# Livestock Slurry Dewatering
## Membrane Technology

# Digestate Processing using Membranes

**Reduced Handling Costs**
**Reduce Storage Costs**
**75% Reduction in Volume**
**Biomass and Nutrient Recovery**
**No Heat Required**
**Auto Operation with Self Cleaning**

Typical Example of a Three Stage Membrane Plant
Processing 65 tones per day slurry.

### Capacities

The clean water throughput of a membrane depends on the 'flux' rate. This varies with every liquid processed and for slurry, a typical flux rate will be 14 litres per sq.m of membrane area per hour of operation or LMH. Flux is also depended on the type of membrane and the surface area provided in the system. A membrane system with a bigger membrane surface area will process at a pro rate higher flow rate.

Below is a table showing the capacities of the three main membrane systems. Multiple membranes can be run in parallel to meet the daily digestate flow. Throughputs and product outputs are given as Tonnes per Day (TPD).

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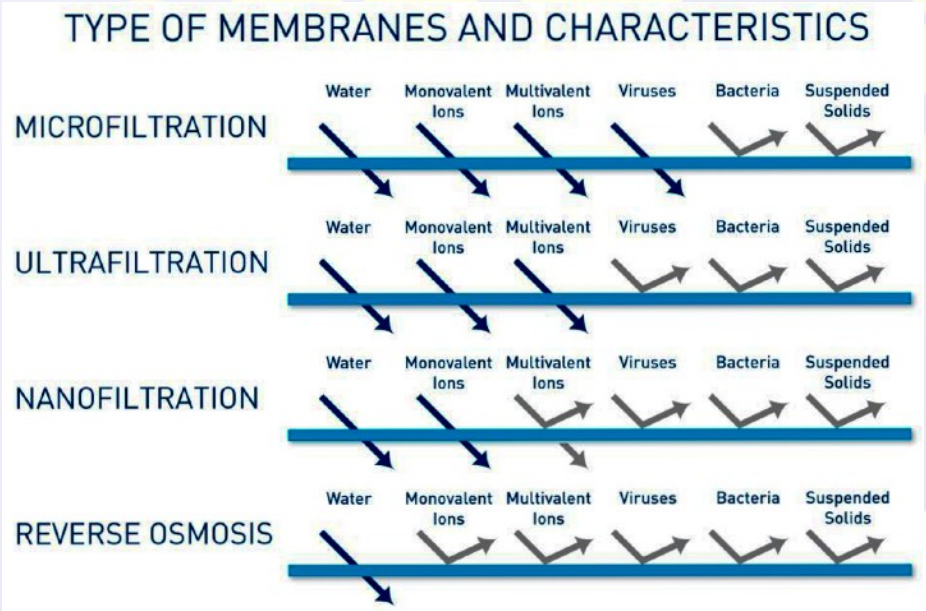
| Membrane Ref | Area m² | Flux Rate (LMH) | Raw Slurry to Separator TPD | Solid Fraction from Separator TPD | Press Water Feed to Membrane System TPD | Clean Water Discharge TPD | Concentrated Slurry TPD | % Vol Reduction of Press Water from Separator |
|---|---|---|---|---|---|---|---|---|
| LFM 450 | 27 | 14 | 12.5 | 1.7 | 10.8 | 8.1 | 2.7 | 75 |
| LFM 900 | 56 | 14 | 25.9 | 3.5 | 22.4 | 16.8 | 5.6 | 75 |
| LFM 2000 | 139 | 14 | 64.4 | 8.7 | 55.7 | 41.8 | 13.9 | 75 |

**Ammonia Nitrogen**

Livestock slurries can have a significant Ammonia concentration of around 2000 mg/l which is some 50 x more concentrated than that found in domestic sewage. It will also have a slightly alkaline pH of around 8.

Ammonia can exist in two forms: Ammonia gas/vapour ($NH_3$) or Ammonium ($NH_4^+$) which is the aqueous form. The difference in form is mostly due to the pH but also the heat. As the alkalinity increase above pH7, the ammonia will vaporise and escape to the atmosphere, hence, agricultural is a significant contributor to atmospheric ammonia which is becoming unacceptable. Also, it is a loss of valuable fertliser.

With the membrane system for dewatering the slurry, the pH is corrected as part of the process by the addition of acid to ensure the ammonia is fixed as the stable form of Ammonium ($NH_4^+$). This ensures minimal ammonia gas is emitted and it also maximises the nitrogen content of the concentrated slurry through the storage period and also ensuring its availability is maximised for crop uptake when spreading.




