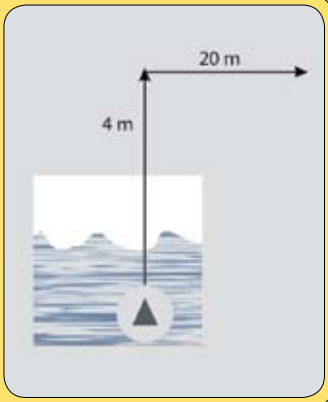
Pumps
Calculation example:

REQUIREMENT

The following variables are given:

1 Discharge capacity Q = 5 l/s
2 Transported medium is trash water containing sand
3 Geodetic height (= height to which the transported medium must be pumped) H_{geo} = 4 meters
4 Pressure line length l = 20 meters
5 The pressure line material is steel
6 Pressure line inside diameter DN50
7 No attachments such as fittings, elbows, shut-off devices



SOLUTION

Which pump must be selected?

1 A flow velocity of at least 2.5 m/s must be maintained for trash water containing sand.
2 According to the pressure losses table and pressure loss diagrams, there is a friction loss per 100 meters of pipeline at a height of 21.66 meters and at a flow velocity of 2.55 m/s. This value is obtained by reading off in the table the intersection point between the values 5 l/s discharge capacity and clear pipe width DN50.
3 The value determined at a height of 21.66 meters must now be converted to the actual pressure line length (= 20 meters) by means of the rule of three. To do this, we divide the 21.66 meters by a factor of 5 to obtain the actual friction loss of the pressure line at a height of 4.332 meters.
4 In order to determine the manometric head of the pump (= the head that the pump must effectively overcome so that the transported medium can be pumped away), the values for the geodetic height and for the friction loss in the pressure line must be added. This gives us a manometric head H_{mano} = 8.332 meters.
5 Armed with the determined values for the manometric head and the given head, it is now possible to select a suitable pump. For this, we use the load curves of our pumps. The performance curves are structured as follows: the x axis is the discharge in the unit l/min. The y axis is the manometric head that the pump can overcome.
6 A suitable pump is selected by entering the two values manometric head H_{mano} = 8.332 meters and the discharge capacity Q = 5 l/s in the performance diagram of the pumps.
7 The pump nearest the intersection point is the right pump for this particular application. If two pumps are ideally at the intersection point, both pumps can be used. The choice of the "right" pump depends on other factors (e.g. reserve in the head or reserve in the discharge capacity or the diameter of the pumps' connection nozzle).
8 In this calculation example, the PS2 1503 and the PS3 1503 are the ideal pumps for this application. The pump's pressure pipe joint is not important for selecting the suitable pump.

