Design Recommendations

FOR PUMP STATIONS WITH MIDRANGE CENTRIFUGAL FLYGT WASTEWATER PUMPS

FLYGT
a xylem brand

Contents

This document is intended for designers, planners, and users of sewage and storm-water pumping systems that incorporate Flygt submersible pumps in the range of 3152-3301 (320 gpm-5500 gpm).

The pump and sump are parts of an overall system that also includes a variety of structures and other elements such as the pipe system, ventilation systems and handling equipment. Operating costs can be reduced with the help of effective planning during the design stage and with optimised operation schedules. The proper design of the pump sump is crucial in order to achieve an optimal environment for the pumps. This brochure illustrates designs of midrange pump stations that meet these requirements. For pump station recommendations outside the scope of this brochure, please refer to your local Xylem representative.

The design recommendations are only valid for Flygt products. Xylem assumes no liability for non-Flygt products.

General principles

The purpose of a sump design is to ensure proper approach flow to the pumps and prevent the accumulation of sediment and surface scum. The sump should also be big enough to prevent flooding. If the sump is not designed correctly, the hydraulic environment may affect the pump operation – resulting in diminished design performance and reduced pump life. To ensure that the pump operates in a suitable environment, some general points must be considered:

- Flow of water from the inlet of the sump should be directed towards the pump inlet.
- The flow is uniform without swirl or air entrainment.
- The walls must be designed and built to avoid stagnation regions in order to prevent the formation of air-entraining surface vortices and sediment accumulation.
- The water depth must be great enough to suppress surface vortices.
- Excessive turbulence or large eddies should be avoided, although a minor amount of turbulence helps to prevent the formation and growth of vortices.

Pump sump

One problem that can occur in a wastewater pump station is the build up of sludge and solids of different densities. To overcome this, Xylem has developed a self-cleaning sump design, called the TOP sump.

The patented hydraulic design prevents any dead zones at the bottom by promoting fluid flow throughout the sump during pumping. The resulting increase in turbulence causes re-suspension of sludge and settled solids, and entrainment of floating debris. The reduction in the build-up of sludge diminishes the risk of formation of noxious gases. This brochure recommends a design for midrange Flygt pump sumps based on the TOP concept.

Pump station intake

Proper positioning of the intake is crucial in order to ensure a good hydraulic environment for the pumps and to guarantee efficient operation. Preferably the intake is positioned within a 120-degree sector on the opposite side of the discharge pipes (see the illustrations on the page 5). If the intake is located high above the water surface, a pipe leading the water down to a lower level is advisable to prevent cascading flow and air entrainment during the pump cycle. Also, it is recommended that inlet velocities to the sump is between 2.3-6 ft/s (0.7-1.8 m/s).

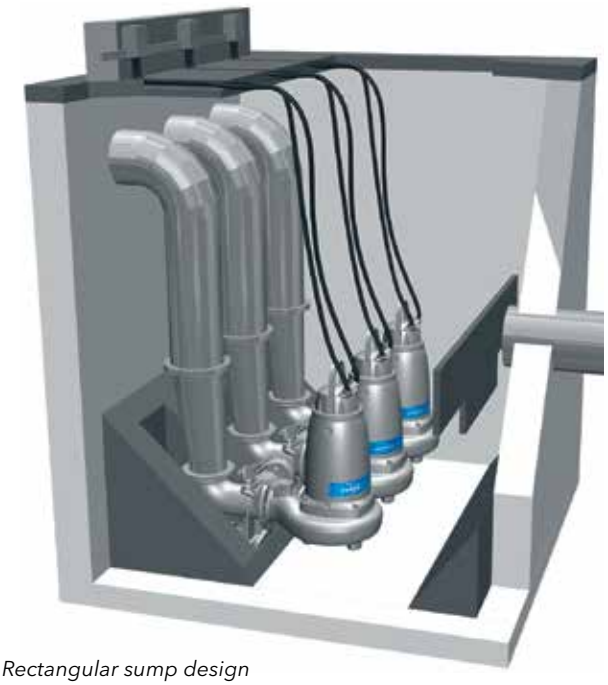
Distance between pump inlet and sump bottom

To provide the best possible inflow to the pump, the minimum distance from the bottom of the sump to the pump shall be 40% of the inlet diameter, provided there is no risk of trapping larger objects between the inlet and the sump floor. To achieve this bottom clearance, sometimes the discharge connection needs to be mounted on a concrete plinth. For information about clearance distance, please refer to the dimensional drawings for each individual pump model.

