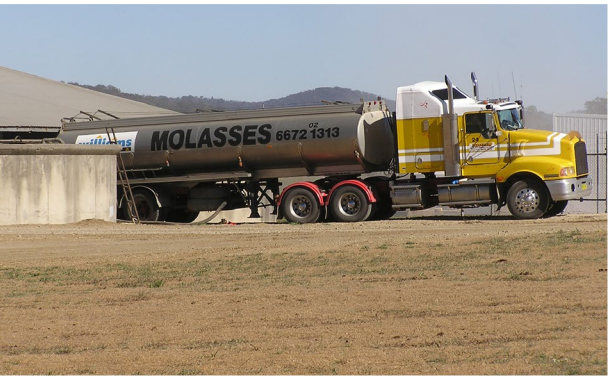

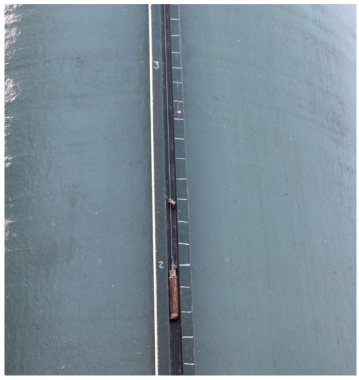

FEEDLOT DESIGN AND CONSTRUCTION

34. Liquid feedstuffs

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Introduction

A feedlot ration combines several available feed ingredients to supply the nutritional needs of cattle in adequate amounts and in a cost effective way. Rations usually contain dry (e.g. grain, roughage), moist (e.g. silage, distiller grains) and liquid feedstuffs (e.g. molasses, vegetable oils, liquid supplements).

The most common liquid feedstuffs used in feedlot rations are molasses, vegetable oil, glycerol, solubles from fermentation (such as condensed distiller solubles), molasses-based vitamin and mineral supplements and water.

Liquid supplements can be either 'suspension' or 'solution' products. Suspension products use suspending agents to hold insoluble ingredients, such as limestone, in the supplement. Solution supplements contain highly soluble ingredients that stay dissolved.

Rates of inclusion of liquid feedstuffs depend on factors such as nutrient density, mixer characteristics, other ration ingredients and production requirements.

Design objectives

Liquid feed storage should be designed and constructed to

- Provide a functional space for storage of a range of liquid feeds.
- Provide separate storage areas for each liquid feed used.
- Provide sufficient storage capacity for a given volume of each liquid feed, considering seasonal supply and delivery patterns.
- Provide adequate storage to meet daily feeding requirements.
- Be close to the feed processing and preparation areas.
- Provide all-weather access and sufficient manoeuvrability for various types of delivery vehicles.
- Provide access from the ground for safe filling, emptying and cleaning.
- Minimise wastage and spoilage of liquid feeds.
- Protect groundwater, surface water quality and riverine ecosystems.
- Be able to effectively deliver liquids under cold conditions.

Mandatory requirements

The building elements, such as concrete footings, floor slabs and steel structures, shall achieve the structural provisions of the Building Code of Australia (BCA) and local building regulations and be designed in accordance with the relevant Australian standards.

Compliance with AS2865-2009 Confined Spaces for confined spaces entry requirements.

Design choices

Because of the variable nature and viscosity of liquid feedstuffs, tanks, pumps and other equipment need to be designed to handle specific products. Storage and handling requirements vary depending on the characteristics of the liquid feedstuffs. For example, molasses is commonly stored in flat-bottom vertical or horizontal tanks and suspension supplements are typically stored in cone-bottom vertical tanks. Heating may be required if vegetable oils contain saturated fat (e.g. palm oil), or for molasses use in colder areas. Insulation may be needed in hot locations.

The following factors should be considered before purchasing and installing liquid feedstuffs storage and handling equipment

- Type of liquid product to be handled (commercial supplement, molasses, vegetable oil or other by-product).
- Volume of liquid ingredients that will be handled.
- Ability to handle a full tanker load of product at each delivery.
- Quantity of product required on a daily basis.
- Feed delivery method.
- Cost of liquid feeds relative to other feeding options, such as dry supplements or other high moisture feeds.

