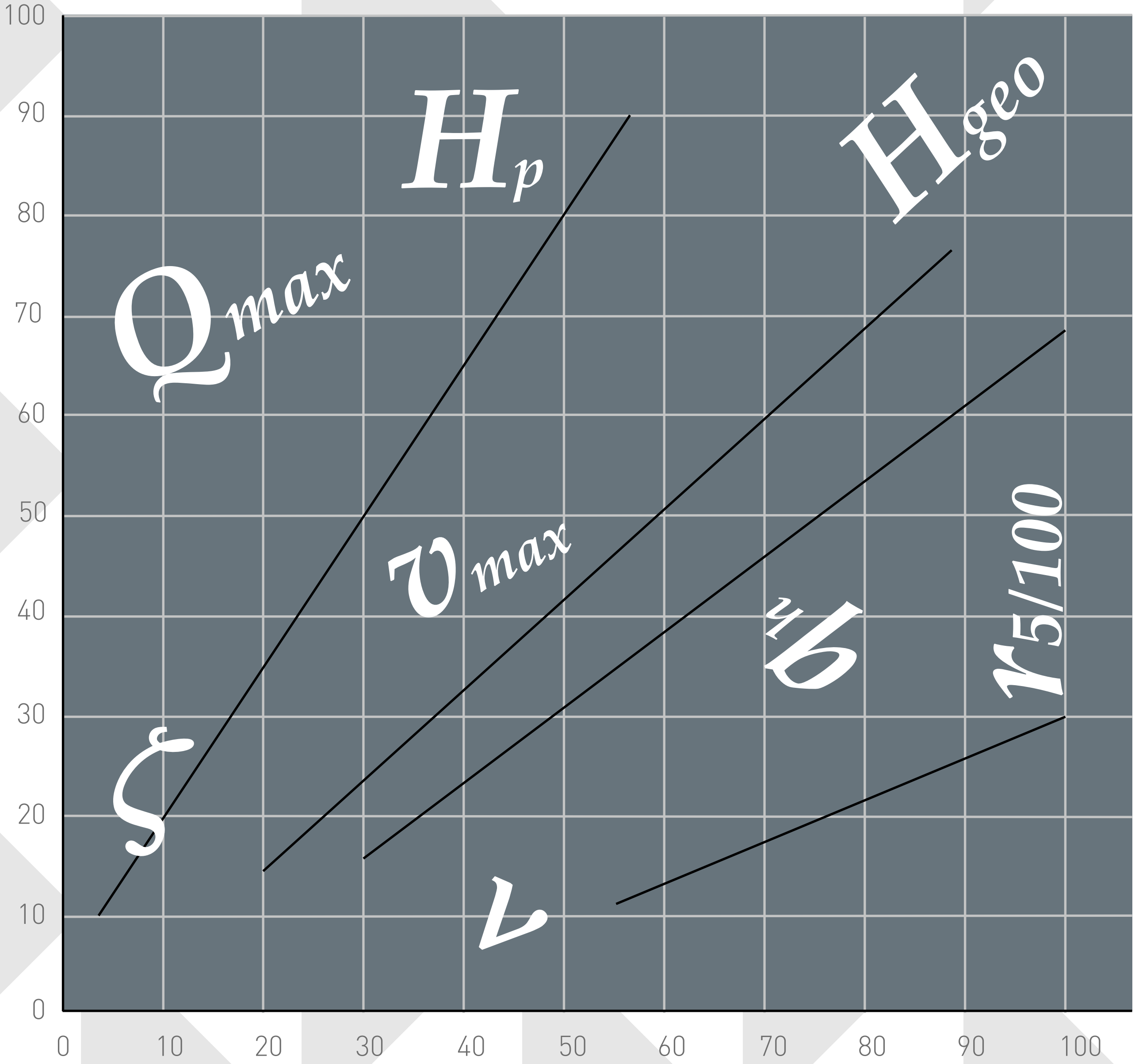
JUNG PUMPEN

CALCULATION OF SEWAGE DISPOSAL UNITS AND PUMPING STATIONS



PENTAIR

JUNG PUMPEN

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CONTENT

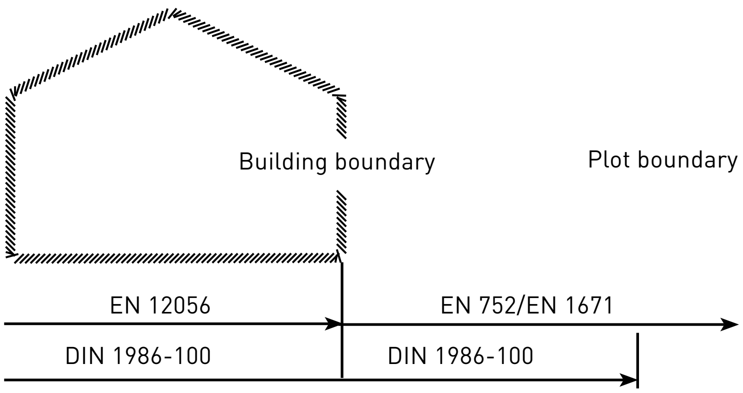
1. INTRODUCTION

The dimensioning of pumps and pressure pipes has to be done step by step. The four most important criteria are

- **WHAT** kind of medium? Pumping medium
- **HOW MUCH** volume? Pumping volume
- **WHERETO**, how far, how high? Pumping distance
- **WHEREWITH** is pumping supposed to take place? Pumping unit

For a better understanding of the symbols used in the formulas you will find a summary of the symbols used at the end of the text. Under 5. Calculation examples you will find two examples of typical application situations that will help you to easily orientate with your application situation.

1.1 OVERVIEW OF NORMS



Source: DIN 1986-100-chart1

2. PUMPING MEDIUM

On principle a distinction can be drawn between

- **faeces free waste water** **(grey water)** and
- **waste water containing faeces** **(black water)**.

However, there are further regulations that may have to be considered. Further information regarding your particular situation will be provide by the government safety organisation, the inspectorate division, local associations for technical inspections e.g. the German TÜV or the department of planning and building inspection.

2.1 WASTE WATER DRAINAGE Q_{WW}

Authoritative for the dimensioning is the quantity of waste water Q_{ww} to be expected according to EN 12056-2, which is determined taking into account the concurrency from the sum of design units (DU), wherein K is the reference point for the drainage characteristic. It depends on the kind of building and results from the frequency of usage of the drainage objects.

Q_c is the continuous flow rate which is not subjected to any observations of concurrency (e.g. grease separator).

	Q_{ww}	[l/s]	= Waste water drainage	
$Q_{ww} = K \bullet \sqrt{\sum (DU)}$	K		= drainage characteristic	
	∑ DU		= Sum of connection values	
	Q_{tot}	[l/s]	= Total waste water drainage	Formula for amount determination
$Q_{tot} = Q_{ww} + Q_c$	Q_{ww}	[l/s]	= Waste water drainage	
	Q_c	[l/s]	= Continuous drainage	

The waste water drainage Q_{ww} can be calculated from the sum DU (table 2) with the above shown formula while taking the respective drainage characteristic K (table 1) into account. Table 3 may be used as an alternative to the calculation. If the calculated waste water drainage Q_{ww} is smaller than the largest connection value of a single drainage object, the latter is authoritative (threshold value).

Tabelle 1: Typical drainage characteristics (K)

Kind of building	K
irregular use, e. g. in residential buildings, guesthouses, offices	0,5
regular use, e. g. in hospitals, schools, restaurants, hotels	0,7
frequent use, e. g. in public restrooms and/or showers	1,0
special use, e. g. laboratories	1,2

Source: EN 12056-2:2000, table 3

Table 2: Connection values DU

Drainage object	System I DU [l/s]	System II DU [l/s]
sink, bidet	0,5	0,3
shower without stopper	0,6	0,4
shower with stopper	0,8	0,5
single urinal with tank	0,8	0,5
urinal with pressure flushing	0,5	0,3
floor standing urinal	0,2*	0,2*
tub	0,8	0,6
kitchen sink	0,8	0,6
dishwasher (household)	0,8	0,6
washing machine up to 6 kg	0,8	0,6
washing machine up to 12 kg	1,5	1,2
toilet with 4,0 l tank	**	1,8
toilet with 6,0 l tank	2,0	1,8
toilet with 7,5 l tank	2,0	1,8
toilet with 9,0 l tank	2,5	2,0
floor drain DN 50	0,8	0,9
floor drain DN 70	1,5	0,9
floor drain DN 100	2,0	1,2
* per person ** not approved		

Source: EN 12056-2:2000, abstract from table 2

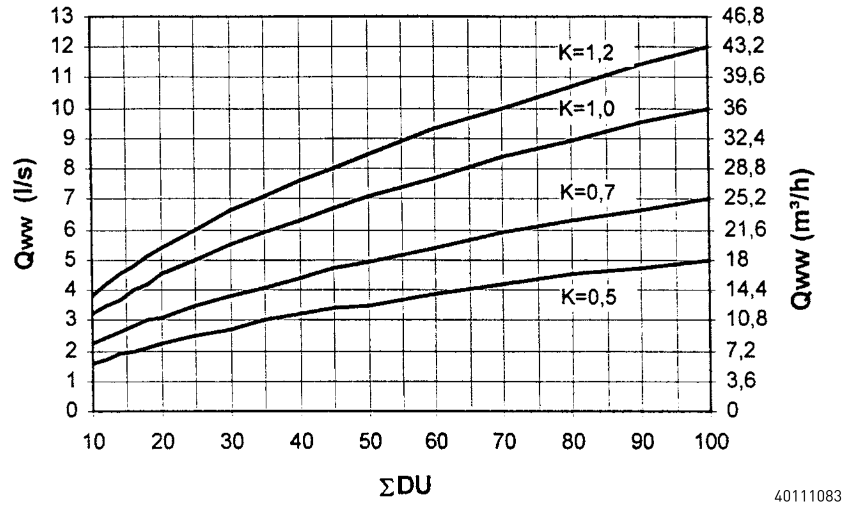
System I: Single unit with partially filled pressure pipes (filling ratio 0,5 or 50 % respectively)

System II: Single unit with pressure pipes of smaller dimension (filling ratio of 0,7 or 70 % respectively)

In accordance with nationaly regulations system I is used in Germany. Upon usage of water saving toilets system II may be applied.

Upon usage of water saving toilets the requirements for system type II in accordance with EN 12056-2 have to be observed as well:
The connected load for a toilet with 4,0 l to 4,5 l flushing has to be DU = 1,8 l/s
(Source: DIN 1986-100, 8.3.2.1)

Table 3: Conversion chart ∑DU in Q_{ww} [l/s]



Example

Drainage object	Quantity		DU	Σ DU
hand wash basin	2	•	0,5	1,0
washing machine up to 6 kg	1	•	0,8	0,8
floor drain DN 100	1	•	2,0	2,0
Toilet with 7,5 l tank	2	•	2,0	4,0
tub	2	•	0,8	1,6
shower without stopper	1	•	0,6	0,6
Σ DU				10,0

When to the conduit with ∑ DU = 10 an additional conduit with ∑ DU = 15 is connected (K = 0,5, e. g. housebuilding), the new sum of DU is then 10 + 15 = 25.
Therewith the drainage of the continuing conduit is

$$Q_{ww} = 0,5 \bullet \sqrt{25} = 2,5 \text{ l/s}$$

2.2 RAINWATER DRAINAGE Q_R

The amounts of rainfall are attributable to climate and vary greatly from region to region.
The occurring rainfalls are grouped depending on their respective frequency by:
$r_{5/2}$ five minute rain which statistically has to be expected once in 2 years
$r_{5/100}$ five minute rain which statistically has to be expected once in 100 years

In DIN 1986-100 (appendix A, table A.1) the values for several German cities are exemplarily listed.
The values differ from $r_{5/2}$ = 200 to 250 l/ (s N ha) or $r_{5/100}$ = > 800 l/(s · ha) respectively. [1 ha = 10.000 m^2]
Indications regarding rainfalls are to be requested from the local authorities or alternatively from the Meteorological Service in your country. Guiding values are given in the DIN 1986-100 appendix A.
If no values are available, $r_{T(n)}$ = 200 l/(s · ha) should be assumed.

Pipesystems and the respective component parts of rain drainage units are to be dimensioned for an average rainfall for economical reasons and in order to ensure self-cleaning capacity. The rain taken as calculation basis is, within the domain of DIN 1986-100, an idealised rainfall (block rainfall) with a constant rain intensity for 5 minutes. The respective annual factor (T_n) to be used for the assessment situation is determined by the objective.
Rainfalls above the calculation basis ($r_{5/2}$) are to be expected in the planning.

$$QR = r_{(D,T)} \cdot C \cdot A \cdot \frac{1}{10000}$$

Q_R	[l/s]	= Rain water drainage
$r_{(D,T)}$	[l/(s · ha]	= Assessment rainfall
C		= Run-off coefficient
A	[m²]	= Precipitation area = (1ha =10000 m²)

Tabelle 4: Abflussbeiwerte C zur Ermittlung des Regenwasserabflusses Q_R DIN 1986-100

No.	Kind of area	Rund-off coefficient C
1	Areas non-permeable to water, e.g.	1,0
	– roofs > 3° slope	1,0
	– concrete areas	1,0
	– ramps	1,0
	– fixed areas with gap sealing	1,0
	– bituminous layer	1,0
	– pavement with joint filling	1,0
	– roofs ≤ 3° slope	1,0
	– gravel roofs	0,5
	– sodded roofs	
	– for intense soddings	0,3
	– for extensive soddings beginning with 10 cm build-up gauge	0,3
	– for extensive soddings with less than 10 cm build-up gauge	0,5
2	Partially permeable and poorly draining expanses, e. g.	
	– concrete paving placed in sand or slag, expanses with tiles	0,7
	– expanses with paving, with >15% of joints e. g. 10 cm x 10 cm and smaller	0,6
	– water bound areas	0,5
	– partially surfaced playgrounds	0,3
	– training grounds with drainage	
	– plastic expanses, artificial lawn	0,6
	– barn floors	0,4
	– lawns	0,3
3	Water-permeable expanses without or with insignificant drainage, e. g.	
	– parks and vegetation areas	
	– Gravel and slag floors, cobble	
	also with surfaced expanse parts such as	
	– Garden paths with water bound surface or	
	– Drive ways and parking spaces with grass paver blocks	0,0

Source: DIN 1986-100, table 6

2.3 DOMESTIC WASTE WATER Q_H

For the dimensioning of larger pumping systems with for example entire streets of houses or housing sites connected to them, it is not the EN 12056 (gravity drainage inside of buildings) that is accessed but the EN 752 (drainage systems outside of buildings) or respectively the ATV A 118 (hydraulic calculation and proof of drainage systems).