Sump design recommendation for greater inflow

For pump stations with larger inflows it may be necessary to use a rectangular sump. To ensure good hydraulic conditions in a rectangular sump the walls should be sloped in the same way as in a circular sump. It is also advised to have an inlet baffle located by the sump intake, providing a good hydraulic environment for the pumps.

Circular sump design



Rectangular sump design

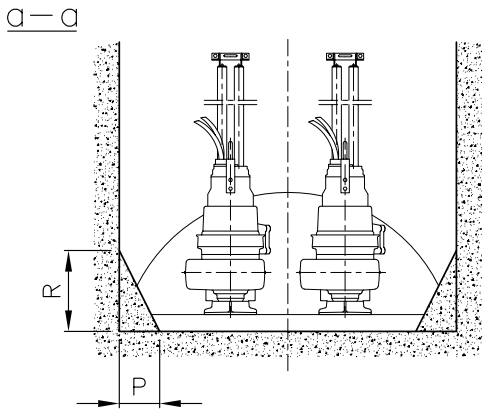
Sump dimensions

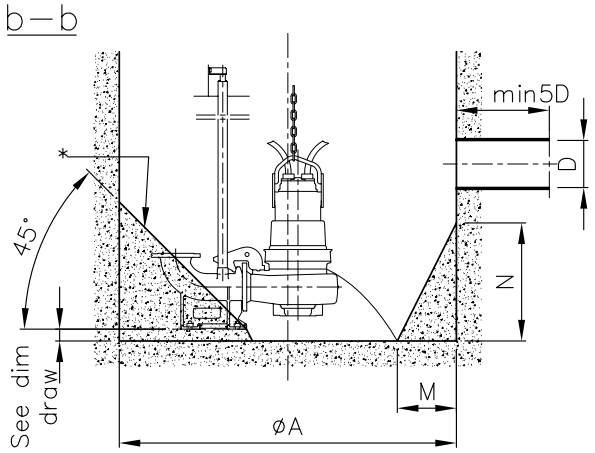
All measurements are in inches.

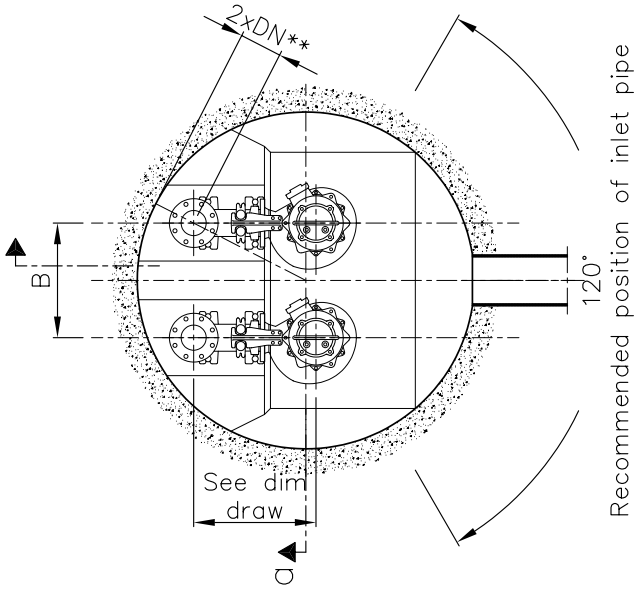
A (in)	M (in)	N (in)	P (in)	R (in)	Max inflow rectangular 3 pumps (GPM)	Max inflow circular 2 pumps (GPM)	Disc. conn. outlet (in)	Install type	Flygt product	Press. type	B (in)
79	14	28	9	19	3186	2849	4	CP	3152	SH	26.4
					3233	2849	4, 6	CP	3152	HT	26.8
					3034	2849	3, 4	DP	3152	HT	25.2
					3034	2849	4	FP	3152	HT	25.2
					3233	2849	6	CP	3152	MT	26.8
					3034	2849	4	DP	3152	MT	25.2
					3138	2849	6	FP	3152	LT	26.0
					2901	2849	3, 4	NP	3153	SH	24.0
					2901	2849	4	NP	3153	HT	24.0
					3186	2849	6	NP	3153	MT	26.4
					3186	2849	4	NP	3171	SH	26.4
					3186	2849	4	NP	3171	HT	26.4
98	17	35	12	24	4042	3883	8	CP	3152	MT	26.8
					4454	3883	8	NP	3153	LT	29.5
					4406	3883	4, 6	CP	3170	HT	29.1
					4406	3883	6, 8	CP	3170	MT	29.1
					4343	3883	6	NP	3171	MT	28.7
					4280	3883	4	CP	3201	SH	28.3
					4454	3883	6, 8	CP	3201	HT	29.5
					4581	3883	6	NP	3202	HT	30.3
					2531	3883	6	RP	3231		34.6
					5056	3883	8	CP	3300	HT	33.5
					4929	3883	6	NP	3301	HT	32.7
118	20	41	14	28	6927	5595	10, 12	CP	3152	LT	38.2
					6499	5595	10	NP	3153	LT	35.8
					7925	5595	10, 12	CP	3170	LT	43.7
					7561	5595	10	NP	3171	LT	41.7
					7418	5595	10	CP	3201	MT	40.9
					6213	5595	8	NP	3202	MT	34.3
					7212	5595	8	CP	3231	6 pole	39.8
					8210	5595	8	CP	3231	4 pole	45.3
					8417	5595	12	CP	3300	MT	46.5
					8210	5595	10	NP	3301	MT	45.3
138	24	48	17	33	10239	7624	12, 14	CP	3201	LT	48.4
					10905	7624	12	NP	3202	LT	51.6
					11159	7624	14	CP	3300	LT	52.8

