

## Variation of Pump Diameter

A variation in pump diameter may also be examined through the similarity laws. For a constant speed,

$$Q_1 / Q_2^3 = Q_2 / D_2^3$$

and

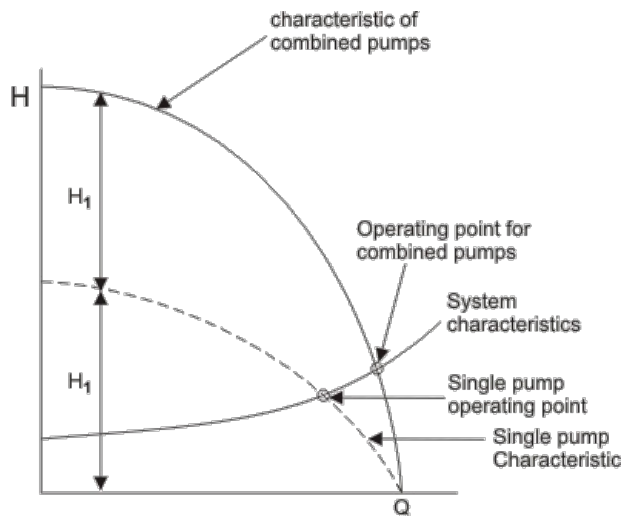
$$H_1 / D_1^2 = H_2 / D_2^2$$

or,

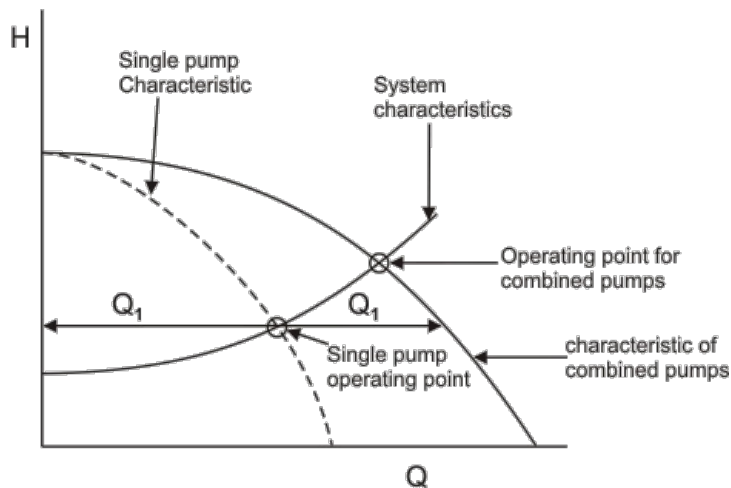
$$H \propto Q^{2/3} \quad (38.1)$$

## Pumps in Series and Parallel

When the head or flow rate of a single pump is not sufficient for an application, pumps are combined in series or in parallel to meet the desired requirements. Pumps are combined in series to obtain an increase in head or in parallel for an increase in flow rate. The combined pumps need not be of the same design. Figures 38.1 and 38.2 show the combined  $H$ - $Q$  characteristic for the cases of identical pumps connected in series and parallel respectively. It is found that the operating point changes in both cases. Fig. 38.3 shows the combined characteristic of two different pumps connected in series and parallel.



**Figure 38.1 Two similar pumps connected in series**



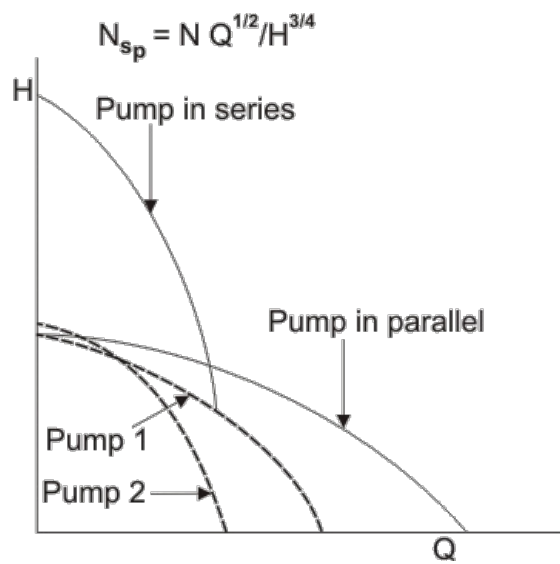
**Figure 38.2 Two similar pumps connected in parallel**

## Specific Speed of Centrifugal Pumps

The concept of specific speed for a pump is same as that for a turbine. However, the quantities of interest are  $N$ ,  $H$  and  $Q$  rather than  $N$ ,  $H$  and  $P$  like in case of a turbine.

For pump

$$N_{sp} = N Q^{1/2} / H^{3/4} \quad (38.2)$$



**Figure 38.3 Two different pumps connected in series and parallel**

The effect of the shape of rotor on specific speed is also similar to that for turbines. That is, radial flow (centrifugal) impellers have the lower values of  $N_{sp}$  compared to those of axial-flow designs. The impeller, however, is not the entire pump and, in particular, the shape of volute may appreciably affect the specific speed. Nevertheless, in general, centrifugal pumps are best suited for providing high heads at moderate rates of flow as compared to axial flow pumps which are suitable for large rates of flow at low heads. Similar to turbines, the higher is the specific speed, the more compact is the machine for given requirements. For multistage pumps, the specific speed refers to a single stage.