This ATV guideline describes the so called „dry weather discharge" Q_t. It includes the domestic waste water discharge Q_h, the commercial waste water discharge Q_g and the infiltration water discharge Q_f without rainwater.

$Q_t = Q_h + Q_g + Q_f$

Infiltration water can come from intruding ground water, from unauthorised connections or from discharged surface water, e. g. through untight duct covers. The infiltration water supplement should be 100% for the calculation of the waste water ducts. For mixed systems the infiltration water supplement can usually be neglected.

The calculation parameters specified here are used when, e.g., complete residential areas, villages etc. are supposed to be connected to a sewage system or a pumping station. For the calculation of gravity drainage within buildings the EN 12056 applies and for drainage systems outside of buildings the EN 752 (see above) applies.

The domestic waste water discharge Qh is significantly determined by the water consumption of the population.
It is influenced by population density, structure, different ways of living, home culture and living standards.

The residential densities are between:
20 E/ha (rural areas, low-density development) and 300 E/ha (city)
The average daily water consumption of the population including small businesses is between 80 and 200 l/(E · d).

Recommendation: For the calculation of the future waste water drainage the prognoses of water consumption of the local water utility are to be taken as a basis.
However, for the purpose of the calculation the waste water factor should not fall below 150 l/(E · d).

Daily fluctuations in the specific peak drains have to be taken into account. The hourly peak drain [m3/h] is between 1/8 (rural areas) and 1/16 (large city) of the day value [m³/d].

Specific domestic waste water drainage

q_h = 0,005 l/(s · E) or
q_h = 5,0 l/(s · 1000 E)

$$Q_h = \frac{qh \cdot ED \cdot A_{E,k,1}}{1000}$$

Q_h	[l/s]	= domestic waste water volume
q_h	[5l/(s · 1000 E)]	= specific domestic waste water drainage
$A_{E,k,1}$	[ha]	= expanse of the residential area covered by the sewage system
ED	[E/ha]	= residential density within the draw area

Example for 20 000 inhabitants [E]

Simplified calculation
$Q_h = q_h \cdot E$
Q_h = 0,005 l/(s · E) · 20 000 E = 100 l/s

The quantities of inflow vary depending on the kind of connected area and time of day.
An overview can be found in the following charts.

Chart 1: Inflow hydrographs (ATV A 134 – illustration 3 and 4)

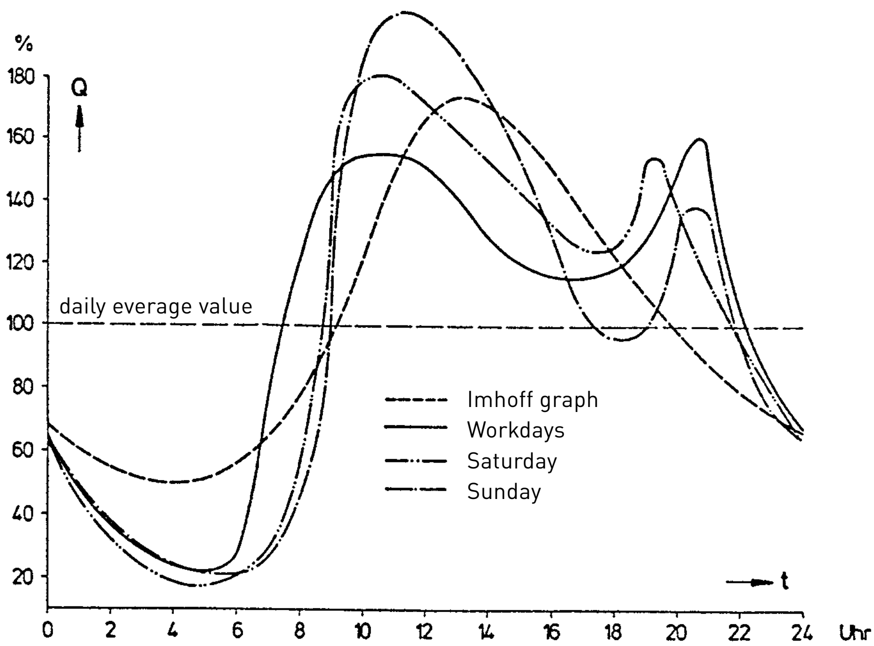


Illustration 3: Examples of inflow hydrographs in dry weather, mainly residential area

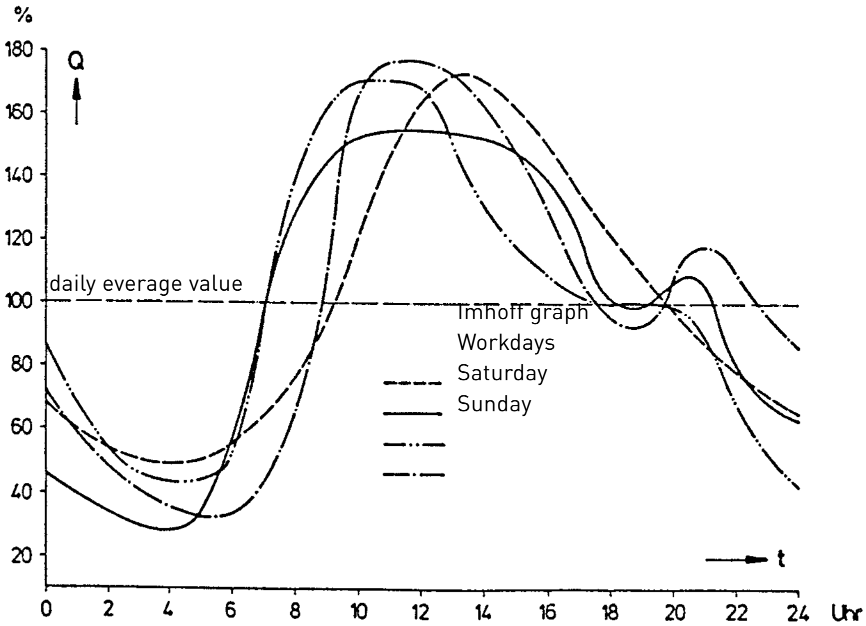


Illustration 4: Examples of inflow hydrographs in dry weather, strong industrial influence

3. PUMPING DISTANCE

3.1 PIPE DIAMETER

When the amount of inflow is determined, the conduit needs to be dimensioned. For the transport of waste water it applies in sewage technology that the minimum flow velocity upon transport may not be less than v_{min} = 0,7 m/s in order to avoid residues in the conduits. On the other hand it should not exceed v_{max} = 2,3m/s (EN 12056-4) in order to avoid flap impacts and water hammers as well as unnecessary waste of energy due to friction loss.

Therefore the ideal flow velocity has to be approximately between v_{min} = 0,7 and approx. 1,0 m/s. The conduit is selected in accordance with several criteria. Faeces free waste water (grey water) can be transported in pressure lines with a minimum diameter of DN 32.

For waste waters containing faeces (black water) pressure lines with a minimum diameter of DN 80 are required in accordance with ATV guidelines or EN 12056 respectively, unless the pump is equipped with an adequate cutting device (e. g. MultiCut). In the EN 12056 the minimum diameter for pressure lines in site drainage with attached pumps with cutting units is set to DN 32. If a sewage disposal unit for the disposal of a single toilet (e.g. WCfix) is used, the pressure line can be run in DN 25. If the tubing diameter has not yet been defined, it is chosen in such a way that a minimum flow velocity of v_{min} > 0,7 m/s is maintained.

Now two cases are conceivable:

Case A: The volume to be pumped off is larger or equal to the volume that is required to reach the minimum flow velocity v_{min} in the fittings and the conduit.

Case B: The volume to be pumped off is smaller than the volume required to reach the minimum flow velocity. (Typical in single residence disposal and backpressure protection). In this case the minimum volume Q to be transported is set to the volume which is required in order to reach the minimum flow velocity v_{min}.

	Q	[l/s]	= capacity
$Q = V_{D/m} \cdot v_{min}$	$V_{D/m}$	[l/m]	= volume of the pressure line/meter (see table 6 and 7)
	v_{min}	[m/s]	= minimum flow velocity (generally 0,7 m/s)

The actual volume of waste water is here only used to maybe later determine the energy costs.

3.2 PIPE FRICTION LOSSES H_{VL}

The flowing of the pumping medium through the tubing results in friction losses. These losses depend on flow velocity, diameter and roughness of the pipework, viscosity of the pumping medium, number and kind of fixtures and the length of the tubing.

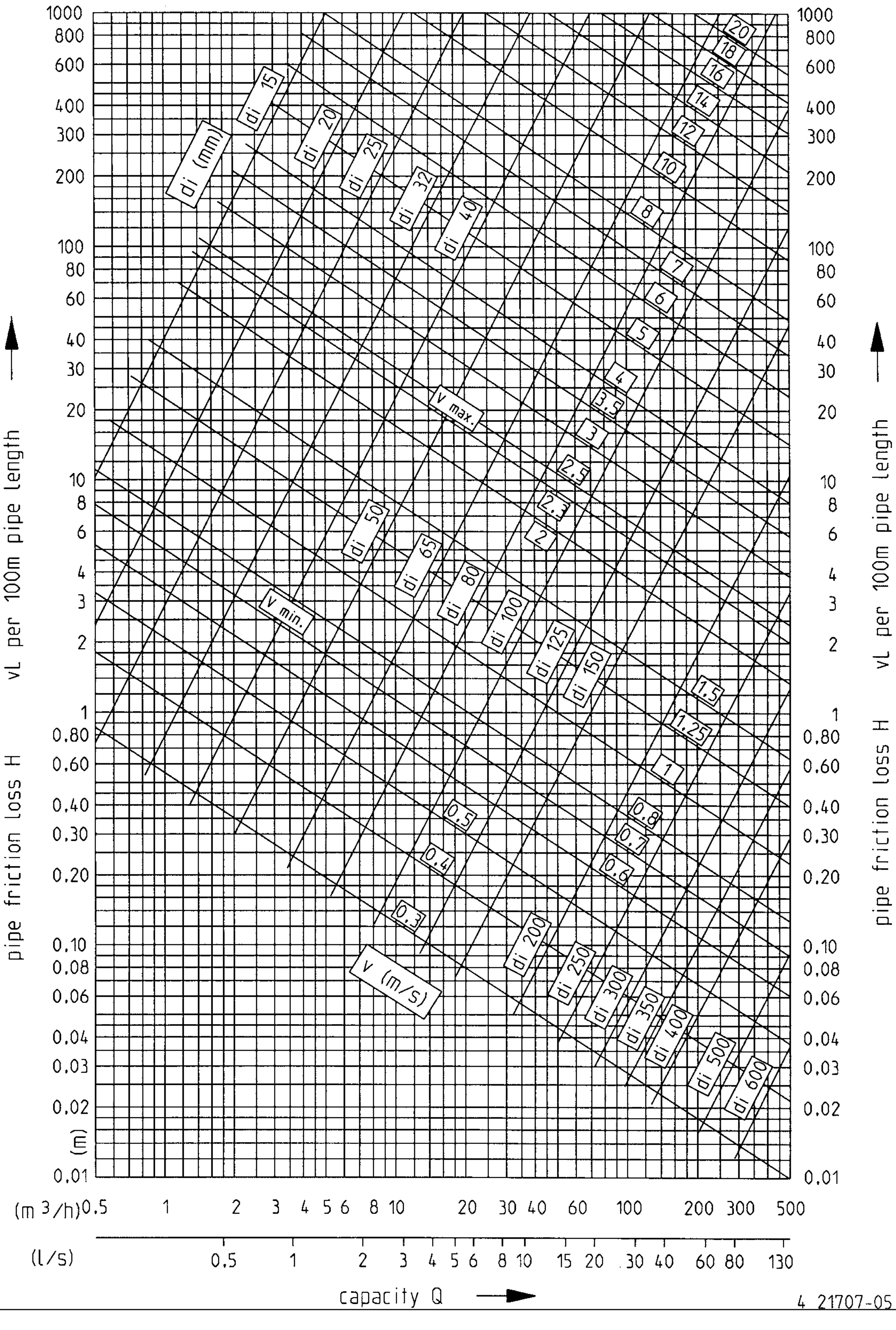
The smaller the diameter, the higher the flow velocity needs to be in order to pump the same volume through the pipe. The higher the flow velocity, the higher the friction losses. They rise by square in comparison to the flow velocity – this means a doubling of the flow velocity yields a quadruplicate of the friction losses.

Another factor is the operational roughness k_b of the interior wall of the tubing. It can be between 0,1 mm and several millimetres. The determining factors are material and condition of the tubing.

If no specific defaults are given a standard factor of k_b = 0,25 mm should be used.

Table 5a or 5b or chart 2 are used to determine the pipe friction loss HvL depending on given or chosen tubing diameter and tubing length.
To do so the nomogramm is entered vertically with the relevant pumping volume until the vertical line intersects with the diagonal tubing line of the chosen diameter.
The other diagonals indicate the flow velocity of the volumes to be pumped in the chosen pipe.
When a horizontal line is now drawn starting from this point, the pipe friction loss for 100 m pipework can be read on the y-axis.
The chart is valid for an operational roughness of k_b = 0,25 mm.

