FOUNTAIN PUMP SYSTEM DESIGN

by
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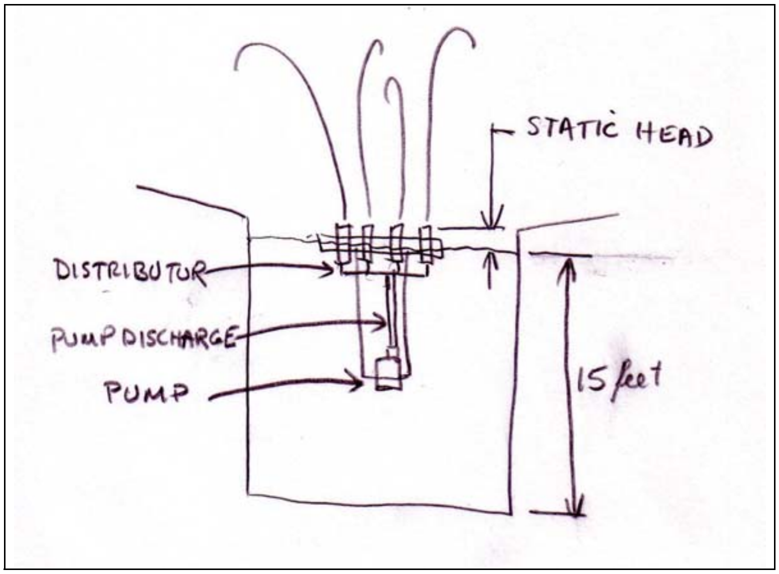
NEW FOUNTAIN PUMP SYSTEM CALCULATIONS AND PUMP SELECTION

To select a centrifugal pump that is appropriate for a fountain design we need to calculate the total head of the pump, for this we need to know the static head, the friction head and the nozzle head loss. The fountain will consist of 12 nozzles mounted on a circular header or distributor with the nozzle tips just protruding above the water level (see next figure). The pump will be a submersible pump mounted directly below the nozzle distributor in the reservoir.



Fountain pump system

The total head of the pump H_P will be the sum of the static head H_S , the pipe friction head H_F and the nozzle head H_N.

$$H_P = H_S + H_F + H_N$$

In this case, the static head is zero or is so small that it is close enough to zero. The static head is the difference in height between the fluid particles located at the inlet of the system (the tank fluid surface) and the outlet (the business end of the nozzle). For more information on static head, see this web page:

http://www.lightmypump.com/tutorial2.htm#energy_and_head

The friction head will depend on the flow and the size of the main distributor and it's length. You can find information and data how to calculate friction loss at the Goulds pump web site: http://www.gouldspumps.com/wd_0001.html

or you can run the friction calculation applet on my web site: http://www.lightmypump.com/applets.htm#applets13

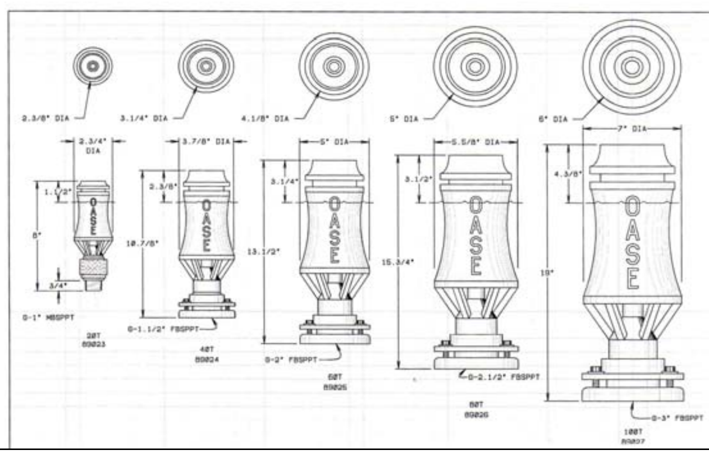
The nozzle that has been selected is supplied by Atlantic Fountains and is called a geyser nozzle. It produces a water spray with the appearance shown in the next figure.