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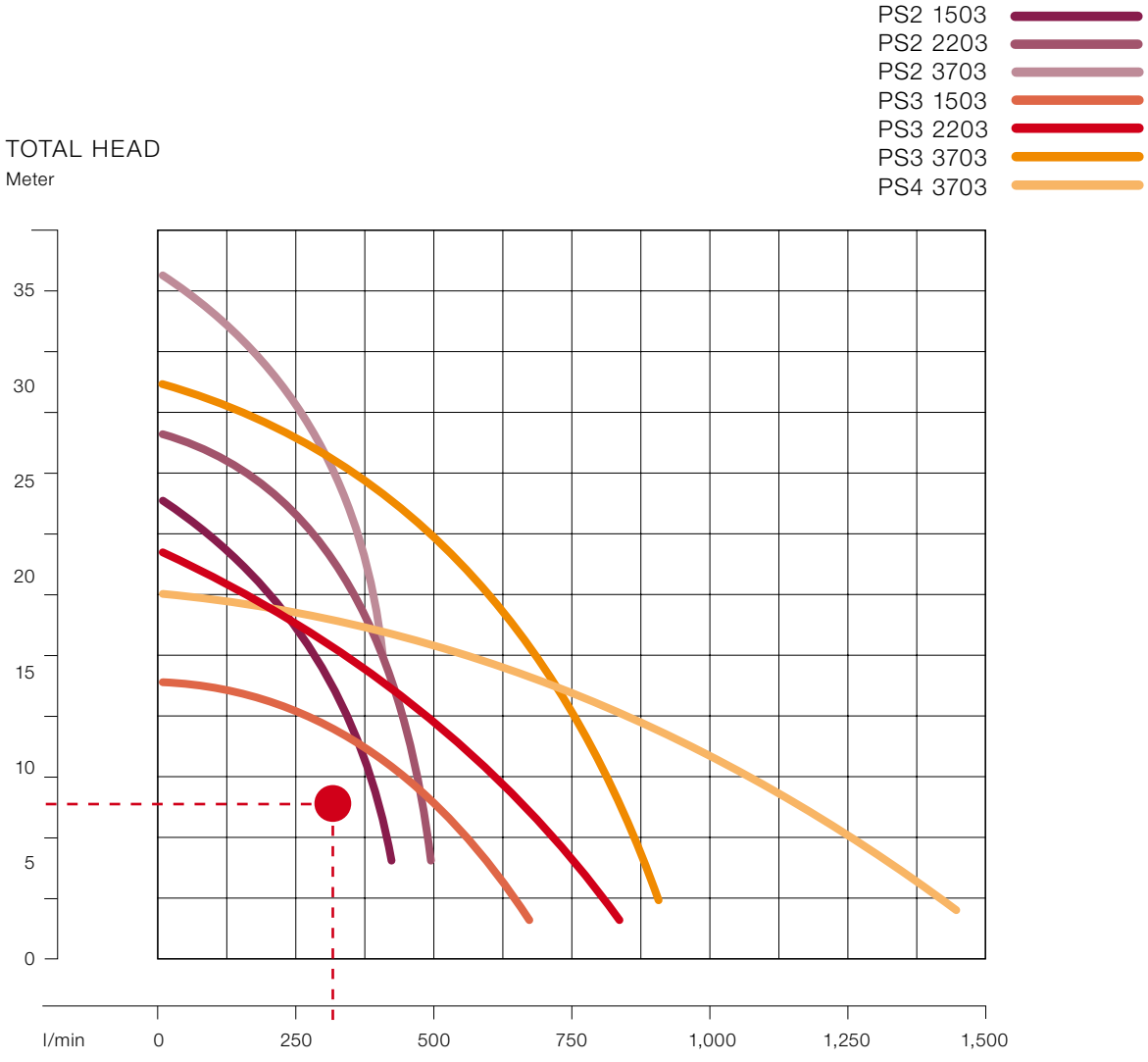
Pumps
Calculation example:

CALCULATION AIDS

Transported media containing solids must display at least the following flow velocities in order to avoid deposits!

Water with normal dirt	1.0 m/s
Water with sand (sand particles < 0.1 mm)	1.5 m/s
Water with sand (sand particles < 0.6 mm)	2.5 m/s
Water with gravel	3.5 m/s
Water with coarse gravel	4.0 m/s



Pumps

Calculation example:

