system total dynamic head can be expressed as:

$$H_t = H_s + H_d + H_o + H_l + H_v \qquad (4)$$

where:

H_t = total dynamic head of the system (TDH)
H_s = static head (static lift + static discharge)
H_d = drawdown
H_o = operating head
H_l = friction loss head
H_v = velocity head

Static head

Static head is the vertical distance from the water level at the source to the highest point where the water must be delivered. It is the sum of static lift and static discharge. Static head is independent of the system discharge (gpm) and is constant for all discharge values. However, it is possible that the static head may vary with time due to the changes in the system.

Static lift

The static lift is the vertical distance between the center line of the pump and the elevation of the water source when the pump is not operating. If the water elevation of the source is below the pump elevation, the static lift is positive. If the pump is located at the elevation below the water surface elevation, the static lift is negative.

Static discharge

The static discharge head is a measure of the elevation difference between the center line of the pump or top of the discharge pipe and the final point of use. When pumps discharge directly into canals a short distance from the pump at the same elevation, the static discharge head is zero. If, however, a pump supplies water to some distant point at another elevation, then it is necessary to compute the static discharge head. To obtain this value, subtract the elevation of the pump or discharge pipe from the elevation of the final point of delivery.

Well drawdown

As a well is pumped the water level in the well declines. This phenomena is commonly called the well drawdown. The amount of the drawdown is a function of the pumping rate, the aquifer properties, well size, method of construction (well screen, etc.) and the time the pump is operated. The best way to determine the well drawdown is to test pump a well at various rates and observe the drawdown. Testing of wells is described in detail in IFAS Extension Circular 803 "Water Wells for Florida Irrigation Systems."

When the water is to be pumped from the well it is important to know the drawdown to account for the additional lift. For a surface water source such as lake or river this water level may drop during a dry season. Any changes in static lift must be accounted for in the static head portion of the total system head.

Operating head

Some irrigation systems require pressure to operate. The range of this pressure varies among systems. High pressure systems, such as traveling guns and high pressure center pivots or sprinkler systems, may require large operating pressures (up to 100 psi). Micro irrigation systems can operate at much lower pressures (8-30 psi). For gravity irrigation systems (furrow, flood or open ditch subirrigation) the operating pressure can be close to zero.

For most irrigation systems, the operating pressure is constant. However, some systems may have a variable operating pressure. A good example is a center pivot system with an end gun for corner irrigation. Operating the gun requires additional pressure head for a relatively short time.

Friction loss

When water flows through a pipe there is a loss of head due to friction. This loss can be calculated using hydraulic formulas or can be evaluated using friction-loss tables, nomographs, or curves provided by pipe manufacturers. The pump must add energy to the water to overcome the friction losses. As the discharge of the system increases the velocity also increases. The friction loss increases as the square of the flow velocity. Due to the high cost of energy, it is often recommended that a larger pipe size be used to decrease the velocity for the same discharge. This is usually economically feasible if the water velocity is more than 5 ft/sec.

For a system having very long pipelines or undersized pipe for a given flow rate, the friction loss can be very significant.

Friction losses must be considered on both the intake and discharge sides of the pump. It is especially necessary to compute or evaluate the friction loss on the suction-side of centrifugal pumps to assure enough net positive suction head available (discussed below) to prevent pump cavitation.