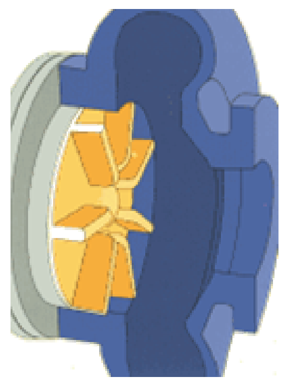
Feb 2005 *vol.2_iss2*

Last month's issue of *Run Times* featured the three most common types of centrifugal pump impellers; open, semi-open and enclosed. These impeller styles are found in the majority of centrifugal pumps and work well over a broad range of applications. In this issue we'll discuss three more specialized impeller styles and their application.

Dale B. Andrews – Editor

<u>Recessed Impellers</u>



Recessed impeller pumps are characterized by impeller vanes that either do not extend into the pump casing. or extend only partially into the casing, essentially leaving the casing as an open flow passage. Recessed impeller pumps are well suited for handling large solids. The maximum solid size is usually limited by the pump suction opening such that any solid that enters the pump will pass through.

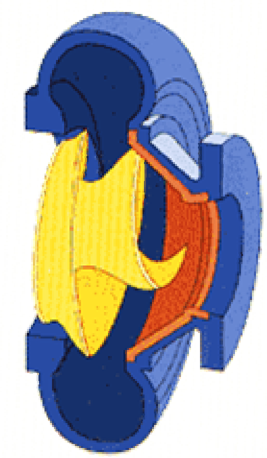
In operation, some of the fluid is drawn into the rotating impeller and discharged back into the casing through centrifugal action. Through fluid dynamics, the partial flow through the impeller imparts a centrifugal rotating motion to the entire fluid body within the casing. Large solids entering the casing are transported by the rotating fluid body from inlet to outlet without necessarily making contact with the impeller.

In addition to handling large solids, a recessed impeller pump will handle a higher concentration of entrained gas than a traditional pump with the impeller centered in the casing. In a traditional centrifugal pump, gas accumulating at the impeller eye prevents fluid from reaching any down stream part of the impeller. This results in a breakdown of the pumping action. In a recessed impeller pump, gas entering the pump does not have to pass through the impeller to exit the pump. Additionally, gas present in one area of the impeller does not prevent other parts of the impeller from pumping. Gas handling capabilities in excess of 30% by volume have been reported with this style of impeller. However, the actual concentration of entrained gas that can be handled for any specific application is dependent on the phase characteristics of the fluid and should be determined by test.

The efficiency of a recessed impeller pump will be less than the efficiency of a traditional centrifugal pump. Efficiency losses result from flow recirculation around the impeller passages, and from the inefficiency of a flow pattern where fluid rotates around the casing numerous times prior to exiting the discharge. Efficiencies in the 40%-50% range are common for recessed impeller pumps.

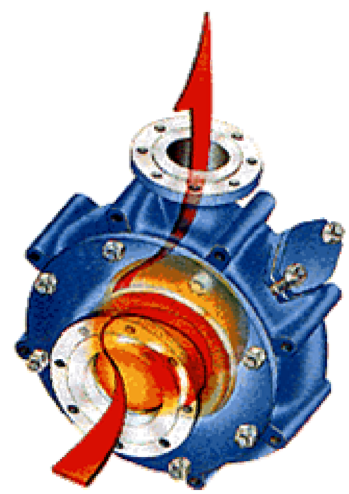
A recessed impeller pump is sometimes promoted for gentle handling, but caution should be the rule before investing. Much of the energy being imparted to the fluid is lost to turbulence and friction, both of which conflict with gentle handling. A better style of pump for gentle handling applications is the screw centrifugal pump described below.

Screw Centrifugal Pump



The screw centrifugal pump impeller is shaped like a tapered Archimedes screw. Originally developed for pumping live fish, the screw centrifugal pump has become popular for many solids handling applications, especially those where gentle handling is an important consideration.

Most screw centrifugal impellers have a single helical vane wrapping around an expanding hub from inlet to outlet. The single passage allows for an easy transition of fluid and solids from the pump inlet onto the impeller. Its inducer-like design exhibits good NPSHR characteristics. Liquid entering the impeller is accelerated more gradually along the smoothly expanding hub to the pump outlet than with a traditional impeller design.

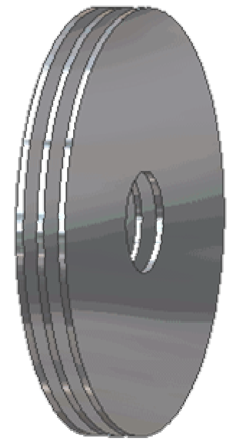


The screw centrifugal pump is a popular choice for handling delicate products such as food and crystals. Its low shear characteristic reduces emulsification when pumping mixtures. The pump's ability to pass long fibrous materials such as rope without clogging makes it a frequent choice for municipal waste water applications.

A screw centrifugal pump typically has an operating efficiency of 70% to 85%. It has a relatively steeply rising head/capacity curve shape giving it good flow control capability over its allowable operating range.

The relatively large size of the screw impeller is a primary disadvantage of this style pump. The heavy impeller mandates a large shaft and power frame to limit shaft deflection; which increases the unit cost. In addition, the single vane impeller is prone to high side thrust when operating off-design. A 1x rpm vane passing frequency vibration, that sets up as the single vane outlet passes the casing cutwater during each rotation, is not uncommon. Multi-vane screw impellers that provide smoother operation are available. The primary trade-off is solid size capability.

Disc Impellers



Disc impellers incorporate two or more parallel discs and do not have traditional impeller vanes. Instead this design relies upon fluid friction and viscosity to generate a pumping action. As liquid enters the disc impeller, friction between the fluid boundary layer and the disc's surface accelerates the boundary layer to about the same speed as the impeller. Resistance to sheer (or viscosity) between the boundary layer and the adjacent fluid layer creates motion in the adjacent layer as well. Each layer in turn is set in motion by the viscous drag from the adjacent layer.

Slip, or the difference in speed between the disc and each layer, increases with distance from the impeller. The effectiveness of a disc impeller is related to the spacing of the discs and the viscosity of the fluid. Close disc spacing and higher viscosity produce better performance than low viscosities with wider disc spacing.

A Disc impeller is well suited for gentle handling of delicate materials. It also performs well in abrasive services as there is little relative motion between the fluid contacting the impeller and the impeller itself. Disc impellers have entrained gas capabilities superior to standard impeller pumps, as gas can enter the impeller and move through the boundary layers without impediment.

The efficiency of a disc impeller is less than that of a standard centrifugal pump. The efficiency of a disc impeller pump is commonly in the 35%-50% range. Because it relies on close disc spacing for effective performance, a disc pump is typically not well suited for large diameter solids.

Summary

All of the impeller styles discussed in the past two issues of *Run Times* are available in pumps operating in applications with low to moderate flows and heads[1]. No one impeller is the best solution for every application. It is important to weigh the advantages and disadvantages relative to each application when choosing. Next month we'll discus some of the impeller and pump designs used in low flow – high head applications.

[1] Specific speed. (N_s) between 15 to 40 (SI), 800-2100 (US). (See our Aug 2004 issue for a discussion of Ns).