Pump ED 101

Lower Flow Non-Clogs - - Solids Handling Options

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The "Ten States Standards" and other municipal and state codes require submersible wastewater pumps to pass a minimum of a 3" spherical solid. This is not a difficult task for many 4" and larger non-clogs but, a problem arises when flow requirements drop and certain heads must be maintained. These lower flow, higher head applications can make it difficult to accommodate a 3" solid.

Have you ever wondered why a typical, ½ HP residential sewage pump has a flow rate of well over 80 GPM? If we turned on every faucet, flushed every toilet, and ran every appliance at the same time flow would not exceed 30 GPM for the average three or four bedroom home. It turns out this 80+ GPM flow rate is due to an impeller characteristic we seldom consider.

When we think about the varying flows and heads produced by a centrifugal pump our brains tend to focus on the affinity laws, impeller diameter, and motor speed. We know that flow is directly proportional to both rotational speed and impeller diameter. And, of course, head varies as the square of a change in diameter and rotational speed. But, there is another factor that contributes to flow - - vane width or the distance between the shrouds of a closed impeller. If we double the width the impeller's internal volume doubles. If we keep diameter and rotational speed constant, flow will vary in proportion to vane width. Since that residential sewage pump is designed to pass a 2" solid, its vane width will dictate a much higher flow than one might expect. The same holds true for a 4" non-clog designed to pass a non-deformable, 3" spherical solid.

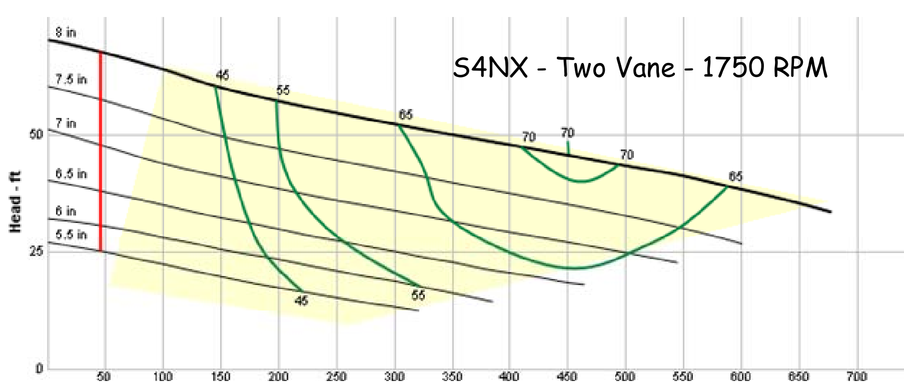


Figure 1 shows the performance of a moderate flow, 4" submersible non-clog that meets the Ten States standard for solids passage. It employs a two vane impeller operating at

1750 RPM to produce a BEP flow of 450 GPM at 70% efficiency. Could we use this pump in an application that requires 225 GPM? If we trim the impeller to about 6" we could obtain that flow at about 22' but our efficiency would drop to about 47%. A better alternative would be to reduce the rotational speed to 1150 RPM as the pump would maintain about 60% efficiency since efficiency moves to the left with a reduction in speed. But, suppose we require 225 GPM @ 38'? Couldn't we just trim the impeller to 7" and run at a lower efficiency? We could - - but if you read my June 2008 P&S article, you now know that we must be willing to accept a lower reliability due to the increased radial forces that are formed when operating that far off BEP.

Unfortunately, this puts us in that proverbial area located between a rock and a hard place. We can reduce flow by reducing the impeller's diameter or rotational speed but, in doing so, head becomes unacceptable. We can also reduce flow by reducing the vane width. Now head will remain acceptable but the impeller will no longer pass a 3" solid. Or, we could run well to the left of BEP and accomplish both at a cost of reduced pump life. Fortunately there are other impeller options.

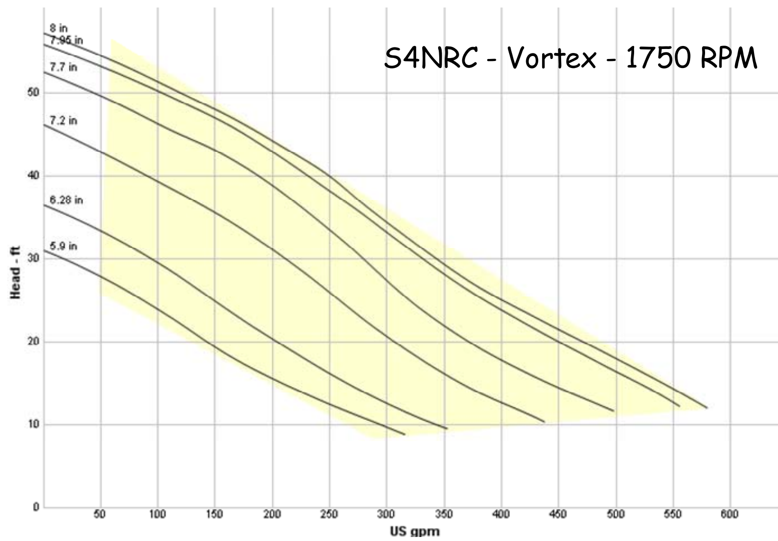
Single Vane Impellers

The single or mono vane impeller, seen in Figure 2, was developed in the late 1940's by Fairbanks-Morse. Its unique geometry produced different flow characteristics and resulted in a steeper H/Q curve than that of a two vane impeller of the same size. It also passed a larger solid and was more tolerant of the radial forces that arose due to off BEP flow. They are still popular today and the only negative is that it can be difficult to balance in the field due to its inherent lack of symmetry.

Figure 3 is the H/Q curve produced by a single vane impeller. This particular model will produce flows of 200 to 350 GPM at a wide range of heads and still pass a 3" spherical solid. This impeller design offers a viable alternative to off BEP operation of a two vane impeller.

Vortex Impellers

In my August 2007 column, "Vortex Action: How Lower Efficiency Can Reduce Overall Cost", I went into detail about the two stage process that gives rise to flow in the vortex pump, so I will not repeat it here. What I will reiterate is that the vortex impeller resides completely outside of the volute and this feature gives rise to two significant advantages. First it is immune to radial thrust and can operate well to the left of BEP. Secondly it allows lower flow pumps to pass a full 3" spherical solid since the solid does not have to traverse the vane passages. These advantages do come at a cost – lower hydraulic efficiency. But, this is usually a small price if you have a low flow application that requires the passage of large solids. Figure 4 shows the performance curve for a 4" vortex pump that meets the Ten States Standard. This particular model provides flows from 150 to 350 GPM at heads up to 45 feet. Other models will provide similar flows at significantly higher heads and still pass a 3" spherical solid.



If you have lower flow applications that still require the passage of large solids, I encourage you to investigate these impeller alternatives. Lower flow, solids handling pumps are generally less efficient than higher flow models. Therefore reliability – not efficiency – should be your major concern.

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