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Selecting Pumps for Nursery Production

Nursery irrigation pumping can consume considerable amounts of energy and be a significant cost for production nurseries. Growers often move water multiple times for irrigation, transferring between storages, pumping through disinfestation systems, moving into storage tanks and finally, pressurising irrigation systems. Poor pump selection and installation can lead to poor performance, high energy costs, premature pump performance decline and mechanical failure.

There are many pump choices, and the decision to purchase should be taken carefully, keeping in mind the life cycle costs of pumping systems. The purchase, or capital cost of a pumping system makes up between five and ten percent of the life cycle cost of owning and operating a pump, while energy costs can account for 45-85%.

Poor pump selection can result from a number of factors including; poor advice due to inexperienced pump sales personnel, insufficient or incorrect data provided to the pump supplier, changes to, or expansion of, the system outside the original specification, and haste to replace a failed pump.

When considering options for improving pump efficiency, the option of designing a new system should always be investigated. It may be, over time, this will result in greater cost savings than upgrading an existing system. If a pumping system is being designed for a new development, it is critical that the system be designed to ensure it meets the required system capacity, while being the most efficient system possible. Replacing a failed pump is the ideal opportunity to improve the pumping system, but some preparation and system analysis is required well in advance so the down time of the irrigation system is minimised.

When making the decision on which pumping system to purchase, it is important to consider the pumping objective, and focus on the application, installation, and operation of the system. It is essential to ensure the selection and purchase of a pumping system is undertaken with the assistance of an irrigation professional.

Pumping application

Good system design considers all the elements within the pumping system. Many of the principles used in designing a new system can be applied to improve the efficiency of an existing system, with enhanced opportunities for improving energy efficiency.

Minimise pumping requirements *through more efficient irrigation layouts, as well as accurate irrigation scheduling. Where possible, reduce operating pressures and reduce vertical and horizontal distances from the pump to the delivery point to minimise pressure losses.*

When upgrading pump systems, an ***analysis of the system pressure and flow rates*** *is necessary to compare different pumps, pump curves and control systems. This information is obtained from a hydraulic analysis of the system to determine the pump performance required. A full hydraulic analysis of a system can also identify areas that*

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are not performing to their maximum efficiency, and suggest changes that may help to reduce operating costs, e.g. altering pipe sizes.

Determine the amount of water required and over what period the water needs to be applied. *System design capacity is a critical part of selecting the correct pump for the situation. Calculating the maximum amount of flow to achieve irrigation in the required time frame forms the basis of further pumping system design, e.g. the largest and smallest flows required for different irrigation zones. Always use the worst case scenario in calculating pumping requirements.*

Pressure (or head) required*. Flow rates and pressures required at the emitter are assessed. Head losses due to friction and the elevation of each irrigation zone above or below the pump is then used to calculate the pressure required at the pump. The distance between the pump station and each irrigation zone, and the type and size of the*

mainline are also taken into consideration in these calculations.

Pumps have a limit of ***suction lift*** *which, if exceeded, results in cavitation, reduction in operating efficiency, and damage to the pump. Cavitation is the implosion of bubbles of water vapour within the pump, and creates a very distinctive gravel like noise. If left unchecked, cavitation can destroy a pump impeller and housing. As the height of the pump above the water level increases, the efficiency of the pump decreases. This results in decreased flow and pressure, so differences in suction conditions from variations in suction lift in surface storages and tanks, i.e. flooded suction, need to be accounted for.*

The combination of operating pressure and flow required to operate the system is termed ***the system duty****. In many nurseries, the system duty is likely to have changed over time due to changes to growing areas and infrastructure. In determining system duty account for other system flow requirements, e.g. filter system backwash, washdown, and hand held hosing, that may be required to operate during and between irrigation cycles.*

Poor water quality and particulate matter *in the water can lead to increased wear if the pump is not designed to handle the water quality, or filtration is inadequate.*

Physical constraints *due to the water source, or where infrastructure can be located, may influence the type or size of pump that is selected, e.g. is a bore pump required, and what size is the casing of the bore?*

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Pump characteristic curves *provide a graphical representation of the performance of a pump, and are used to select the most efficient pump for a given duty point. Select a pump that has the duty point as close as possible to the Best Efficiency Point (BEP) for that pump - see figure 1.*