Chart 2: Pressure loss in pipes (kb = 0,25 mm) v = 1,31 mm2/s (water 10°C)



A linear conversion of the found H_{vL100} value may be performed for the existing conduit length.

1. Example: d_i and Q known, H_{vL} searched

Q = 25 m³/h cuts DN 100 bei H_{vL100} = 1,1 m

v = 0,9 m/s

This means for a pressure line of 350 m:

$$H_{vL} = \frac{1{,}1\ m}{100\ m} \bullet 350\ m = \underline{\underline{3{,}85\ m}}$$

2. Example: Q known, HvL and di searched

Q = 30 m³/h cuts DN 100 between v = 0,7 m/s and 2,3 m/s

chosen: DN 100, since v L 0,7 m/s and equals H_{vL100} = 1,6 m

v = 1,1 m/s

This means for a pressure line of 160 m:

$$H_{vL} = \frac{1{,}6\ m}{100\ m} \bullet 160\ m = \underline{\underline{2{,}56\ m}}$$

For the estimate assessment of pipe friction losses table 5a or 5b may also be used.

Table 5a: Pipe friction losses $H_{vL\ 100}$ per 100 m conduit length

Flow rate	Inner diameter in mm										
in m³/h	25	32	40	50	65	80	100	125	150	200	250
2	11,0	2,9	0,9	0,3							
4	43,0	11,2	3,6	1,1	0,3						
6	95,0	26,0	7,7	2,4	0,6	0,2					
8			13,5	4,2	1,1	0,4					
10			21,0	6,5	1,7	0,6	0,2			$H_{vL\ 100}$ [m]	
15				14,5	3,7	1,3	0,4	0,1			
20				25,5	6,5	2,2	0,7	0,2			
25				39,6	10,0	3,4	1,1	0,3			
30					14,3	4,9	1,5	0,5			
35					19,4	6,6	2,1	0,7	0,3		
40					25,3	8,5	2,7	0,9	0,3		
45					31,9	10,8	3,4	1,1	0,4		
50						13,2	4,1	1,3	0,5		
55						16,0	5,0	1,6	0,6		
60						19,0	5,9	1,9	0,7		
70						25,8	8,0	2,5	1,0	0,2	
80						33,6	10,4	3,3	1,3	0,3	
100							16,2	5,1	2,0	0,5	
150								11,3	4,4	1,0	0,3
200								19,9	7,7	1,7	0,5
300									17,2	3,8	1,2
400									30,4	6,8	2,1

absolute roughness k_b = 0,25 mm
kinematic viscosity ν = 1,31 mm²/s
(water 10°C)

Table 5b: Friction losses $H_{vL\ 100}$ for pressure pipework as per DIN 14811

Flow rate	Losses in mWS per length of 100 m		
in m³/h	C 42	C 52	B 75
6	4	2	–
9	9	3	–
12	15	5	1
15	22	8	1,5
18	30	11	2
21	41	15	3
24	53	20	4
30	–	26	5
36	–	40	8
48	–	65	14
60	–	–	22
72	–	–	30
96	–	–	45

3.3 LOSSES H_{VE} IN MOUNTING PARTS, VALVES AND FITTINGS

Additional values are the flow losses in the installation. In order to determine the resistance coefficients for valves and fittings it is sufficiently precise to take the respective ζ-values from table 6.

Table 6: Drag coefficient for valve and shaped parts

Mounting part		DN	ζ -values
GR 35/40	foot + claw		1,30
GR 50	foot + claw		1,00
GR-system		65	0,25
GR-system		80-150	0,22
Bend 45°,	R/D = 2,5		0,20
Elbow 45°,	R/D = 1,0		0,35
Bend 90°,	R/D = 2,5		0,35
Elbow 90°,	R/D = 1,0		0,50
Flat slide		32	0,50
Flat slide		40	0,46
Flat slide		50	0,42
Flat slide		80	0,36
Flat slide		100	0,34
Flat slide		150	0,30
T-piece		80	1,30
T-piece		100	1,30
T-piece		150	1,30
T-piece		200	1,30

		ß	ζ -values
Extension	50/ 40 = 1,25	8°	0,08
Extension	100/ 80 = 1,25	8°	0,08
Extension	150/100 = 1,5	8°	0,12
Extension	200/150 = 1,33	8°	0,10
Extension	50/ 40 = 1,25	10°	0,11
Extension	100/ 80 = 1,25	10°	0,11
Extension	150/100 = 1,5	10°	0,20
Extension	200/150 = 1,33	10°	0,14
Extension	50/ 40 = 1,25	18°	0,12
Extension	100/ 80 = 1,25	18°	0,12
Extension	150/100 = 1,5	18°	0,24
Extension	200/150 = 1,33	18°	0,17
Free outflow			1,00

The ζ-values of the reflux valves can be taken from chart 3 depending on the capacity Q.
The found ζ-values are added up (Σζ).

With the help of chart 4 the chart is entered starting at the top left with the capacity Q. When the chosen pipe diameter d_i is intersected, the line has to be drawn straight down to the second part of the chart starting with this point. From there it is taken parallely to the lines of the flow velocity until the line with the sum of zeta values is intersected. Starting from here the line is again drawn straight down which yields the pressure loss factor H_{vE}.

Example: $Q = 30 m^3/h$

Mounting parts	ζ		ζ-complete
1 valve DN 100	0,34		0,34
2 elbows 90°, DN 100	0,50		1,00
1 swing-type check valve R 100 G weight in the middle	7,00		7,00
Sum		Σ ζ	8,34

Chart 4 results in: $H_{vE} = 0{,}45$ m
H_{vE} is then added to H_{vL} addiert: $H_v = H_{vL} + H_{vE}$

Chart 3: characteristics frictions of reflux valves

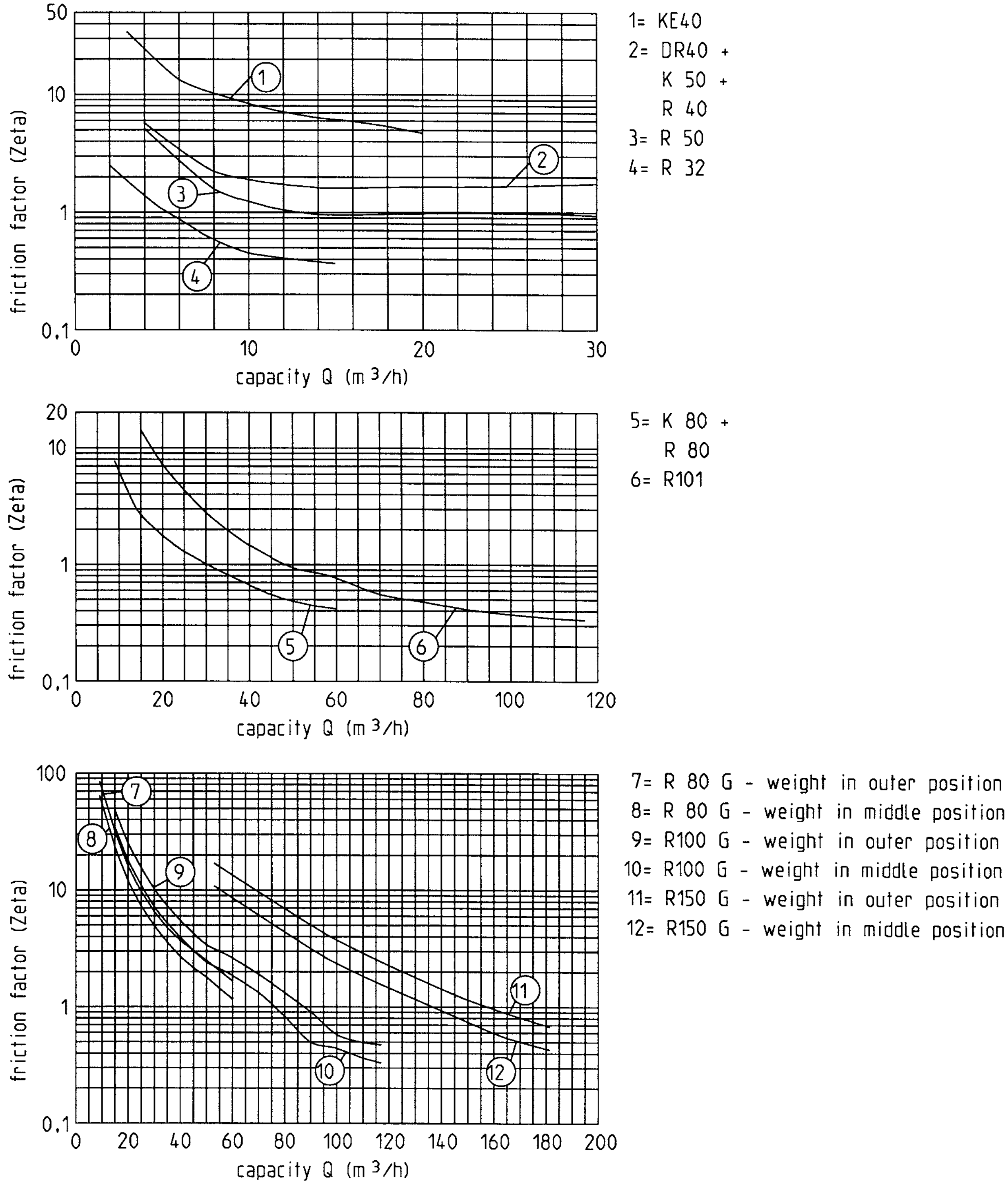


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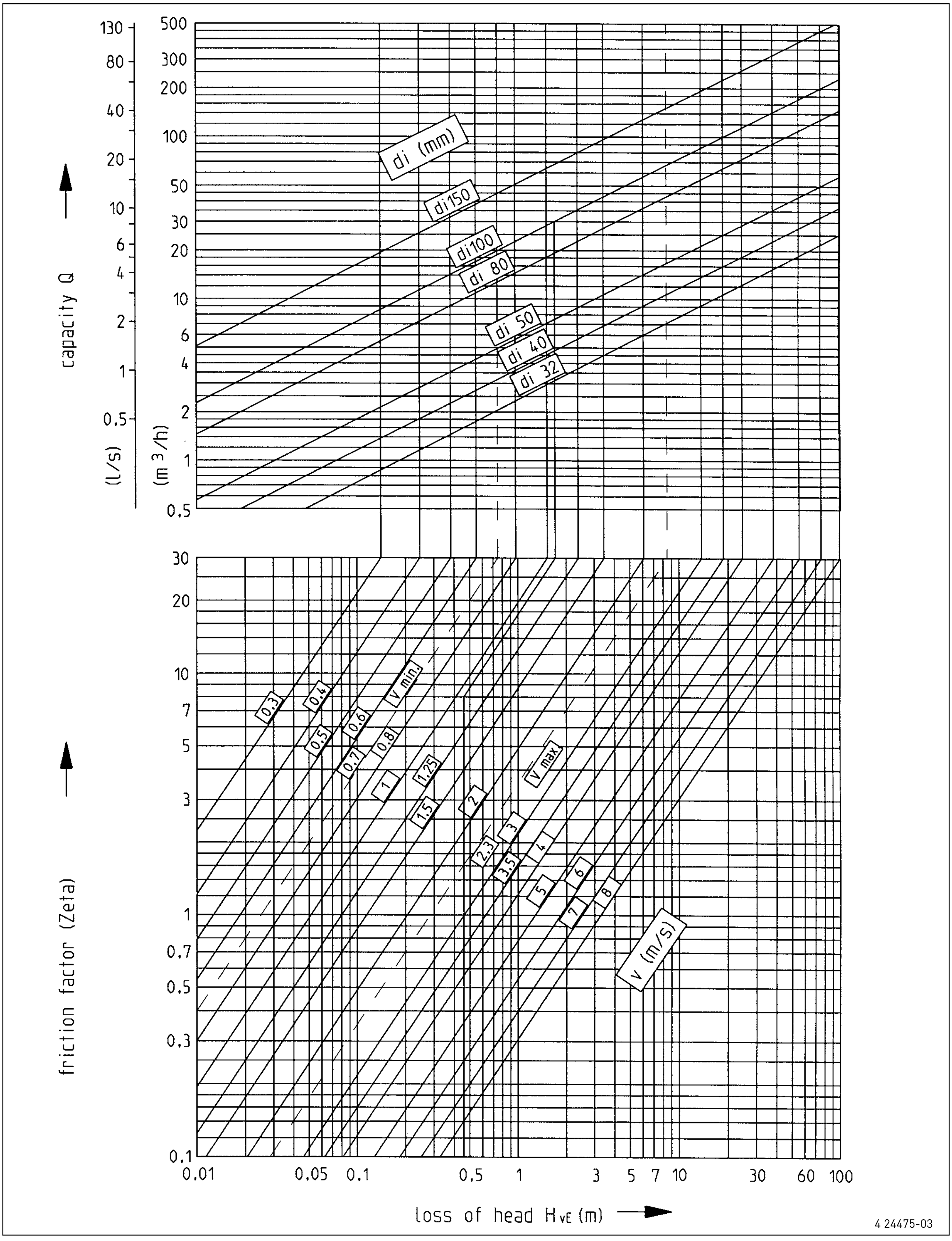
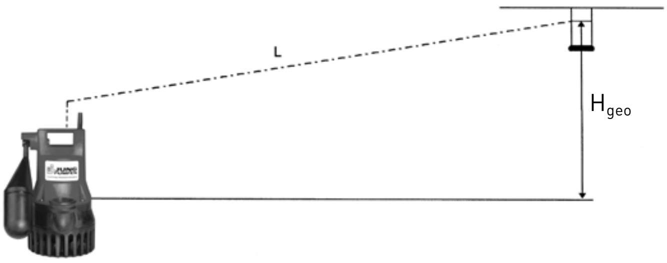
Chart 4: Level of pressure loss for mounting parts and fittings

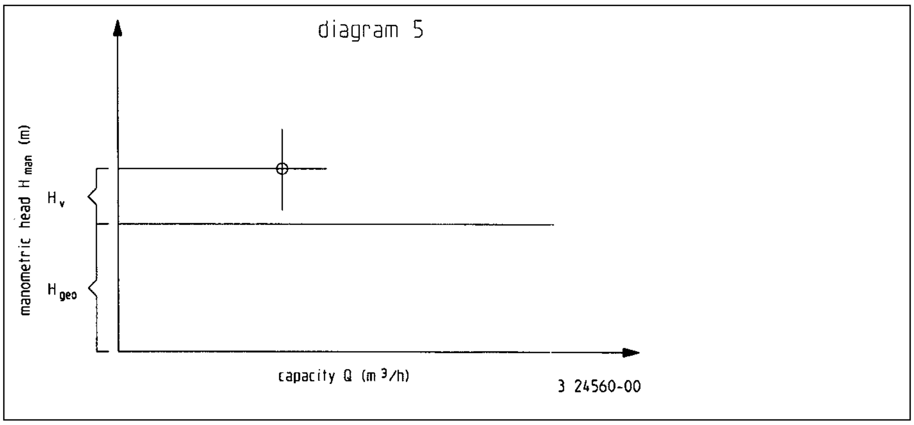


3.4 GEODETIC HEAD H_{geo}

The geodetic head indicates the difference between switch-off point of the pump and the connection to the gravity sewer. The pump has to "lift" the pumping medium this far.