Consideration must be given to where and how liquid ingredients will be added to the feed ration.

Site selection

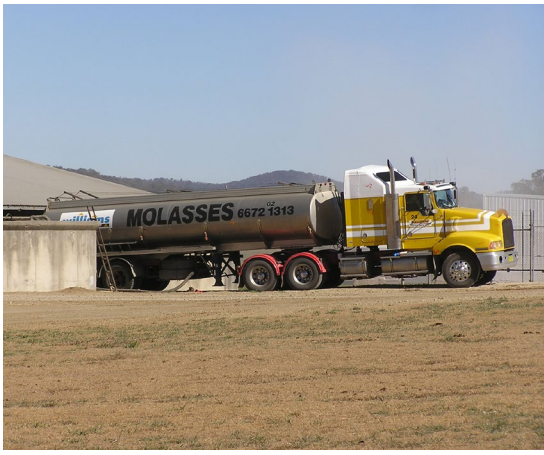
General site considerations for liquid ingredient storage are discussed in *Section 28 – Feed preparation and storage* and *Section 2 – Feedlot site layout.*

Additional factors to be considered when selecting a site for liquid storage are outlined below.

Accessibility

The storage site should be located close to the point of addition to the feed truck to minimise the distance the liquids need to be transferred, pumped or gravitated.

Liquid ingredient delivery vehicles should be able to freely access the storage tank inlet, or take-off point, without interfering with the usual movement of feed delivery vehicles.



Delivery vehicles need all-weather and convenient access to the tank inlet or take-off point.

Topography and drainage

To protect against accidental spills or leaks, liquid feed storage systems should preferably be located in the controlled drainage area (CDA) of the feedlot. The liquid feedstuffs storage area could be bunded, as these products are difficult to clean up if spilled.

Liquid feed characteristics

Some physical properties of various liquid feedstuffs are provided in Table 1, below.

Table 1. Physical properties of some liquid feedstuffs.

Feed	Density (kg/m^3)	Viscosity (Centiposes)
Molasses	1400–1480	9,600
Glycerol	1,260	1,200*
Peanut oil	920	38
Cotton seed oil	880–930	62
Palm oil	890–920	43

**at 20^{0}C*

Types of storage

Liquid ingredients are typically stored in horizontal or vertical above ground tanks, with a flat or conical bottom. Tanks with a conical bottom require a metal stand because the pump and hoses will be placed at the bottom of the cone.

Conical bottom tanks allow all of the material to be pumped easily from the tank. The floors of flat-bottom tanks should be domed slightly to achieve complete emptying and periodic dewatering. Storage tanks should allow for periodic bleeding-off of any water that may separate to the bottom of the tank.

Liquid feeds can be stored indefinitely in steel, fibreglass or polyethylene tanks . Concrete tanks may require sealing to prevent corrosion by the liquids. Below ground concrete tanks, or HDPE-lined earth reservoirs (e.g. for molasses), are less common because of costs and practicality of management.

Separate tanks should be used for each liquid feedstuff. Mixing products in the same tank sometimes can result in reactions that make pumping difficult, or cause ingredients to separate or precipitate.

Any second hand tank must be cleaned effectively before use, especially if it has contained fuels, oils or cleaning chemicals.

A well-prepared site with a solid foundation for liquid ingredient storage tanks. Flat-bottom concrete tanks are commonly used.

Storage capacity

The minimum capacity of the storage vessel must be greater than the anticipated size of the delivery vehicle (and multiples thereof), with allowance for additional storage in the event of a supply interruption.

Liquid feedstuffs are usually transported in semi-trailers or B-Double vehicles with a loaded capacity of about 25t and 38t respectively. Storage volume can be estimated using the density data in Table 1.

Most suppliers of liquid pre-mixes use trucks with a number of smaller tanks so that various pre-mix formulations can be delivered at one time.

Installing at least one spare storage vessel will enable each tank to be drained completely and remove impurities, residue or sludge before refilling. This can be important when using molasses and some vegetable oils, as they may solidify in cool climatic conditions.

