Digestate Dewatering
Membrane Technology

Digestate Dewatering & Nutrient Recovery using Membrane Technology

Reduced Handling Costs
Reduce Storage Costs
Ammonia Emissions Minimised
Up to 75% Reduction in Volume
Biomass and Nutrient Recovery in Concentrate
Clean Water for Discharge or Re-Use
No Heat Required
Auto Operation under PLC with Clean-in-Place

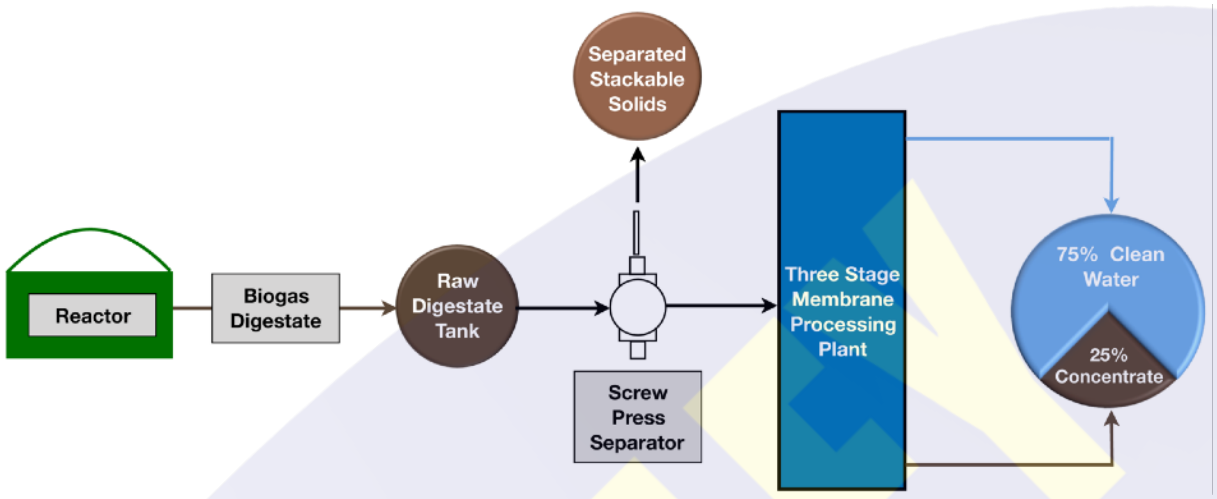
Typical system for 500 m3 per day digestate using a three stage reverse osmosis membrane system with two stages of conventional reverse osmosis following Low Fouling Membranes.
Systems available for 10 - 1000 tonnes per day

Crowley Environmental
Crowley Engineering
Upper Glanmire Bridge, Co. Cork,
Ireland

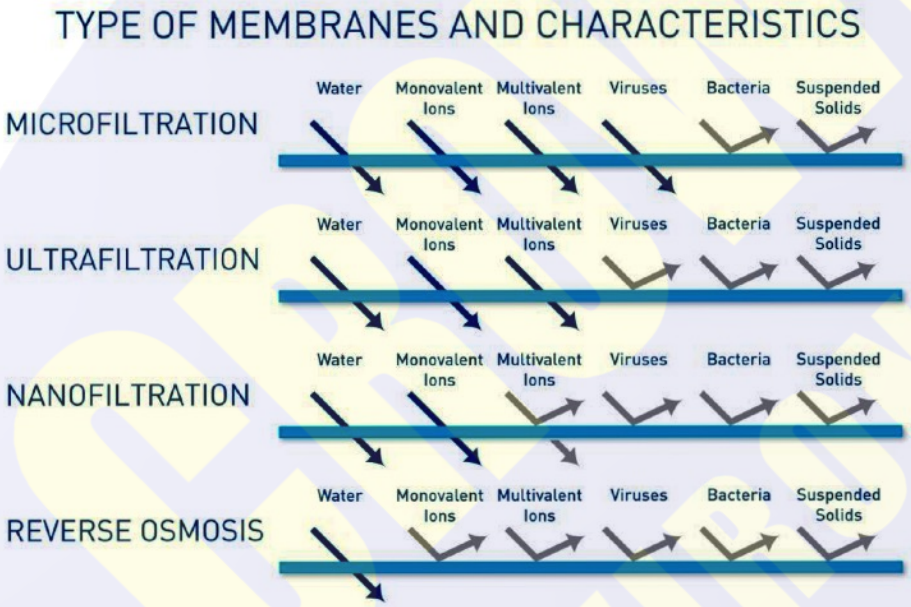
Tel +44 (0) 1295 533230
Email: steven@dynameau.co.uk