PIPE FRICTION LOSSES AND FLOW VELOCITIES IN PLASTIC PIPES

Clear pipe width in mm				DE	40	50		63		75		90			110		110/125	125		160				200		
				PN	12.5	12.5	8	12.5	8	12.5	8	12.5	8	4	12.5	8	4/10	8	4	12.5	8	4	3.2	12.5	8	4
				Di	32.6	40.8	44	51.4	55.4	61.4	66	73.6	79.2	83	90	96.8	102	110.2	115.4	130.8	141	147.6	150.2	163.6	176.2	184.6
Q l/sec	Q l/min	Q m^3/h	Pressure loss per 100 m of pipeline K value = 0.1 mm **Plastic pipes**																							
0.2	12	0.72	h	0.25																						
			v	0.24																						
0.4	24	1.44	h	0.98	0.30	0.20																				
			v	0.48	0.31	0.26																				
0.6	36	2.16	h	2.21	0.68	0.46																				
			v	0.72	0.46	0.39																				
0.8	48	2.88	h	3.92	1.20	0.81	0.36																			
			v	0.96	0.61	0.53	0.39																			
1	60	3.6	h	6.13	1.88	1.26	0.56	0.38																		
			v	1.20	0.77	0.66	0.48	0.41																		
1.5	90	5.4	h	13.79	4.23	2.84	1.26	0.85	0.49	0.34																
			v	1.80	1.15	0.99	0.72	0.62	0.51	0.44																
2	120	7.2	h	24.51	7.52	5.06	2.23	1.51	0.88	0.60	0.34	0.23	0.18													
			v	2.40	1.53	1.32	0.96	0.83	0.68	0.58	0.47	0.41	0.37													
3	180	10.8	h		16.93	11.38	5.02	3.39	1.97	1.35	0.76	0.52	0.41	0.27	0.18											
			v		2.30	1.97	1.45	1.24	1.01	0.88	0.71	0.61	0.55	0.47	0.41											
4	240	14.4	h		30.09	20.23	8.93	6.02	3.51	2.40	1.35	0.92	0.72	0.47	0.32	0.24	0.16									
			v		3.06	2.63	1.93	1.66	1.35	1.17	0.94	0.81	0.74	0.63	0.54	0.49	0.42									
5	300	18	h			31.60	13.95	9.41	5.48	3.75	2.12	1.44	1.13	0.74	0.50	0.38	0.25	0.20								
			v			3.29	2.41	2.07	1.69	1.46	1.18	1.02	0.92	0.79	0.68	0.61	0.52	0.48								
6	360	21.6	h			45.51	20.09	13.55	7.89	5.40	3.05	2.07	1.62	1.06	0.72	0.55	0.37	0.29	0.15							
			v			3.95	2.89	2.49	2.03	1.75	1.41	1.22	1.11	0.94	0.82	0.73	0.63	0.57	0.45							
8	480	28.8	h				35.72	24.09	14.03	9.60	5.42	3.69	2.88	1.88	1.29	0.98	0.65	0.51	0.27	0.18	0.14	0.13				
			v				3.86	3.32	2.70	2.34	1.88	1.62	1.48	1.26	1.09	0.98	0.84	0.77	0.60	0.51	0.47	0.45				
10	600	36	h				55.81	37.64	21.93	15.00	8.46	5.76	4.50	2.94	2.01	1.53	1.02	0.80	0.41	0.28	0.22	0.20	0.13	0.09	0.07	
			v				4.82	4.15	3.38	2.92	2.35	2.03	1.85	1.57	1.36	1.22	1.05	0.96	0.74	0.64	0.58	0.56	0.48	0.41	0.37	
12	720	43.2	h					54.20	31.57	21.60	12.19	8.29	6.49	4.24	2.89	2.20	1.47	1.15	0.60	0.40	0.32	0.29	0.19	0.13	0.10	
			v					4.98	4.05	3.51	2.82	2.44	2.22	1.89	1.63	1.47	1.26	1.15	0.89	0.77	0.70	0.68	0.57	0.49	0.45	