The capacity of storage tanks is usually specified as either

- Brimfull capacity – the maximum volume of fluid held without overflowing.
- Nominal capacity – maximum volume of fluid that may be stored in the tank as identified by the tank manufacturer.

Liquid ingredients can be stored in various types of storage vessels and configurations. These are conical-bottom, HDPE tanks.

Foundations

The foundations and/or base of the storage must be capable of withstanding the mass of the fully loaded storage vessel. See Table 1 for bulk densities of typical liquid feeds.

Foundation design is more critical with vertical or overhead tanks, as these are engineered to support liquids in a vertical plane with pressure exerted and distributed evenly around the base support frame. Guidance is recommended from a structural engineer for foundation design requirements for vertical tanks.

Construction

Concrete molasses tank construction should be monolithic (i.e. no joints in the floor or walls) to avoid seepage of molasses into joints - with subsequent deterioration of the concrete. A minimum 50mm cover should be put over the reinforcing steel and the entire mass of concrete should be protected with a recognised sealing and hardening agent.

To facilitate draining, the floor of a concrete tank may be constructed with a fall of about 5% (150mm in 3m) to its centre to form a dome shape.

Steel storage tanks that will hold liquids with a specific gravity of greater than 1000kg/m^3 must be of stronger construction than those for use with water - and designed for this. Steel tanks are best emptied using a cone-shaped base.

A bank of conical and flat-bottom steel tanks. Filling point is easily accessible at ground level, or at the base of conical tanks. Note there is insulation on some tanks to keep liquid warm and reduce viscosity.

Heating

For liquid ingredients that thicken at lower temperatures, storage facilities must be protected from the temperature drop by heating insulation, locating below ground or by housing the tank and handling equipment indoors. Insulation can be provided with 50mm thick glass fibre, or mineral wool.

Stored molasses should be kept at a temperature range of between 20-38°C to ensure the contents remain able to be pumped and can drain freely from the tank. In colder areas, molasses may need to be heated to a temperature of 32–38°C using water circulating through heating coils. A suitable heating system could be installed in a smaller tank holding approximately one day's supply and which is topped up daily from a larger storage tank. In a smaller installation, the storage and heating tank could be the same vessel using a domestic type of hot water boiler. Heating with low-pressure steam, or running steam lines alongside a molasses pipe, may ultimately result in caramelisation and blockage. Surfactants are available to help molasses remain liquid at lower temperatures.

Some liquid products, such as fats, will solidify when exposed to low temperatures and heating coils can be added to the storage vessels.

Insulation may be required for those liquids that thicken in low temperatures.

Handling equipment should be of adequate size to deliver the liquid to the delivery point. Larger diameter pipes are required for viscous feedstuffs, such as molasses.

Delivery lines may also need to be heated to prevent products from solidifying in cold weather.

Molasses can be supplied with a surfactant added and this can reduce the need for heating in colder areas.

Handling equipment

Some liquid feedstuffs that are high in moisture (e.g. condensed distillers solubles) may freeze during the winter, while molasses and molasses-based products will thicken and make pumping difficult.

Positive displacement pumps are typically used for handling liquid commodities and may be of gear, sliding vane or reciprocating type. Centrifugal pumps are rarely suitable. Positive displacement pumps maintain pumping efficiency at variable motor speeds and can pump low and high viscosity fluids and small solids. These also have a low Net Positive Suction Head (NPSH), a high suction lift capacity and can provide accurate flow rate measurement.

Positive displacement pumps need precautions on both sides of the pump. On the suction side, pumping liquid from a closed vessel could result in a collapse of the tank and piping. On the discharge side, it is important to check for closed valves, or relief valves, to prevent danger to operating personnel, damage to equipment and loss of product from blown fittings.

The pump and motor should have sufficient capacity to deliver the liquid feedstuff to the delivery point fast enough to ensure efficient loading of the feed truck.

For tanks housed indoors, the distance from the bung of the tank to the pump should be as short as possible to minimise the chance of blockage in the pipe during cold weather.

Corrosive liquid ingredients, such as condensed distiller solubles, require more maintenance of their pump and handling equipment than do less corrosive products, such as molasses-based supplements.