**Membranes General description**

Membranes allow some things to pass through while rejecting the rest. Any liquid stream sent to a membrane system will be split into two. The part of the stream that can pass through the membrane is called the permeate. The permeate is the "clean water". The part of the stream that is rejected by the membrane is called the concentrate.

In a product recovery or concentration context, the concentrate is the desirable material. With digestate and slurry, the clean water (permeate) can be re-used as feed make up and animal drinking water respectively.

There are four general classifications of membranes, any of which can be used in the low fouling membrane system. These are shown opposite.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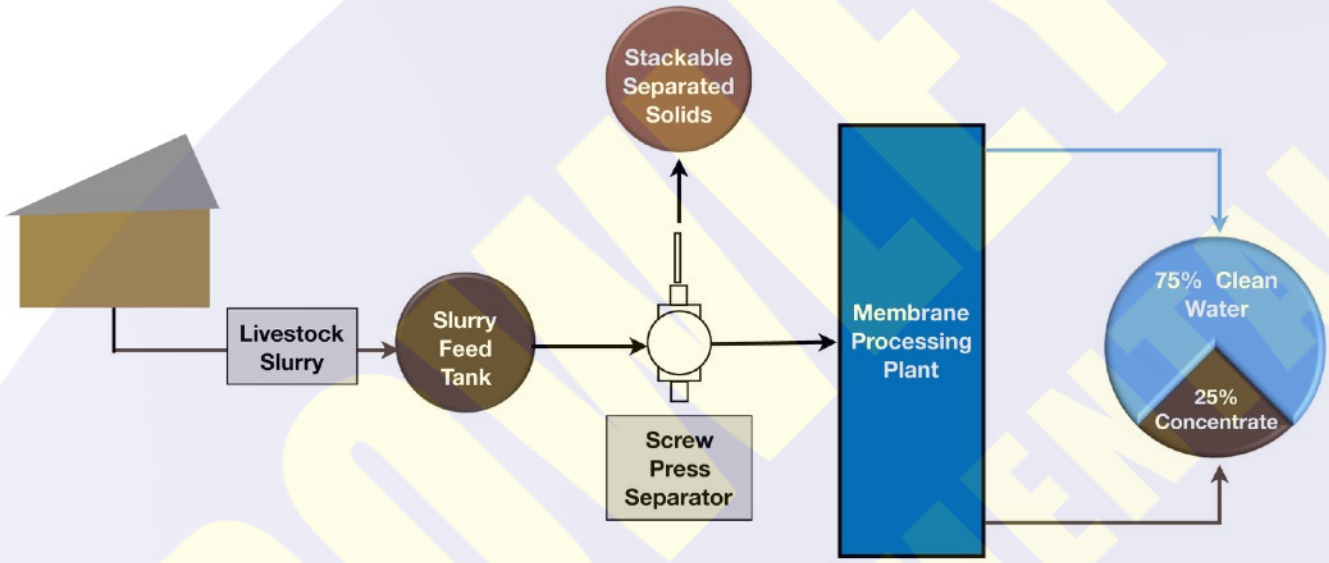
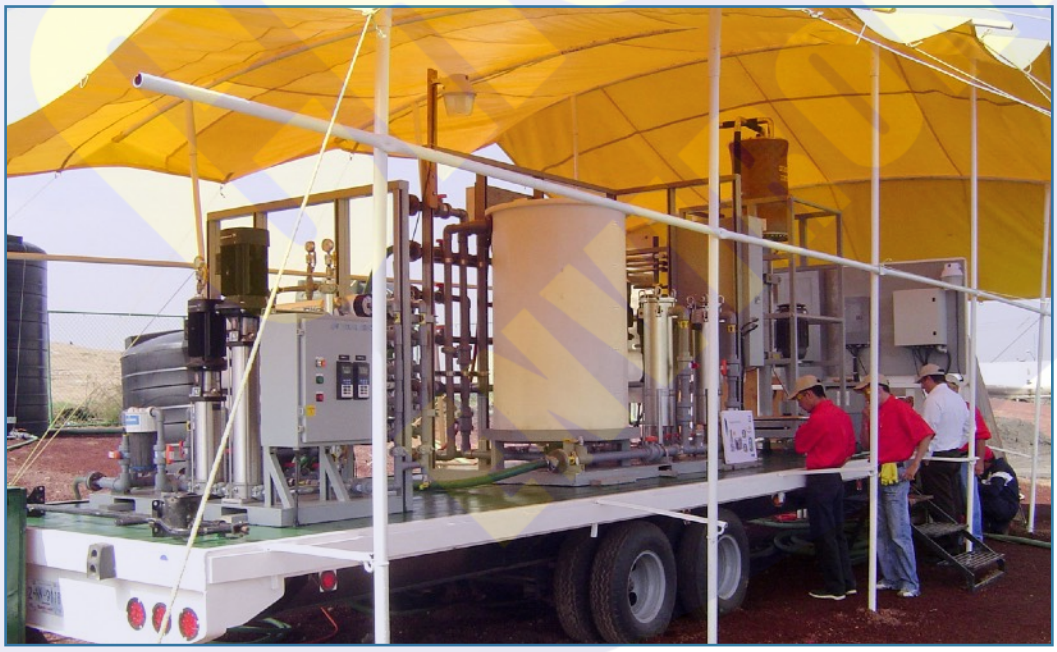
Schematic showing the process steps for processing livestock slurry to achieve a 75% reduction in volume and the capture of the valuable nutrients in the biomass rich concentrate.

