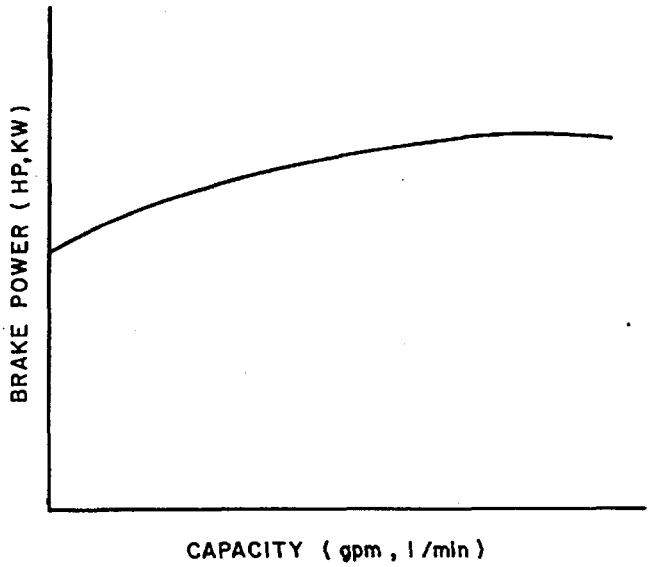

Figure 7. A typical brake power versus capacity characteristic curve of a centrifugal pump.

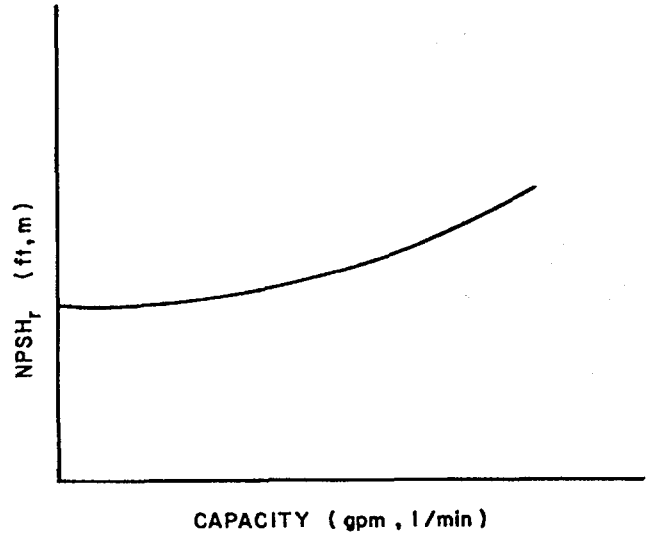

Figure 8. A typical characteristic curve representing net positive suction head required ($NPSH_r$) versus capacity for a centrifugal pump.

$NPSH_r$, versus capacity, Q. For a typical centrifugal pump the $NPSH_r$ steadily increases as Q increases. To assure that the required energy is available, an analysis must be made to determine the net positive suction head available $NPSH_a$, which is a function of the pumping-system design. Net positive suction head available in the system is calculated using following formula:

$$NPSH_a = BP - SH - FL - VP \qquad (6)$$

where:

BP = barometric pressure
SH = suction head or lift
FL = friction losses in the intake pipe
VP = water vapor pressure at a given temperature
(all terms should be expressed in feet of water).

After these calculations are performed the $NPSH_r$ versus Q curve can be used. The $NPSH_a$ must be greater than $NPSH_r$ at a given Q to avoid pump cavitation. A typical curve representing $NPSH_r$ versus capacity Q is shown in Figure 8.

Pump operating point

A centrifugal pump can operate at a combination of head and discharge points given by its H-Q curve, called the operating point. Once this point is determined, brake power, efficiency, and net positive suction head required for the pump can be obtained from the set of pump curves.

The operating point is determined by the head and discharge requirement of the irrigation system. A system curve, which describes the head and discharge requirements of the irrigation system, and a head-discharge characteristic curve of the pump are used to determine the pump operating point (Figure 9). At the operating point the head-discharge requirements of the system are equal to the head-discharge produced by the pump.

A system curve is produced by calculating the total dynamic head H_t (see equation 4) required by the irrigation system to deliver a certain volume of

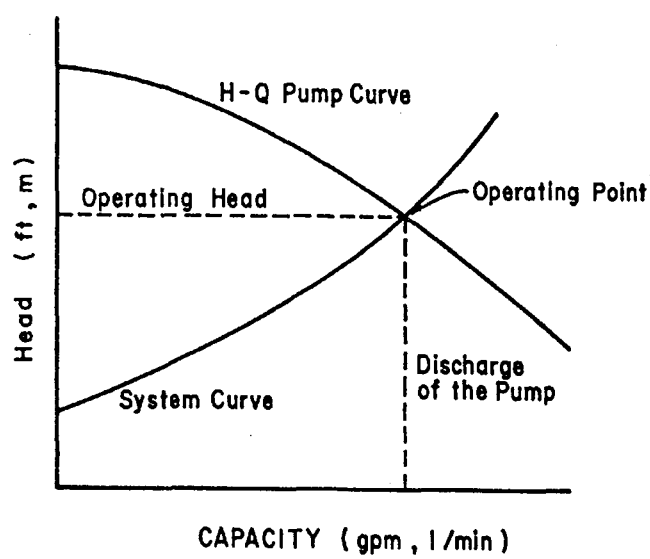

Figure 9. Determination of the operating point for a given centrifugal pump and water system.