.33	0.0102
225.00	–	–	–	–	7.50	0.0106
230.00	–	–	–	–	7.67	0.0111
235.00	–	–	–	–	7.83	0.0115
240.00	–	–	–	–	8.00	0.0119
245.00	–	–	–	–	8.17	0.0123
250.00	–	–	–	–	8.33	0.0128
255.00	–	–	–	–	8.50	0.0132
260.00	–	–	–	–	8.67	0.0137
265.00	–	–	–	–	8.83	0.0141
270.00	–	–	–	–	9.00	0.0146
275.00	–	–	–	–	9.17	0.0150
280.00	–	–	–	–	9.33	0.0155
285.00	–	–	–	–	9.50	0.0160
290.00	–	–	–	–	9.67	0.0165
295.00	–	–	–	–	9.83	0.0170
300.00	–	–	–	–	10.00	0.0175

5.4 5TH GAS FAMILY, GROUP D, HYDROGEN, PURITY ≥ 99.97 %

Medium:	5th gas family, group D, hydrogen, purity ≥ 99.97 %
Density:	0.091 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 50: Pressure loss for copper pipes in accordance with DVGWGW392 5th gas family, group D, d12–22 mm

d [mm]	**12 x 0.8**		**12 x 1.0**		**15 x 1.0**		**18 x 1.0**		**22 x 1.0**	
V̇ [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	0.82	0.0363	0.88	0.0424	0.52	0.0149	–	–	–	–
0.50	1.63	0.0726	1.77	0.0849	1.05	0.0297	0.69	0.0130	–	–
0.75	2.45	0.1088	2.65	0.1273	1.57	0.0446	1.04	0.0194	0.66	0.0080

d [mm]	12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0		22 x 1.0	
V̇ [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]
1.00	3.27	0.1451	3.54	0.1698	2.09	0.0594	1.38	0.0259	0.88	0.0106
1.25	4.09	0.1814	4.42	0.2122	2.62	0.0743	1.73	0.0324	1.11	0.0133
1.50	4.90	0.2177	5.31	0.2546	3.14	0.0892	2.07	0.0389	1.33	0.0159
1.75	5.72	0.2540	6.19	0.2971	3.66	0.1040	2.42	0.0453	1.55	0.0186
2.00	6.54	0.2902	7.07	0.3395	4.19	0.1189	2.76	0.0518	1.77	0.0212
2.25	7.36	0.3265	7.96	0.3820	4.71	0.1337	3.11	0.0583	1.99	0.0239
2.50	8.17	0.3628	8.84	0.4244	5.23	0.1486	3.45	0.0648	2.21	0.0265
2.75	8.99	0.3991	9.73	0.4669	5.76	0.1635	3.80	0.0712	2.43	0.0292
3.00	9.81	0.4353	–	–	6.28	0.1783	4.14	0.0777	2.65	0.0318
3.25	–	–	–	–	6.80	0.1932	4.49	0.0842	2.87	0.0345
3.50	–	–	–	–	7.32	0.2080	4.84	0.0907	3.09	0.0371
3.75	–	–	–	–	7.85	0.2229	5.18	0.0971	3.32	0.0398
4.00	–	–	–	–	8.37	0.2378	5.53	0.1036	3.54	0.0424
4.50	–	–	–	–	9.42	0.2675	6.22	0.1166	3.98	0.0477
5.00	–	–	–	–	10.46	0.2972	6.91	0.1295	4.42	0.0531
5.50	–	–	–	–	–	–	7.60	0.1425	4.86	0.0584
6.00	–	–	–	–	–	–	8.29	0.1554	5.31	0.0637
6.50	–	–	–	–	–	–	8.98	0.1684	5.75	0.0690
7.00	–	–	–	–	–	–	9.67	0.1813	6.19	0.0743
7.50	–	–	–	–	–	–	10.36	0.1943	6.63	0.0796
8.00	–	–	–	–	–	–	–	–	7.07	0.0849
8.50	–	–	–	–	–	–	–	–	7.52	0.0902
9.00	–	–	–	–	–	–	–	–	7.96	0.0955
9.50	–	–	–	–	–	–	–	–	8.40	0.1008
10.00	–	–	–	–	–	–	–	–	8.84	0.1061
10.50	–	–	–	–	–	–	–	–	9.28	0.1114
11.00	–	–	–	–	–	–	–	–	9.73	0.1167
11.50	–	–	–	–	–	–	–	–	10.17	0.1220

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Table 51: Pressure loss for copper pipes in accordance with DVGWGW392 5th gas family, group D, d28–35 mm

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
1.00	0.52	0.0037	0.57	0.0043	–	–	–	–
1.25	0.65	0.0046	0.71	0.0054	–	–	–	–
1.50	0.78	0.0056	0.85	0.0065	–	–	0.52	0.0024
1.75	0.92	0.0065	0.99	0.0076	0.58	0.0026	0.60	0.0028
2.00	1.05	0.0074	1.13	0.0087	0.67	0.0030	0.69	0.0032
2.25	1.18	0.0084	1.27	0.0098	0.75	0.0034	0.78	0.0036
2.50	1.31	0.0093	1.41	0.0109	0.83	0.0038	0.86	0.0040
2.75	1.44	0.0102	1.56	0.0120	0.92	0.0041	0.95	0.0045
3.00	1.57	0.0111	1.70	0.0130	1.00	0.0045	1.04	0.0049
3.25	1.70	0.0121	1.84	0.0141	1.08	0.0049	1.12	0.0053
3.50	1.83	0.0130	1.98	0.0152	1.16	0.0053	1.21	0.0057
3.75	1.96	0.0139	2.12	0.0163	1.25	0.0056	1.30	0.0061
4.00	2.09	0.0149	2.26	0.0174	1.33	0.0060	1.38	0.0065
4.50	2.35	0.0167	2.55	0.0196	1.50	0.0068	1.55	0.0073
5.00	2.62	0.0186	2.83	0.0217	1.66	0.0075	1.73	0.0081

d [mm]	28 x 1.0		28 x 1.5		35 x 1.2		35 x 1.5	
V̇ [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]
5.50	2.88	0.0204	3.11	0.0239	1.83	0.0083	1.90	0.0089
6.00	3.14	0.0223	3.40	0.0261	2.00	0.0090	2.07	0.0097
6.50	3.40	0.0241	3.68	0.0282	2.16	0.0098	2.25	0.0105
7.00	3.66	0.0260	3.96	0.0304	2.33	0.0105	2.42	0.0113
7.50	3.92	0.0279	4.24	0.0326	2.50	0.0113	2.59	0.0121
8.00	4.19	0.0297	4.53	0.0348	2.66	0.0120	2.76	0.0130
8.50	4.45	0.0316	4.81	0.0369	2.83	0.0128	2.94	0.0138
9.00	4.71	0.0334	5.09	0.0391	3.00	0.0135	3.11	0.0146
9.50	4.97	0.0353	5.38	0.0413	3.16	0.0143	3.28	0.0154
10.00	5.23	0.0371	5.66	0.0435	3.33	0.0150	3.45	0.0162
10.50	5.49	0.0390	5.94	0.0456	3.49	0.0158	3.63	0.0170
11.00	5.76	0.0409	6.22	0.0478	3.66	0.0165	3.80	0.0178
11.50	6.02	0.0427	6.51	0.0500	3.83	0.0173	3.97	0.0186
12.00	6.28	0.0446	6.79	0.0522	3.99	0.0180	4.14	0.0194
12.50	6.54	0.0464	7.07	0.0543	4.16	0.0188	4.32	0.0202
13.00	6.80	0.0483	7.36	0.0565	4.33	0.0195	4.49	0.0210
13.50	7.06	0.0502	7.64	0.0587	4.49	0.0203	4.66	0.0219
14.00	7.32	0.0520	7.92	0.0608	4.66	0.0210	4.84	0.0227
14.50	7.59	0.0539	8.21	0.0630	4.83	0.0218	5.01	0.0235
15.00	7.85	0.0557	8.49	0.0652	4.99	0.0225	5.18	0.0243
16.00	8.37	0.0594	9.05	0.0695	5.32	0.0240	5.53	0.0259
17.00	8.89	0.0632	9.62	0.0739	5.66	0.0256	5.87	0.0275
18.00	9.42	0.0669	10.19	0.0782	5.99	0.0271	6.22	0.0291
19.00	9.94	0.0706	–	–	6.32	0.0286	6.56	0.0308
20.00	10.46	0.0743	–	–	6.66	0.0301	6.91	0.0324
21.00	–	–	–	–	6.99	0.0316	7.25	0.0340
22.00	–	–	–	–	7.32	0.0331	7.60	0.0356
23.00	–	–	–	–	7.65	0.0346	7.94	0.0372
24.00	–	–	–	–	7.99	0.0361	8.29	0.0389
25.00	–	–	–	–	8.32	0.0376	8.63	0.0405
30.00	–	–	–	–	9.98	0.0451	10.36	0.0486