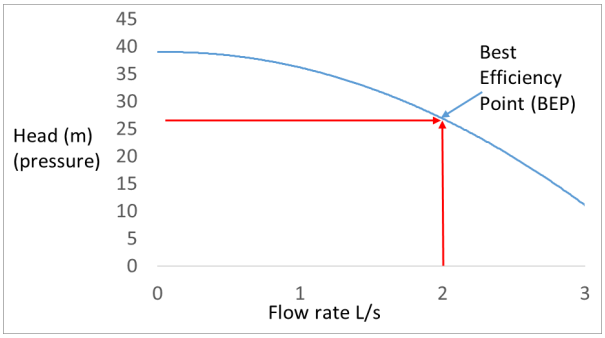

Figure 1: Example of a pump curve

In nursery situations, pumps may need to cover a range of duty points due to the variations in pressure and flow requirements for different irrigation zones and non-irrigation activities. The duration of operation at each of the duty points should be considered in deciding if a particular pump is the most efficient for the overall system. There are a number of different pump types available, each with specific pumping characteristics that may suit particular situations. Consider variable speed drives or multiple pumps for varying flows. Pump manufacturers also have online software that can be used to assist in selecting the most efficient pump for a given duty point.

Selecting a pump *that is oversized rather than matched to the system requirements may cause it to operate at 'part load' for extended periods, causing reduced efficiency, increased energy use, an increase in noise, vibration, wear and possibly cavitation damage.*

Installation

Consider capital cost, depreciation, running costs and interest charges over the lifetime of the pumping system. *The cost and installation of a pump is approximately 5-10% of the lifetime cost of the pump. The selection of the right pump, while perhaps being initially more expensive, can reduce the total cost of the irrigation system over its lifetime by increased energy efficiency and reduced maintenance costs.*

Select an appropriate power source. *In some situations ready access to mains power is not possible, or is prohibitively expensive. Other fuel sources such as diesel must then be considered, and may reduce the range of suitable pumps. The amount and type of electricity available, e.g. single or three phase electricity may also need to be considered, as well as business operational requirements, e.g. available operating windows to take advantage of time of use tariffs.*

To ***minimise running costs****, an appropriate electricity tariff should be selected. If other fuel sources are an option, the overall cost of these need to be compared before deciding in the best energy source.*

What pump protection is required?*. Does an electric motor need waterproofing? Does the pump need to be protected from flood water or designed to be relocated?*

The location and installation of the pump *is a critical factor in maximising performance and operating life of the pump. If there are multiple pumps in a pumping station, ensure they are not working against each other, and controls are set for the pumps to work as designed. Ensure the pumps have been sized correctly for the flow rates*

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of the system, and if combinations of fixed and variable speed pumps are used, that they are configured correctly. Ensure sound installation to make certain the installation is stable. Consider access requirements for installation and maintenance.

Consider the efficiency and sizing of of pump drives and controllers. *High efficiency pumps and motors should be selected, and attention paid to correct impeller sizing.*

Well designed piping systems *provide benefits in reduced maintenance.*

- *Select piping material to minimise friction losses without excessive capital expenditure.*
- *Optimise pipe sizes, and design pipe layouts to minimise pressure loss.*
- *Use long radius bends.*
- *Minimise the length of pipe between the pump and the delivery point. Have the pump as close to the delivery point as practical.*
- *Minimise the number of valves, fittings, and bends to minimise pressure losses.*
- *Minimise the height water has to be pumped to.*
- *Consider the configuration of suction pipes to reduce suction pipe pressure losses.*

Other considerations to be taken into account include:

- *Noise, particularly if internal combustion engines are used to drive the pump.*
- *After sales service and availability of spare parts. Select a service provider who understands energy efficiency and helps with solutions.*
- *Energy and pump backup systems.*

Don't assume the first attempt at designing the system is the most efficient outcome. *Go over the design again and review the trade-offs and see if further improvements can be made. Some efficiency options may have a quicker payback than others.*

Operation

Frequency of operation *of the system affects payback periods of upgrades. Pumps must have adequate capacity and perform reliably in situations where water must be applied during a critical time, e.g. for frost protection the pump must have the capacity to deliver the necessary amount of water in the required time for effective frost control.*

In most nursery situations ***high reliability of pumps and irrigation systems*** *is required. This may mean a multiple pump system being installed so the system can still perform if one pump fails, although at a reduced capacity.*

Consider variable-speed drives *for flow management rather than throttling valves or flow bypass. The pump type must be compatible with variable-speed drives, e.g. multi-stage pumps.*

Monitor flows, pressures and energy consumption. *Some systems are able to record system use data which can assist in trouble shooting or monitoring of system use.*

Put a maintenance schedule in place.

Technical articles on pumping and irrigation in nursery production can be found on the NGIQ website under technical information—http://www.ngiq.asn.au/

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