Fine-Tuning Pump Performance Bands

Wallace Wittkoff, Hygienic Director, Dover's Pump Solutions Group (PSG)

When it comes to evaluating a pump’s performance or choosing the proper pump for an application, many people focus solely on flow rate. In reality, a number of fluid-transfer concepts must work in concert in order to have a pump that is dependable while meeting the needs of the application. These concepts include inlet/discharge conditions, speed and power requirements, durability, and energy usage.

Over the years, as the benefits and operational advantages on in-line continuous-blend processing have made themselves evident, rotary-style positive-displacement pumps have been determined to offer the precise flow control for precise metering applications. Users of rotary-style positive-displacement pumps have found ways to produce a product at the least cost considering factors such as plant-wide labor, floor space, capital investment, cleaning infrastructure and total process energy usage.

In the past, several drawbacks in the use of continuous-blend processes have been caused by limitations in the pumping technology employed. Past and existing systems can be effective, but cannot accommodate wide changes in process parameters like flow rates (affecting proportion limits) and viscosity (ingredient flexibility). Additional issues with existing continuous in-line blending processes include stability as a result of startup/shutdown conditions, equipment aging and process upsets.

However, new pump technologies, as well as the correct selection of existing technologies, are now enabling the wider use of continuous-blending processes that require more flexibility and stability.

A key consideration in this area is a pump's performance band. This is the pump's family of duty points (pump speed vs. delivered flow rate) resulting from pump slip for a range of possible process conditions, including viscosity, back pressure, temperature and even pump wear during its lifetime. The pump performance band can be described as either tight or loose, which indicates how much the flow can change (think of slack) for a fixed pump speed. The performance band can also be described as wide or narrow to indicate the possible range of speeds the pump can run at while producing flow.

From a practical standpoint for in-line blending applications, the tighter the pump performance band, the better the metering accuracy under varying process conditions. At the same time, the wider the performance/flow rate band, the more flexibility there is in handling formulations that require a wide range of possible ingredient input flows. In addition to the pump just simply working, the correct application of a pump's performance band allows refinement to the transfer process, permitting new and enhanced applications that were previously not possible or reliable.

Tight Vs. Loose Pump Performance

The root issue with rotary positive-displacement pumps is that the flow performance on all pumps is to some degree affected by internal clearances that result in slip. The degree of slip changes with:

- Change in viscosities.
- Change in differential pressure.
- Clearance allowances for temperature change.
- Wear (resulting in an increase in clearance).

Given these product/process variables, tight performance is one in which the pump maintains close to its theoretical displacement independent of changes to the variables listed above. The very definition of a positive-displacement pump is a pump that transfers a set displacement per unit operation, such as revolution or stroke.

Tight vs. loose pump performance is the extent to which, under a given range of conditions, the pump maintains high volumetric efficiency. Pump slip is the difference between the theoretical displacement and the actual displacement. Therefore, the lower the pump slip in any condition, the tighter the pump's performance would be under conditions of changing viscosity, pressure, temperature or wear.

Classifying a pump as simply positive displacement without quantifying the tightness of its performance band can greatly affect the desired results in an application. The extreme example is one in which, regardless of the pump speed, the slip is 100 percent. That is, all fluid that is pumped forward then flows (slips) back through the pump's internal clearances to produce no net fluid transfer. While sounding dramatic, it is not uncommon that a pump reaches this point (total loss of flow) before it is taken out of service to be repaired or replaced.

Most users specifying pumps attempt to control the extreme variabilities of viscosity, pressure, temperature and wear all at the same time. In many applications, this variation is sufficient to produce a challenging operational scenario. In some cases, advanced automation can help, such as using flowmeters with speed/pressure control loops. However, there are cases in which the possible variation cannot be compensated without recalibration or retuning the processes. These methods can prove costly or unfeasible, and could also increase system complexity (thus reducing reliability).

Today's more advanced pump manufacturers provide the tools that permit evaluating the possible slip for a given application. Curves are supplied that demonstrate how to down-rate the flow given changes in back pressure, viscosity or change of internal component clearance to handle certain temperature ranges. These tools are helpful to be able to compensate for the performance. At times, however, these performance changes can't be adequately or reliably compensated and may not produce optimal control.

For more information, please take a look at the full white paper *[1], or* www.pumpsg.com *[2].*

Look for part two of this pump discussion sometime next week in the IMPO Insider Daily.

Links:
[1] http://www.pumpsg.com/PDF/whitepaper_PSG_PumpPerformance.pdf
[2] http://www.pumpsg.com/