14	840	50.4	h						42.98	29.40	16.59	11.29	8.83	5.77	3.94	2.99	2.00	1.57	0.81	0.55	0.43	0.39	0.25	0.17	0.13	
			v						4.73	4.09	3.29	2.84	2.59	2.20	1.90	1.71	1.47	1.34	1.04	0.90	0.82	0.79	0.67	0.57	0.52	
16	960	57.6	h							38.40	21.67	14.74	11.53	7.54	5.14	3.91	2.61	2.05	1.06	0.72	0.56	0.51	0.33	0.22	0.17	
			v							4.68	3.76	3.25	2.96	2.52	2.17	1.96	1.68	1.53	1.19	1.02	0.94	0.90	0.76	0.66	0.60	
18	1,080	64.8	h								27.42	18.66	14.59	9.54	6.51	4.95	3.30	2.59	1.34	0.91	0.71	0.65	0.42	0.28	0.22	
			v								4.23	3.65	3.33	2.83	2.45	2.20	1.89	1.72	1.34	1.15	1.05	1.02	0.86	0.74	0.67	
20	1,200	72	h								33.85	23.04	18.01	11.78	8.04	6.11	4.07	3.20	1.66	1.12	0.88	0.80	0.51	0.35	0.27	
			v								4.70	4.06	3.70	3.14	2.72	2.45	2.10	1.91	1.49	1.28	1.17	1.13	0.95	0.82	0.75	
22	1,320	79.2	h									27.87	21.80	14.25	9.73	7.39	4.93	3.87	2.01	1.36	1.07	0.97	0.62	0.42	0.33	
			v									4.47	4.07	3.46	2.99	2.69	2.31	2.10	1.64	1.41	1.29	1.24	1.05	0.90	0.82	
24	1,440	86.4	h										25.94	16.96	11.58	8.80	5.87	4.61	2.39	1.61	1.27	1.16	0.74	0.50	0.39	
			v										4.44	3.77	3.26	2.94	2.52	2.30	1.79	1.54	1.40	1.35	1.14	0.98	0.90	
26	1,560	93.6	h										30.44	19.91	13.58	10.32	6.88	5.41	2.80	1.89	1.49	1.36	0.87	0.59	0.46	
			v										4.81	4.09	3.53	3.18	2.73	2.49	1.94	1.67	1.52	1.47	1.24	1.07	0.97	
28	1,680	100.8	h											23.09	15.76	11.97	7.98	6.27	3.25	2.19	1.73	1.58	1.01	0.68	0.54	
			v											4.40	3.81	3.43	2.94	2.68	2.08	1.79	1.64	1.58	1.33	1.15	1.05	
30	1,800	108	h											26.50	18.09	13.75	9.16	7.20	3.73	2.52	1.98	1.81	1.16	0.78	0.62	
			v											4.72	4.08	3.67	3.15	2.87	2.23	7.92	1.75	1.69	1.43	1.23	1.12	
32	1,920	115.2	h												20.58	15.64	10.43	8.19	4.25	2.87	2.26	2.06	1.32	0.89	0.70	
			v												4.35	3.92	3.36	3.06	2.38	2.05	1.87	1.81	1.52	1.31	1.20	
34	2,040	122.4	h												23.23	17.66	11.77	9.24	4.80	3.24	2.55	2.32	1.49	1.01	0.79	
			v												4.62	4.16	3.57	3.25	2.53	2.18	1.99	1.92	1.62	1.39	1.27	
36	2,160	129.6	h												26.04	19.79	13.20	10.36	5.38	3.63	2.86	2.61	1.67	1.13	0.89	
			v												4.89	4.41	3.78	3.44	2.68	2.31	2.10	2.03	1.71	1.48	1.35	
38	2,280	136.8	h													22.06	14.70	11.55	5.99	4.04	3.18	2.90	1.86	1.26	0.99	
			v													4.65	3.98	3.63	2.83	2.43	2.22	2.15	1.81	1.56	1.42	
40	2,400	144	h													24.44	16.29	12.80	6.64	4.48	3.53	3.22	2.06	1.40	1.09	
			v													4.90	4.19	3.83	2.98	2.56	2.34	2.26	1.90	1.64	1.49	
42	2,520	151.2	h														17.96	14.11	7.32	4.94	3.89	3.55	2.27	1.54	1.21	
			v														4.40	4.02	3.13	2.69	2.46	2.37	2.00	1.72	1.57	