Flygt pump 3201, see Design recommendations for large wastewater pumps.

Circular





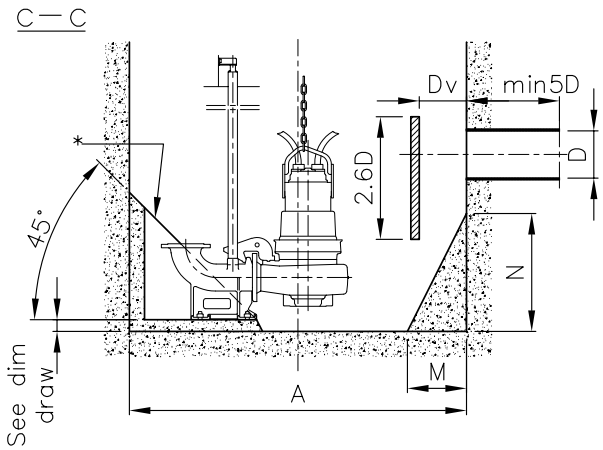


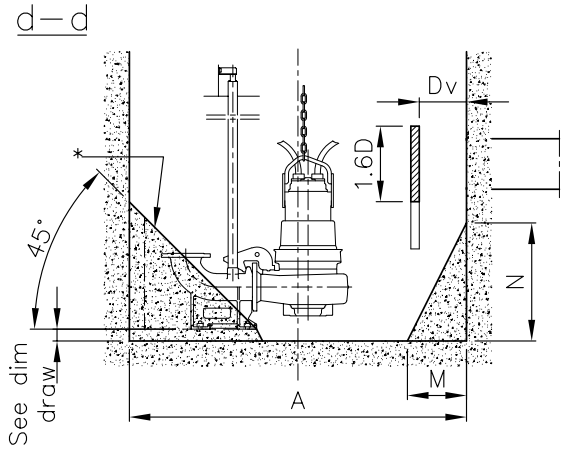
DN = Outlet of discharge connection.

