Dairy Effluent: Pumps and Sumps

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Many dairies can utilise their effluent by pumping directly from a sump to pasture. This optimises the utilisation of the nutrients in the effluent and therefore can be an inexpensive management option. The main disadvantage is that during winter, effluent should not be applied when additional water can cause pugging and pasture damage. The pasture nutrient requirement at this time is also low and the potential for effluent run-off and nutrient leaching is high.

Pumping from sumps may also be essential when gravity cannot be used to move effluent from the collection outlet in the yard to a storage facility.

Sumps

The sump is normally located where it can collect the gravity flow of effluent from the dairy yard, pit and milk room. This can then be pumped to a storage facility or directly to land application.

A pumped sump can be quite successful in pumping effluent with entrained solids. Unfortunately materials such as baling twine, wire, cow horns and straw have difficulty passing through a pump thereby causing blockages.

To reduce maintenance and maximise pump performance a number of good practices should be incorporated into the design of any pumped sump.

Pumped sumps - Good practices

Solids removal

Non-manure solids in the effluent should be removed before the pump.

This will extend pump life and lower maintenance costs and problems. A stone trap located before the sump consisting of a simple depression or settling chamber will collect heavier non- floating solids in the effluent stream.

Stone traps have to be cleaned out regularly, otherwise, material will fill the trap and make it ineffective. The size of the trap should be sufficient that it will hold the material collected from at least one milking. The trap must be easily accessible for cleaning with a shovel.

For larger herds especially where coarse track material is used, larger trafficable solids traps (Figure 2) can be utilised before a pumped sump. Solids traps simplify the process of solids separation, as well as being trafficable and self- draining. The trap is cleaned out every few months with a front-end loader, reducing cleaning time and contact with effluent. Design and construction requirements are detailed in the Agriculture Note; *Dairy effluent: Trafficable solids trap*.

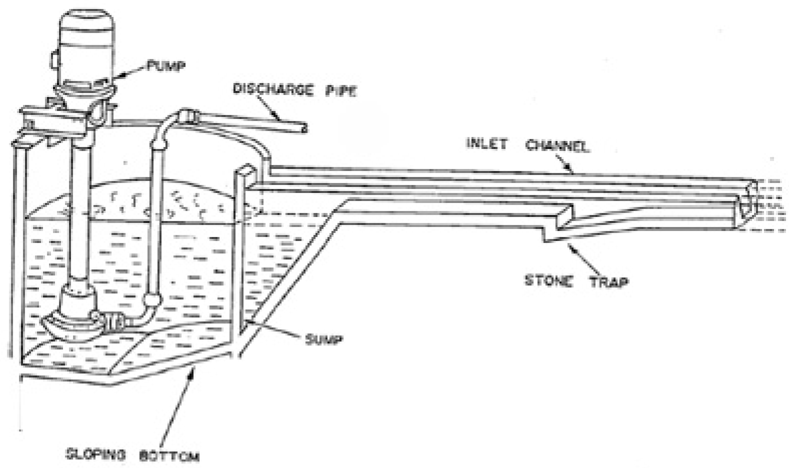

Figure 1. A common pumping sump used in the dairy industry – can be round, rectangular or square