Fountain pump system

The nozzle data head loss and dimensional data is given in the next figure.

Geyser Nozzle

Display Height	20 T				40 T				60 T				80 T				100 T				Display Height
Feet	GPM	TDH	LPM	BAR	GPM	TDH	LPM	BAR	GPM	TDH	LPM	BAR	GPM	TDH	LPM	BAR	GPM	TDH	LPM	BAR	Meters
1'-8"	8.0	6.7	30.4	0.20	21.8	9.0	82.7	0.27	33.8	8.0	128.4	0.24									0.50
2'-6"	8.9	8.3	33.9	0.25	23.4	10.3	89.1	0.31	36.9	9.7	140.3	0.29									0.75
3'-3"	9.8	10.0	37.2	0.30	25.0	11.7	95.0	0.35	39.8	11.3	151.3	0.34	63.7	12.3	242.0	0.37					1.00
4'-11"	11.3	13.0	42.9	0.39	27.9	14.7	105.9	0.44	45.1	14.3	171.2	0.43	71.9	15.7	273.3	0.47					1.50
6'-7"	12.6	16.3	47.9	0.49	30.5	17.3	115.8	0.52	49.7	17.7	189.0	0.53	79.3	19.0	301.3	0.57	120.9	18.7	459.4	0.56	2.00
8'-2"	13.8	19.7	52.5	0.59	32.9	20.3	124.9	0.61	54.0	20.7	205.3	0.62	86.1	22.3	327.0	0.67	130.8	22.0	497.0	0.66	2.50
9'-10"	14.9	23.0	56.7	0.69	35.1	23.0	133.4	0.69	58.0	24.0	220.4	0.72	92.3	25.7	350.8	0.77	140.0	25.0	532.0	0.75	3.00
13'-1"	16.9	29.7	64.3	0.89	39.2	28.7	149.0	0.86	65.2	30.3	247.9	0.91	103.8	32.3	394.3	0.97	156.8	31.3	596.0	0.94	4.00
16'-5"	18.7	36.4	71.1	1.09	42.9	34.4	163.1	1.03	71.8	36.7	272.8	1.10	114.1	39.4	433.5	1.18	172.1	37.7	653.9	1.13	5.00
19'-8"	20.3	42.7	77.3	1.28	46.4	40.0	176.2	1.20	77.8	43.0	295.6	1.29	123.6	46.0	469.6	1.38	186.1	44.4	707.3	1.33	6.00
23'-0"					49.6	46.0	188.4	1.38	83.4	52.4	316.9	1.57	132.4	53.0	503.2	1.59	199.2	50.7	757.0	1.52	7.00
26'-3"					52.6	51.7	199.8	1.55	88.6	55.7	336.8	1.67	140.7	59.7	534.8	1.79	211.5	57.0	803.8	1.71	8.00
32'-10"									98.3	68.7	373.7	2.06	156.1	73.7	593.1	2.21	234.3	70.0	890.5	2.10	10.00
39'-4"									107.2	81.4	407.5	2.44	170.1	87.4	646.5	2.62	255.2	83.0	969.8	2.49	12.00
45'-11"													183.2	101.4	696.1	3.04	274.6	96.4	1043.6	2.89	14.00
52'-6"													195.4	115.4	742.7	3.46	292.8	109.4	1112.8	3.28	16.00
59'-1"													207.0	129.4	786.7	3.88	310.1	122.7	1178.3	3.68	18.00
65'-7"													218.1	143.4	828.7	4.30	326.5	136.1	1240.8	4.08	20.00
82'-0"																	364.7	169.8	1386.0	5.09	25.00
98'-5"																	399.8	204.1	1519.1	6.12	30.00
Mat'l	Brass				Brass				Brass				Brass				Brass				Mat'l
Weight	1.50 Kg		3.30 Lbs		3.20 Kg		7.04 Lbs		5.30 Kg		11.66 Lbs		9.30 Kg		20.46 Lbs		16.20 Kg		35.64 Lbs		Weight
Article #	710-550				711-550				712-550				713-550				714-550				Article #
ID #	50991				50992				50993				50994				50995				ID #
Part #	89023				89024				89025				89026				89027				Part #