The geodetic head is a system constant that cannot be altered. Therefore it is also set in the Q-H-chart as a constant to which the other losses H_v are added.

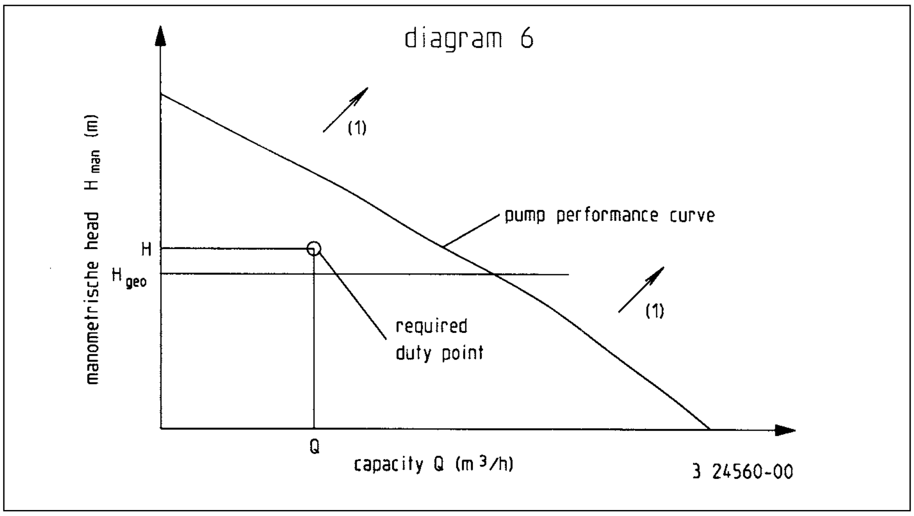


3.5 MANOMETRIC HEAD H_{man}

The addition of H_v and H_{geo} yields the manometric head H_{man}, necessary for selecting a pump.

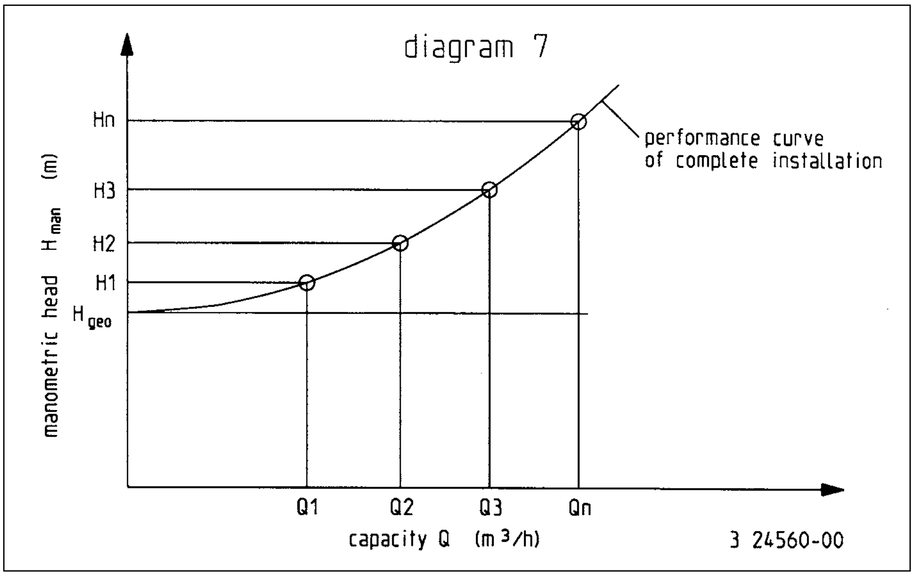
$H_{man} = H_v + H_{geo}$

With this calculated factor and with the required pumping volume a suitable pump for the case of use is chosen. The characteristic of the pump has to be above or on this desired operation point (1).

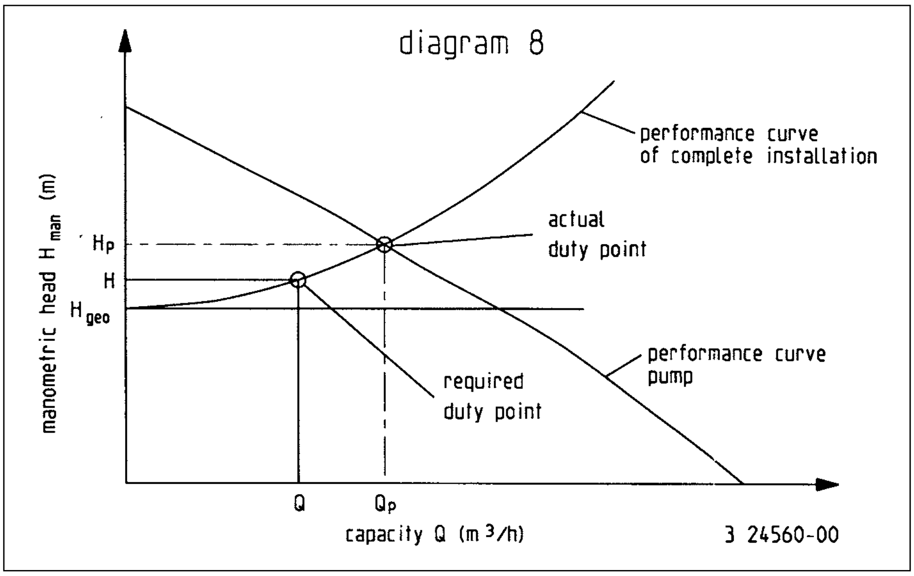


At this point, however it can only be stated that the pump is able to pump the occurring waste water volume. A statement regarding the actual operation point is not yet possible. To do so it is necessary to assess the pipework or unit characteristic.

When one assumes several different quantities Q and determines the factors Hv for these, one finds several points that can be entered into the Q-H-chart. The connection of these points equals the tubing or unit characteristic.



In order to now determine the actual operation point of the pump the intersection point of unit characteristic and pump characteristic has to be found. This is the actual operation point of the pump. It is both in capacity and manometric head higher than the desired operation point found for the pre-selection of the pump.



3.6 FLOW VELOCITY V

The volumes of the pressure pipe per meter VD/m are needed for the verification of the flow velocity.
For short lengths of pipework it is sufficiently exact to work with the values of table 7.

$$v = \frac{QP}{V_{D/m}} \qquad v_{min} \leq v < v_{max} \qquad 0{,}7\ m/s \leq v < 2{,}3\ m/s$$

Table 7

DN	25	32	40	50	65	80	100	125	150	200	250	300
VD/m (l/m)	0,5	0,8	1,3	2	3,3	5	8	12,3	18	31	50	71

When larger distances have to be crossed it is necessary to calculate with the exact volumes or respectively diameters (table 8) because otherwise the derivations occurring in the loss factors will be too great.

The inner diameters vary in part greatly due to the different materials and their solidity. Among other things this is due to the fact that the outer diameters of the plastic pipes are the same while different wall thiknesses result in different inner diameters.

Example:
PVC-pipe DN 100, PN 10 110 x 5,3 mm d_i = 99,4 mm $V_{D/m}$ = 7,76 l/m
PEHD-pipe DN 100, PN 10 110 x 10 mm d_i = 90,0 mm $V_{D/m}$ = 6,36 l/m

Table 8: gauge table of common pressure lines

	Grey cast iron pipes PN 16 DIN 28610 class K10				PVC-pipes DIN 8061/8062 PN 10 serial 4				PEHD-pipes DIN 8074 PN 12,5 – PE80 – SDR 11			
DN	D x s [mm]	d_i [mm]	$V_{D/m}$ [l/m]	Q_{min} [l/s]	D x s [mm]	d_i [mm]	$V_{D/m}$ [l/m]	Q_{min} [l/s]	D x s [mm]	d_i [mm]	$V_{D/m}$ [l/m]	Q_{min} [l/s]
25					32 x 1,5	28,4	0,63	0,44	32 x 2,9	26,2	0,54	0,38
32					40 x 1,9	36,2	1,03	0,72	40 x 3,7	32,6	0,83	0,58
40					50 x 2,4	45,2	1,60	1,12	50 x 4,6	40,8	1,31	0,92
50					63 x 3,0	57,0	2,55	1,79	63 x 5,8	51,4	2,07	1,45
65					75 x 3,6	67,8	3,61	2,53	75 x 6,8	61,4	2,96	2,07
80	98 x 9,0	80	5,03	3,52	90 x 4,3	81,4	5,20	3,64	90 x 8,2	73,6	4,25	2,98
100	118 x 9,0	100	7,85	5,50	110 x 5,3	99,4	7,76	5,43	110 x 10,0	90,0	6,36	4,45
					125 x 6,0	113,0	10,03	7,02				
									125 x 11,4	102,2	8,20	5,74
125	144 x 9,2	125,6	12,39	8,67	140 x 6,7	126,6	12,59	8,81	140 x 12,7	114,6	10,31	7,22
150	170 x 9,5	151,0	17,91	12,54	160 x 7,7	144,6	16,42	11,50	160 x 14,6	130,8	13,44	9,41
									180 x 16,4	147,2	17,02	11,91
					180 x 8,6	162,8	20,82	14,57	200 x 18,2	163,6	21,02	14,71
					200 x 9,6	180,8	25,67	17,97				
200	222 x 10,0	202,0	32,05	22,43	225 x 10,8	203,4	32,49	22,75	225 x 20,5	184,0	26,59	18,61
					250 x 11,9	226,2	40,19	28,13	250 x 22,7	204,6	32,88	23,02
250	274 x 10,5	253,0	50,27	35,19	280 x 13,4	253,2	50,35	35,25	280 x 25,4	229,2	41,26	28,88
					315 x 15,0	285,0	63,79	44,66	315 x 28,6	257,8	52,20	36,54
300	326 x 11,0	304,0	72,58	50,81	355 x 16,9	321,2	81,03	56,72	355 x 32,3	290,6	66,33	46,43

VL = notation from pipe norms

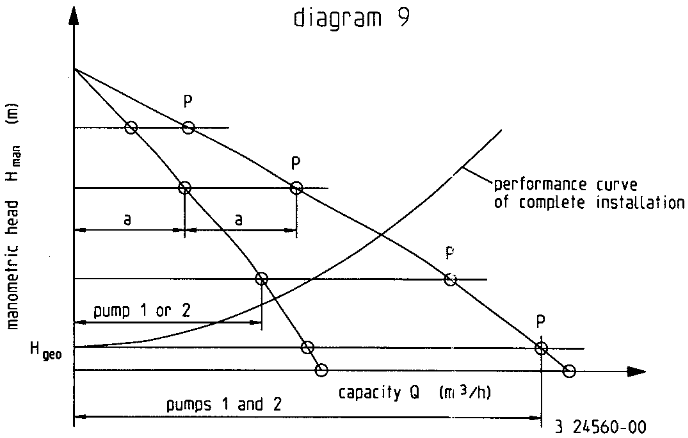
4. PUMPING UNIT

4.1 SINGLE OR DUPLEX SYSTEM

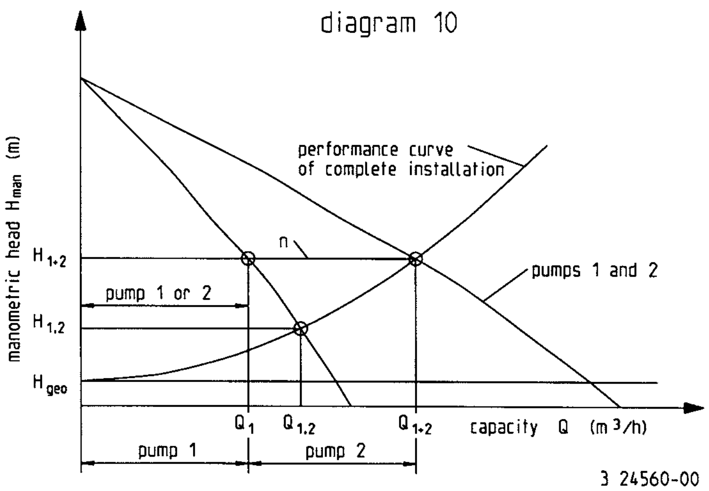
Systems for overlookable single cases can be executed as single units with only one pump. In systems where waste water transport may not be interrupted a double unit must be installed (EN 12056-4). In this case the pumping capacity of one pump has to be chosen in such a way that it can pump the maximum quantity of possible waste water.