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Table 52: Pressure loss for copper pipes in accordance with DVGWGW392 5th gas family, group D, d42–54 mm

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
2.25	0.51	0.0016	0.52	0.0017	–	–	–	–
2.50	0.56	0.0017	0.58	0.0018	–	–	–	–
2.75	0.62	0.0019	0.64	0.0020	–	–	–	–
3.00	0.68	0.0021	0.70	0.0022	–	–	–	–
3.25	0.73	0.0022	0.76	0.0024	–	–	–	–
3.50	0.79	0.0024	0.81	0.0026	–	–	–	–
3.75	0.85	0.0026	0.87	0.0028	0.51	0.0009	0.53	0.0010
4.00	0.90	0.0028	0.93	0.0029	0.54	0.0010	0.57	0.0011
4.50	1.01	0.0031	1.05	0.0033	0.61	0.0011	0.64	0.0012
5.00	1.13	0.0035	1.16	0.0037	0.68	0.0013	0.71	0.0014
5.50	1.24	0.0038	1.28	0.0040	0.75	0.0014	0.78	0.0015
6.00	1.35	0.0041	1.40	0.0044	0.82	0.0015	0.85	0.0016

d [mm]	42 x 1.2		42 x 1.5		54 x 1.5		54 x 2.0	
V̇ [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]
6.50	1.47	0.0045	1.51	0.0048	0.88	0.0016	0.92	0.0018
7.00	1.58	0.0048	1.63	0.0051	0.95	0.0018	0.99	0.0019
7.50	1.69	0.0052	1.74	0.0055	1.02	0.0019	1.06	0.0020
8.00	1.80	0.0055	1.86	0.0059	1.09	0.0020	1.13	0.0022
8.50	1.92	0.0059	1.98	0.0062	1.16	0.0021	1.20	0.0023
9.00	2.03	0.0062	2.09	0.0066	1.22	0.0023	1.27	0.0024
9.50	2.14	0.0066	2.21	0.0070	1.29	0.0024	1.34	0.0026
10.00	2.26	0.0069	2.33	0.0073	1.36	0.0025	1.41	0.0027
10.50	2.37	0.0072	2.44	0.0077	1.43	0.0026	1.49	0.0029
11.00	2.48	0.0076	2.56	0.0081	1.50	0.0028	1.56	0.0030
11.50	2.59	0.0079	2.67	0.0084	1.56	0.0029	1.63	0.0031
12.00	2.71	0.0083	2.79	0.0088	1.63	0.0030	1.70	0.0033
12.50	2.82	0.0086	2.91	0.0092	1.70	0.0031	1.77	0.0034
13.00	2.93	0.0090	3.02	0.0095	1.77	0.0033	1.84	0.0035
13.50	3.04	0.0093	3.14	0.0099	1.84	0.0034	1.91	0.0037
14.00	3.16	0.0097	3.26	0.0103	1.90	0.0035	1.98	0.0038
14.50	3.27	0.0100	3.37	0.0106	1.97	0.0036	2.05	0.0039
15.00	3.38	0.0104	3.49	0.0110	2.04	0.0038	2.12	0.0041
16.00	3.61	0.0110	3.72	0.0117	2.18	0.0040	2.26	0.0043
17.00	3.83	0.0117	3.95	0.0125	2.31	0.0043	2.41	0.0046
18.00	4.06	0.0124	4.19	0.0132	2.45	0.0045	2.55	0.0049
19.00	4.29	0.0131	4.42	0.0139	2.58	0.0048	2.69	0.0052
20.00	4.51	0.0138	4.65	0.0147	2.72	0.0050	2.83	0.0054
21.00	4.74	0.0145	4.88	0.0154	2.86	0.0053	2.97	0.0057
22.00	4.96	0.0152	5.12	0.0161	2.99	0.0055	3.11	0.0060
23.00	5.19	0.0159	5.35	0.0169	3.13	0.0058	3.25	0.0062
24.00	5.41	0.0166	5.58	0.0176	3.26	0.0060	3.40	0.0065
25.00	5.64	0.0173	5.81	0.0183	3.40	0.0063	3.54	0.0068
30.00	6.77	0.0207	6.98	0.0220	4.08	0.0075	4.24	0.0081
35.00	7.89	0.0242	8.14	0.0257	4.76	0.0088	4.95	0.0095
40.00	9.02	0.0276	9.30	0.0294	5.44	0.0100	5.66	0.0109
45.00	10.15	0.0551	10.46	0.0591	6.12	0.0113	6.37	0.0122
50.00	–	–	–	–	6.80	0.0125	7.07	0.0136
55.00	–	–	–	–	7.48	0.0236	7.78	0.0259
60.00	–	–	–	–	8.16	0.0273	8.49	0.0300
65.00	–	–	–	–	8.84	0.0313	9.20	0.0343
70.00	–	–	–	–	9.52	0.0355	9.90	0.0389
75.00	–	–	–	–	10.20	0.0398	–	–

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Table 53: Pressure loss for copper pipes in accordance with DVGWGW392 5th gas family, group D, d76.1–108 mm

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
V̇ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
7.50	0.51	0.0005	–	–	–	–
8.00	0.54	0.0005	–	–	–	–
8.50	0.58	0.0005	–	–	–	–
9.00	0.61	0.0006	–	–	–	–
9.50	0.65	0.0006	–	–	–	–