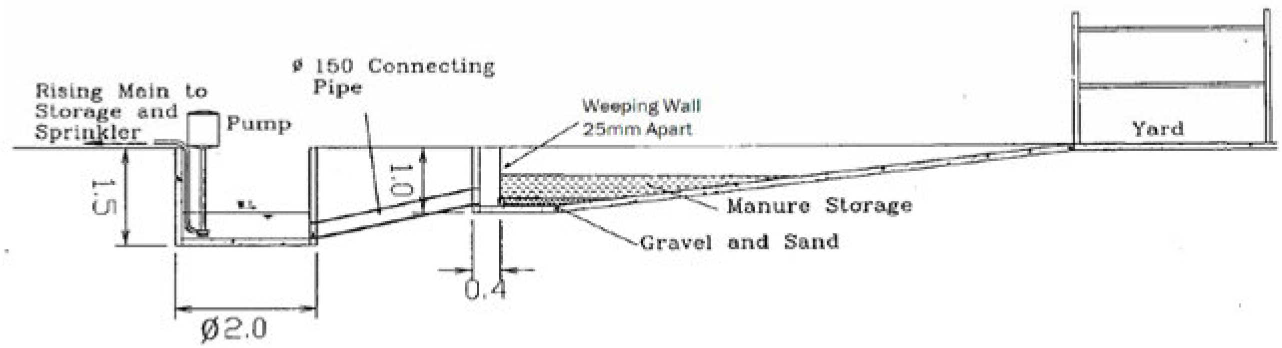

Figure 2. Trafficable solids trap and pump sump

Sloping floor

A sloping floor of approximately 45° will direct solids in suspension directly to the pump inlet resulting in less sludge build up thereby lowering maintenance time.

Provision of an emergency overflow

In the event of pump failure or blockage the provision of an emergency overflow will keep effluent away from the pump motor and switchgear. Any overflow must be directed away from the dairy and where it won't pollute watercourses.

Inflow into the bottom of sumps

To maximise pump efficiency effluent should enter at the base of a sump. Avoid turbulence of cascading flows from the inlet pipeline, channel or stream to minimise air entrapment, which can adversely influence pump and delivery line performance.

If a cascading fall into a sump cannot be avoided, there must be sufficient length and depth to the pump inlet to compensate.

Adequate pump inlet submergence

Pump sumps should be of sufficient size to allow for satisfactory intake of water into the pump suction. Clearance between the bottom of the sump and bottom of the suction pipe should be an absolute minimum of 100mm. Clearance between side and end walls should also be a minimum of half pipe diameter.

The water level in the sump should not be less than one and a half times the pipe diameter above the suction (see figure 3). If this is not the case, air can be drawn into the inlet. A vortex could also be created causing a rotation of the intake water. This could cause vibration and cavitation of the pump.

Sump volume

Sump capacity and shapes can be designed differently to match different site requirements, pumping arrangements and management schemes.

Small diameter pipes have been used as sumps for pump **installations servicing milking sheds**. These sumps are usually 450 mm to 900 mm in diameter and 1.2 metres deep. This arrangement offers little buffer storage thereby needing a pump with a similar capacity to the peak inflow rates. In the event of pump failure an overflow will occur. Access for cleaning can also be restricted due to the small diameters. Larger sumps will overcome the issues identified above and will also provide greater flexibility in the management of the pumping system.

Larger sumps are advocated to provide storage for 4 to 6 milking's, or at least storage for 1 milking. This allows time for pump repairs in case of breakdowns and allows for easier access for cleaning.

A larger sump also allows greater flexibility in pump selection thereby optimising performance and minimising operating costs. Pumps turning on and off constantly will also increase the chance of a burn out. Therefore bigger sumps allow time between pumping to be maximised. The sump depth should be matched to the column length of the pump to ensure ideal flow conditions.

Pumps

Pump selection

When pumps are used to transport dairy effluent, problems can arise if unsuitable equipment is used. Factors to consider in the selection of an effluent handling pump include:

- pressure or head requirements
- flow rate
- effluent volume
- the solids content of the effluent stream
- power source
- suction and priming characteristics
- quality of components
- maintenance
- reliability and price.

Pump operating pressures vary considerably with application. Moving effluent to a nearby pond system of similar elevation requires a low lift pump with a system head of between 3 to 10 metres. Sprinkler systems for land application require much higher working heads at between 20 and 50 metres.

Care must be taken in following flow rate guidelines provided by pump manufactures. These flow rates are for pumping clean water not effluent. Pumping effluent can reduce pumping efficiency dramatically. When a sump is used at the dairy yard without a solids trap the pump must be able to handle solids. The effluent from dairies can also be corrosive, so pumps should be constructed from brass, cast iron or gun metal in preference to mild steel.

Type of pumps

The types of pumps generally used on dairy effluent systems are described below and their characteristics are listed in Table 1. These pumps are basically used to either pump out sumps or to transport effluent from ponds to re-use systems or channels for shandying with fresh water. The configuration of the pump may vary depending on which of these applications it is used for.