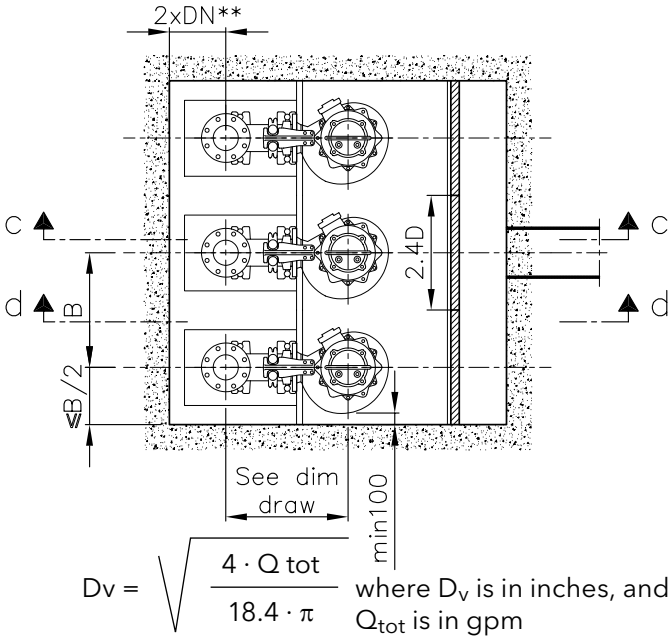
* If any pumps in the sump are to be equipped with a flush valve, this benching may need to be modified. Please contact Xylem for detailed advice.

** Check that there is enough space for valves, bends, etc. on the discharge pipe.

Rectangular







$$Dv = \sqrt{\frac{4 \cdot Q\,tot}{18.4 \cdot \pi}}$$ where D_v is in inches, and Q_{tot} is in gpm

If the distance between the centerline of the pump station inlet and the sump bottom is > 2 N, the inner design of the sump may need to be modified. Please contact Xylem for detailed advice.

If three pumps are to be installed, an inlet baffle should be used.

Required volumes

The starting frequency of the pump depends on the inflow to the sump and the volume between start and stop levels, which is refered to as the "active" or "storage" volume. The real inflow to a sewage pumping station will never be constant. It will differ according to the time of the day, the weather, and the location of the station within the system.

If the maximum value of the inflow is used as a constant inflow value, the volume will be overestimated. This results in long periods of pump inactivity, i.e. at night and in dry weather. This can lead to problems as the sediment settles on the sump floor and floating materials accumulate on the surface. The settled sediment may cause clogging at start and noxious gases may build-up. Blockages of this sort are one of the most common causes of emergency call-outs for pump failure. One way of solving the problem is to reduce the sump volume, which consequently increases the starting frequency. For Flygt pumps, 15 starts/hour are possible without endangering the life of the pump.

Calculating the active sump volume

The required active volume of the sump, V (gallons), i.e. the volume between the start level and the stop level, depends upon such factors as the cycle time for the pump, T (minutes), the pump capacity, Q (gpm), and the rate of the inflow, q (m^3/sec).

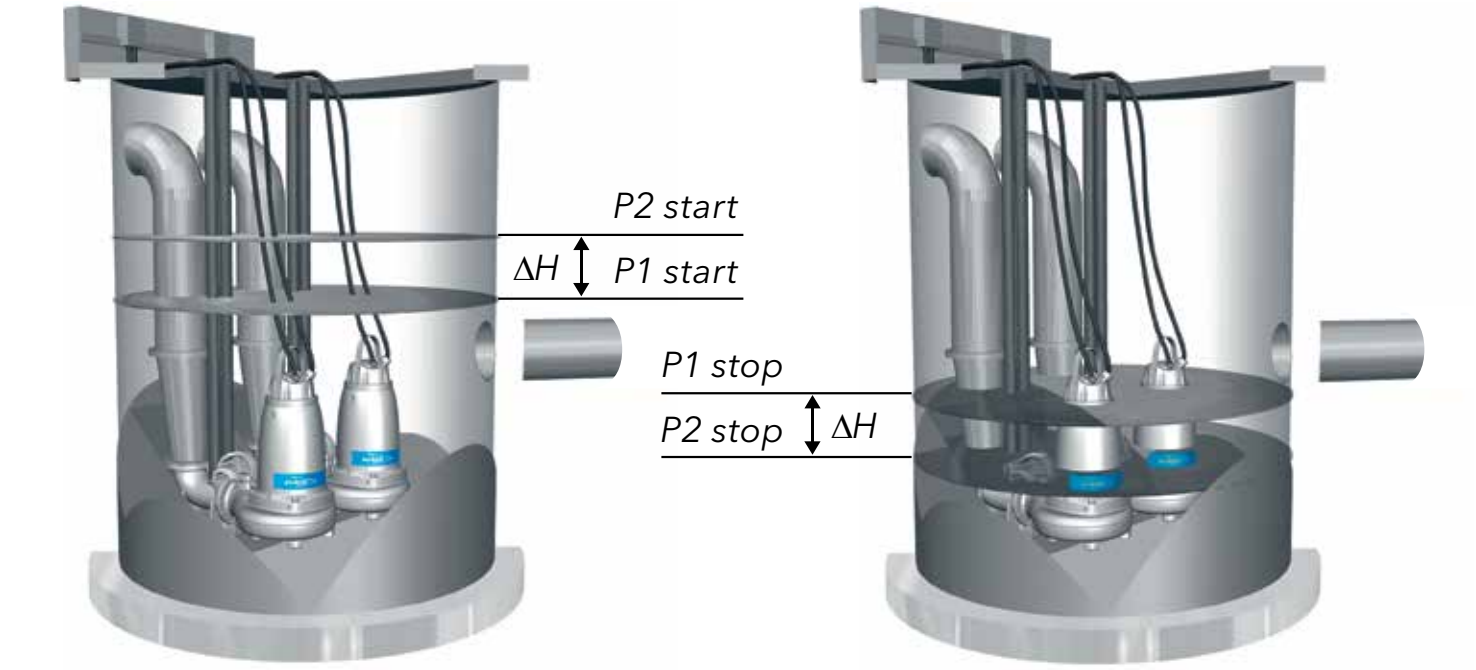
When one pump is operating with variable inflow rate, the shortest cycle time occurs if q = Q/2 which gives the minimum required volume of the sump:

$$V\,min = Tmin \times Q / 4$$

The minimum cycle time is determined by the number of pump starts with regard to the mechanical stress from the temperature rise in the motor. Assuming 15 starts per hour implies a critical cycle time T of 4 minutes, the above equation becomes:

$$Vmin = Qpump$$

where
Qpump: individual pump capacity in gpm (in gallons).



Start and stop levels in a pump sump

For pump stations with several identical pumps, the required volume of the sump can be minimized if the pumps start in sequence as the water level rises due to increasing inflow, and stop in the reverse order as the water level drops due to decreasing inflow. The start and stop levels of all pumps differ by a constant value ΔH (see illustration on previous page) that is determined by the characteristics of the control system. ΔH should be large enough to eliminate accidental pump starts that could be caused by surface waves or imprecise level sensors. In general, the total volume required for a sump with n pumps and a constant value H is:

$$V_{tot,n} = V_{min} + (n-1) \times \Delta H \times S$$

in which S is the plan area of the sump and Vmin is the volume required for a single pump. A significant reduction of the required sump can be achieved if cyclic alternation of the pump is used. In this case, the required volume for one pump equals the volume that is required without alternating, divided by the total number of pumps in the alternative cycle, n:

$$V_{tot,n} = Q_{pump}/n + (n-1) \times \Delta H \times S$$

If a pump station consists of several pumps of different capacities, the required volume for each pump, or group of identical pumps, must be determined separately.

The combined required sump volume will depend on operating requirements for the pump station and must be analyzed in each case.

Systems Engineering

Xylem offers in-depth expertise in the design and execution of comprehensive solutions for water and wastewater transport and treatment.

Our know-how and experience are combined with a broad range of suitable products for delivering customized solutions that ensure trouble-free operations for customers. To do this our engineers utilize our own specially developed computer programs, as well as commercially available programs, for design and development projects.

Scope of assistance includes a thorough analysis of the situation and proposed solutions – together with selection of products and accessories.

We also provide hydraulic guidance and assistance for flow-related or rheological issues. Customers turn to us, as well, for analysis of complex systems for network pumping, including calculations for hydraulic transients, pump starts, and flow variations.

Additional services:

- Optimization of pump sump design for our products and specific sites
- Assistance with mixing and aeration specifications and design of appropriate systems
- System simulation utilizing computational fluid dynamics (CFD)
- Guidance for model testing
- Guidance for achieving the lowest costs in operations, service, and installation
- Specially developed engineering software for system design

The range of services is comprehensive, but our philosophy is very simple: There is no substitute for excellence.

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're 12,000 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

For more information on how Xylem can help you, go to **www.xyleminc.com**

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