Fountain pump system

The nozzle head loss is what Atlantic calls the TDH which is a misnomer. TDH means total dynamic head and is a term reserved for the pump and these days referred to as the total head of the pump. They cannot give us the total head of the pump because they do not know where the pump will be located unless they were to supply a complete system comprising pump, distributor and nozzles.

Submersible pumps of the type we are considering here (sump pumps) come with an integrated motor so that there is no need to calculate the motor horsepower required, if the pump can handle the flow and total head that you calculated then there is no doubt that the motor installed will be adequate.

Detail calculations

The water display that will consist of 12 jets that will produce a pray 6 feet high. I searched the internet and found the geyser nozzle no. 20T which will give a height of 5'-9" at this web site: http://www.atlanticfountains.com/NozzleSpecs/SectionE-7A.pdf

The manufacturer of the nozzle indicates that each nozzle should have a flow rate of 12.6 gpm and that there will be a pressure head loss of 16.3 feet which they call TDH.

Therefore the total flow requirement for the system which will have to be supplied by the pump is 12 x 12.6 = 151 gpm.

At this point we need to calculate the pipe friction loss. We will install a 2.5" pipe that will go from the pump discharge to the distributor, let's assume the pump will lie at the bottom of the reservoir so that the pipe length will be 15 feet.

I can use the two sources mentioned previously to evaluate the pipe friction loss.

lightmypump.com gives me a head loss of 2 feet.

The Goulds web site chart 4 gives me 13.5 feet per 100 feet of pipe since there is only 15 feet of pipe then the friction loss is 13.5 x 15 / 100 = 2, the same as lightmypump.com.

There will be a short piece of pipe (the distributor) that will connect the nozzle inlet to the end of the pump discharge pipe. I will allow 1 foot friction head loss for this short segment which is conservative.

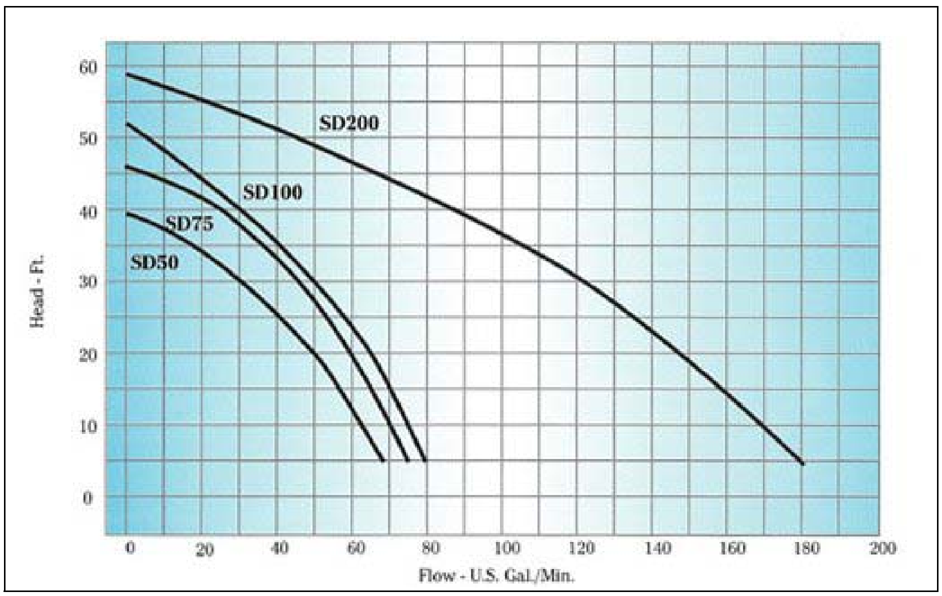
To determine the total head of the pump we add the static head to the pipe friction head loss to the nozzle head loss. We only need to take the head loss of one nozzle, however the flow rate will the total flow required for all nozzles.