The clean water is ammonia free and can be used as flushing water in the livestock buildings



Trailer mounted LFM membrane system with standard spiral wound reverse osmosis polishing membranes.
Used for processing landfill leachate to remove solids, COD and Ammonia.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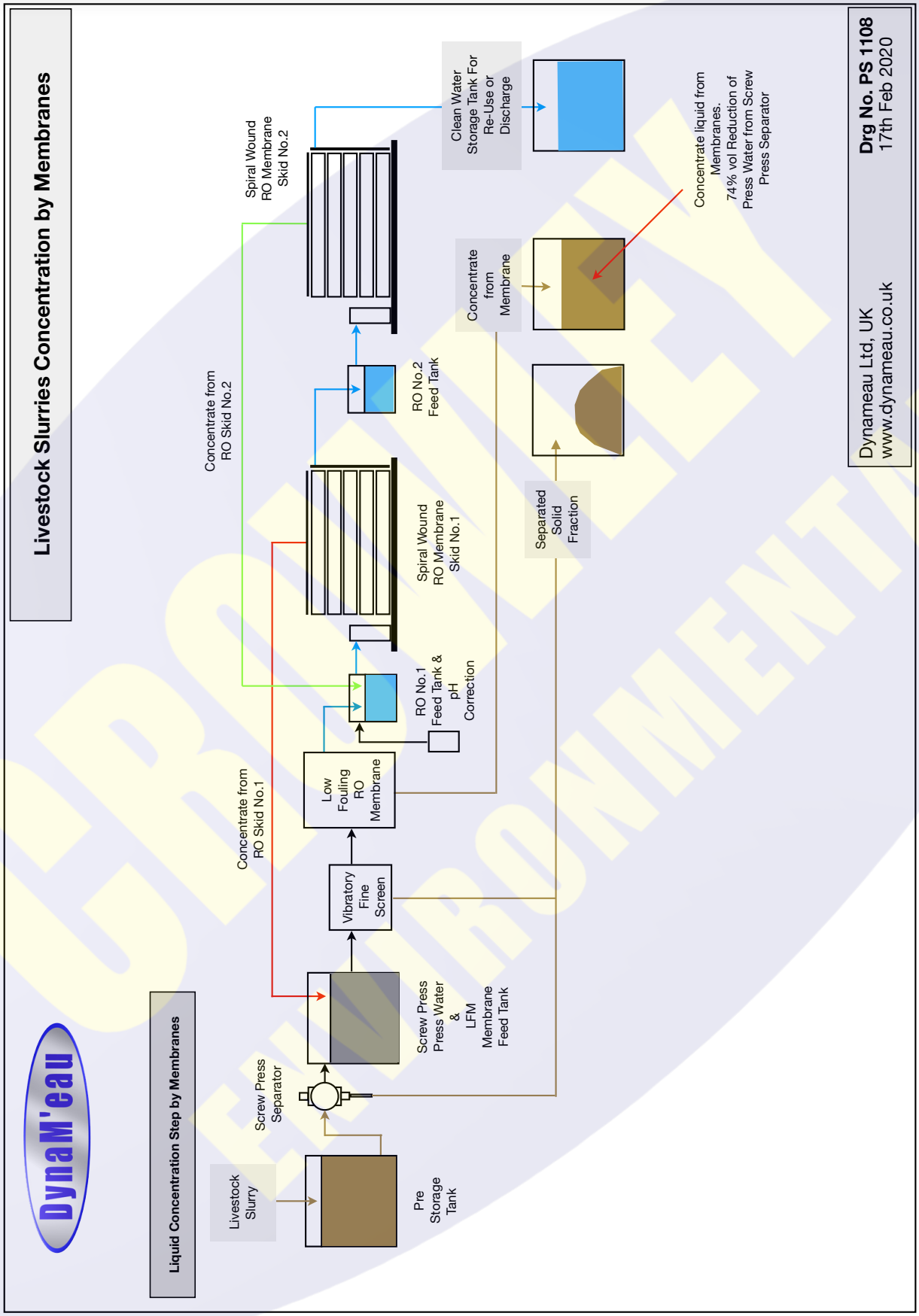



