Run Times
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Approximately one third of the static pressure developed in a centrifugal pump occurs downstream of the impeller. Designers use volutes and/or diffusers to efficiently convert kinetic energy imparted by the impeller into static pressure and to direct the flow to the next stage or pump discharge. In this issue we cover the most common pressure recovery configurations.

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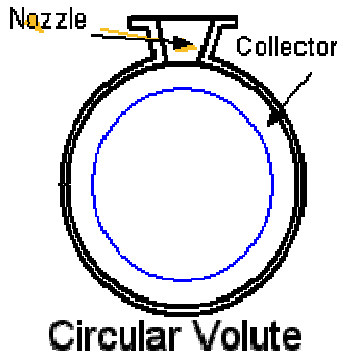
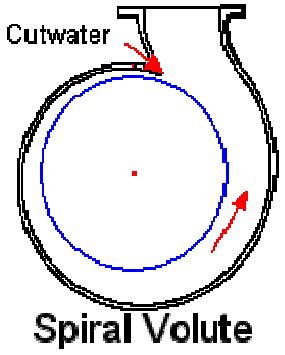
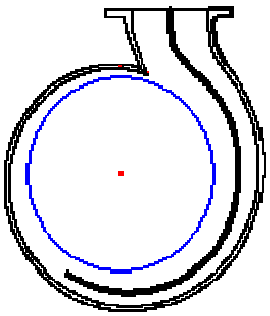
Kinetic energy is converted to static pressure rise by reduction of fluid velocity. Increasing the flow passage area, and/or flow path radius, will result in a velocity reduction. The most common method for controlled velocity reduction in a single stage centrifugal pump is a volute used in concert with a discharge nozzle. Volutes may be circular or spiral in shape. The volute serves as a collector of fluid discharging from the impeller. Expansion, and the corresponding conversion from kinetic energy to static pressure, occurs mostly in the discharge nozzle of the pump, in the section between the cutwater and the pump exit.



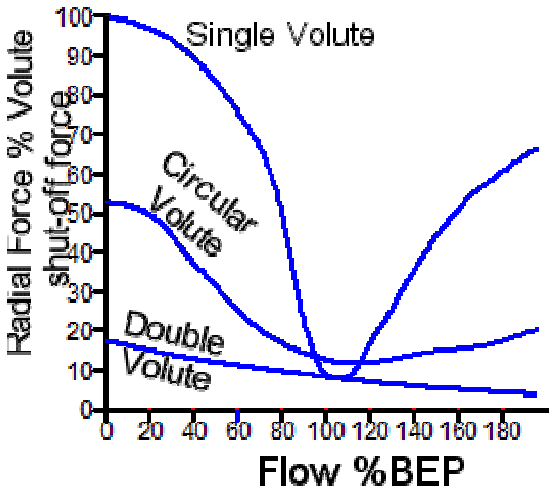
The simplest volute is the circular volute. A circular volute is concentric with respect to the impeller's longitudinal axis. Circular volutes are sometimes used for pumps that require high solids passing capability. When operated away from the pump's best efficiency point flow (BEP), the impeller side loading for a circular volute is typically lower than for a single spiral volute, but is higher than for most other designs. Flow paths in a circular volute are often split as flow takes the path of least resistance to the stage exit. This causes a good deal of turbulence within the volute, resulting in a loss of stage efficiency relative to other volute designs.

Spiral volute pumps incorporate a logarithmic spiral, the purpose of which is to closely match the volumetric flow-rate of the impeller at the best efficiency point. Spiral volute pumps are manufactured in both single and multiple volute configurations. Flow in a spiral volute travels in a single direction from impeller discharge to the volute exit.



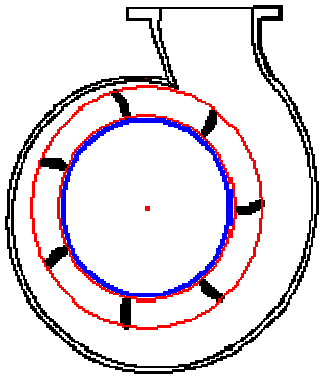


Double Volute



In a properly designed single volute pump operating at BEP, pressure is closely balanced at the periphery of the impeller. Off-BEP operation results in a pressure imbalance around the impeller that causes increased bearing loads and shaft deflection, adversely impacting pump bearing and mechanical seal life. Multiple volutes or diffusers are sometimes used to reduce off-BEP forces. Multiple volute pumps may have a separate discharge for each volute. Most pumps of this type use a single discharge nozzle that incorporates a splitter vane that extends approximately half way around the casing. This is referred to as a double volute pump. There are also a few pump designs available that have two separate volutes feeding diametrically opposed discharge nozzles. Referred to as dual discharge pumps, these pumps are relatively uncommon due to the piping costs associated with them, and are primarily limited to sump applications where the dual discharges are brought into a common header at the mounting plate. Single volute designs have higher efficiency and a larger solids passing capability than similarly rated multiple volute designs. The primary advantage of a multiple volute design is its reduced side loading over a broader operating range. Unless operation can be strictly limited closely to BEP, from a reliability standpoint, multiple volute designs become necessary in high energy pump design.

Diffuser pump designs are characterized by vaned or vane-less sections of expanding volume. They are most commonly used on multistage pumps as an efficient means of delivering fluid from one stage to the next. Diffusers offer the pump designer the most efficient means of pressure recovery. When used in combination, a vaned diffuser and volute often provide higher efficiency than is available with other designs. This is a very common configuration for large centrifugal compressors and sophisticated turbopump designs. However, commercial application has thus far been limited due to the increased costs associated with the manufacture of these units. Most industrial pump applications require relatively small pumps where the increased pump efficiency does not readily justify the additional purchase cost.



Vaned Diffuser

Factors that influence volute selection are maximum solid size, equipment reliability, cost, and efficiency, not necessarily in that order. Prioritization is dependent on the requirements of each specific application.