Dynameau Ltd
The Colin Sanders Innovation Centre,
Mewburn Rd, Banbury, Oxfordshire,
OX16 9PA, UK

Livestock Slurry Dewatering
Membrane Technology



Schematic above shows the steps for processing digest to achieve a typical 75% reduction in volume of the press water from the screw press. The clean water can be discharged or re-used. The concentrate contains the nutrients and biomass. A more detailed process flow diagram is given below in Drg PS 1137 including an optional drying and pelleting step.



Membranes General description

Membranes allow some things to pass and reject 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 context, the concentrate is the desirable material. With slurry, the clean water (permeate) can be re-used as wash water or for animal drinking.

Of the common membrane types Reverse Osmosis (RO) is used.

Below is a table showing the membrane process performance relative to various initial organic solids concentrations. Most digests will be the 5% to 8% solids range and these will be dewatered - or concentrated - by up to 75%

Membrane System Performace Estimate

Raw Slurry / Digestate m3	Organic Dry Solids Tonnes %	Screw Press Separator Removal Efficiency %	Separated Solid Fraction Tonnes	Press Water Volume m3	Separated Solid Fraction Dry Matter %	Permeate Clean Water Production m3	Permeate Clean Water as % of Press Water	Concentrate Volume m3	Concentrate Volume as % of Press Water	Concentrate Dry Solids tonnes %	Total of Separated Solid Fraction and Concentrate	Total of Separated Solid Fraction and Concentrate as % of Raw Feed
1,000	10	13	130	870	25	522	60	348	40	19	478	47.8
1,000	8	11	110	890	25	605	68	285	32	18	395	39.5
1,000	5	7	70	930	25	697	75	233	25	14	303	30.3
1,000	3	4	40	960	25	739	77	221	23	9	261	26.1

Crowley Environmental
Crowley Engineering
Upper Glanmire Bridge, Co. Cork,
Ireland

Tel +44 (0) 1295 533230
Email: steven@dynameau.co.uk

Dynameau Ltd
The Colin Sanders Innovation Centre,
Mewburn Rd, Banbury, Oxfordshire,
OX16 9PA, UK

Livestock Slurry Dewatering

Membrane Technology

Membrane Types Used in Digestate Treatment

Livestock slurry is rich in nutrients, high in beneficial solids levels both of which make it a valuable fertiliser or feedstock to a biogas plant. It is also very high in water often 92% - 95% and this very high water content leads to high handling and storage costs.

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 rapidly blind the membrane surface. In spite of the high cross flows used, the flow at the membrane's boundary layer will be very low or zero flow and therefore be susceptible to fouling by the solids as the liquid is forced onto the membrane surface. Fouling reduces the flux and the permeate flow. Many have tried to use conventional membranes but have failed in the longer term even with extensive and expensive chemical dosing pre-treatments.

The Low Fouling Membrane (LFM) used in the Dynameau slurry treatment system employs an 'shear enhanced', mechanically 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 PS1137 below.

Before any digestate is presented to the three stage membrane system, it is first processed using a standard screw press separator to separate some solids from the digestate. It is the press water from the screw press its further treated using mechanical, self cleaning fine screens before it 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 other nutrients including the ammonia. 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 clean water discharge (permeate). Each additional membrane step will remove around 85 - 95 % of the ammonia in their feed waters. 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 for wash down or reactor feed make-up water.

