Application Note to the Field	Minimum Flow Rate for Centrifugal Pumps
Application Note Number: 1602-4	**Date: February 2, 2016**

Unlike a positive displacement pump, a centrifugal pump can, and should, be controlled by throttling the discharge to obtain the desired operating point. The operating point must always fall on the pump curve to prevent damage to the pump, such as that resulting from cavitation. However, operating too far to the left or right of the performance curve is less than optimal for a centrifugal pump as it can cause shaft deflection, bearing and seal wear, and if too far to the right, cavitation.

When a centrifugal pump is operated very close to dead-head (also called "back" or "to the left" of the curve), the discharge flow is throttled and reduced. With nowhere else to go, this causes most of the fluid inside the pump to recirculate. This can cause noise and erosion at the eye of the impeller and can also raise the temperature of the fluid.

If you need to operate a centrifugal pump back on the curve, the minimum suggested point is at 10% of BEP (Best Efficiency Point). For example, a 620 pump with a full impeller has a BEP of 44% at 24 GPM. Therefore, the minimum flow should be limited to 10% of 24 or 2.4 GPM. The pump is, of course, capable of pumping at lower flows; however, excessive wear and shortened life may occur.

Also, one must determine if the temperature rise at the minimum flow is acceptable for the application. The temperature rise can be determined using the following formulas:

$$\Delta \boldsymbol{T} = \frac{\boldsymbol{H}}{\mathbf{778}\, \boldsymbol{C_p}} * \left(\frac{\mathbf{1}}{\boldsymbol{E}} - \mathbf{1}\right) \quad where: \boldsymbol{E} = \frac{FHP}{BHP} = \frac{Q_{min} * H * SG}{BHP * 3960}$$

ΔT = Temperature Rise [°F]
H = Total Head [feet]
C_p = Specific Heat of Fluid [Btu/lb-°F]
E = Pump Efficiency

Q_{min} = Minimum Flow Rate [GPM]
SG = Specific Gravity of Fluid
FHP = Fluid Horsepower
BHP = Brake Horsepower (determined from pump curve)

Note: The above formula does not include the additional rise in temperature resulting from eddy currents induced in a mag-drive pump's metallic containment can. Consult factory for additional information.

Likewise, operating within 10% of the right of the curve should be avoided to prevent a system fluctuation from causing the pump to "run off the curve," which can increase the NPSH required by the pump, possibly going above the NPSH available in the system and causing cavitation.

The most important point to remember when operating a centrifugal pump is that the system curve and pump curve must intersect. That is, the pressure requirements of the system have a direct effect on the flow rate of the pump, unless the pump is artificially controlled, or throttled, to reach a lower flow rate.

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