

A Water Pump Primer

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The need to move fluids from one place to another is universal on boats. Water pumps clear bilges and flush heads and holding tanks, supply house water to sinks and showers, circulate engine coolant, and provide pressurized water for washdown and refrigeration. Other pumps transfer fuel, drain oil, compress refrigerants, and pressurize hydraulic systems. This report addresses water pumps only. A separate issue of Boat-keeper discusses bilge pumps specifically.

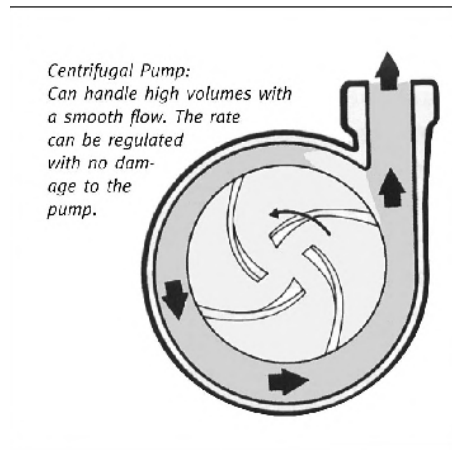
Water pumps fall into three general types: **center-suction centrifugal pumps, variable-volume flexible-impeller and vane pumps, and positive displacement pumps**, including power and manual diaphragm pumps and piston, gear, rotary, and lobe pumps. Vane, gear, and rotary pumps normally are used for moving oils and fuels, and lobe pumps are used to move cosmetics and solids.

How They Work

All pumps use atmospheric pressure to push the fluid into the pump housing to fill the vacuum created when fluid or air already in the housing is expelled by the action of the pump. If the pump is capable of starting up dry and sucking fluid up an inlet line it is considered self-priming. If its inlet has to be immersed or if the fluid has to be poured into it prior to starting, it is non-self-priming.

Centrifugal water pumps use an electric motor to drive a hard plastic or metal rotor. The blades are set in a pattern such that when the rotor turns water is sucked into the center of the chamber and spun outward to the periphery of the housing and through the housing outlet. Center-suction centrifugal pumps (like the common electric bilge pump) are non-self-priming and must be submerged to work. Some types of centrifugals are self-priming; they have a suction inlet above the centerline of the pump housing.

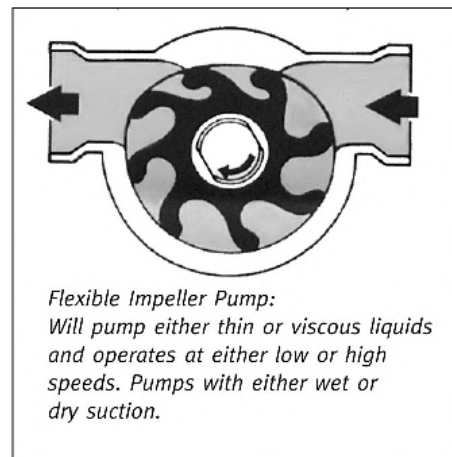
Centrifugal pumps are somewhat inefficient but are versatile and relatively simple, cheap, and easy to maintain and re-



Centrifugal Pump:
Can handle high volumes with a smooth flow. The rate can be regulated with no damage to the pump.

pair. They are moderately resistant to clogging and damage from debris in the water. The rotor does not contact the housing so there is no friction or damage from running dry, although the lip seal that prevents water from entering the motor may soon overheat and cause the motor to burn up if it is not lubricated and cooled by water. They are subject to drastic reduction in flow rate as a result of head pressure, which is discussed further in the report on bilge pumps. Most engine coolant circulating pumps are centrifugal, an application where neither debris nor head pressure is a problem.

The variable-volume flexible impeller pump has an impeller with neoprene or nitrile blades revolving inside a housing that



Flexible Impeller Pump:
Will pump either thin or viscous liquids and operates at either low or high speeds. Pumps with either wet or dry suction.

is circular except for a ramped cam in the liner adjacent to the outlet port. As the impeller spins, each blade leaves the cam, unfolds to full length at the inlet port, and entraps a small quantity of water. As it approaches the side of the housing with the outlet port it is folded back by the cam and compresses the trapped water, forcing it out through the port. Commonly called a "Jabsco," these pumps are also made by Johnson, Sherwood, and other companies.