The output products from the membrane system are i) Separated Solids ii) Concentrated liquid iii) Clean Water. The volume of the concentrated liquid is down to 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 Three Stage Membrane Plant Processing 65 tonnes per day digestate.

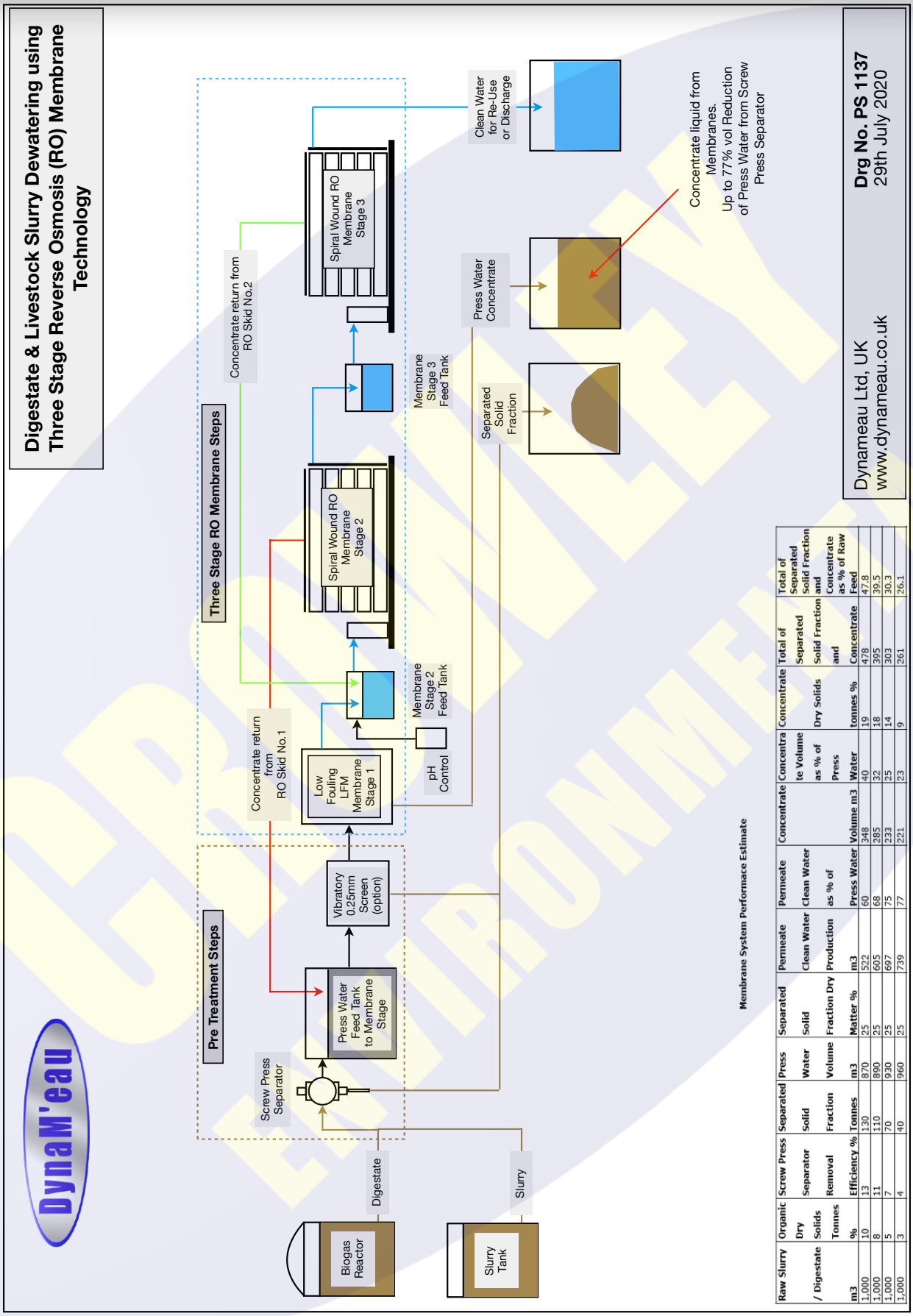
Stage 1: LFM Low Fouling RO Membrane
Stage 2: Spiral Wound RO Membrane
Stage 3: Spiral Wound RO Membrane