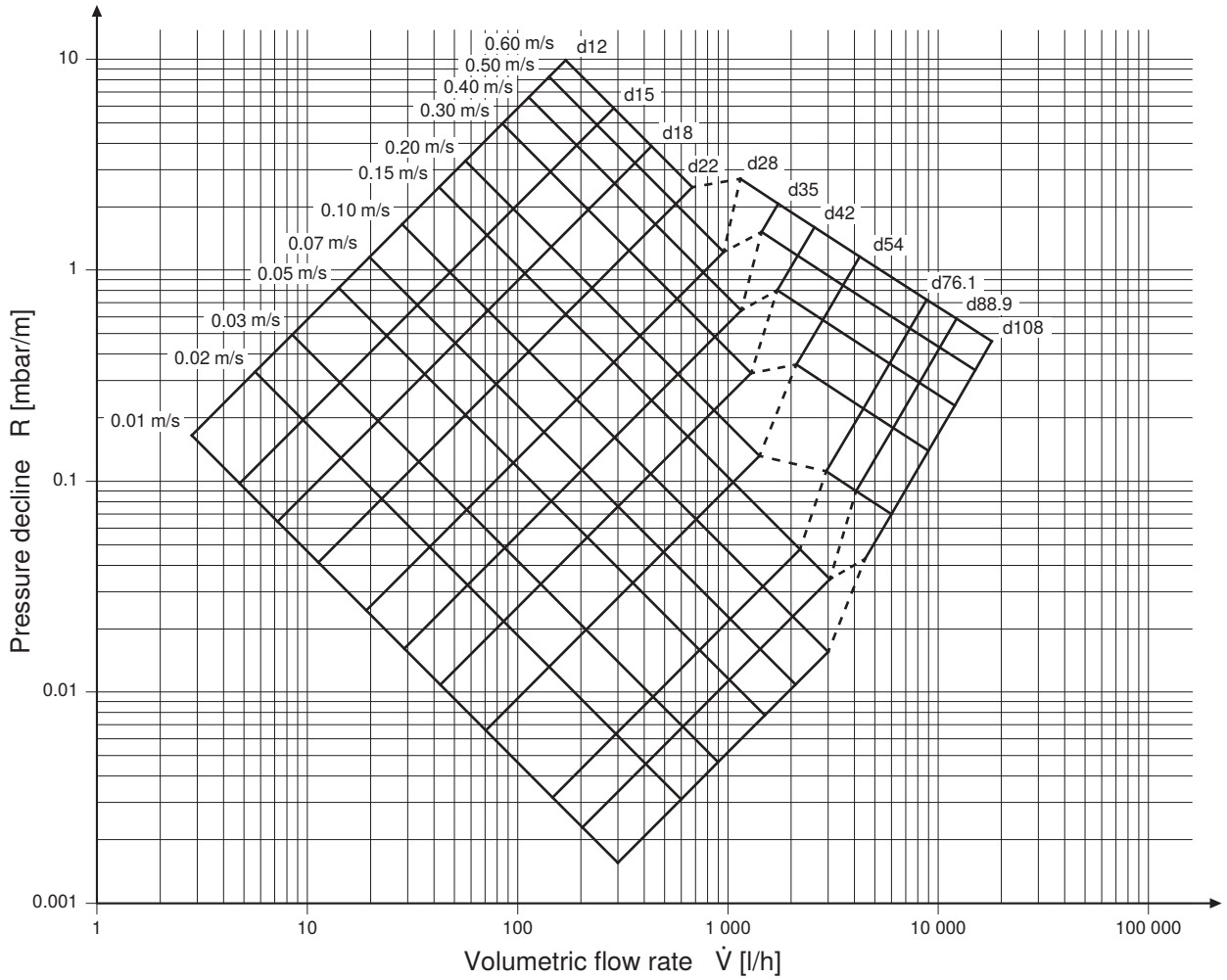
d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
10.00	0.68	0.0006	–	–	–	–
10.50	0.71	0.0007	0.52	0.0003	–	–
11.00	0.75	0.0007	0.54	0.0004	–	–
11.50	0.78	0.0007	0.56	0.0004	–	–
12.00	0.82	0.0008	0.59	0.0004	–	–
12.50	0.85	0.0008	0.61	0.0004	–	–
13.00	0.88	0.0008	0.64	0.0004	–	–
13.50	0.92	0.0008	0.66	0.0004	–	–
14.00	0.95	0.0009	0.69	0.0005	–	–
14.50	0.99	0.0009	0.71	0.0005	–	–
15.00	1.02	0.0009	0.74	0.0005	0.50	0.0002
16.00	1.09	0.0010	0.79	0.0005	0.53	0.0002
17.00	1.16	0.0011	0.83	0.0006	0.57	0.0003
18.00	1.22	0.0011	0.88	0.0006	0.60	0.0003
19.00	1.29	0.0012	0.93	0.0006	0.63	0.0003
20.00	1.36	0.0013	0.98	0.0007	0.67	0.0003
21.00	1.43	0.0013	1.03	0.0007	0.70	0.0003
22.00	1.50	0.0014	1.08	0.0007	0.73	0.0003
23.00	1.56	0.0014	1.13	0.0008	0.77	0.0003
24.00	1.63	0.0015	1.18	0.0008	0.80	0.0004
25.00	1.70	0.0016	1.23	0.0008	0.83	0.0004
30.00	2.04	0.0019	1.47	0.0010	1.00	0.0005
35.00	2.38	0.0022	1.72	0.0011	1.17	0.0005
40.00	2.72	0.0025	1.96	0.0013	1.33	0.0006
45.00	3.06	0.0028	2.21	0.0015	1.50	0.0007
50.00	3.40	0.0031	2.45	0.0016	1.67	0.0008
55.00	3.74	0.0035	2.70	0.0018	1.83	0.0008
60.00	4.08	0.0038	2.94	0.0020	2.00	0.0009
65.00	4.42	0.0041	3.19	0.0021	2.17	0.0010
70.00	4.76	0.0044	3.43	0.0023	2.33	0.0011
75.00	5.10	0.0047	3.68	0.0025	2.50	0.0011
80.00	5.44	0.0088	3.93	0.0026	2.67	0.0012
85.00	5.78	0.0097	4.17	0.0028	2.83	0.0013
90.00	6.12	0.0107	4.42	0.0029	3.00	0.0014
95.00	6.46	0.0117	4.66	0.0054	3.17	0.0014
100.00	6.80	0.0128	4.91	0.0059	3.33	0.0015
105.00	7.14	0.0139	5.15	0.0064	3.50	0.0016
110.00	7.48	0.0150	5.40	0.0070	3.67	0.0017
115.00	7.82	0.0162	5.64	0.0075	3.83	0.0030
120.00	8.16	0.0174	5.89	0.0081	4.00	0.0033
125.00	8.50	0.0186	6.13	0.0087	4.17	0.0035
130.00	8.84	0.0199	6.38	0.0092	4.33	0.0037
135.00	9.18	0.0213	6.62	0.0099	4.50	0.0040
140.00	9.53	0.0226	6.87	0.0105	4.67	0.0042
145.00	9.87	0.0240	7.11	0.0111	4.83	0.0045
150.00	10.21	0.0254	7.36	0.0118	5.00	0.0048
155.00	–	–	7.61	0.0125	5.17	0.0050
160.00	–	–	7.85	0.0132	5.33	0.0053
165.00	–	–	8.10	0.0139	5.50	0.0056

d [mm]	76.1 x 2.0		88.9 x 2.0		108 x 2.5	
$\dot{V}$ [m³/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
170.00	–	–	8.34	0.0146	5.67	0.0059
175.00	–	–	8.59	0.0153	5.83	0.0062
180.00	–	–	8.83	0.0161	6.00	0.0065
185.00	–	–	9.08	0.0169	6.17	0.0068
190.00	–	–	9.32	0.0177	6.33	0.0071
195.00	–	–	9.57	0.0185	6.50	0.0074
200.00	–	–	9.81	0.0193	6.67	0.0078
205.00	–	–	10.06	0.0201	6.83	0.0081
210.00	–	–	10.30	0.0210	7.00	0.0084
215.00	–	–	–	–	7.17	0.0088
220.00	–	–	–	–	7.33	0.0091
225.00	–	–	–	–	7.50	0.0095
230.00	–	–	–	–	7.67	0.0098
235.00	–	–	–	–	7.83	0.0102
240.00	–	–	–	–	8.00	0.0106
245.00	–	–	–	–	8.17	0.0110
250.00	–	–	–	–	8.33	0.0114
255.00	–	–	–	–	8.50	0.0118
260.00	–	–	–	–	8.67	0.0122
265.00	–	–	–	–	8.83	0.0126
270.00	–	–	–	–	9.00	0.0130
275.00	–	–	–	–	9.17	0.0134
280.00	–	–	–	–	9.33	0.0138
285.00	–	–	–	–	9.50	0.0142
290.00	–	–	–	–	9.67	0.0147
295.00	–	–	–	–	9.83	0.0151
300.00	–	–	–	–	10.00	0.0155