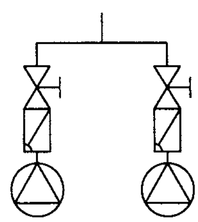
4.2 PARALLEL CONNECTION OF PUMPS

When two pumps for example in a duplex pumping system pump together into one pipeline, the total pumping volume is larger than with single use, but not twice as large. The reason therefore can be found in the loss factors which rise in squares to the flow velocity.
In order to determine the performance of the pumps the respective pump characteristics are graphically added. To this effect auxiliary lines can be entered into the Q-H-chart, from which the same amounts (a) are respectively deducted from left to right. These new points P are connected and yield the collective characteristic of pump 1 and 2.



The intersection points with the unit characteristic yield the operation points $Q_{1,2}$ / $H_{1,2}$ for single use of the pumps 1 or 2 and the operation points Q_{1+2} / H_{1+2} for parallel use of both pumps. The performance of the single pumps is found by drawing a horizontal line (n) from the intersection point of the unit characteristic with the combined pump characteristic.
The x-axis now shows that with equal pumps 1 and 2 each pump pumps approximately half of the total pumping quantity but clearly less than when working alone.

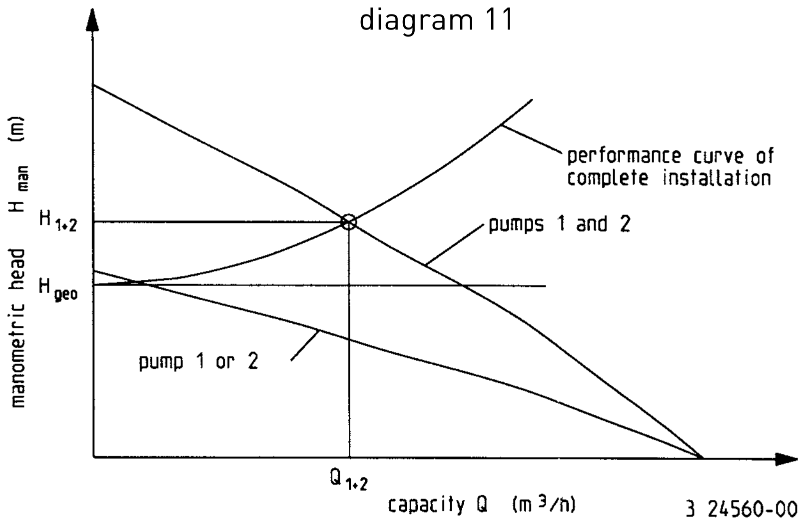


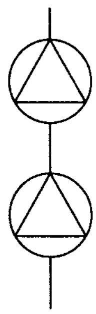


4.3 SERIES CONNECTION OF PUMPS

When a greater pumping volume is reached by paralleling, higher pumping heads can be reached by series connection.
The way of graphic illustration and determination of the operation points is to be performed similar to the parallel connection. The difference is in not adding over the pumping volume but over the pumping head.

diagram 11





4.4 PRESSURE PIPE VOLUME V_D

In order to avoid that the waste water remains for long periods of time in the pressure line and therewith causes unpleasant odour at the transfer chamber it is sensible that the pipe volume is exchanged with each operating cycle of the pumps by the pump volume Vp, provided that the length of the pipe allows this.

$Vp \geq V_D$?

When the exchange is not ensured, an appropriate pressure flushing unit has to be used in case of need.
The pipe volume per meter $V_{D/m}$ can be taken from table 7 or respectively table 8. The pipe volume VD results from the following formula:

$$V_D = V_{D/m} \cdot L_D$$

V_D	[l]	= Volume of the pressure pipe
$V_{D/m}$	[l/m]	= Volume of the pressure pipe per meter
L_D	[m]	= Length of the pressure pipe

4.5 DURATION OF SWITCHING INTERVAL T_{SP}

In order to avoid undue strain to the motors of the pump due to too frequent starting (chatter effect) there are minimum switch-on intervals for the duration of switching intervals TSp depending on the assumed motor performance P1.
With motors that are at least half way immersed into the sump well, longer switching intervals are also permissible.

Table 9: Duration of switching interval T_{Sp}

for motors up to P1 = 4 kW (direkt starting)	T_{Sp} = 120 s
for motors up to P1 = 7,5 kW (star-delta starting)	T_{Sp} = 144 s
for motors up to P1 = 7,5 kW (star-delta starting)	T_{Sp} = 180 s

4.6 PUMP VOLUME V_P

For the selection of the right sump and for adjusting the level contactors it is necessary to determine the minimum pumping volume Vp.
The pumping volume is the volume between switch-on and switch-off point of the pump in the sump.
When the inlet volume Qz does not fluctuate greatly the following formula can be used for calculating:

$$V_p = \frac{T_{Sp} \cdot Q_z \cdot (Q_p - Q_z)}{Q_p}$$

V_p	[l]	= Pumping volume
T_{Sp}	[s]	= Duration of switching interval
Q_z	[l/s]	= Inlet volume
Q_p	[l/s]	= Pumping volume of the pump at operation point

Upon greatly fluctuating inlet volumes, like for example in rainwater pumping stations – soft or hard rain – the maximum required pumping volume should be determined for the calculation of the pumping volume V_p.

It is reached when $Q_z = \frac{Q_p}{2}$ is entered into the formula.

4.7 HYSTERESIS H_P

The hysteresis h_p, i. e. the adjustment distance of the level contactors within the PKS, is taken from chart 13 by means of the determined minimum pumping volume V_p.
The hysteresis h_p in chart 14 are valid for the standard water sump inlets.
In case of special versions, the curves need to be adjusted.

Chart 13: hysteresis h_p PKS-A/PKS-B/ PKS-D

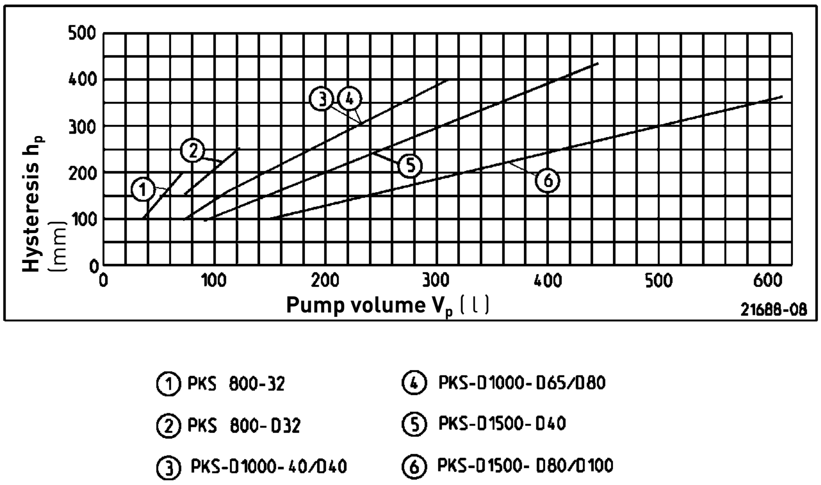
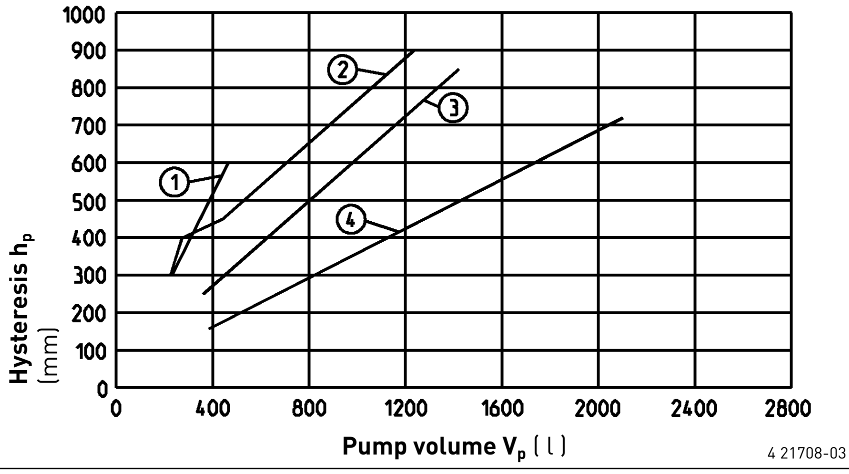


Chart 14: hysteresis h_p DKS/KS/KSS



1	DKS	1000-50/D 50	**3**	KS	1500-D 180	**4**	KS	2000-D 100
2	KS	1500-D 150		KS	1500-D 100		KS	2000-D 150

4.8 SUMP VOLUME V_{SU}, SWITCH-OFF LEVEL H_{AUS}

The volume remaining in the sump V_{su} and the switch-off level h_{Aus} can be determined by means of the table below. It has to be verified if the switch-off level is larger or equals the factor which ensures that the spiral casing of the pump does not emerge (see dimensions of the chosen pump).
The banking level h results from $h = h_p + h_{Aus}$

Table 10: level switch-off points h_{Aus} / sump volume V_{su}
Sumps for sewage pumps UAK/UFK

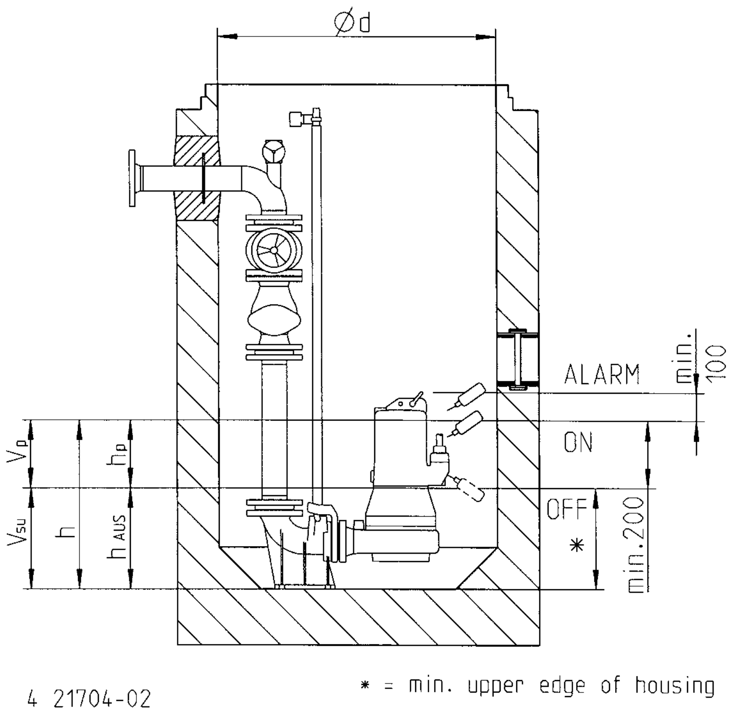
	PKS-A 800		PKS-B 800	PKS-D 1000	PKS-D 1000		PKS-A 1200		PKS-D 1500	
	-D 32	-80	-D 32	-40/ D 40	-68 -80	-D 65 -D 80	-40/ D 40	-80/ D 80	-40/ D 40	-D 80/ D 100
h_{Aus} [mm]	270	250	200	270	230	340	200	240	280	280
V_{su} [l]	89	129	45	118	90	170	480	515	225	295

	DKS 1000	KS 1000		KS 1500	KS/KSS 1500	KS 2000	KSS 2000
	-50/ D 50	65/80	-D 65/ D 80	-D 50	-D 80/ D 100	-D 100/ D 150	-D 100/ D 150
h_{Aus} [mm]	250	200	250	250	250	300	350
V_{su} [l]	150	135	178	196	310	540	660

Sumps for drainage pumps U/US

	PKS-A 800 -40/D40
h_{Aus} [mm]	235
V_{su} [l]	137

Upon selection of a provided sump attention has to be paid that the measurement h is not larger than the maximum banking level from sump bottom to approx. 100 mm below the lower edge of the inlet. Should this be the case the inlet has to be relocated or a respectively larger sump has to be selected.



5. CALCULATION EXAMPLES

5.1 CALCULATION EXAMPLE 1

Sewage disposal unit for waste water containing faeces

1. Determination of volumes in accordance with DIN EN 12056-2

Installation location: boarding house => K = 0,5 l/s

Depending of the kind of object to be drained the concurrence of use of the connected drainage objects is determined by the factor K.

The following drainage objects are to be discharged (system I):

	name	connecting valves DU		ΣDU
12	hand wash basins	0,5		6,0
8	toilets (with 6 l tank)	2,0		16,0
4	urinals	0,5		2,0
2	floor drains DN 70	1,5		3,0
		Σ	=	27,0
1	Grease separator NG 2 (manufacturer requirement) connected to it: 1 dishwasher, 2 kitchen drains, 2 sinks in the kitchen	Q_c	=	2,0 l/s

The total volume therewith results at:

$$Q_{ww} = K \bullet \sqrt{\sum DU_s} + Q_c$$

$$= 0,5 \bullet \sqrt{27,0} + 2,0 \text{ l/s}$$

$$\underline{\underline{Q_{ww} = 4,60 \text{ l/s}}}$$

Q_{ww} [l/s] = waste water discharge
K = drainage characteristic
DU [l/s] = connecting valves
Q_c [l/s] = continuous discharge

Note: When the determined waste water discharge Q_{ww} is smaller than the largest connection value of a single drainage object, the latter is controlling!

2. Verification of the minimum flow velocity v_{min}

The unit is supposed to be connected by way of an existing pressure line DN 100 with a length of L = 25 m.
The operational roughness is kb = 0,25 mm. The minimum flow velocity in pressure lines is v_{min} > 0,7 m/s
The pressure line has a volume
$V_{D/m}$ = 8 l/m (see table 7 – the values are approximated values for d_i = DN. With larger tubing lengths it is recommended to calculate with the actual inner diameters of the pipes from table 8. These, however, vary greatly due to the different materials and the resulting wall thiknesses of the pipes.)

This means that a minimum capacity Q of

$$Q = V_{D/m} \bullet 0,7 \text{ m/s}$$

$$= 8,0 \text{ l/m} \bullet 0,7 \text{ m/s}$$

$$\underline{\underline{Q = 5,6 \text{ l/s}}}$$

is here required.

