Queensland Farmers' Federation
Irrigation and Energy Factsheet

Australia's rainfall sees extreme variability and intensity requiring the need to store then later pumped to irrigate crops. A properly designed irrigation system will not only save you water but also energy costs, as water flowing through pipes will occur some pressure head losses.

Contributing to the total energy losses, and to establish an efficient pump selection in an irrigation system the **Total Dynamic Head (TDH)** is the sum of all factors below.

STATIC HEAD	Includes Suction Lift, which is the height distance (m) of the pump from the water surface. It is the vertical distance the water is required to be moved to the point of discharge.
PRESSURE HEAD	Sprinkler requirements the pressure required to correctly operate the sprinkler/s in an irrigation system.
FRICTION HEAD	Energy losses due to pipe friction and all fittings in the irrigation system. Determined by the flow rate (Q) at velocity through the length (m), diameter (A) and construction of the pipe material. Generally, 10% is added to this figure to allow for unknowns.
VELOCITY HEAD	The faster we try to push water through a pipe the more energy we lose.

The TDH helps establish the waterpower of the system this is the theoretical power necessary if the pump was 100% efficient. Waterpower is the product of the weight of water (1.00), flow rate being pumped and TDH. No system is 100% efficient so mechanical power is needed.

Mechanical power is the actual power output at the shaft of the pump and is calculated by dividing the pump efficiency into the waterpower, following these principles the;

Pump Required (kW) = (Weight of Water x Flow Rate x TDH)/ (Motor Efficiency x 1000)

PUMP CURVES- The performance of a centrifugal pump is usually plotted using the following characteristics

Flow (Q in (l/s), Head (H in m), Power (P in kW), Speed (N in rpm), and Efficiency (η in %).

For a given pump speed, the pump has a specific head-discharge characteristic curve. The power curve reaches a maximum value and then drops. The drop-off point normally occurs around maximum discharge and is beyond the most desirable operating range of pump. An efficient operating region of the pump selected is in the region of 80% to 90% of the maximum attainable efficiency of the pump.

Affinity laws- If the pump performance at one speed is known, the characteristic at any other speed may be determined. Knowledge of these pump laws is useful for estimating the effect of changing the operating pump speed. A new head discharge and power characteristic can than be plotted.

In some cases installation of a Variable Speed Drive (VSD) will automatically take care of variations in irrigation and elevation in system design. It does this by regulating water flow from frequency changes altering the pump speed based on the affinity laws. More information on the benefits of a VSD is available.

Useful to know -the quantity of water flowing through a system is doubled by doubling the pump speed. All other conditions remaining the same, pressure head is increased four times and the power consumed is increased eight times. If a bigger pipe diameter is selected, the head loss due to friction will be reduced and hence, the power required and running costs for pumping will be reduced. However, if too large a diameter pipe is selected in the initial design costs and payback period will be increased.

Important- ***Minimise pipe fittings, bends and length in your design*** as this leads to an increase of friction losses. Select a pump according to the pump curve that meets your requirements to ensure you are operating as efficiently as possible.

Quick Wins

- Limit your water velocity to 2 meters per second
- Remove trash from suction inlets to improve pump performance by up to 20%
- Reduce air entrapment in suction ends: a 2% increase in air can reduce pump performance by 20%

Common Terms in Irrigation

Flow Rate (Q)- m3/s or L/s	Pressure (P)- 100kpa= 1atm
Velocity (V)-	Weight of water- 9.81
Cross Sectional Pipe diameter (A)- m2	Motor efficiency (N) = output power/input power

This fact sheet was developed in 2021 as part of The Energy Savers Plus Program Extension, funded by the Queensland Department of Energy and Public Works.

QFF Queensland Government