6 PRESSURE LOSS HEATING OIL EL

6.1 HEATING OIL EL, 20 °C

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



——— Pure turbulent or laminar flow

- - - - - Transition between turbulent and laminar flow

Table 54: Pressure loss for copper pipes in accordance with DVGW GW 392, heating oil EL 20 °C, d12–18 mm

d [mm]		12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0	
ṁ [kg/h]	V̇ [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	0.0290	0.002	0.0340	0.001	0.0119	–	–
0.75	0.9	0.003	0.0435	0.003	0.0509	0.002	0.0178	0.001	0.0078
1.00	1.2	0.004	0.0580	0.004	0.0679	0.002	0.0238	0.002	0.0104
1.25	1.5	0.005	0.0726	0.005	0.0849	0.003	0.0297	0.002	0.0130
1.50	1.7	0.006	0.0871	0.006	0.1019	0.004	0.0357	0.002	0.0155
1.75	2.0	0.007	0.1016	0.007	0.1188	0.004	0.0416	0.003	0.0181
2.00	2.3	0.008	0.1161	0.008	0.1358	0.005	0.0476	0.003	0.0207
2.25	2.6	0.009	0.1306	0.009	0.1528	0.005	0.0535	0.004	0.0233
2.50	2.9	0.010	0.1451	0.010	0.1698	0.006	0.0594	0.004	0.0259
2.75	3.2	0.010	0.1596	0.011	0.1867	0.007	0.0654	0.004	0.0285
3.00	3.5	0.011	0.1741	0.012	0.2037	0.007	0.0713	0.005	0.0311
3.25	3.8	0.012	0.1887	0.013	0.2207	0.008	0.0773	0.005	0.0337
3.50	4.1	0.013	0.2032	0.014	0.2377	0.009	0.0832	0.006	0.0363
3.75	4.4	0.014	0.2177	0.015	0.2546	0.009	0.0892	0.006	0.0389
4.00	4.7	0.015	0.2322	0.016	0.2716	0.010	0.0951	0.006	0.0414
4.25	4.9	0.016	0.2467	0.017	0.2886	0.010	0.1010	0.007	0.0440
4.50	5.2	0.017	0.2612	0.019	0.3056	0.011	0.1070	0.007	0.0466
4.75	5.5	0.018	0.2757	0.020	0.3226	0.012	0.1129	0.008	0.0492
5.00	5.8	0.019	0.2902	0.021	0.3395	0.012	0.1189	0.008	0.0518
5.50	6.4	0.021	0.3193	0.023	0.3735	0.013	0.1308	0.009	0.0570
6.00	7.0	0.023	0.3483	0.025	0.4074	0.015	0.1427	0.010	0.0622
6.50	7.6	0.025	0.3773	0.027	0.4414	0.016	0.1545	0.010	0.0674
7.00	8.1	0.027	0.4063	0.029	0.4753	0.017	0.1664	0.011	0.0725
7.50	8.7	0.029	0.4353	0.031	0.5093	0.018	0.1783	0.012	0.0777
8.00	9.3	0.030	0.4644	0.033	0.5432	0.019	0.1902	0.013	0.0829
8.50	9.9	0.032	0.4934	0.035	0.5772	0.021	0.2021	0.014	0.0881
9.00	10.5	0.034	0.5224	0.037	0.6112	0.022	0.2140	0.014	0.0933
9.50	11.0	0.036	0.5514	0.039	0.6451	0.023	0.2259	0.015	0.0984
10	11.6	0.038	0.5805	0.041	0.6791	0.024	0.2378	0.016	0.1036
15	17.4	0.057	0.8707	0.062	1.0186	0.037	0.3566	0.024	0.1554
20	23.3	0.076	1.1609	0.082	1.3581	0.049	0.4755	0.032	0.2072
25	29.1	0.095	1.4512	0.103	1.6977	0.061	0.5944	0.040	0.2590
30	34.9	0.114	1.7414	0.123	2.0372	0.073	0.7133	0.048	0.3108
35	40.7	0.133	2.0316	0.144	2.3767	0.085	0.8322	0.056	0.3627
40	46.5	0.152	2.3219	0.165	2.7162	0.097	0.9510	0.064	0.4145
45	52.3	0.171	2.6121	0.185	3.0558	0.110	1.0699	0.072	0.4663
50	58.1	0.190	2.9023	0.206	3.3953	0.122	1.1888	0.080	0.5181
55	64.0	0.209	3.1926	0.226	3.7348	0.134	1.3077	0.088	0.5699
60	69.8	0.228	3.4828	0.247	4.0744	0.146	1.4265	0.096	0.6217
65	75.6	0.247	3.7730	0.267	4.4139	0.158	1.5454	0.104	0.6735
70	81.4	0.266	4.0632	0.288	4.7534	0.170	1.6643	0.112	0.7253
75	87.2	0.285	4.3535	0.308	5.0930	0.183	1.7832	0.120	0.7771
80	93.0	0.304	4.6437	0.329	5.4325	0.195	1.9021	0.129	0.8289
85	98.8	0.323	4.9339	0.350	5.7720	0.207	2.0209	0.137	0.8807
90	104.7	0.342	5.2242	0.370	6.1115	0.219	2.1398	0.145	0.9325
95	110.5	0.361	5.5144	0.391	6.4511	0.231	2.2587	0.153	0.9844
100	116.3	0.380	5.8046	0.411	6.7906	0.243	2.3776	0.161	1.0362
125	145.3	0.475	7.2558	0.514	8.4883	0.304	2.9720	0.201	1.2952

d [mm]		12 x 0.8		12 x 1.0		15 x 1.0		18 x 1.0	
ṁ [kg/h]	V̇ [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]
150	174.4	–	–	–	–	0.365	3.5664	0.241	1.5542
175	203.5	–	–	–	–	0.426	4.1608	0.281	1.8133
200	232.6	–	–	–	–	0.487	4.7552	0.321	2.0723
250	290.7	–	–	–	–	–	–	0.402	2.5904
300	348.8	–	–	–	–	–	–	0.482	3.1085

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Table 55: Pressure loss for copper pipes in accordance with DVGW GW 392, heating oil EL 20 °C, d22–28 mm