Upon verifying if the occurring capacity is larger than the necessary one (Qww ⩾ Q) it is determined that
$Q_{ww} < Q$
4,60 l/s < 5,60 l/s

This means that the next steps of the calculations are not performed with the actually occurring volume of waste water but that the volume necessary for reaching the minimum flow velocity is applied.

$\underline{\underline{Q = 5,60 \text{ l/s}}}$ With the conversion factor 3,6 a conversion can be performed from unit [l/s] to [m3/h].

$\underline{\underline{Q = 20,16 \text{ m}^3\text{/h} \approx 20 \text{ m}^3\text{/h}}}$

3. Determination of the tubing friction losses of the tubing H_{vL}

The loss level H_{vL} is determined from chart 2. To do so the intersection point of the pumping stream
Q = 20,0 m³/h
with the pressure line DN 100 is searched. Starting with this intersection point a horizontal line is drawn on the side edge of the chart. The loss factor H_{vL} for 100 m tubing can now be read off from here.
$H_{vL}100$ = 0,70 m / 100 m tubing
The total loss factor for the tubing results from the multiplication with the tubing length L_D.

$$H_{vL} = H_{vL100} \bullet L_D$$
$$= \frac{0{,}7\ m}{100\ m} \bullet 25\ m$$
$$H_{vL} = 0{,}18\ m$$

4. Determination of the loss factor H_{vE} of the mounting parts and fittings

In table 6 and chart 3 the zeta values for fittings and mouldings can be determined. The following fittings and mouldings are supposed to be installed in the pressure line:

piece	name	ς	for Q = 20 m³/h
1	sluice valve DN 100	0,34	0,34
3	elbows DN 100, 90°	0,35	1,05
1	swing-type check valve R 101	7,00	7,00
		Σ ς =	8,39
	Chart 4 yields for Q = 20 m³/h and Σ ς = 8,39 m ein	H_{vE} = 0,2 m	

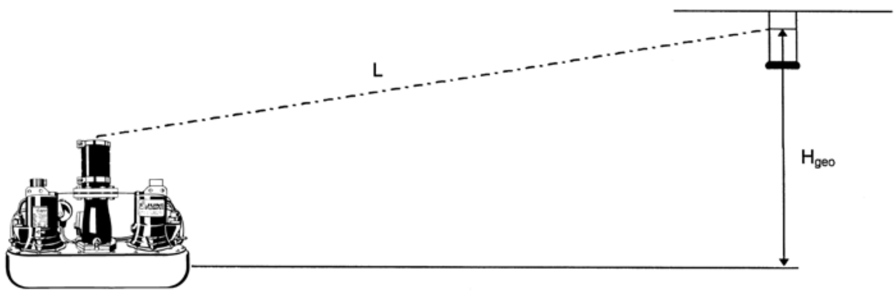
5. Total loss factor H_v

The total loss factor results from the addition of all single loss factors

$$H_v = H_{vL} + H_{vE}$$
$$= 0{,}18\ m + 0{,}2\ m$$
$$H_v = 0{,}38\ m$$

6. Geodetic head H_{geo}

The level difference between the switch-off point of the pump and the transfer point is called geodetic head.
In this example the H_{geo} = 3,1 m.



7. Manometric head H_{man}

The manometric head is the sum of the total loss factor and geodetic head lift.

H_{man} = $H_v + H_{geo}$

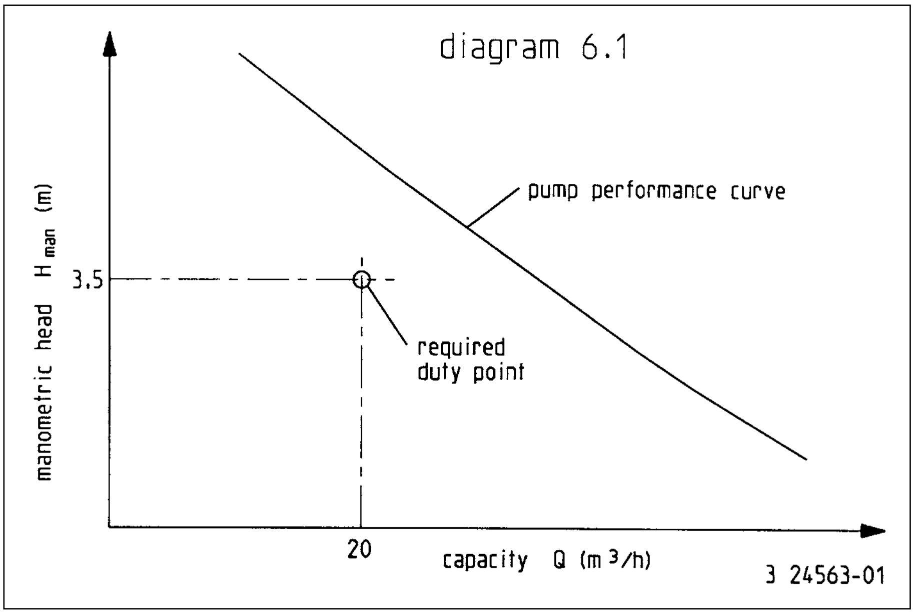
= 0,38 m + 3,1 m = 3,48 m

H_{man} ≈ 3,5 m

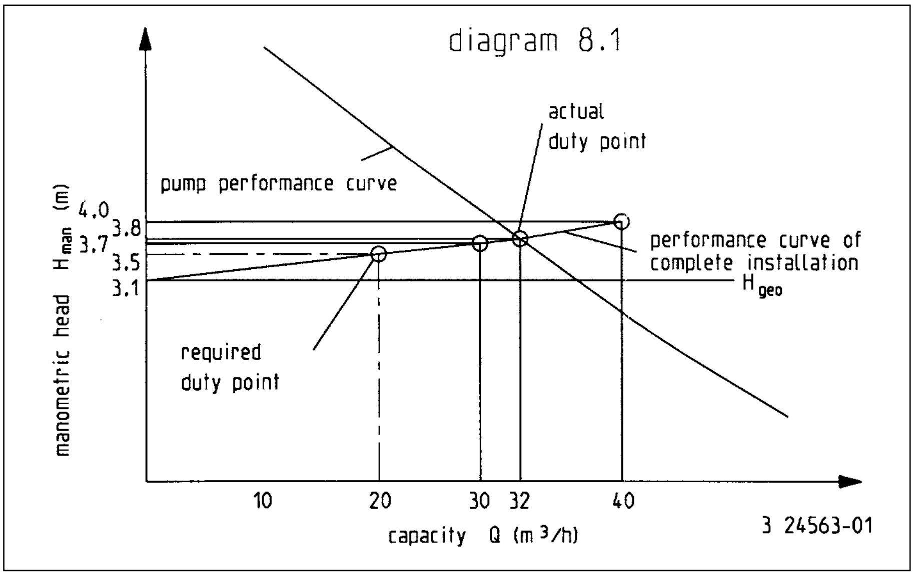
8. System selection

The values Q = 20 m³/h (see pt. 2) and H_{man} = 3,5 m (see pt. 7) yield the „desired operation point".
It is used to pre-dimension the sewage disposal unit.
The pump characteristic has to be above the desired operation point.
Since it is a boarding house where, according to DIN EN 12056-4 part 1, waste water discharge may not be interrupted, an automatic spare pump or a double unit has to be provided for. Therefore a double unit is selected for safety reasons.

Selected unit: compli 1010/4 BW

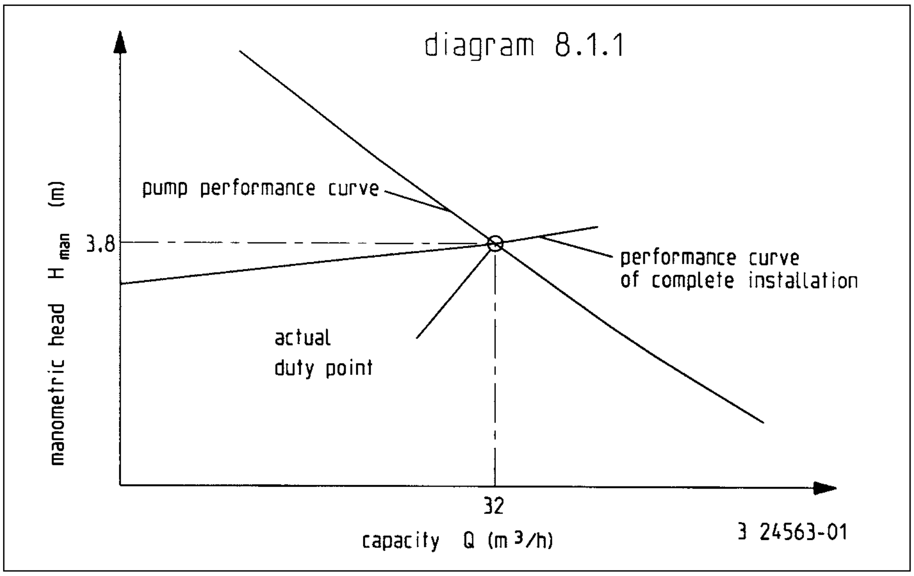


This way the unit can be sufficiently dimensioned. If, however, the precise operation point is required, the pipe or unit characteristic has to be determined and entered into the above chart.
To do so several pumping volumes are assumed at random. Then the corresponding loss factors are determined (see pt. 3–7).
The geodetic head H_{geo} is to be entered as a constant on the y-axis. The determined H_v values are added to it.



In the example at hand the losses for the quantities Q = 30 und 40 m³/h were determined and entered into the chart. Connecting the points found this way results in the unit or pipe characteristic. The intersection point yields the actual operation point of the pump.

The pump has a capacity Q = 32,0 m³/h bei H_{man} = 3,8 m.



9. Verification of the flow velocity v

The flow velocity should, in order to avoid, water hammers and impacts on the reflux valve, not be greater than v_{max} = 2,3 m/s sein.

$$v = \frac{Q_p}{V_{D/m}} = \frac{32\ m^3/h}{8{,}0\ l/m \cdot 3{,}6} = \underline{\underline{1{,}11\ m/s}}$$ [3,6 = conversion factor m³/h in l/s]

$v_{min} \leq v < v_{max}$

$\underline{\underline{0{,}7\ m/s \leq 1{,}11\ m/s < 2{,}3\ m/s}}$ => The flow velocity is within the permitted range.

5.2 CALCULATION EXAMPLE 2

Rainwater pumping unit with drain pumps UAK and concrete sump

Attention: In eplosion hazadous locations only the ioeration of ex-proof pumps is permitted.

1. Quantity determination according to DIN 1986 part 100

In table 4 the drainage coefficients C depending on the kind of connected precipitation area can be determined.

The following precipitation a reas are connected:

Name	Area	Drainage coeffiecient
roof (slope ⩾ 3°)	A1 = 170,0 m²	C = 1,0
footpath with pavement 10 x 10 cm	A2 = 110,0 m²	C = 0,6
parking site with black top	A3 = 76,5 m²	C = 1,0

For the calculation it is necessary to have knowledge regarding the assessment level of rainfall which varies greatly from region to region. For a precise calculation the factor has to be requested with the local building authority. An overview can be taken from EN 12056-4 appendix A.

For the example at hand a mean assessment level of rainfall is assumed at

$r_{(D,T)} = 200\ l / (s \cdot ha)$ [1 ha = 10.000 m²]

$$Q_R = C \cdot A \cdot \frac{r_{(D,T)}}{10.000\ m^2 / ha}$$

$$Q_{R1} = 1,0 \cdot 170\ m^2 \cdot \frac{200\ l / (s \cdot ha)}{10.000\ m^2 / ha} = 3,40\ l/s$$

$$Q_{R2} = 0,6 \cdot 110\ m^2 \cdot \frac{200\ l / (s \cdot ha)}{10.000\ m^2 / ha} = 1,32\ l/s$$

$$Q_{R3} = 1,0 \cdot 76,5\ m^2 \cdot \frac{200\ l / (s \cdot ha)}{10.000\ m^2 / ha} = 1,53\ l/s$$

$$\Sigma Q_{R1-3} = 6,25\ l/s$$

The conversion factor 3,6 can be used to convert from unit [l/s] to [m³/h].

$$\Sigma \dot{V}_{r\ 1-3} = Q = 22,5\ m^3/h$$

2. Dimensionierung der Druckleitung

The unit is supposed to be connected via a pressure line of L = 520 m. The operational roughness is kb = 0,25 mm. The minimum flow velocity inside pressure lines is $v_{min} > 0,7$ m/s.
In order to keep energy costs as low as possible it is attempted that the flow velocity does not rise considerably above v = 1,0 m/s.

The determination of the necessary diameter can be performed with chart 2. Therefore the chart is entered from top to bottom with Q = 22,5 m³/h. When the quantity Q intersects the line v_{min} one can see that the intersection point is between the diagonal rows of diameters d_i 100 and di 125. This means in the pressure line d_i 100 v is > 0,7 m/s and in the line d_i 125 v is <0,7 m/s.

Extending the vertical line further to the diagonal di 100 yields the result that the flow velocity of this line is approx. v = 0,8 m/s and therewith greater than the minimum flow velocity of V_{min} = 0,7 m/s ist.

Chosen: **pressure line DN 100**

3. Determination of the pipe friction losses H_{vL}

The loss factor Hv is taken from chart 2:
To do so the intersection point of the pumping capacity Q = 22,5 m^3/h with the pressure line d_i 100 is determined. Starting from this intersection point a horizontal line is drawn on the side edge of the chart. The loss factor $H_{vL\ 100}$ for 100 m of pipe can be read off from here.

