IMPROVING CENTRIFUGAL PUMP PERFORMANCE

Production facilities often require increased output and consider means of improving the performance of installed equipment. For a pump, this is generally the need for increased flow rate.

The applicable concept is the fact that all centrifugal pumps operate at a flow rate that corresponds to the intersection of the pump curve and the system curve.

To increase the flow rate from an existing pump, either the pump operating characteristics, or the system resistance characteristics need to change. If other modifications to the pumping system are being considered such as new piping, heat exchangers, etc, a new system curve needs to be developed as a baseline reference before considering any of the following modifications

Options for increased flow from an existing pump:

- Increase the impeller diameter
- Increase the pump speed
- Modify the impeller blades
- Install a different impeller
- Install a suction inlet splitter vane
- Decrease the system resistance

Impeller diameter/speed change
In systems where the primary flow resistance originates from friction (pipe, valves, heat exchangers, etc) flow will increase in direct proportion to a change in impeller diameter or speed (a 10% increase in speed or impeller diameter will yield a 10% change in flow). The pump operating point as a relative percentage of the pump best efficiency point will remain unchanged

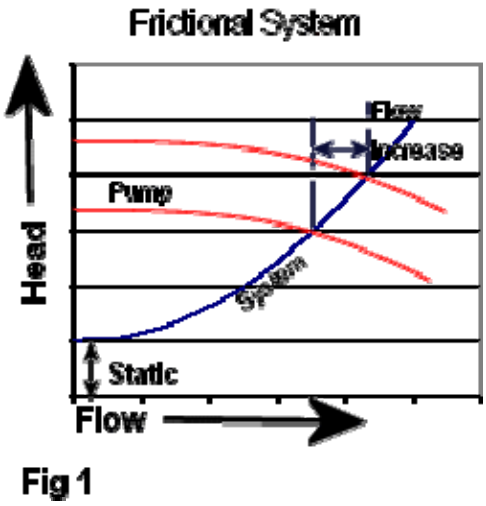

Fig 1

In systems where the primary resistance comes from a pressure vessel, any increase in flow will be primarily dependent on the shape of the pump characteristic curve. Flatter curves will experience a higher percentage of flow increase than steep curves. The pump operating point relative to the pump best

efficiency point may change. The only way to predict the performance is to plot the intersection of the pump and system curves.

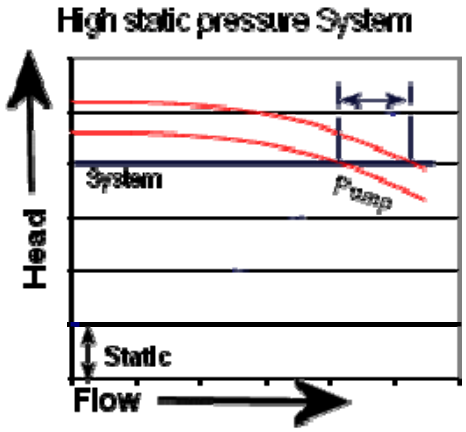

Fig 2

Impeller blade modifications

In some cases flow may be increased through modifications to an existing impeller or volute. Impeller modifications might include blade shape modifications through machining or grinding and typically result in a flattening of the pump curve, resulting in higher head as the pump reaches higher flows. Head increases are usually less than 10% using these methods. Modifications of this type are usually expensive to perform and are unpredictable in their result or repeatability. They are mentioned here by means of acknowledgement - not suggestion

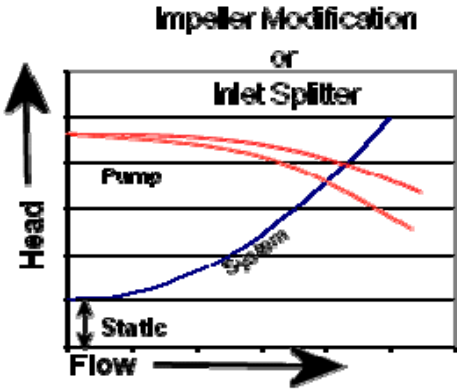

Fig 3

Installation of a different impeller

The available head from an impeller is largely a function of peripheral speed which is set by diameter and RPM. The available flow from an impeller operating at a constant peripheral speed is controlled by the blade angles at the impeller inlet, and the volume of the impeller vane passages. Many pump manufacturers offer multiple impeller designs to fit within a single pump body that, along with interchangeable diffusers or volute liners, offer a significant change in flow characteristic for a given TDH.

Installation of a suction splitter vane

Installation of one or more stator vanes adjacent to the pump inlet will have an effect similar to that described under impeller blade modifications. The amount of performance increase achievable is dependant on impeller design and operating point, but a 10-15% increase of TDH at BEP is not uncommon. Unlike the impeller modifications, inlet vane installation is often relatively simple and does not require customization of spare parts. The impact on NPSHR should be determined through testing.

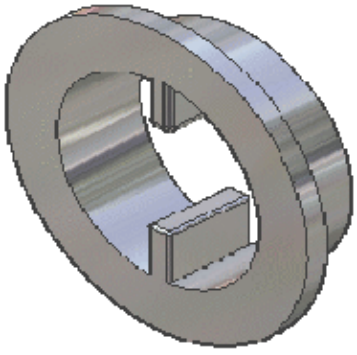

Fig 4

Decrease system resistance

Upgrading valves, replacing heat exchangers, or modifying piping or other system components to lower the resistance head at any given flow will result in a pump that will operate at an increased flow. The pump will also have a reduced horsepower requirement as compared to the previous methods that increase pump TDH to achieve the desired increase in flow.

Summary

Although several methods of increasing flow rate have been discussed, it is our opinion that the modification of impellers and installation of suction splitter vanes are not really viable. The reasons are the uncertainty of the improvement and the repeatability of the process particularly in the case of blade modification. The better means of achieving increased flow are

- increase speed
- increase impeller diameter
- reduce system resistance

Other considerations

There are a number of associated mechanical and hydraulic issues that should also be evaluated when investigating modifications to increase a pump's flow rate. It is a good idea to consult the OEM's service department to assist in evaluating the pump requirements. Some of the items are as follows:

NPSHR: It is likely that the NPSHR will increase if either flow or pump RPM is increased.

Seal flush requirements: The pressure at the seal chamber will increase in proportion to the pump discharge pressure. Make sure that there is adequate seal flush pressure to give the required flow rate through the seal.

Power: Increasing flow rate will result in increased power draw unless it is accompanied by an adequate decrease in system head requirements. When changing speed or impeller diameter, power will vary approximately as the cube of the ratio of the change. Couplings, base plate dimensions, and electrical components will all require re-evaluation.

Mechanical: Planned changes to the operating speed should be evaluated with respect to rotor critical speed, pressure containment, and mechanical seal limitations.

Operating Limits: Changes that move the pump further away from the best efficiency point may decrease pump reliability due to hydraulic instability.

Courtesy of Lawrence Pump Inc