Flexible impeller pumps are self-priming but should not be run dry more than a few seconds or the impeller blades may burn and break. They serve as engine cooling seawater pumps, but a sea strainer is necessary to protect the impellers from being damaged by debris. Head macerator pumps combine a flexible impeller (suction side) with a centrifugal impeller (discharge side) and set of cutting blades to lift water into the toilet bowl, chop waste, and discharge it to the holding tank with a single motor drive.

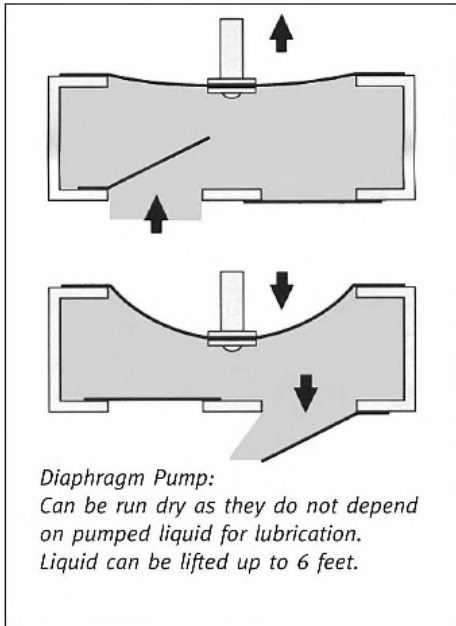
The flexible impeller pump differs from the vane pump, which has spring-loaded rigid vanes that slide in and out through grooves in the rotor hub. The rotor is offset in the housing, and the vanes retract rather than bend as they contact the near side of the liner. Vane pumps tend to be more durable and more expensive than flexible impeller pumps, and are generally used to pump oils or other fluids that would be damaging to flexible impellers.

Positive-displacement pumps work on the principle of changing the interior volume of the pump chamber, increasing it to suck fluid in, then decreasing it to force the fluid out the other side. Although different mechanisms are employed in different pumps, nearly all are self-priming and use atmospheric pressure to charge the chamber.

As the name implies, diaphragm pumps use one or more flexible rubber-like diaphragms attached to a lever or cam arrangement which, when activated, sucks water through the inlet and pushes it through the outlet. A set of flapper valves keeps the fluid

from going the wrong direction. Bellows pumps work the same way except for a different housing shape.

With no internal restriction, single diaphragm pumps can pass fairly large lumps without choking, although small solids like screws and even hair can damage or disable the flapper valves. They are ideal for emptying holding tanks, but have limitations as bilge pumps because they have to be mounted above maximum bilge-water level, and because of the potential for debris damage. The larger capacity permanently installed manual bilge pumps use double diaphragms.

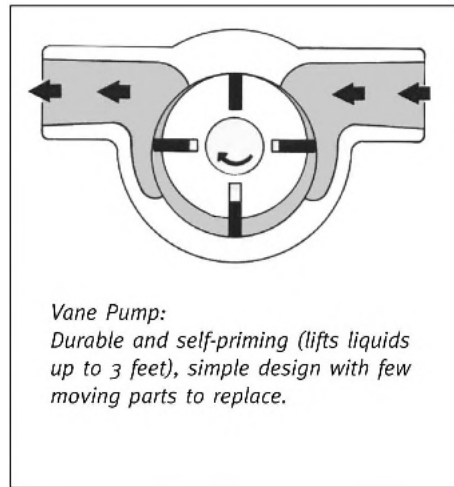


Most house water pumps have a single diaphragm in a single housing with three, four, or five small chambers and a wobble plate actuated by a revolving shaft. This design is compact and quiet, and provides a more even flow than a single chamber diaphragm pump but is very sensitive to solid objects in the water.

Piston pumps work in much the same fashion as the diaphragm and bellows types except that a rigid piston is used instead of a flexible diaphragm. Manual heads (toilets) use piston pumps.

Pump Selection

Pumps are selected on the basis of the following criteria: type of fluid to be moved (is it pure water, does it contain debris, oils, corrosive chemicals or non-macerated sewage?), capacity required, lift required, space constraints, whether it is likely ever to be run dry, and whether it needs to be self-priming.