Piping for liquid feedstuffs may be made of steel, cast iron or polythene or PVC of adequate strength for the duty to be performed. Pipes should generally not be less than 50mm in diameter, with a minimum number of changes in direction. Suction lines for viscous liquids, such as molasses, should not be less than 75mm.

Unrestricted valves, such as gate or plug valves, minimise diameter reductions and are recommended to ensure adequate flow rates. Rising spindle-type gate valves will also show whether the valve is closed or open. Ball valves may inhibit flow rate.

Storage should be filled via valves located near the base of the tanks, or silos, to enhance mixing of old or settled products. This also prevents the operator from having to work at height to access the valves. For quick filling or emptying of storage vessels, pipe and valve diameters should be at least 125mm.

Metering and proportioning

Liquid ingredients must be added in feed formulations accurately, consistently and at the desired application rate. Correct application can be achieved by a metering pump below a constant head tank, a liquid batching system or weighed to the feed truck using the vehicle weigh scales.

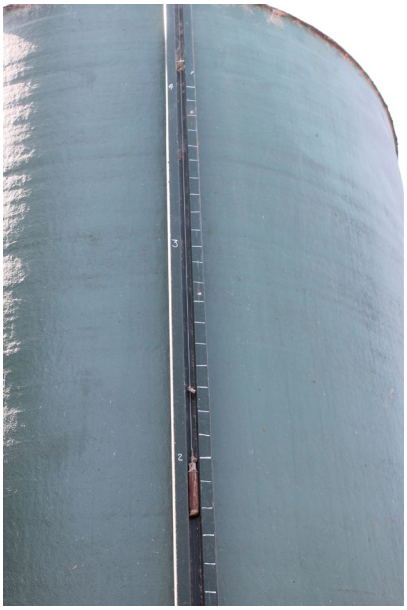
Regardless of the metering method used, application should be checked frequently by measuring test quantities via a valve downstream of the meter.

Ventilation

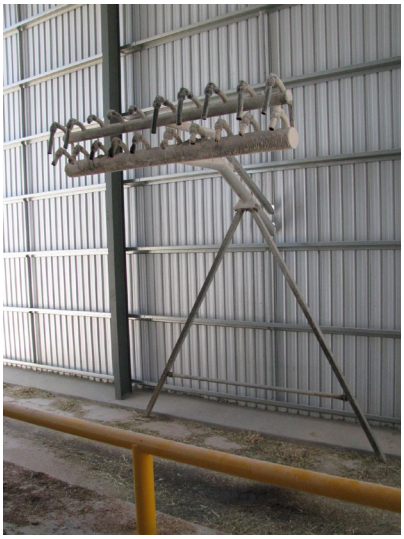
Regardless of its type of construction or location, the tank must have adequate vents. This is to minimise condensation (which causes corrosion in steel tanks), vent fugitive emissions and prevent a vacuum being drawn on the tank by pumping - which could cause it to collapse.

Typically, molasses is relatively safe to handle. But if water has entered the tank, fermentation could generate carbon dioxide gas, which is asphyxiating, and alcohol vapour, which is flammable.

If any fermentation is suspected to have occured, the tank should be thoroughly ventilated before entery and any residue should be thoroughly cleaned out before any heat-generating work, such as welding, is carried out on the tank.



Level indicator fixed to the outside of a storage tank allows inventory levels to be easily checked and recorded.



Liquid feed-out station. Storage tanks and pumping equipment are located on the outside of commodity shed wall with a delivery pipe through the wall.

Quick tips

- Liquid feed storages should be located near the feed preparation area, but have safe access for delivery vehicles without interfering with feed trucks.
- Liquid storage tanks and delivery lines may need to be heated in colder climates.
- Provision should be made in the storage tank for bleeding-off water that may separate to the bottom of the tank.
- Fill molasses tanks from the base, as agitating the molasses helps to prevent the accumulation of impurities.
- Molasses and molasses-based products are low in moisture but will thicken at low temperatures, making pumping difficult.
- A sight gauge or float gauge on a liquid tank makes it easier to check inventory.

Further reading

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