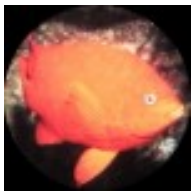
Aquarium Professionals Group

2533 Hartrey Avenue
Evanston, IL 60201

Author: David Hauser

What is Pump "Head-Pressure?"



Along with "flow rate," a pump's "head pressure" (or more accurately "pressure-head," "shut-off head," or "shut-off pressure") is a term often used in pump literature to describe how powerful a pump is. "Flow rate" is simply the volume of water a pump can move during a given amount of time. Pump flow rates are usually expressed in gallons per hour or gallons per minute.

"Head pressure" on the other hand is more complicated. "Head" may be simply defined as any resistance to the flow of a pump. When pump manufacturers list the head pressure, they are referring to the vertical discharge pressure head. Described in very simple terms, a pump's vertical discharge "pressure-head" is the vertical lift in height (usually measured in feet of water) at which a pump can no longer exert enough pressure to move water. At this point, the pump may be said to have reached its "shut-off" head pressure. When you look at a flow curve chart for a pump, the "shut-off head" is the point on the graph where the curved line becomes horizontal as the flow rate at that point is zero. The higher a pump's head pressure, the more powerful the pump.

To use flow rate and head pressure to help you select a water pump, you first need to know: 1) how much water you need to move through your filter system (volume of your aquarium and filters combined), 2) how many times per hour you need to turn over the aquarium volume (flow rate - typically three to five times per hour), and 3) how much resistance (head) the pump will encounter as it moves water from point A to point B. The first two are easy. Calculating the resistance a pump will encounter as it does it's job is a science. If you want to get precise, we recommend you purchase "Aquatic Systems Engineering" by Dr. Pablo Escobal and be prepared to do some math.

Please keep in mind that although the following method of calculating total head pressure is very over-simplified as it ignores resistance from friction as water passes through tubing, exponential pressure curves for water depth in return lines, exact pipe diameters and many other variables, it won't give you a headache as you do the math and you'll still wind up with a pump that'll do the job. Please note however, that if you're planning a very large aquarium, a multi-tank system or any system which will have filtration on a lower level or basement of your home, we suggest you either do some more research or e-mail us for more help and advice.

First, determine the lift or height the pump will need to move water. If the pump draws water from a reservoir below the aquarium, measure (in feet) from the pump to the point water returns to the tank. This will be your initial head pressure in feet.

If the pump draws water from and returns water to the aquarium through a filter, divide this figure in half as the pump is getting assistance from gravity on the intake side.

Keep in mind that every turn the water takes as it returns to your aquarium increases head and reduces flow. Keep tight turns to a minimum. A good rule of thumb if using 1/2" to 1" I.D. tubing is to add one to two feet of head for every 90 degree elbow or tee on the return side of the pump. The smaller the diameter of the tubing, the MORE head you should add.

If you reduce the diameter of the return line at any point, add a number of head-feet to your calculation equal to the percentage of reduction. If, for example, you've calculated a head pressure of ten feet in a 1" tube and you then decrease the diameter of the tube to 3/4", add 25% or 2.5 feet to your head pressure.
If you are using mechanical or chemical filter modules, UV sterilizers, or other inline filters or devices as part of your filtration scheme, add two to ten feet of head per device to your calculation. The finer the material the water must pass through, the more head you should add. Keep in mind that as filter material clogs, head pressure increases. Err on the safe side here.

If you are returning the water to your aquarium at or above the water surface, do nothing. If however the pump must overcome the pressure of water pushing back from a return line below the surface, you must add some more feet of head to your calculation. For each return, add one feet of head for every foot the return point is located below the water and then add these together. If the return is more than two feet below the water's surface, make that two feet of head for every foot below the surface of your aquarium.

Add all your head variables together to determine total head pressure. Add a couple of feet to that just to be safe.

Finally, you'll need the flow curve charts or tables for the particular pumps you're considering. We supply tables for most of the pumps we sell online in the detail pages on our storefront. If you want to buy a pump from us, and you need flow charts, please e-mail us and we can send them to you.

Calculate the flow rate you need by multiplying the number of times you want to turn your system over in an hour by the total system volume. Next, locate the point in the pump flow curve chart where the flow rate intersects with the head pressure you calculated. If the pump is right for the job, this point should be about halfway up the flow curve.

Remember that bigger is not always better when it comes to pumps.

We think that Dolphin®, a major manufacturer of aquarium pumps designed primarily for larger aquaria and multiple aquarium systems, has one of the best web pages on pumps and pump plumbing tips around. Visit www.dolphinpumps.com/plumbing.htm to find out more.

Another great web page written for the proper selection of pumps is actually for the swimming pool and spa industry. This page, written by David Dickman for the "Pool and Spa Service Industry News" (Published by "Wise Software and Computer Products Inc."), may be viewed by visiting www.poolspa.com/publications/sin/stories/pumps.htm. Although the principles and pipe diameters are more applicable to pool applications, we love his simple explanation of head pressures and how to calculate resistance.