$H_{vL\ 100}$ = 0,90 m / 100 m conduit

The total loss factor for the tubing is determined by multiplication with the pipe length L.

$$H_{vL} = H_{vL\ 100} \cdot L$$

$$H_{vL} = \frac{0,9\ m}{100\ m} \cdot 520\ m$$

$$H_{vL} = 4,68 \approx 4,7\ m$$

4. Determination of the friction losses H_{vE} of the mounting parts and fittings

In table 6 and chart 3 the zeta values for fittings and mounting parts can be determined. The following fittings and mountings are supposed to be installed in the pressure line and the pump sump:

piece	name	ς	for Q = 22,5 m³/h
1	sluice valve DN 100	0,34	0,34
12	elbows DN 100, 90°	0,35	4,20
1	swing-type check valve R 100 G, weight on the outside	20,00	20,00
		Σ ς =	24,54

Chart 4 yields H_{vE} = 0,8 m for Q = 22,5 m^3/h and Σ ς = 24,54.

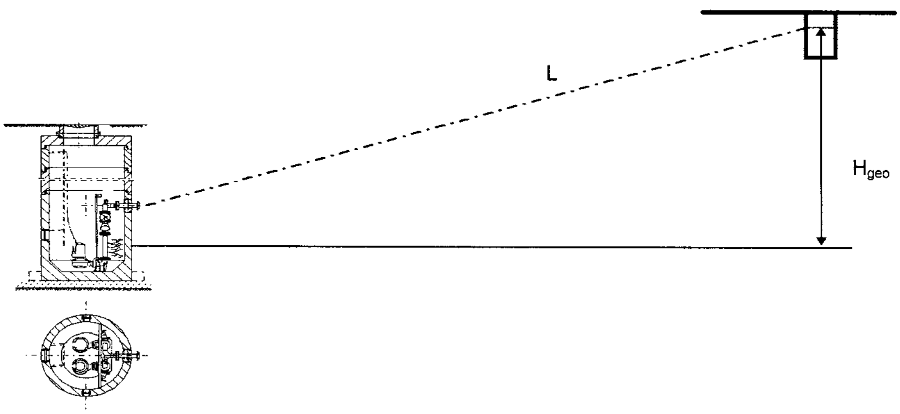
5. Total friction loss H_v

The friction loss results from the addition of all single loss factors

$$H_v = H_{vL} + H_{vE}$$
$$= 4,7\ m + 0,8\ m$$
$$H_v = 5,5\ m$$

6. Geodetic head H_{geo}

The level difference between the switch-off point of the pump and the outflow into the gravity sewer is called geodetic head. In this example the H_{geo} = 1,8 m



7. Manometric head H_{man}

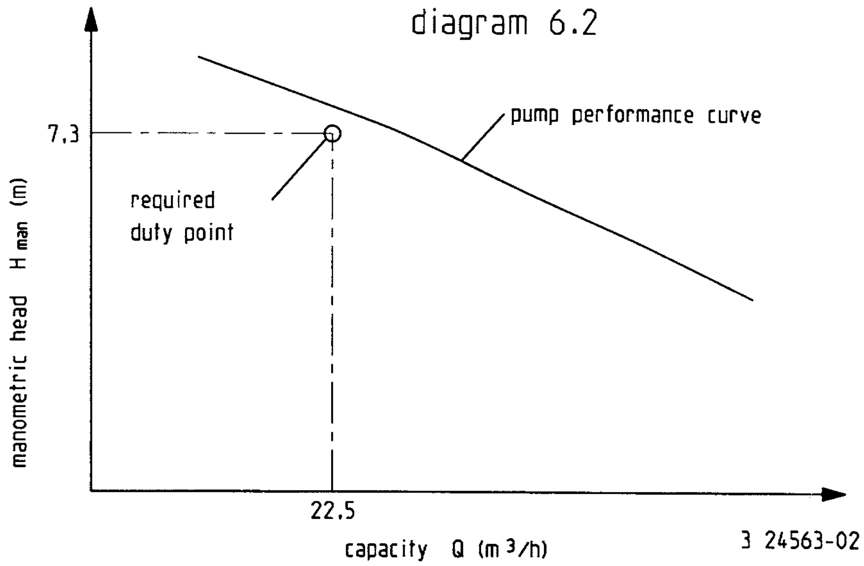
The manometric head is the sum of the total friction losses and geodetic head.

$$H_{man} = H_v + H_{geo}$$
$$= 5{,}5\ m + 1{,}8\ m$$
$$H_{man} = 7{,}3\ m$$

8. Pump selection

The values Q = 22,5 m³/h (see pt. 2) and H_{man} = 7,3 m (see pt. 7) yield the "desired operation point". This is used to pre-dimension the pumps.
The pump characteristic has to be located above the desired operation point. Depending on the desired security the pump can be more or less overdimensioned.

Selected pump: UAK 25/4 CW 1



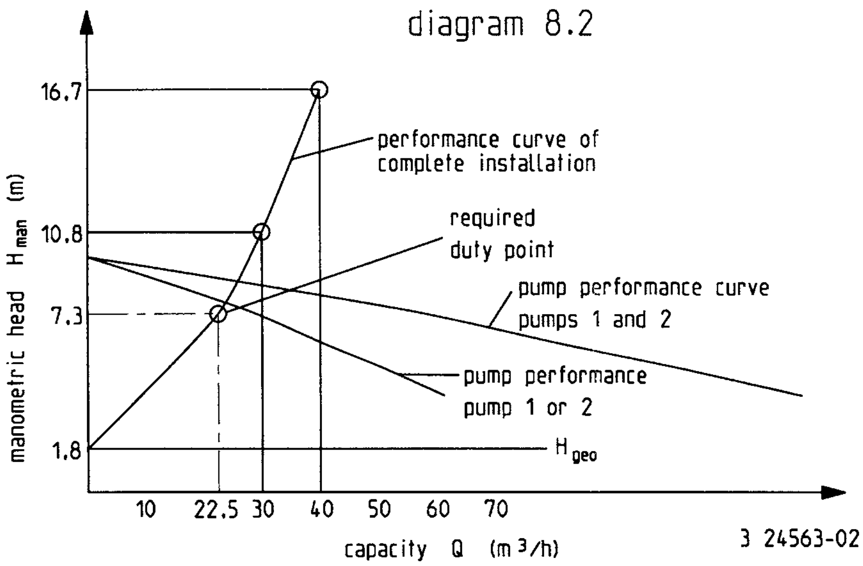
This way the unit can be sufficiently dimensioned. If, however, the precise operation point is required, the pipe and unit characteristic has to be determined and entered into the above chart.

To do so several pumping volumes are taken at random. Then the corresponding loss factors (s. pt. 3–7) are determined.

The geodetic head H_{geo} has to be set to the y-axis as constant. The determined Hv values are added on it.

Since it is a double unit it can also be determined how much water is pumped when both pumps are simultaneously working at peak load.

To do so the characteristic of the second pump is graphically added to the first characteristic. Then the actual operation points are determined.



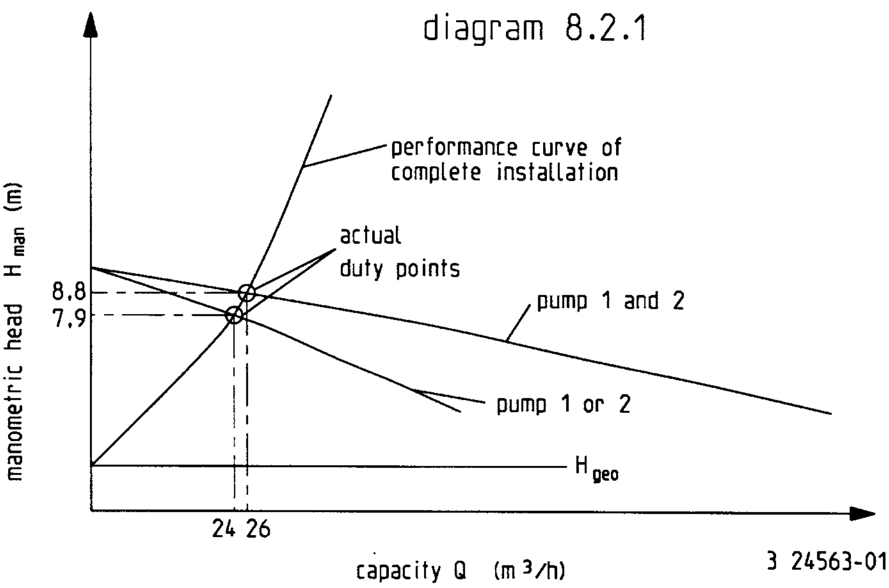
In the example at hand the losses for the quantities Q = 30 and 40 m³/h were determined and entered into the chart.

Connecting the points found this way results in the unit and pipe characteristic. The points of intersection

indicate the actual operation points of the pumps for base and peak load.

The pumps have a performance of Q = 24,0 m³/h bei H_{man} = 7,9 m (base load) and
Q = 26,0 m³/h bei H_{man} = 8,8 m (peak load).

Since pumps are usually set up in such a way that one pump can handle the total amount of occurring water the second pump is referred to as stand by pump. Only in special cases the so called peak load is used.



9. Checking of flow velocity v

The flow velocity should not exceed v_{max} = 2,3 m in order to avoid water hammers and impacts on the reflux valve.

$$v = \frac{Q_p}{V_{D/m}}$$

$$= \frac{24\ m^3/h}{8{,}0\ l/m \cdot 3{,}6}$$

$$v = \underline{\underline{0{,}83\ m/s}}$$ [3,6 = conversion factor m³/h in l/s]

$$v_{min} \leqslant v < v_{max}$$

$$\underline{\underline{0{,}7\ m/s \leqslant 0{,}83\ m/s < 2{,}3\ m/s}}$$

10. Duration of switching period T_{sp}

The chosen pumps of type UAK 25/4 CW1 are having a power consumption of P1 = 2,7 kW.
According to table 9 this results in a duration of switching period of

$$\underline{\underline{T_{Sp} = 120\ s}}$$

11. Pump volume V_p

For the required minimum pump volume V_p the following formula applies:

$$V_p = \frac{T_{Sp} \cdot Q_z \cdot (Q_p - Q_z)}{Q_p}$$

$$V_p = \frac{120\ s \cdot 22{,}5\ m^3/h \cdot (24\ m^3/h - 22{,}5\ m^3/h)}{24\ m^3/h \cdot 3{,}6}$$ [3,6 = conversion factor m³/h in l/s]

$$\underline{\underline{V_p = 46{,}9\ l}}$$

12. Sump selection

A sump KS 1500-D 100 is selected. The minimum hysteresis h_p can be taken from chart 14.
It is V_p = 46,9 l

h_p = 250 mm is the lowest hysteresis.

The volume V_{su} remaining inside the sump and the switch-off level h_{Aus} could be determined in tabele 10.

$$h_{Aus} = 250\ mm$$

The damming height h results from

$$h = h_p + h_{Aus}$$

$$h = 250\ mm + 250\ mm$$

$$\underline{\underline{h = 500\ mm}}$$

The sump volume results in

$$\underline{\underline{V_{su} = 310\ l}}$$

PENTAIR JUNG PUMPEN

6. PUMP DIMENSIONING SUPPORT

Company: ______________________ Phone/Fax: ______________________

Adress: ______________________ Project, Place: ______________________

ZIP, Place: ______________________ ☐ New construction ☐ Refurbishment

Please send back by fax at +49 52 04 / 80 368 or by e-mail at info@jung-pumpen.de

1.0 Objects vor dewatering

- Celler / single bath / washroom ☐
- Single appartment ☐
- Detached house ☐
- Two-/Multi-family house ☐
- Commercial operation / Office building ☐
- Guesthouse / Restaurant / Hotel ☐
- Industrial facility ☐
- Public building ☐
- Recreational facility / Sports venue ☐
- Initiate in public sewer system ☐
- Other ______________________

2.0 Types of wastewater/Wastewater ingredients

- Domestic wastewater ☐
- Domestic sewage ☐
- Surface water (Drainage) ☐
- Condensate from heating boilers oder air conditioning ☐
- Wastewater with high amount of fibres & solid materials ☐
- Wastewater with aggressive components, e.g. silage ☐
- Wastewater with mineral components, e.g. sand ☐
- Activated sludge / effluent ☐
- Other ______________________

1.1 Objects vor dewatering (DUs)

Designation	**Number**
Urinal (booth or row, per position)	
Single urinal	
Washbasin, bidet	
Shower without plug	
Shower with plug, bathtub	
Kitchen sink, dishwasher	
Washing-machine 6 kg, floor drain DN 50	
Washing-machine 12 kg, floor drain DN 70	
Floor drain DN 100	
WC 6 l, WC 7,5 l	
WC 9 l	
Other ______________________	

2.1 Output

Whole wastewater discharge Q

(if determined) ________ ☐ l/s ☐ m³/h

or

Number of inhabitants EW

Quantity EW (0,005 l/s*d) ________

or

Surface drainage

ZIP, place for destination of rainfall intensity ____________

Total roof surface for dewatering ______________ m²

Total site area for dewatering ______________ m²

- from that partially transmissive, e.g. sett ________ m²

- from that impermeable, e.g. asphalt, concrete ________ m²

- from that below the backpressure level, ________ m²
  (e.g. celler entry, driveways etc.)