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1.25	1.5	0.001	0.0036	–	–	–	–
1.50	1.7	0.001	0.0043	–	–	–	–
1.75	2.0	0.001	0.0051	0.001	0.0026	0.001	0.0030
2.00	2.3	0.002	0.0058	0.001	0.0030	0.001	0.0035
2.25	2.6	0.002	0.0065	0.001	0.0033	0.001	0.0039
2.50	2.9	0.002	0.0072	0.002	0.0037	0.002	0.0043
2.75	3.2	0.002	0.0080	0.002	0.0041	0.002	0.0048
3.00	3.5	0.003	0.0087	0.002	0.0045	0.002	0.0052
3.25	3.8	0.003	0.0094	0.002	0.0048	0.002	0.0056
3.50	4.1	0.003	0.0101	0.002	0.0052	0.002	0.0061
3.75	4.4	0.003	0.0109	0.002	0.0056	0.002	0.0065
4.00	4.7	0.003	0.0116	0.002	0.0059	0.003	0.0070
4.25	4.9	0.004	0.0123	0.003	0.0063	0.003	0.0074
4.50	5.2	0.004	0.0130	0.003	0.0067	0.003	0.0078
4.75	5.5	0.004	0.0138	0.003	0.0071	0.003	0.0083
5.00	5.8	0.004	0.0145	0.003	0.0074	0.003	0.0087
5.50	6.4	0.005	0.0159	0.003	0.0082	0.004	0.0096
6.00	7.0	0.005	0.0174	0.004	0.0089	0.004	0.0104
6.50	7.6	0.006	0.0188	0.004	0.0097	0.004	0.0113
7.00	8.1	0.006	0.0203	0.004	0.0104	0.005	0.0122
7.50	8.7	0.006	0.0217	0.005	0.0111	0.005	0.0130
8.00	9.3	0.007	0.0232	0.005	0.0119	0.005	0.0139
8.50	9.9	0.007	0.0246	0.005	0.0126	0.006	0.0148
9.00	10.5	0.008	0.0261	0.005	0.0134	0.006	0.0156
9.50	11.0	0.008	0.0275	0.006	0.0141	0.006	0.0165
10	11.6	0.008	0.0290	0.006	0.0149	0.007	0.0174
15	17.4	0.013	0.0435	0.009	0.0223	0.010	0.0261
20	23.3	0.017	0.0580	0.012	0.0297	0.013	0.0348
25	29.1	0.021	0.0725	0.015	0.0371	0.016	0.0435
30	34.9	0.025	0.0870	0.018	0.0446	0.020	0.0522
35	40.7	0.030	0.1015	0.021	0.0520	0.023	0.0608
40	46.5	0.034	0.1160	0.024	0.0594	0.026	0.0695
45	52.3	0.038	0.1304	0.027	0.0669	0.030	0.0782
50	58.1	0.042	0.1449	0.030	0.0743	0.033	0.0869
55	64.0	0.047	0.1594	0.033	0.0817	0.036	0.0956
60	69.8	0.051	0.1739	0.037	0.0892	0.039	0.1043
65	75.6	0.055	0.1884	0.040	0.0966	0.043	0.1130
70	81.4	0.059	0.2029	0.043	0.1040	0.046	0.1217

d [mm]		22 x 1.0		28 x 1.0		28 x 1.5	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
75	87.2	0.064	0.2174	0.046	0.1114	0.049	0.1304
80	93.0	0.068	0.2319	0.049	0.1189	0.053	0.1391
85	98.8	0.072	0.2464	0.052	0.1263	0.056	0.1478
90	104.7	0.076	0.2609	0.055	0.1337	0.059	0.1565
95	110.5	0.081	0.2754	0.058	0.1412	0.063	0.1651
100	116.3	0.085	0.2899	0.061	0.1486	0.066	0.1738
125	145.3	0.106	0.3623	0.076	0.1857	0.082	0.2173
150	174.4	0.127	0.4348	0.091	0.2229	0.099	0.2608
175	203.5	0.149	0.5073	0.106	0.2600	0.115	0.3042
200	232.6	0.170	0.5798	0.122	0.2972	0.132	0.3477
250	290.7	0.212	0.7247	0.152	0.3715	0.165	0.4346
300	348.8	0.255	0.8696	0.183	0.4458	0.197	0.5215
350	407.0	0.297	1.0146	0.213	0.5201	0.230	0.6084
400	465.1	0.340	1.1595	0.243	0.5944	0.263	0.6954
450	523.3	0.382	1.3045	0.274	0.6687	0.296	0.7823
500	581.4	0.425	1.4494	0.304	0.7430	0.329	0.8692
550	639.5	0.467	1.5943	0.335	0.8173	0.362	0.9561
600	697.7	0.510	1.7393	0.365	0.8916	0.395	1.0430
650	755.8	–	–	0.395	0.9659	0.428	1.1300
700	814.0	–	–	0.426	1.0402	0.461	1.2169
750	872.1	–	–	0.456	1.1145	0.494	1.3038
800	930.2	–	–	0.487	1.1888	–	–
850	988.4	–	–	0.517	1.2631	–	–

Table 56: Pressure loss for copper pipes in accordance with DVGW GW 392, heating oil EL 20 °C, d35–42 mm

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
ṁ [kg/h]	V̇ [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]
2.50	2.9	–	–	0.001	0.0016	–	–	–	–
2.75	3.2	0.001	0.0017	0.001	0.0018	–	–	–	–
3.00	3.5	0.001	0.0018	0.001	0.0019	–	–	–	–
3.25	3.8	0.001	0.0020	0.001	0.0021	–	–	–	–
3.50	4.1	0.001	0.0021	0.001	0.0023	–	–	–	–
3.75	4.4	0.001	0.0023	0.002	0.0024	–	–	0.001	0.0011
4.00	4.7	0.002	0.0024	0.002	0.0026	0.001	0.0011	0.001	0.0012
4.25	4.9	0.002	0.0026	0.002	0.0028	0.001	0.0012	0.001	0.0012
4.50	5.2	0.002	0.0027	0.002	0.0029	0.001	0.0012	0.001	0.0013
4.75	5.5	0.002	0.0029	0.002	0.0031	0.001	0.0013	0.001	0.0014
5.00	5.8	0.002	0.0030	0.002	0.0032	0.001	0.0014	0.001	0.0015
5.50	6.4	0.002	0.0033	0.002	0.0036	0.001	0.0015	0.001	0.0016
6.00	7.0	0.002	0.0036	0.002	0.0039	0.002	0.0017	0.002	0.0018
6.50	7.6	0.003	0.0039	0.003	0.0042	0.002	0.0018	0.002	0.0019
7.00	8.1	0.003	0.0042	0.003	0.0045	0.002	0.0019	0.002	0.0021
7.50	8.7	0.003	0.0045	0.003	0.0049	0.002	0.0021	0.002	0.0022
8.00	9.3	0.003	0.0048	0.003	0.0052	0.002	0.0022	0.002	0.0023
8.50	9.9	0.003	0.0051	0.003	0.0055	0.002	0.0023	0.002	0.0025
9.00	10.5	0.003	0.0054	0.004	0.0058	0.002	0.0025	0.002	0.0026
9.50	11.0	0.004	0.0057	0.004	0.0062	0.002	0.0026	0.003	0.0028

