Run Times
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Solids are a fact of life for many pump applications; especially sumps, where almost anything can find its way into a pump. This month's newsletter is about some of the primary controlling factors that limit the maximum solid size in a centrifugal pump.

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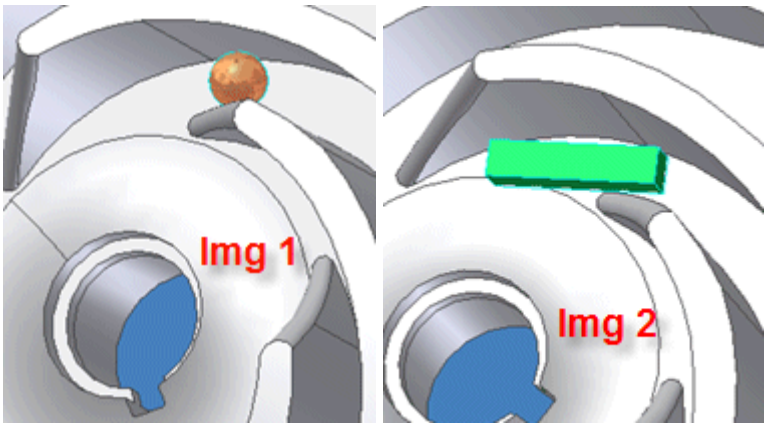
The solids passing limitation of a centrifugal pump is mainly determined by the design of the impeller, the volute, and the pump's flow capacity. Additionally, the shape and strength of the solid itself is determinative of whether it will pass through the impeller or become trapped within the pump. Symptoms of pump blockage are loss of performance, vibration, rubbing, and cavitation. Unless completely plugged, shut-off TDH will usually match the curve, but will fall off rapidly as flow is increased.

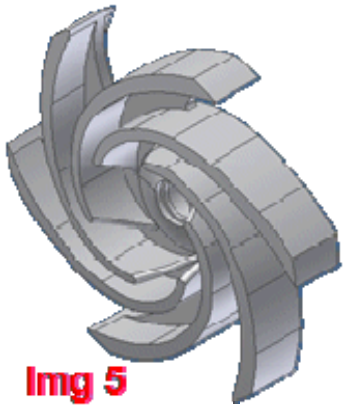


Any analysis of a pump's ability to pass solids starts with the eye of the impeller. Factors that limit solids passing at the inlet include the size of the inlet passage and the curvature of the blades. The smallest passage area in an impeller is generally a point just slightly outboard of the vane inlet at the impeller eye. The distance between the vanes and shrouds establish a diameter limitation of the solid that will pass (Img 1). Most impellers have curved vanes for efficiency. Increased curvature of the impeller vanes more severely restricts the length of a solid that will pass through the impeller (Img 2).

Some impellers have shrouds that taper so that the impeller width narrows between the eye and the impeller outlet. This is done to manage the relative flow velocity and impeller blade loading. A consequence of tapered shrouds can be that the smallest passage width is at the impeller tip and not at the eye, making the impeller tip the size limiting point (Img 3). Multi-vane Impellers designed specifically for solids usually incorporate vane passages of constant width such that the most restrictive point is adjacent to the impeller eye.

Once a solid has made it through the impeller it will almost always pass through the volute, as the area at the volute is larger than that of any single impeller passage. One notable exception is recessed impeller pumps. Recessed impeller pumps utilize a circular casing with the impeller set into the back plate so that the vanes are recessed from the casing space (Img 4). The impeller rotation action creates a vortex in the circular casing such that the centrifugal force of the vortex moves fluid through the pump. The only restriction to solid size in a recessed impeller pump is the smallest diameter of the casing inlet or outlet.

In addition to recessed impeller pumps, manufacturers facilitate solid passing capability by lowering the impeller vane count to increase the available passage size, reducing the curvature of the vanes, and by utilizing open impellers instead of enclosed impellers (Img 5). The impeller passage size isn't necessarily any larger with open impellers, but an open impeller causes the solids to have to interact with the stationary casing wall which can facilitate breaking the solids so that they may pass more readily. The flow capacity of a pump is also a factor. Capacity determines pump size and the pump size limits the solid size. One can't get a two inch solid out of a one inch pump.



Finally, the type of solid that enters the pump has a big influence on a pumps solid handling capability. Long fibrous solids like rope or bark will not pass through a conventional impeller. A flexible solid will often conform to the Impeller eye and ensnare the vane leading edges, becoming a trap for other solids entering the pump. Some pump styles are manufactured with cutter or breaker devices at the inlet to reduce the size of solids entering a pump. Without a positive means of size reduction, the best alternative is to use an inlet strainer of a mesh smaller than the maximum allowable solid size.