All too often emphasis is placed in the selection process on the pump manufacturer and the price of the unit, rather than the type of pump or the match between the pump and the effluent system.

The size of the inlet and outlet pipes, the size of the sump and the effectiveness of solids removal, frequently provide more limitations to the system's effectiveness than the manufacturer or the price paid for the pumpset.

Vertical shafted centrifugal pumps with open impellers are commonly utilised on dairy farms for pumping from sumps to ponds and sprinkler systems. These units work well as long as solids entering the pump are not long and inflexible. High-pressure systems usually warrant the installation of a helical screw rotor pump, a highly efficient pump when utilised for pumping effluent free of abrasive solids. For simple lift applications, diaphragm pumps are popular and are now widely used in dairies in the irrigation areas of northern Victoria. The most commonly used effluent handling pumps are based on one of three designs outlined below.

Diaphragm pumps

These are ideal for short lift on a farm where effluent is being transferred without too much difference in elevation. Debris can be handled without causing major maintenance problems.

These pumps are self-priming and relatively cheap to operate. **They do not produce adequate pressure to operate a sprinkler**.

Centrifugal pumps

These are manufactured with either a horizontal shaft or a vertical shaft for use in sumps, or on fixed or floating platforms.

The vertical shaft types generally operate with lower pressure than the horizontal shaft as vertical shaft pumps are designed for a high level of solids.

The "cantilever" type of vertical shaft pump (which has no bearing in the pump bowl) is preferred. The effluent must cover the pump bowl before pumping commences. Horizontal shaft centrifugal pumps are not self-priming. To use these to pump from a sump the impeller should be of the non-clog open type, and have large inlets and outlets to reduce blockages.

Helical rotor pumps

These pumps are sometimes called helical screw pumps. The advantage of these pumps is that they can achieve relatively high pressure, ie. greater than 60 metres head. They also have a very high suction lift capability that allows them to be sited above or away from the storage where power is available. They are not suited to effluent with rocks, gravel or abrasive materials, as these will quickly damage the pump components. For this reason they should not be used to pump raw effluent from the dairy or to draw from the bottom of ponds.

When used to move effluent over long distances to an elevated storage, their flow rate is low with high pressure and care needs to be taken not to run these pumps dry.

Pump set-up

Vertical shaft pumps should be suspended from beams, which span the sump to keep the shaft vertical. Only very rigid cantilever supports should be employed instead. Bearing damage will occur if the shaft is not vertical. Conventional horizontal shaft pumps can be housed on the edge of the sump with a vertical suction pipe into the sump. Both types of pumps should be housed in a weatherproof enclosure and switchgear should be protected.

Selecting the right pump

Dairy effluent systems are tailored to suit specific farm characteristics as well as the labour and management requirements associated with the farm. Pumping solutions and the options available should therefore be discussed will pump manufactures.

Table 1: Pump Characteristics

Type of pump	Maximum solids content (%)	Volumetric flow rate (L/sec)	Pump head (m)	Power requirements (kW)	Applications	Comments
Conventional centrifugal (horizontal shaft)	5	>2	>60	35	Recirculation. Sprinkle irrigation.	Must have high quality effluent. Needs priming.
Open and semi-open vertical shaft (centrifugal)	15	<80	90	40	Transfer to storage. Gravity irrigation. Tanker filling. Travelling irrigator	Up to 2m lift capacity. Avoids priming and foot valves.
Submersible (centrifugal)	15	<4	<10	7.5	Transfer to storage. Uncommon.	Low lift capability.
Diaphragm	20	<1	<10	7.6	Transfer to storage	Very simple operation.
Helical screw (rotor)	6	<1.5	>60	30	Sprinkler irrigation. Pumping water over long distance. Pumping to elevated storage.	Good for high solids effluent. Abrasive material can destroy stator.
Piston pump	20	<1	<10	7.5	Transfer to storage of fibrous material. Sludge pumping.	Limited use for effluent. Good for solids and slurries.
Vacuum pump	10	<1.5	Maximum lift 3.5 m	40	Tanker loading. Priming syphons.	Good for livestock waste.

Acknowledgments:

The original note on Pumps and sumps was written by Guy Corbett 1995 & Andrew Crocus 2000

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