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
ṁ [kg/h]	V̇ [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]
10	11.6	0.004	0.0060	0.004	0.0065	0.003	0.0028	0.003	0.0029
15	17.4	0.006	0.0090	0.006	0.0097	0.004	0.0041	0.004	0.0044
20	23.3	0.008	0.0120	0.008	0.0130	0.005	0.0055	0.005	0.0059
25	29.1	0.010	0.0150	0.010	0.0162	0.007	0.0069	0.007	0.0073
30	34.9	0.012	0.0180	0.012	0.0194	0.008	0.0083	0.008	0.0088
35	40.7	0.014	0.0210	0.014	0.0227	0.009	0.0097	0.009	0.0103
40	46.5	0.015	0.0240	0.016	0.0259	0.010	0.0110	0.011	0.0117
45	52.3	0.017	0.0271	0.018	0.0291	0.012	0.0124	0.012	0.0132
50	58.1	0.019	0.0301	0.020	0.0324	0.013	0.0138	0.014	0.0147
55	64.0	0.021	0.0331	0.022	0.0356	0.014	0.0152	0.015	0.0161
60	69.8	0.023	0.0361	0.024	0.0389	0.016	0.0166	0.016	0.0176
65	75.6	0.025	0.0391	0.026	0.0421	0.017	0.0179	0.018	0.0191
70	81.4	0.027	0.0421	0.028	0.0453	0.018	0.0193	0.019	0.0205
75	87.2	0.029	0.0451	0.030	0.0486	0.020	0.0207	0.020	0.0220
80	93.0	0.031	0.0481	0.032	0.0518	0.021	0.0221	0.022	0.0235
85	98.8	0.033	0.0511	0.034	0.0550	0.022	0.0235	0.023	0.0249
90	104.7	0.035	0.0541	0.036	0.0583	0.024	0.0249	0.024	0.0264
95	110.5	0.037	0.0571	0.038	0.0615	0.025	0.0262	0.026	0.0279
100	116.3	0.039	0.0601	0.040	0.0648	0.026	0.0276	0.027	0.0294
125	145.3	0.048	0.0752	0.050	0.0810	0.033	0.0345	0.034	0.0367
150	174.4	0.058	0.0902	0.060	0.0971	0.039	0.0414	0.041	0.0440
175	203.5	0.068	0.1052	0.070	0.1133	0.046	0.0483	0.047	0.0514
200	232.6	0.077	0.1202	0.080	0.1295	0.052	0.0552	0.054	0.0587
250	290.7	0.097	0.1503	0.100	0.1619	0.066	0.0690	0.068	0.0734
300	348.8	0.116	0.1804	0.120	0.1943	0.079	0.0828	0.081	0.0881
350	407.0	0.135	0.2104	0.141	0.2267	0.092	0.0966	0.095	0.1027
400	465.1	0.155	0.2405	0.161	0.2590	0.105	0.1105	0.108	0.1174
450	523.3	0.174	0.2706	0.181	0.2914	0.118	0.1243	0.122	0.1321
500	581.4	0.193	0.3006	0.201	0.3238	0.131	0.1381	0.135	0.1468
550	639.5	0.213	0.3307	0.221	0.3562	0.144	0.1519	0.149	0.1614
600	697.7	0.232	0.3607	0.241	0.3886	0.157	0.1657	0.162	0.1761
650	755.8	0.252	0.3908	0.261	0.4209	0.170	0.1795	0.176	0.1908
700	814.0	0.271	0.4209	0.281	0.4533	0.184	0.1933	0.189	0.2055
750	872.1	0.290	0.4509	0.301	0.4857	0.197	0.2071	0.203	0.2201
800	930.2	0.310	0.4810	0.321	0.5181	0.210	0.2209	0.216	0.2348
850	988.4	0.329	0.5110	0.341	0.5505	0.223	0.2347	0.230	0.2495
900	1,046.5	0.348	0.5411	0.361	0.5828	0.236	0.2485	0.243	0.2642
950	1,104.7	0.368	0.5712	0.382	0.6152	0.249	0.2623	0.257	0.2789
1,000	1,162.8	0.387	0.6012	0.402	0.6476	0.262	0.2761	0.270	0.2935
1,050	1,220.9	0.406	0.6313	0.422	0.6800	0.275	0.2899	0.284	0.3082
1,100	1,279.1	0.426	1.1307	0.442	1.2335	0.288	0.3038	0.297	0.3229
1,150	1,337.2	0.445	1.2186	0.462	1.3294	0.302	0.3176	0.311	0.3376
1,200	1,395.3	0.464	1.3092	0.482	1.4284	0.315	0.3314	0.324	0.3522
1,250	1,453.5	0.484	1.4026	0.502	1.5303	0.328	0.3452	0.338	0.3669
1,300	1,511.6	0.503	1.4987	–	–	0.341	0.3590	0.351	0.3816
1,350	1,569.8	–	–	–	–	0.354	0.6418	0.365	0.6893
1,400	1,627.9	–	–	–	–	0.367	0.6823	0.379	0.7329
1,450	1,686.0	–	–	–	–	0.380	0.7239	0.392	0.7776
1,500	1,744.2	–	–	–	–	0.393	0.7665	0.406	0.8234

d [mm]		35 x 1.2		35 x 1.5		42 x 1.2		42 x 1.5	
ṁ [kg/h]	V̇ [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]
1,550	1,802.3	–	–	–	–	0.406	0.8101	0.419	0.8702
1,600	1,860.5	–	–	–	–	0.420	0.8547	0.433	0.9182
1,650	1,918.6	–	–	–	–	0.433	0.9004	0.446	0.9673
1,700	1,976.7	–	–	–	–	0.446	0.9471	0.460	1.0174
1,750	2,034.9	–	–	–	–	0.459	0.9947	0.473	1.0686
1,800	2,093.0	–	–	–	–	0.472	1.0433	0.487	1.1209
1,850	2,151.2	–	–	–	–	0.485	1.0929	0.500	1.1742
1,900	2,209.3	–	–	–	–	0.498	1.1435	0.514	1.2286
1,950	2,267.4	–	–	–	–	0.511	1.1951	–	–

Table 57: Pressure loss for copper pipes in accordance with DVGW GW 392, heating oil EL 20 °C, d54–76.1 mm

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
6.50	7.6	0.001	0.0007	0.001	0.0007	–	–
7.00	8.1	0.001	0.0007	0.001	0.0008	–	–
7.50	8.7	0.001	0.0008	0.001	0.0008	–	–
8.00	9.3	0.001	0.0008	0.001	0.0009	–	–
8.50	9.9	0.001	0.0009	0.001	0.0009	–	–
9.00	10.5	0.001	0.0009	0.001	0.0010	–	–
9.50	11.0	0.002	0.0010	0.002	0.0010	–	–
10	11.6	0.002	0.0010	0.002	0.0011	–	–
15	17.4	0.002	0.0015	0.002	0.0016	0.001	0.0004
20	23.3	0.003	0.0020	0.003	0.0022	0.002	0.0005
25	29.1	0.004	0.0025	0.004	0.0027	0.002	0.0006
30	34.9	0.005	0.0030	0.005	0.0033	0.002	0.0008
35	40.7	0.006	0.0035	0.006	0.0038	0.003	0.0009
40	46.5	0.006	0.0040	0.007	0.0043	0.003	0.0010
45	52.3	0.007	0.0045	0.007	0.0049	0.004	0.0011
50	58.1	0.008	0.0050	0.008	0.0054	0.004	0.0013
55	64.0	0.009	0.0055	0.009	0.0060	0.004	0.0014
60	69.8	0.009	0.0060	0.010	0.0065	0.005	0.0015
65	75.6	0.010	0.0065	0.011	0.0071	0.005	0.0016
70	81.4	0.011	0.0070	0.012	0.0076	0.006	0.0018
75	87.2	0.012	0.0075	0.012	0.0081	0.006	0.0019
80	93.0	0.013	0.0080	0.013	0.0087	0.006	0.0020
85	98.8	0.013	0.0085	0.014	0.0092	0.007	0.0021
90	104.7	0.014	0.0090	0.015	0.0098	0.007	0.0023
95	110.5	0.015	0.0095	0.016	0.0103	0.008	0.0024
100	116.3	0.016	0.0100	0.016	0.0109	0.008	0.0025
125	145.3	0.020	0.0125	0.021	0.0136	0.010	0.0031
150	174.4	0.024	0.0151	0.025	0.0163	0.012	0.0038
175	203.5	0.028	0.0176	0.029	0.0190	0.014	0.0044
200	232.6	0.032	0.0201	0.033	0.0217	0.016	0.0050
250	290.7	0.040	0.0251	0.041	0.0272	0.020	0.0063
300	348.8	0.047	0.0301	0.049	0.0326	0.024	0.0075
350	407.0	0.055	0.0351	0.058	0.0380	0.028	0.0088
400	465.1	0.063	0.0402	0.066	0.0435	0.032	0.0101