Total head = 0 + 2 + 1+ 16.3 = 19.3 feet.

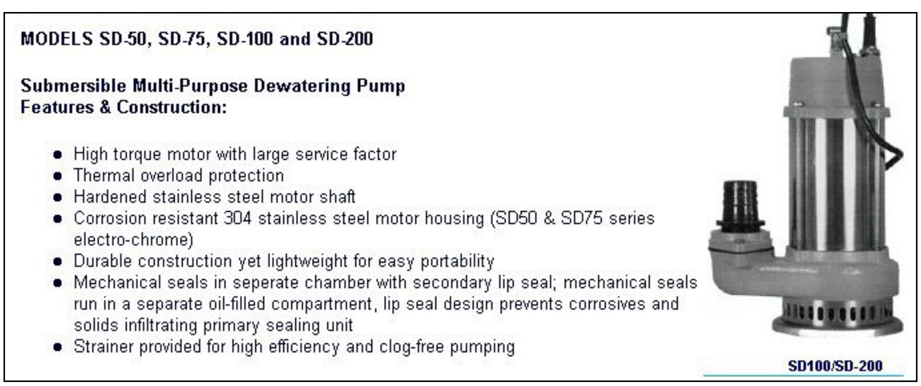
We need to find a submersible pump that can deliver 150 gpm at 19 feet of total head. Why a submersible pump? The installation will be simpler, more compact and efficient if we put the pump as close to the water as possible and in this case in the water.

This is a rather big residential project which means that you are not likely to find a pump this size in the pond or fountain supply stores. A pump this size is however available in the commercial sector.

There are not that many pumps available that will suit this requirement, this is one the Stancor SD-200, , see http://www.stancorpumps.com/sd.htm..



Stancor submersible pump model SD200 characteristic curve.

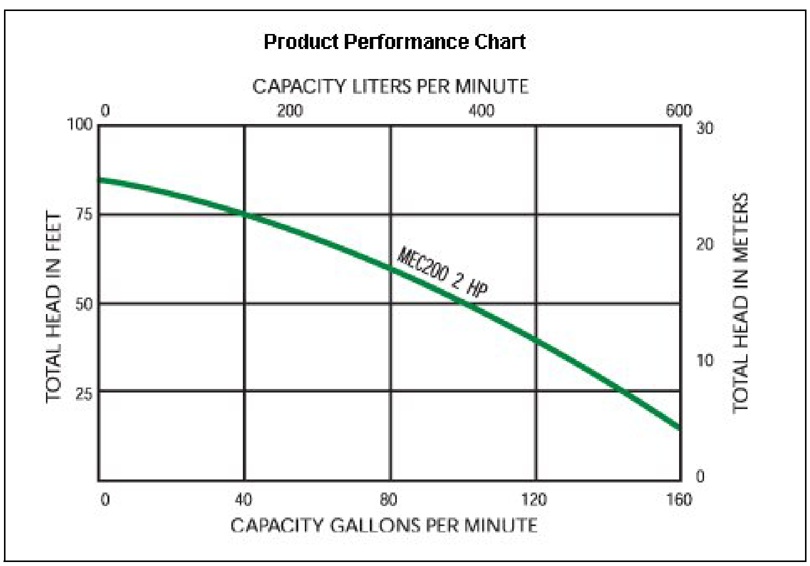


Stancor submersible pump image

Another possible selection is the Myers MEC20 series

see http://www.femyers.com/products/sse/sse_mec200.html

Myers pump model MEC200 series image.