h = friction loss in meters per 100 meters of pipe v = velocity in meters per second

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Pumps

Calculation example:

PIPE FRICTION LOSSES AND FLOW VELOCITIES IN STEEL PIPES

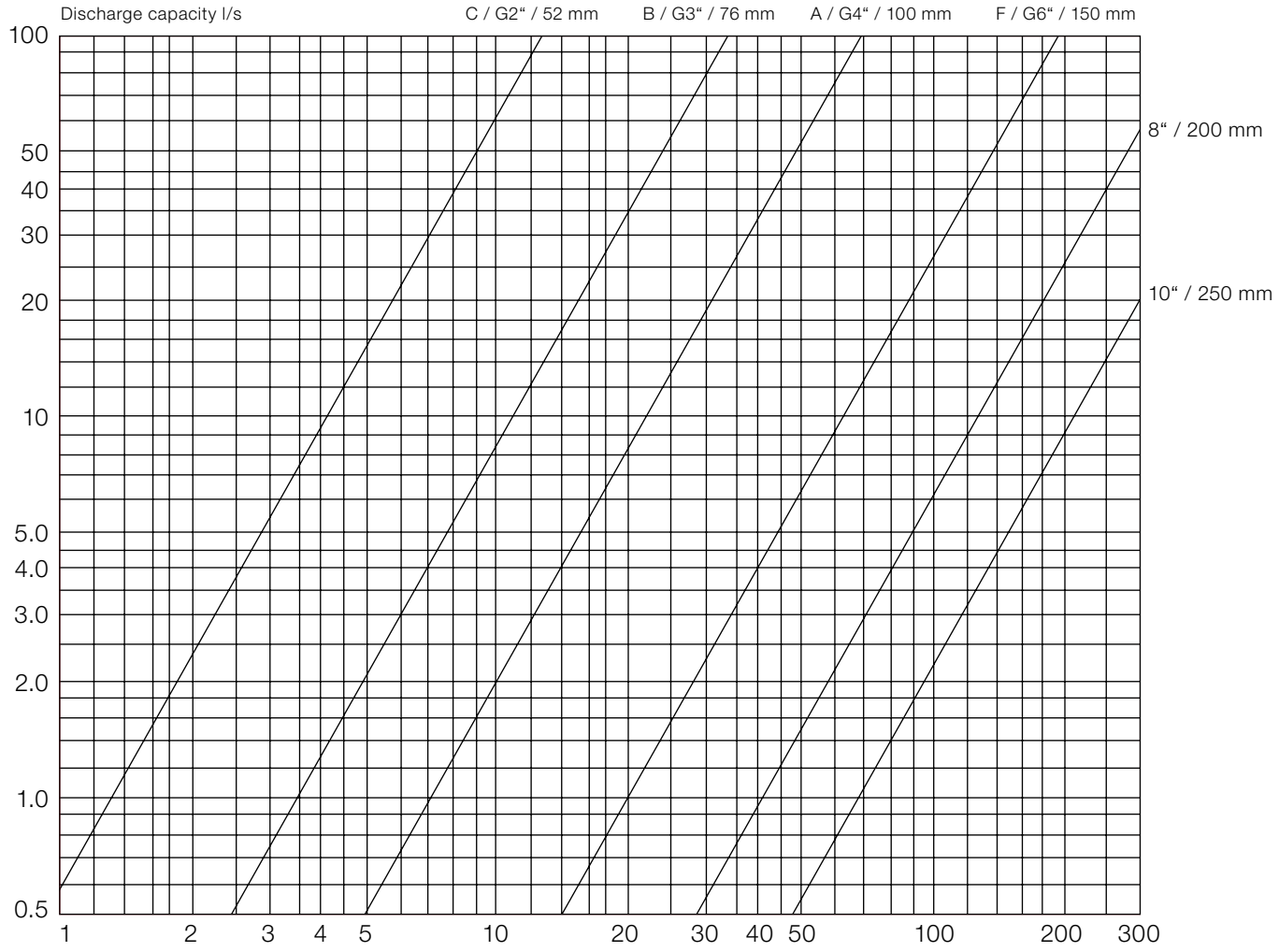
Clear pipe width in inches				1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	DN	DN	DN	DN	DN	DN	DN	DN	DN	DN	DN	DN	DN
Clear pipe width in mm				16	21.5	27	36	41.5	53	68	80.5	40	50	65	80	100	125	150	175	200	225	300	350	400	450
Q	Q	Q	Pressure loss per 100 m of pipeline K value = 0.3 mm **Steel pipes**																					
l/sec	l/min	m³/h																						
0.2	12	0.72	h	14.30	2.99	0.90																		
			v	0.99	0.55	0.35																		
0.4	24	1.44	h	57.00	11.98	3.59	0.79	0.37				0.45												
			v	2.00	1.10	0.70	0.39	0.30				0.32												
0.6	36	2.16	h		26.95	8.08	1.77	0.83	0.23			1.01	0.31											
			v		1.65	1.05	0.59	0.44	0.27			0.48	0.31											
0.8	48	2.88	h		47.92	14.37	3.14	1.48	0.41			1.80	0.55											
			v		2.20	1.40	0.79	59.00	36.00			0.64	0.41											
1	60	3.6	h		75.00	22.45	4.91	2.32	0.64	0.17		2.81	0.87	0.22										
			v		3.00	1.75	0.98	0.74	0.45	0.28		0.80	0.51	0.30										
1.5	90	5.4	h			50.51	11.05	5.21	1.43	0.39	0.16	6.33	1.95	0.49	0.16									
			v			2.62	1.47	1.11	0.68	0.41	0.29	1.19	0.76	0.45	0.30									
2	120	7.2	h			90.00	19.64	9.27	2.55	0.68	0.28	11.26	3.47	0.87	0.29									
			v			3.00	1.97	1.48	0.91	0.55	0.39	1.59	1.02	0.60	0.40									
3	180	10.8	h				44.18	20.85	5.73	1.54	0.63	25.33	7.80	1.95	0.64	0.20								
			v				2.95	2.22	1.36	0.83	0.59	2.39	1.53	0.90	0.60	0.38								