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
450	523.3	0.071	0.0452	0.074	0.0489	0.036	0.0113
500	581.4	0.079	0.0502	0.082	0.0543	0.040	0.0126
550	639.5	0.087	0.0552	0.090	0.0598	0.044	0.0138
600	697.7	0.095	0.0602	0.099	0.0652	0.047	0.0151
650	755.8	0.103	0.0652	0.107	0.0706	0.051	0.0163
700	814.0	0.111	0.0703	0.115	0.0761	0.055	0.0176
750	872.1	0.119	0.0753	0.123	0.0815	0.059	0.0188
800	930.2	0.126	0.0803	0.132	0.0869	0.063	0.0201
850	988.4	0.134	0.0853	0.140	0.0924	0.067	0.0214
900	1,046.5	0.142	0.0903	0.148	0.0978	0.071	0.0226
950	1,104.7	0.150	0.0954	0.156	0.1032	0.075	0.0239
1,000	1,162.8	0.158	0.1004	0.165	0.1086	0.079	0.0251
1,050	1,220.9	0.166	0.1054	0.173	0.1141	0.083	0.0264
1,100	1,279.1	0.174	0.1104	0.181	0.1195	0.087	0.0276
1,150	1,337.2	0.182	0.1154	0.189	0.1249	0.091	0.0289
1,200	1,395.3	0.190	0.1205	0.197	0.1304	0.095	0.0302
1,250	1,453.5	0.198	0.1255	0.206	0.1358	0.099	0.0314
1,300	1,511.6	0.206	0.1305	0.214	0.1412	0.103	0.0327
1,350	1,569.8	0.213	0.1355	0.222	0.1467	0.107	0.0339
1,400	1,627.9	0.221	0.1405	0.230	0.1521	0.111	0.0352
1,450	1,686.0	0.229	0.1455	0.239	0.1575	0.115	0.0364
1,500	1,744.2	0.237	0.1506	0.247	0.1630	0.119	0.0377
1,550	1,802.3	0.245	0.1556	0.255	0.1684	0.123	0.0389
1,600	1,860.5	0.253	0.1606	0.263	0.1738	0.127	0.0402
1,650	1,918.6	0.261	0.1656	0.271	0.1793	0.131	0.0415
1,700	1,976.7	0.269	0.1706	0.280	0.3174	0.134	0.0427
1,750	2,034.9	0.277	0.3037	0.288	0.3332	0.138	0.0440
1,800	2,093.0	0.285	0.3185	0.296	0.3494	0.142	0.0452
1,850	2,151.2	0.293	0.3335	0.304	0.3659	0.146	0.0465
1,900	2,209.3	0.300	0.3488	0.313	0.3828	0.150	0.0477
1,950	2,267.4	0.308	0.3645	0.321	0.3999	0.154	0.0490
2,000	2,325.6	0.316	0.3804	0.329	0.4174	0.158	0.0503
2,050	2,383.7	0.324	0.3966	0.337	0.4352	0.162	0.0515
2,100	2,441.9	0.332	0.4131	0.345	0.4533	0.166	0.0528
2,150	2,500.0	0.340	0.4299	0.354	0.4717	0.170	0.0540
2,200	2,558.1	0.348	0.4469	0.362	0.4904	0.174	0.0553
2,250	2,616.3	0.356	0.4643	0.370	0.5095	0.178	0.0565
2,300	2,674.4	0.364	0.4819	0.378	0.5288	0.182	0.0578
2,350	2,732.6	0.372	0.4998	0.387	0.5485	0.186	0.0591
2,400	2,790.7	0.379	0.5179	0.395	0.5684	0.190	0.0603
2,450	2,848.8	0.387	0.5364	0.403	0.5887	0.194	0.1057
2,500	2,907.0	0.395	0.5551	0.411	0.6092	0.198	0.1094
2,550	2,965.1	0.403	0.5741	0.419	0.6300	0.202	0.1131
2,600	3,023.3	0.411	0.5933	0.428	0.6512	0.206	0.1168
2,650	3,081.4	0.419	0.6128	0.436	0.6726	0.210	0.1207
2,700	3,139.5	0.427	0.6326	0.444	0.6944	0.214	0.1245
2,750	3,197.7	0.435	0.6527	0.452	0.7164	0.218	0.1284
2,800	3,255.8	0.443	0.6730	0.461	0.7387	0.222	0.1324
2,850	3,314.0	0.451	0.6936	0.469	0.7613	0.225	0.1364

d [mm]		54 x 1.5		54 x 2.0		76.1 x 2.0	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
2,900	3,372.1	0.459	0.7145	0.477	0.7842	0.229	0.1405
2,950	3,430.2	0.466	0.7356	0.485	0.8074	0.233	0.1446
3,000	3,488.4	0.474	0.7570	0.494	0.8309	0.237	0.1488
3,100	3,604.7	0.490	0.8005	0.510	0.8787	0.245	0.1573
3,200	3,720.9	0.506	0.8451	–	–	0.253	0.1660
3,300	3,837.2	–	–	–	–	0.261	0.1748
3,400	3,953.5	–	–	–	–	0.269	0.1839
3,500	4,069.8	–	–	–	–	0.277	0.1932
3,600	4,186.0	–	–	–	–	0.285	0.2027
3,700	4,302.3	–	–	–	–	0.293	0.2123
3,800	4,418.6	–	–	–	–	0.301	0.2222
3,900	4,534.9	–	–	–	–	0.309	0.2322
4,000	4,651.2	–	–	–	–	0.316	0.2424
4,100	4,767.4	–	–	–	–	0.324	0.2528
4,200	4,883.7	–	–	–	–	0.332	0.2634
4,300	5,000.0	–	–	–	–	0.340	0.2742
4,400	5,116.3	–	–	–	–	0.348	0.2852
4,500	5,232.6	–	–	–	–	0.356	0.2963
4,600	5,348.8	–	–	–	–	0.364	0.3077
4,700	5,465.1	–	–	–	–	0.372	0.3192
4,800	5,581.4	–	–	–	–	0.380	0.3309
4,900	5,697.7	–	–	–	–	0.388	0.3427
5,000	5,814.0	–	–	–	–	0.396	0.3548
5,100	5,930.2	–	–	–	–	0.403	0.3670
5,200	6,046.5	–	–	–	–	0.411	0.3794
5,300	6,162.8	–	–	–	–	0.419	0.3920
5,400	6,279.1	–	–	–	–	0.427	0.4048
5,500	6,395.3	–	–	–	–	0.435	0.4177
5,600	6,511.6	–	–	–	–	0.443	0.4308
5,700	6,627.9	–	–	–	–	0.451	0.4441
5,800	6,744.2	–	–	–	–	0.459	0.4575
5,900	6,860.5	–	–	–	–	0.467	0.4712
6,000	6,976.7	–	–	–	–	0.475	0.4849
6,100	7,093.0	–	–	–	–	0.483	0.4989
6,200	7,209.3	–	–	–	–	0.490	0.5130
6,300	7,325.6	–	–	–	–	0.498	0.5273
6,400	7,441.9	–	–	–	–	0.506	0.5418
6,500	7,558.1	–	–	–	–	0.514	0.5565

Table 58: Pressure loss for copper pipes in accordance with DVGW GW 392, heating oil EL 20 °C, d88.9–108 mm

d [mm]		88.9 x 2.0		108 x 2.5	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
20	23.3	0.001	0.0003	–	–
25	29.1	0.001	0.0003	–	–
30	34.9	0.002	0.0004	0.001	0.0002
35	40.7	0.002	0.0005	0.001	0.0002
40	46.5	0.002	0.0005	0.002	0.0002