Crowley Environmental
Crowley Engineering
Upper Glanmire Bridge, Co. Cork, Ireland

Tel +44 (0) 1295 533230
Email: steven@dynameau.co.uk

Dynameau Ltd
The Colin Sanders Innovation Centre, Mewburn Rd, Banbury, Oxfordshire, OX16 9PA, UK

Livestock Slurry Dewatering
Membrane Technology



Membrane System Performace Estimate

Raw Slurry / Digestate	Organic Dry Solids	Screw Press Separator Removal	Separated Solid Fraction	Press Water Volume	Separated Solid Fraction Dry Matter	Permeate Clean Water Production	Permeate Clean Water as % of Press Water	Concentrate Volume m3	Concentrate as % of Press Water	Concentrate Dry Solids tonnes	Total of Separated Solid Fraction and Concentrate	Total of Separated Solid Fraction and Concentrate as % of Raw Feed
m3	%	Efficiency %	Tonnes	m3	%	m3	%					
1,000	10	13	130	870	25	522	60	348	40	19	478	47.8
1,000	8	11	110	890	25	605	68	285	32	18	395	39.5
1,000	5	7	70	930	25	697	75	233	25	14	303	30.3
1,000	3	4	40	960	25	739	77	221	23	9	261	26.1

Crowley Environmental
Crowley Engineering
Upper Glanmire Bridge, Co. Cork,
Ireland

Tel +44 (0) 1295 533230
Email: steven@dynameau.co.uk

Dynameau Ltd
The Colin Sanders Innovation Centre,
Mewburn Rd, Banbury, Oxfordshire,
OX16 9PA, UK

Livestock Slurry Dewatering
Membrane Technology

Membrane Types Used in Digestate Treatment

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. The membranes are auto cleaned using regular chemicals such a citric acid and caustic.

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 digestate concentration system.

Ammonia Nitrogen

Digestate can have a significant ammonia concentration of around 3000 mg/l or higher which is some 100 x more concentrated than that found in domestic household sewage. It will also have an 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 increases 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 digestate, 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 allows the RO membranes to reject the ammonia as ammonium within the concentrate produced by the LFM membrane shown in Drg PS1137 above.

The concentrate is either stored for use later and this stored concentrate will suffer minimal ammonia vapourisation to the atmosphere. Further, it makes for the near the full amount of the ammonia in the raw digestate available for crop utilisation as only a fraction of ammonia is lost to the atmosphere during spreading.

The Concentrate and Separated Solids from the Screw Press.

The concentrate produced from the LFM membrane will contain all of the original nutrients (NPK) and valuable biosolids that were contained within the raw digestate. Just in a vastly concentrated form which adds value to the product. The biosolids and nutrients are blended together as a liquids with around 10% solids content. This can be mixed with the separated solids fraction from the screw press to increase the solids content of the blend before being spread on the holding, transported further afield or dried to a pellet.

Crowley Environmental
Crowley Engineering
Upper Glanmire Bridge, Co. Cork,
Ireland

Tel +44 (0) 1295 533230
Email: steven@dynameau.co.uk

Dynameau Ltd
The Colin Sanders Innovation Centre,
Mewburn Rd, Banbury, Oxfordshire,
OX16 9PA, UK

Livestock Slurry Dewatering

Membrane Technology

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

Biological FBBR Water Treatment

Solid Waste MRF's

Combine UV & Ozone Disinfection

Crowley Engineering

Grain Driers

Conveyors & Elevators

Feed mills complete

Agricultural silos & augers

Marine Pontoons

Helicopter escape simulators

Crowley Environmental
Crowley Engineering
Upper Glanmire Bridge, Co. Cork, Ireland

Tel +44 (0) 1295 533230
Email: steven@dynameau.co.uk

Dynameau Ltd
The Colin Sanders Innovation Centre, Mewburn Rd, Banbury, Oxfordshire, OX16 9PA, UK