4	240	14.4	h				78.55	37.07	10.19	2.74	1.13	45.02	13.86	3.47	1.16	0.36	0.11							
			v				3.93	2.96	1.81	1.10	0.79	3.18	2.04	1.21	0.80	0.51	0.33							
5	300	18	h				123.00	57.92	15.93	4.28	1.76	70.35	21.66	5.43	1.82	0.56	0.17							
			v				5.00	3.70	2.27	1.38	0.98	3.98	2.55	1.51	0.99	0.64	0.41							
6	360	21.6	h					83.41	22.94	6.16	2.53	101.00	31.19	7.82	2.62	0.81	0.25	0.10						
			v					4.44	2.72	1.65	1.18	5.00	3.06	1.81	1.19	0.76	0.49	0.34						
8	480	28.8	h					148.0	40.77	10.95	4.50		55.45	13.89	4.65	1.44	0.44	0.17	0.08					
			v					6.00	3.63	2.20	1.57		4.08	2.41	1.59	1.02	0.65	0.45	0.33					
10	600	36	h						63.71	17.11	7.03		87.00	21.71	7.27	2.24	0.69	0.27	0.12	0.06				
			v						4.53	2.75	1.97		5.00	3.01	1.99	1.27	0.82	0.57	0.42	0.32				
12	720	43.2	h						92.00	24.64	10.13			31.26	10.46	3.23	1.00	0.38	0.17	0.08	0.05			
			v						5.00	3.30	2.36			3.62	2.39	1.53	0.98	0.68	0.50	0.38	0.30			
14	840	50.4	h							33.54	13.78			42.55	14.24	4.40	1.36	0.52	0.23	0.11	0.06	0.04		
			v							3.86	2.75			4.22	2.79	1.78	1.14	0.79	0.58	0.45	0.35	0.29		
16	960	57.6	h							43.81	18.00			55.58	18.60	5.74	1.77	0.68	0.30	0.15	0.08	0.05		
			v							4.41	3.14			4.82	3.18	2.04	1.30	0.91	0.67	0.51	0.40	0.33		
18	1,080	64.8	h							55.4	22.78			70.00	23.54	7.27	2.25	0.86	0.38	0.19	0.10	0.06		
			v							5.0	3.54			5.00	3.58	2.29	1.47	1.02	0.75	0.57	0.45	0.37		
20	1,200	72	h								28.13				29.06	8.97	2.77	1.06	0.47	0.23	0.13	0.07	0.03	
			v								3.93				3.98	2.55	1.63	1.13	0.83	0.64	0.50	0.41	0.28	
22	1,320	79.2	h								34.03				35.17	10.86	3.35	1.29	0.57	0.28	0.15	0.09	0.03	
			v								4.32				4.38	2.80	1.79	1.25	0.91	0.70	0.55	0.45	0.31	