d [mm]		88.9 x 2.0		108 x 2.5	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
45	52.3	0.003	0.0006	0.002	0.0003
50	58.1	0.003	0.0007	0.002	0.0003
55	64.0	0.003	0.0007	0.002	0.0003
60	69.8	0.003	0.0008	0.002	0.0004
65	75.6	0.004	0.0008	0.003	0.0004
70	81.4	0.004	0.0009	0.003	0.0004
75	87.2	0.004	0.0010	0.003	0.0005
80	93.0	0.005	0.0010	0.003	0.0005
85	98.8	0.005	0.0011	0.003	0.0005
90	104.7	0.005	0.0012	0.003	0.0005
95	110.5	0.005	0.0012	0.004	0.0006
100	116.3	0.006	0.0013	0.004	0.0006
125	145.3	0.007	0.0016	0.005	0.0008
150	174.4	0.009	0.0020	0.006	0.0009
175	203.5	0.010	0.0023	0.007	0.0011
200	232.6	0.011	0.0026	0.008	0.0012
250	290.7	0.014	0.0033	0.010	0.0015
300	348.8	0.017	0.0039	0.012	0.0018
350	407.0	0.020	0.0046	0.014	0.0021
400	465.1	0.023	0.0052	0.016	0.0024
450	523.3	0.026	0.0059	0.017	0.0027
500	581.4	0.029	0.0065	0.019	0.0030
550	639.5	0.031	0.0072	0.021	0.0033
600	697.7	0.034	0.0078	0.023	0.0036
650	755.8	0.037	0.0085	0.025	0.0039
700	814.0	0.040	0.0091	0.027	0.0042
750	872.1	0.043	0.0098	0.029	0.0045
800	930.2	0.046	0.0105	0.031	0.0048
850	988.4	0.048	0.0111	0.033	0.0051
900	1,046.5	0.051	0.0118	0.035	0.0054
950	1,104.7	0.054	0.0124	0.037	0.0057
1,000	1,162.8	0.057	0.0131	0.039	0.0060
1,050	1,220.9	0.060	0.0137	0.041	0.0063
1,100	1,279.1	0.063	0.0144	0.043	0.0066
1,150	1,337.2	0.066	0.0150	0.045	0.0069
1,200	1,395.3	0.068	0.0157	0.047	0.0072
1,250	1,453.5	0.071	0.0163	0.048	0.0075
1,300	1,511.6	0.074	0.0170	0.050	0.0078
1,350	1,569.8	0.077	0.0176	0.052	0.0081
1,400	1,627.9	0.080	0.0183	0.054	0.0084
1,450	1,686.0	0.083	0.0190	0.056	0.0087
1,500	1,744.2	0.086	0.0196	0.058	0.0091
1,550	1,802.3	0.088	0.0203	0.060	0.0094
1,600	1,860.5	0.091	0.0209	0.062	0.0097
1,650	1,918.6	0.094	0.0216	0.064	0.0100
1,700	1,976.7	0.097	0.0222	0.066	0.0103
1,750	2,034.9	0.100	0.0229	0.068	0.0106
1,800	2,093.0	0.103	0.0235	0.070	0.0109
1,850	2,151.2	0.106	0.0242	0.072	0.0112

d [mm]		88.9 x 2.0		108 x 2.5	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
1,900	2,209.3	0.108	0.0248	0.074	0.0115
1,950	2,267.4	0.111	0.0255	0.076	0.0118
2,000	2,325.6	0.114	0.0261	0.078	0.0121
2,050	2,383.7	0.117	0.0268	0.079	0.0124
2,100	2,441.9	0.120	0.0274	0.081	0.0127
2,150	2,500.0	0.123	0.0281	0.083	0.0130
2,200	2,558.1	0.126	0.0288	0.085	0.0133
2,250	2,616.3	0.128	0.0294	0.087	0.0136
2,300	2,674.4	0.131	0.0301	0.089	0.0139
2,350	2,732.6	0.134	0.0307	0.091	0.0142
2,400	2,790.7	0.137	0.0314	0.093	0.0145
2,450	2,848.8	0.140	0.0320	0.095	0.0148
2,500	2,907.0	0.143	0.0327	0.097	0.0151
2,550	2,965.1	0.145	0.0333	0.099	0.0154
2,600	3,023.3	0.148	0.0340	0.101	0.0157
2,650	3,081.4	0.151	0.0346	0.103	0.0160
2,700	3,139.5	0.154	0.0353	0.105	0.0163
2,750	3,197.7	0.157	0.0359	0.107	0.0166
2,800	3,255.8	0.160	0.0366	0.109	0.0169
2,850	3,314.0	0.163	0.0634	0.110	0.0172
2,900	3,372.1	0.165	0.0653	0.112	0.0175
2,950	3,430.2	0.168	0.0672	0.114	0.0178
3,000	3,488.4	0.171	0.0692	0.116	0.0181
3,100	3,604.7	0.177	0.0731	0.120	0.0187
3,200	3,720.9	0.183	0.0771	0.124	0.0193
3,300	3,837.2	0.188	0.0812	0.128	0.0199
3,400	3,953.5	0.194	0.0854	0.132	0.0205
3,500	4,069.8	0.200	0.0897	0.136	0.0363
3,600	4,186.0	0.205	0.0941	0.140	0.0380
3,700	4,302.3	0.211	0.0985	0.143	0.0398
3,800	4,418.6	0.217	0.1031	0.147	0.0416
3,900	4,534.9	0.223	0.1077	0.151	0.0435
4,000	4,651.2	0.228	0.1125	0.155	0.0454
4,100	4,767.4	0.234	0.1173	0.159	0.0473
4,200	4,883.7	0.240	0.1222	0.163	0.0493
4,300	5,000.0	0.245	0.1272	0.167	0.0513
4,400	5,116.3	0.251	0.1322	0.171	0.0533
4,500	5,232.6	0.257	0.1374	0.174	0.0554
4,600	5,348.8	0.262	0.1426	0.178	0.0575
4,700	5,465.1	0.268	0.1479	0.182	0.0597
4,800	5,581.4	0.274	0.1533	0.186	0.0618
4,900	5,697.7	0.280	0.1588	0.190	0.0640
5,000	5,814.0	0.285	0.1644	0.194	0.0663
5,100	5,930.2	0.291	0.1700	0.198	0.0685
5,200	6,046.5	0.297	0.1757	0.202	0.0708
5,300	6,162.8	0.302	0.1815	0.205	0.0731
5,400	6,279.1	0.308	0.1874	0.209	0.0755
5,500	6,395.3	0.314	0.1934	0.213	0.0779
5,600	6,511.6	0.320	0.1994	0.217	0.0803

d [mm]		88.9 x 2.0		108 x 2.5	
ṁ [kg/h]	V̇ [l/h]	v [m/s]	R [mbar/m]	v [m/s]	R [mbar/m]
5,700	6,627.9	0.325	0.2056	0.221	0.0828
5,800	6,744.2	0.331	0.2118	0.225	0.0853
5,900	6,860.5	0.337	0.2181	0.229	0.0878
6,000	6,976.7	0.342	0.2244	0.233	0.0903
6,100	7,093.0	0.348	0.2309	0.236	0.0929
6,200	7,209.3	0.354	0.2374	0.240	0.0955
6,300	7,325.6	0.359	0.2440	0.244	0.0982
6,400	7,441.9	0.365	0.2506	0.248	0.1009
6,500	7,558.1	0.371	0.2574	0.252	0.1036
7,000	8,139.5	0.399	0.2923	0.271	0.1175
7,500	8,720.9	0.428	0.3291	0.291	0.1323
8,000	9,302.3	0.456	0.3677	0.310	0.1477
8,500	9,883.7	0.485	0.4082	0.329	0.1639
9,000	10,465.1	0.513	0.4505	0.349	0.1808
9,500	11,046.5	–	–	0.368	0.1985
10,000	11,627.9	–	–	0.388	0.2168
10,500	12,209.3	–	–	0.407	0.2358
11,000	12,790.7	–	–	0.426	0.2555
11,500	13,372.1	–	–	0.446	0.2759
12,000	13,953.5	–	–	0.465	0.2969
12,500	14,534.9	–	–	0.485	0.3186
13,000	15,116.3	–	–	0.504	0.3410

7 GENERAL INFORMATION

7.1 DISCLAIMER

All information contained in this document, which is based on standards, ordinances or regulations, etc., has been thoroughly researched and compiled with the greatest possible care. However, no guarantee is given that such information is accurate, complete or up to date. Geberit is not liable for damage resulting from the use of this information.

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