Most flexible impellers are neoprene, which is cheap and flexible but quickly destroyed by all sorts of chemicals, from antifreeze to detergents, diesel fuel, and urine. Nitrile may be more expensive but is also more resistant to chemicals and oils. The last four digits of the impeller's model number tell the material: 0001 is neoprene and 0003 is nitrile (0004 is viton, a more chemical resistant plastic used to pump acids and solvents). Centrifugal pump impellers generally are immune to chemical and oil damage because usually they are bronze or plastic, although their lip seals may have chemical tolerance problems. Diaphragm and bellows pumps may be susceptible to damage by chemicals.

Although some pump types—large volume diaphragm pumps and centrifugal pumps—are less subject to debris damage than others, all pumps should be protected by intake strainers, and diaphragm pumps with multiple small chambers or valves should have a good in-line screen or filter.

Vane and flexible-impeller pumps should not be run dry. The others can be run without water for extended periods without damaging impeller or diaphragm, but motors and shaft seals may overheat. Motors are designed so that, if the mechanism becomes jammed, the overheating condition won't start a fire.

Centrifugal and displacement pumps react differently to head pressure (resistance on the discharge side). Flexible impeller, vane, and positive-displacement pumps will continue to try to pump the same volume of fluid—drawing more amperage as they do so—until resistance overcomes the power of the pump and a fuse pops or the motor overheats and stops. This means that in applications where flow can be stopped at the discharge, such as on a washdown

system with garden hose nozzle, the pump must be fitted with an automatic pressure switch. Centrifugal pumps will continue to run but flow will diminish to the point of ceasing altogether if resistance is sufficient.

Only centrifugal pumps are designed to be submerged. Other types of pumps may operate at or below the level of the fluid they are pumping as long as the fluid is contained in the plumbing. Positive-displacement pumps can suck fluids to heights of three to ten feet or more, so they can be mounted well above the level of the fluid, and can be mounted in any position. In some applications, self-priming capacity can be enhanced by addition of a check valve in the suction line to retain fluid in the line.

Flow capacity and the ability to push water uphill are important factors in selecting a pump. They are addressed in the report on bilge pumps.

Operating and Maintenance Tips

Electric Pumps:

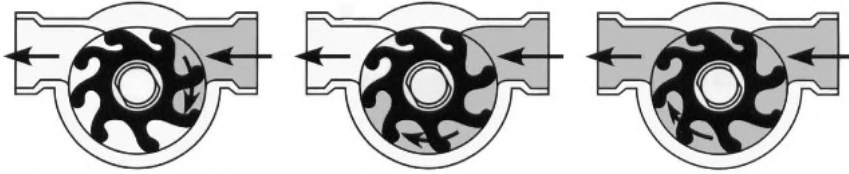
- Ensure that voltage is adequate. Voltage drops diminish pump output dramatically.
- Except for submersibles, mount pumps where they will stay dry. Corrosion kills electric pumps.
- Keep electrical wiring and connections out of the bilge, dry, and sealed against moisture.
- Use an in-line fuse or breaker to prevent overheating and possibly a fire if the pumping mechanism jams.

Saltwater Pumps:

- Use an inlet grate and sea strainer that can be cleaned to prevent debris damage.
- Use an appropriate-size through-hull fitting complete with ball valve seacock.
- If the pump is mounted below the vessel's waterline put an anti-siphon loop in the line.

Flexible Impeller Pumps:

- Use the correct impeller and check it periodically for damage. Keep spares handy. Write down the model



Flexible impeller blades, upon leaving the offset cam, create a nearly perfect vacuum for instant self-priming.

As impeller rotates, each successive blade draws in liquid and carries it from intake to outlet port.

When flexible impeller blades contact the offset cam, they bend with a squeezing action that provides a continuous, uniform flow.

number. Some Jabsco and Johnson splined shaft impellers are interchangeable but Sherwood impellers don't interchange with either because they fit a keyed shaft.

- If the pump is stored for a long period, remove the impeller. To winterize, loosen the end cap and drain the water to prevent freeze damage.
- When replacing a flexible impeller it doesn't matter which way the vanes face; they will align themselves correctly as soon as the pump operates.

All Types of Pumps:

- Use appropriate smooth-wall hose materials in the correct diameter. Keep hose runs as short as possible and minimize bends to allow a free flow of discharge water.
- In house-water applications, use a collector tank to minimize surging in lines and reduce the amount of cycling. ♦

Thanks to Ron Evans of Great Western Pump Co. in Seattle for help with this report.