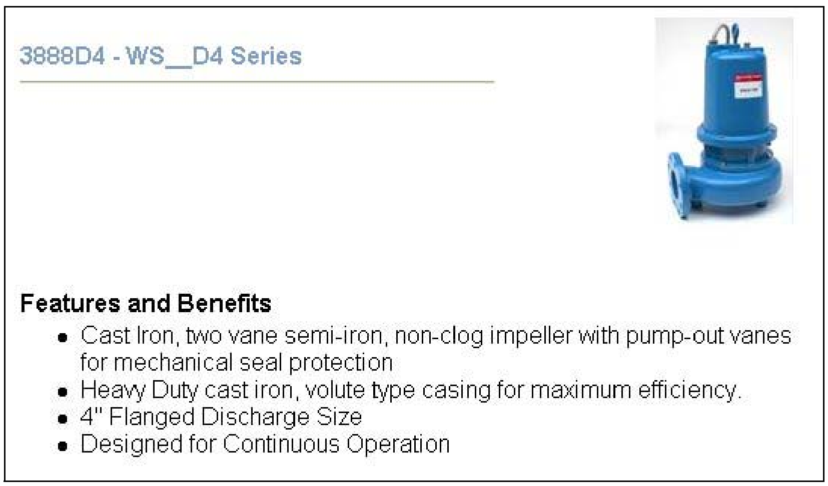


Myers submersible pump model MEC200 series characteristic curve.

However I would not consider either of these pumps an ideal selection, first they are close to their maximum capacity and this may cause the pump to vibrate shortening it's operating life. Second both of these pumps are built for pumping effluent which means they are designed to handle solids which can be a good thing but you are paying extra for something you don't need. I have yet to find another pump that is more suitable for this application.

One final selection is this effluent pump from Goulds. It is a bigger pump, no doubt more expensive and would be more suitable and trouble free for long term operation. You can find the information on this web site

http://www.goulds.com/product.asp?ID=144&MASTERID=4

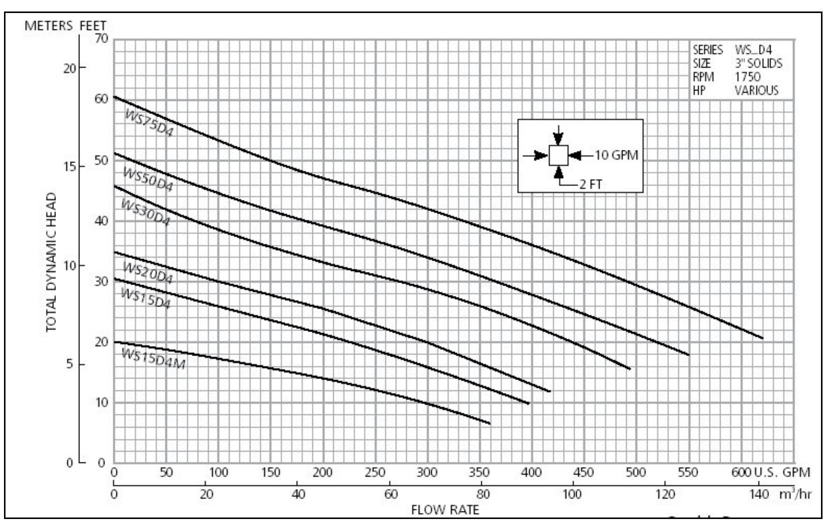

3888D4 - WS__D4 Series

Features and Benefits

- Cast Iron, two vane semi-iron, non-clog impeller with pump-out vanes for mechanical seal protection
- Heavy Duty cast iron, volute type casing for maximum efficiency.
- 4" Flanged Discharge Size
- Designed for Continuous Operation

Goulds pump model 3888D series image.

I would select model WS15D4 which gives slightly more total head at 150 gpm than required which means that you have to put a pressure reducing valve somewhere between the pump discharge and the fountain head distributor to reduce the pressure to get the desired effect.



Goulds submersible pump model 3888D series characteristic curve.