Chapter 15
HEAT GENERATED IN PUMPING

In centrifugal pumps, some of the input energy is transformed by fluid friction into heat, which increases the temperature of the liquid being pumped. The temperature increase is dependent upon the flow rate of liquid moving through the pump. At normal flow rates, this temperature rise is negligible; while under shutoff (zero flow) conditions, the temperature will continue to rise, resulting in eventual damage to the pump. It is obvious that some minimum flow rate must be maintained to prevent this from occurring. In order to determine the minimum flow rate, the maximum allowable temperature must be known.

The maximum allowable temperature rise is established by three basic considerations:

1. The temperature at which the pumped product will be adversely affected.

2. The temperature at which the properties of the pumped product are changed so as to adversely affect the action of the pump (e. g. vaporization, polymerization, etc.)

3. The maximum temperature which various components of the pump and/or piping system (e. g. mechanical seals, packing, gaskets, etc.) can accommodate.

In most applications, 10° F. is an acceptable temperature rise; however, when NPSH is critical, the temperature rise should be limited to 5°F. or less.

The minimum flow rate which must be maintained may be calculated as follows:

$$Q = \frac{5 \times BHP_o \times C_{hp}}{\Delta T \times sp\ ht} \qquad \text{Equation 15.1}$$

where:

Q	=	minimum flow rate, in gpm
BHP_o	=	the non-viscous performance curve horsepower at shutoff
sp ht	=	specific heat of liquid
ΔT	=	maximum allowable temperature rise, degrees F.
C_{hp}	=	viscous horsepower correction factor. (See Chapter 8, Figure 8.1).

To find the temperature rise resulting from a known flow rate, the Equation 15.1 can be written as follows:

$$\Delta T = \frac{5 \times BHP_o \times C_{hp}}{Q \times sp\ ht} \qquad \text{Equation 15.2}$$

Example 1 **Calculating Minimum Flow Rate**

Given a 4 x 3 -13 pump at 1750 rpm (See Figure 8.3), handling a liquid with a 1.23 specific gravity, a 0.85 specific heat, and a viscosity of 1625 centipoise, what is the minimum allowable flow rate for the 12½" impeller if the temperature rise is to be kept below 10° F.? (See Figure 8.1.).

Solution

1. From Figure 8.3, read the non-viscous shutoff horsepower for the 12½" impeller equals 11.8.

2. Following the procedure outlined in Example 1 of Chapter 8, (which calls for the same pump, operating under the same conditions as the example) find the viscous horsepower correction factor, $C_{hp} = 1.5$.

3. Substituting into Equation 15.1.