1.2 Installation site of the pump/lifting station

- Inside the building, above floor ☐
- Inside the building, underfloor ☐
- Outside the building, underfloor ☐
- Inlet depth (OKG – pipe bottom) ________ cm

Load on the manhole cover

- Walkable ☐
- Drivable for cars ☐
- Drivable for trucks ☐

Duct existing, Ø ________ m ☐

Duct depth ________ m

2.2 Hydraulic informations

Geodesic delivery head H_{geo} ________ m

(from the switch-off point to the transfer point)

Lenght of the pressure line ________ m

Pressure line contains downgrades ☐

More information about the pressure line (if known)

Nominal width DN ______

Pressure stage PN ______

Inner diameter ______ mm

Material: ☐ PVC-U ☐ PE-HD ☐ Other ________

Contact person ______________________ Date ______________________

E-mail ______________________

Phone for questions ______________________ Stamp, signature ______________________

PENTAIR JUNG PUMPEN

7. DESIGN HELP FOR CONTROL TECHNOLOGY

Company: ______________________ Phone/Fax: ______________________

Adress ______________________ Project, Place: ______________________

ZIP, Place: ______________________ E-mail: ______________________

Please send back by fax at +49 52 04 / 80 368 or by e-mail at info@jung-pumpen.de

3. Description of the System

☐ See attached data sheet

Pump to be controlled: ______________________ line length of the pump / level sensor: __________ m

☐ Single system ☐ Duplex system ☐ Triple system ☐ Other: ______________________

☐ Ex-protection required

Description of the duct: (Pleas complete under point 1.2 design help for pumps and liftingstations)

Type of electrical system: ☐ TN ☐ TT

Available power supply: Three-phase alternating 3N/PE 230V/400V~50Hz ☐

One-phase alternating 1N/PE 230V~50Hz ☐

Fill level indicator: ☐ Yes ☐ No

Comment: ______________________ ☐

4. Additional features

Alarm signal : ☐ No

☐ Collective fault signal (network-dependent)

☐ Single fault signal (pump 1, pump 2, flood alarm) network-dependent

Additional: ______________________

Remote transmission: ☐ No ☐ SMS ☐ Potential-free contact ☐ EnOcean wireless sensor

PumpRemoter: ☐ LAN ☐ WiFi ☐ GPRS Remote control: ☐ Yes ☐ No

☐ Network-independent alarm signal ☐ Oil chamber monitoring of the pump

☐ Local power indicator ☐ Local voltage display

☐ Local hourmeter ☐ Automatic test run

☐ Main switch ☐ Fuse control

☐ Terminal block ☐ Network monitoring

☐ Fault-current circuit breaker (pump 1, pump 2) Comment: ______________________

☐ Speed control ☐ Flow measuring

☐ Soft start/discharge ☐ Overvoltage protection Comment: ______________________

5. Installation site of the controls

Outdoor installation housing ☐ No ☐ Yes ☐ Wall mounting (outdoor) ☐ Wall mounting (interior)

Freiplatz ☐ No ☐ Yes for: ______________________

☐ Strobe light: ☐ 230 V ☐ 12 V ☐ Warning light 230 V

☐ Profile half-cylinder ☐ Heating with thermostat

☐ Outside cabinet lighting ☐ Emergency power supply

☐ Horn: ☐ 230 V ☐ 12 V Maintenance socket ☐ 230 V ☐ 400 V ☐ Combination

6. Breeze

☐ Pump sump ventilation ☐ Pressure pipe ventilating

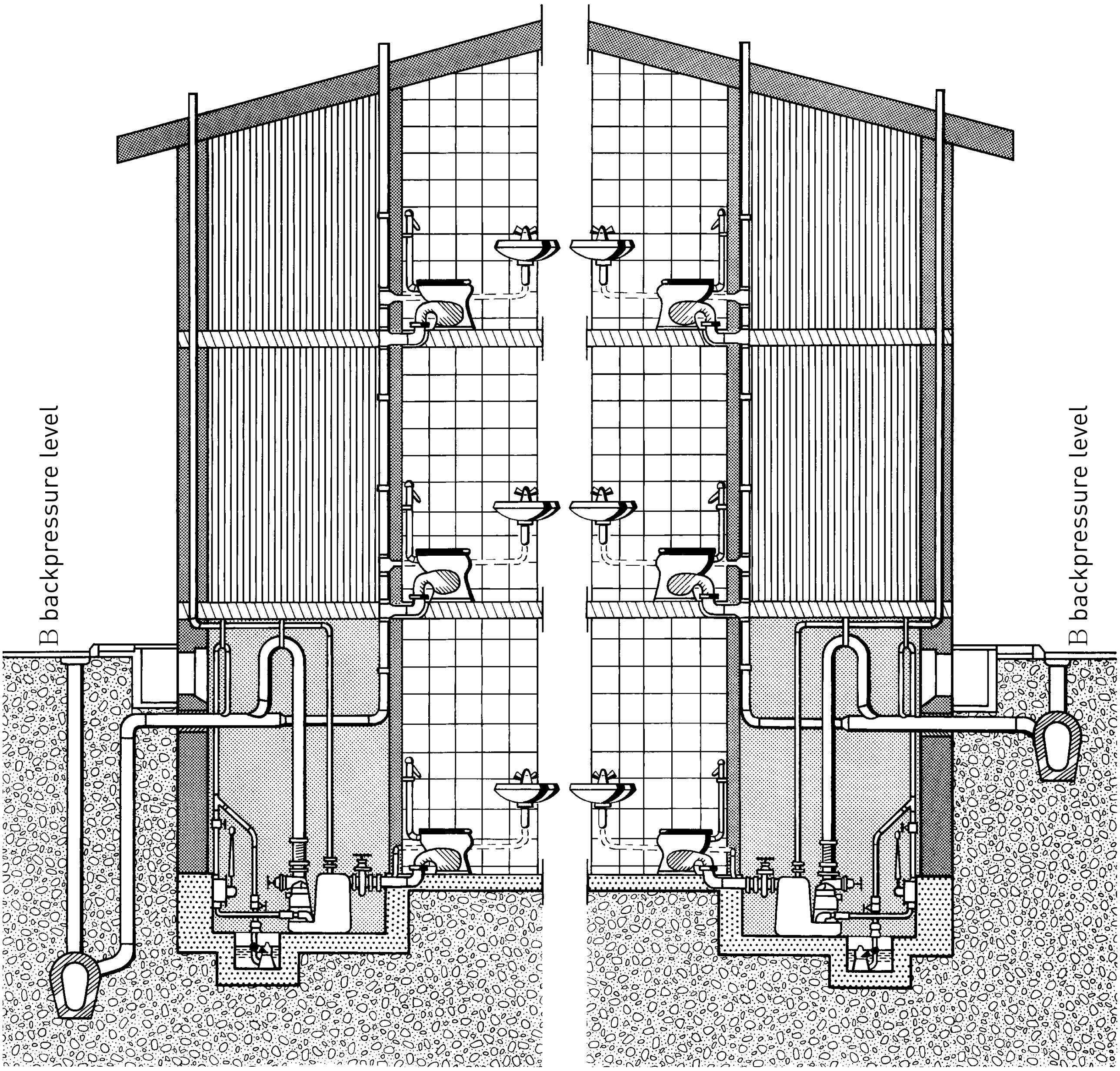
☐ Pressure pipe flushing number of strands: ☐ 1 ☐ 2 ☐ 3 ☐ 4

7. Other comments:

____

____

Contact person __________ Further questions (phone) __________ Date, stamp, signature __________



Sewer level below the basement floor

Sewer level above the basement floor

8. BACKPRESSURE LEVEL

In accordance with EN 12056-4 the top level of the street at the connection site is regarded as backpressure level if not otherwise defined by local regulations. Drainage objects below backpressure level have to be connected to the public sewage system by way of a pumping station with backpressure loop.

All drainage objects located above backpressure level are to be drained using natural incline. In case of a "backpressure situation" within the sewage system and the building connection lines the use of the connected drainage objects is possible through an automatically working wastewater pumping station.

9. FORMULA SYMBOLS USED

Symbol	Explanation	Unit
A	Rainfall area	m²
C	Run-off coefficient	–
DU	Connection values (design unit)	l/s
DN	Nominal width	mm
d_i	Inner diameter of conduit	mm
E	Resident	–
h	Banking level in the sump well	mm
h_{Aus}	Switch-off level in the sump well	mm
h_p	Differential height	mm
H_{geo}	Geodetic head	m
H_{man}	Manometric head	m
H_p	Pumping head at operation point	m
H_v	Total friction losses	m
H_{vE}	Friction losses of fittings etc.	m
H_{vL}	Pipe friction losses	m
$H_{v,i}$	Pressure losses	m
K	Abflusskennzahl	–
k_b	Operational roughness	mm
L_D	Length of pressure line	m
P	Point	–
P_1	Power consumption	kW
Q	Capacity	l/s
Q_c	Continuous discharge	l/s
Q_f	Infiltration water	l/s
Q_g	Commercial and industrial waste water	l/s
Q_h	Domestic waste water	l/s
Q_{max}	admissible waste water discharge for v_{max} = 2,5 m/s	l/s
Q_{min}	admissible waste water discharge for v_{min} = 0,7 m/s	l/s
Q_p	pump capacity at the operating point	m³/h oder l/s
Q_R	Rainwater discharge	l/s
Q_t	Dry weather discharge	l/s
Q_{tot}	Total waste water discharge	l/s
Q_{ww}	Waste water discharge	l/s
Q_z	Inflow	m³/h oder l/s
q_h	Specific occurrence of domestic waste water	l/(s • 1000 E)
$r_{5/2}$	Five minute rain, once in two years	l/(s • ha)
$r_{5/100}$	Five minute rain, once in 100 years	l/(s • ha)
$r_{(D,T)}$	Assessment rainfall	l/(s • ha)
T_{Sp}	Duration of switching period	s
v	Flow velocity	m/s
V_D	Volume of pipeline	l
$V_{D/m}$	Pipeline volume per meter	l/m
v_{max}	Maximum admissible flow velocity	m/s
v_{min}	Minimum flow velocity	m/s
V_p	Pumping volume	l
V_{SU}	Sump volume	–
v	Kinematic viscosity (Ny)	mm²/s
ζ	Drag coefficient (Zeta)	–

Symbols used

10. PEHD PRESSURE LINES (EXCERPT)

PEHD-pipes DIN 8074																								
	PN 12,5 - PE 80 - SDR 11							S 8 (PN 16) PE 100 - SDR 17							S 5 (PN 10) PE 100 -SDR 11									
DN	D	x	s	di	$V_{D/M}$ (V_L)	Q_{min} for v = 0,7 m/s	D	x	s	di	$V_{D/M}$ (V_L)	Q_{min} for v = 0,7 m/s	D	x	s	di	$V_{D/M}$ (V_L)	Q_{min} for v = 0,7 m/s						
20	25,0	x	2,3	20,4	0,33	0,23	25,0	x	1,8	21,4	0,36	0,25												
25	32,0	x	2,9	26,2	0,54	0,38	32,0	x	1,9	28,2	0,62	0,44	32,0	x	2,9	26,2	0,54	0,38						
32	40,0	x	3,7	32,6	0,83	0,58	40,0	x	2,4	35,2	0,97	0,68	40,0	x	3,7	32,6	0,83	0,58						
40	50,0	x	4,6	40,8	1,31	0,92	50,0	x	3,0	44,0	1,52	1,06	50,0	x	4,6	40,8	1,31	0,92						
50	63,0	x	5,8	51,4	2,07	1,45	63,0	x	3,8	55,4	2,41	1,69	63,0	x	5,8	51,4	2,07	1,45						
65	75,0	x	6,8	61,4	2,96	2,07	75,0	x	4,5	66,0	3,42	2,39	75,0	x	6,8	61,4	2,96	2,07						
80	90,0	x	8,2	73,6	4,25	2,98	90,0	x	5,4	79,2	1,93	3,45	90,0	x	8,2	73,6	4,25	2,98						
100	110,0	x	10,0	90,0	6,36	4,45	110,0	x	6,6	96,8	7,36	5,15	110,0	x	10,0	90,0	6,36	4,45						
	125,0	x	11,4	102,2	8,20	5,74	125,0	x	7,4	110,2	9,54	6,68	125,0	x	11,4	102,2	8,20	5,74						
125	140,0	x	12,8	114,4	10,28	7,20	140,0	x	8,3	123,4	11,96	8,37	140,0	x	12,7	114,6	10,31	7,22						
150	160,0	x	14,6	130,8	13,44	9,41	160,0	x	9,5	141,0	15,61	10,93	160,0	x	14,6	130,8	13,44	9,41						
	180,0	x	16,4	147,2	17,02	11,91	180,0	x	10,7	158,6	19,76	13,83	180,0	x	16,4	147,2	17,02	11,91						
	200,0	x	18,2	163,6	21,02	14,71	200,0	x	11,9	176,2	24,38	17,07	200,0	x	18,2	163,6	21,02	14,71						
200	225,0	x	20,5	184,0	26,59	18,61	225,0	x	13,4	198,2	30,85	21,60	225,0	x	20,5	184,0	26,59	18,61						
	250,0	x	22,8	204,4	32,81	22,97	250,0	x	14,8	220,4	38,15	26,71	250,0	x	22,7	204,6	32,88	23,02						
250	280,0	x	25,5	229,0	41,19	28,83	280,0	x	16,6	246,8	47,84	33,49	280,0	x	25,4	229,2	41,26	28,88						
	315,0	x	28,7	257,6	52,12	36,48	315,0	x	18,7	277,6	60,52	42,37	315,0	x	28,6	257,8	52,20	36,54						
300	355,0	x	32,3	290,4	66,23	46,36	355,0	x	21,1	312,8	76,85	53,79	355,0	x	32,2	290,6	66,33	46,43						
350	400,0	x	36,4	327,2	84,08	58,86	400,0	x	23,7	352,6	97,65	68,35	400,0	x	36,3	327,4	84,19	58,93						
400	450,0	x	41,0	368,0	106,36	74,45	450,0	x	26,7	396,6	123,54	86,48	450,0	x	40,9	368,2	106,48	74,54						

D x s = outer diameter x wall thickness [mm]
d_i = inner diameter of conduit [mm]
$V_{D/m}$ = Volume of conduit [l/m] defined as V_L in pipeline standards
Q = Capacity [l/s]
v = Flow velocity [m/s]

SDR = Relation of diameter/wall thickness (standard dimension ratio)

	Formula	Units
Flow velocity:	$v = Q/V_{D/m}$	[m/s] = [l/s] / [l/m]
Volume:	$Q = v \times V_{D/m}$	[l/s] = [m/s] x [l/m]
Content of Conduit:	$V_{D/m} = Q/v$	[l/m] = [l/s] / [m/s]

JUNG PUMPEN

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