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### Membrane Types Used in Livestock Slurry Treatment

Livestock slurry has a typical analysis rich in nutrients, a high solids levels and water. The solids concentration makes it unsuitable for processing in conventional membrane systems as these would quickly suffer severe fouling problems and fail. This is because the solids will very rapidly blind the membrane surface. In spite of the high flow velocity & cross flows used, the boundary layer at the membrane surface suffers very low or zero flow velocity and therefore is susceptible to fouling by solids as the liquid is forced onto the membrane surface. Fouling will quickly reduce the flux rate and the permeate flow.

The Low Fouling Membrane (LFM) used in the Dynameau slurry treatment system employs an induced vortex at the membrane surface which physically lifts the solids in the water up from the membrane surface allowing the water to pass through. This LFM membrane is the first membrane of a total of three membrane steps shown in Drg PS1108 above.

Before any slurry is presented to the three stage membrane system, it is first processed using a standard screw press separator to separate the bulk of the solids from the 'press water'. It is the press water that is processed by the membrane system.

The LFM is system is fitted with Reverse Osmosis (RO) membranes which are the finest membranes available. This will remove all of the remaining solids in the press water and the bulk of the other nutrients including the ammonia. Therefore, the permeate from the LFM is solids free, however, it will still retain some ammonia. Since the permeate from the LFM membrane is solids free, the two further membrane steps can be done using economical, conventional, tubular, spiral wound RO membranes. These are used to 'polish' the permeate to achieve a very low ammonia concentration in final discharge water (permeate). Each additional membrane step will remove around 85% of the ammonia in the feed water. The final permeate water is clean and subject to consent can be discharged to land or a water course. Of course it can be reused as well.

The output products from the membrane system are i) Separated Solids ii) Concentrated liquid iii) Clean Water. The volume of the concentrated liquid is 25% of the original press water volume from the separator.

If the concentrated digestate is dried using CHP heat, is possible to dry the material sufficiently to allow it to be pelletised.

Typical example of a Low Fouling Membrane system. This is a three lane skid running in parallel. The membranes fitted are reverse osmosis system. This system is capable of processing press water from the separator with around 3% solids and maintain a flux of 14 LMH. The membranes are auto cleaned using regular chemicals such a citric acid.

Typical example of a conventional, spiral wound reverse osmosis system. This is skid mounted and is complete with pre filtration, pumps, clean-in-place system with cleaning chemical systems all under plc control.

Two of these are used in series in the slurry and digestate concentration system.

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Crowley Environmental is division of Crowley Engineering, Cork, Ireland making OEM products for the solid waste processing, water, gasification and biogas industries. With nearly a half century of business experience of engineering designing and fabrication, Crowley Engineering are your global partner in environmental solutions in the energy, solid waste and water treatment industries.

Dynameau Ltd, UK have partnered with Crowley Engineering to bring their water treatment technologies and solid waste processing capabilities to a wider market.


### Crowley Environmental Products

PulpStar MSW Processing

Electrocoagulation Dirty Water Treatment

Oil Water Separation

Biomass to Energy Plants

Biogas plants

Biogas Digestate Treatment

Livestock Slurry Treatment

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Feed mills complete

Agricultural silos & augers

Marine Pontoons

Helicopter escape simulators

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