24	1,440	86.4	h								40.50				41.85	12.92	3.99	1.53	0.68	0.34	0.18	0.10	0.04	
			v								4.72				4.78	3.06	1.96	1.36	1.00	0.76	0.60	0.49	0.34	
26	1,560	93.6	h								47.50				49.12	15.16	4.68	1.80	0.80	0.40	0.21	0.12	0.05	
			v								5.10				5.17	3.31	2.12	1.47	1.08	0.83	0.65	0.53	0.37	
28	1,680	100.8	h													17.58	5.43	2.08	0.93	0.46	0.25	0.14	0.05	0.02
			v													3.57	2.28	1.58	1.16	0.89	0.70	0.57	0.40	0.29
30	1,800	108	h													20.19	6.24	2.39	1.06	0.53	0.28	0.16	0.06	0.03
			v													3.82	2.45	1.70	1.25	0.96	0.75	0.61	0.42	0.31
32	1,920	115.2	h													22.97	7.10	2.72	1.21	0.60	0.32	0.19	0.07	0.03
			v													4.08	2.61	1.81	1.33	1.02	0.80	0.65	0.45	0.33
34	2,040	122.4	h													25.93	8.01	3.07	1.37	0.68	0.36	0.21	0.08	0.04
			v													4.33	2.77	1.92	1.41	1.08	0.86	0.69	0.48	0.35
36	2,160	129.6	h													29.07	8.98	3.44	1.53	0.76	0.41	0.24	0.09	0.04
			v													4.58	2.93	2.04	1.50	1.15	0.91	0.73	0.51	0.37
38	2,280	136.8	h													32.39	10.01	3.83	1.71	0.85	0.46	0.26	0.10	0.04	0.02
			v													4.84	3.10	2.15	1.58	1.21	0.96	0.77	0.54	0.40	0.30
40	2,400	144	h													35.90	11.09	4.25	1.89	0.94	0.50	0.29	0.11	0.05	0.02
			v													5.10	3.26	2.26	1.66	1.27	1.01	0.82	0.57	0.42	0.32
42	2,520	151.2	h														12.22	4.68	2.08	1.03	0.56	0.32	0.12	0.05	0.03
			v														3.42	2.38	1.75	1.34	1.06	0.86	0.59	0.44	0.33

h = friction loss in meters per 100 meters of pipe v = velocity in meters per second

WACKER NEUSON

Pumps
Calculation example:

PRESSURE LOSSES IN HOSES (SMOOTH, INTERNALLY RUBBERIZED HOSE)



Smooth, internally rubberized hose - Water at 20 °C
Pressure loss in m water column per 100 m of hose