ESMIL GROUP

ESMIL PROCESS SYSTEMS

esmil.co.uk

Advanced Digestate Treatment Process

Separate solids from water to reduce digestate volume by 3-7 times

Reduce COD by 90%+ and Ammonia by 97%+

Reduce Phosphates by 99%+

Concentrate NPK, Recycle by-products

Achieve an average of 80%+ Water Recovery suitable for reuse

Reduce Digestate management costs by 80% by using a Esmil's Process Solutions

Estimated payback: 1.5 years for dewatering +2.4 years when including membrane filtration

Turning Waste into Value: Esmil's Circular Approach to Digestate Treatment

The biogas industry is expanding rapidly across the globe, with a growing number of anaerobic digestion plants being built each year. However, one of the industry's biggest challenges remains: the effective management of digestate, the main byproduct of the anaerobic digestion process.

As production volumes increase, so does the urgency to treat digestate in a way that is both technologically efficient and economically viable. Traditional methods of handling this nutrient-rich sludge are often costly and unsustainable.

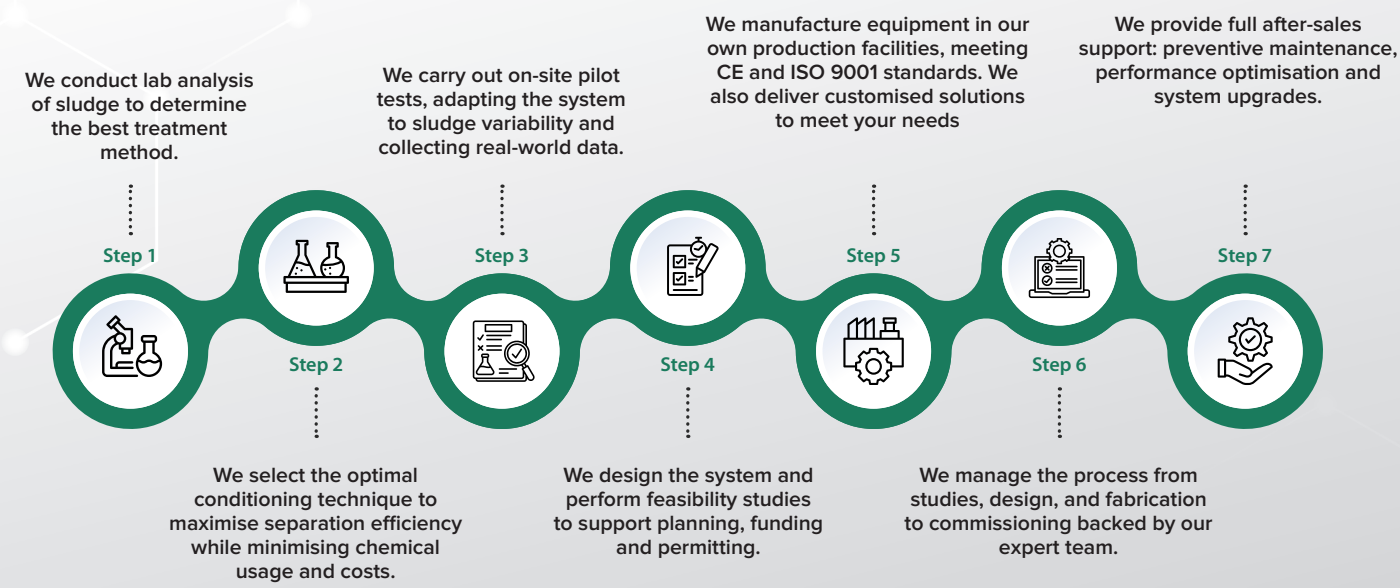
At Esmil, our engineers have spent years developing an advanced treatment solution designed specifically for digestate. Through extensive trials, in-depth studies and successful operation at multiple sites, we've perfected a four-stage treatment process that delivers maximum performance.

Our system is built on circular design principles, recovering valuable resources, reducing operational costs and enabling the reuse of water and byproducts within the plant. The result is a treatment solution that not only solves a pressing environmental challenge, but also drives profitability and growth for biogas businesses.

With Esmil, digestate becomes a resource not a burden.

Esmil's Project Philosophy

As no two digestates are equal, it is essential to follow a number of steps to ensure that your tailored treatment process performs as efficient and economical as possible to achieve treatment goals.



Process Description

CONDITIONING › DEWATERING › SUPER FILTRATION › REVERSE OSMOSIS

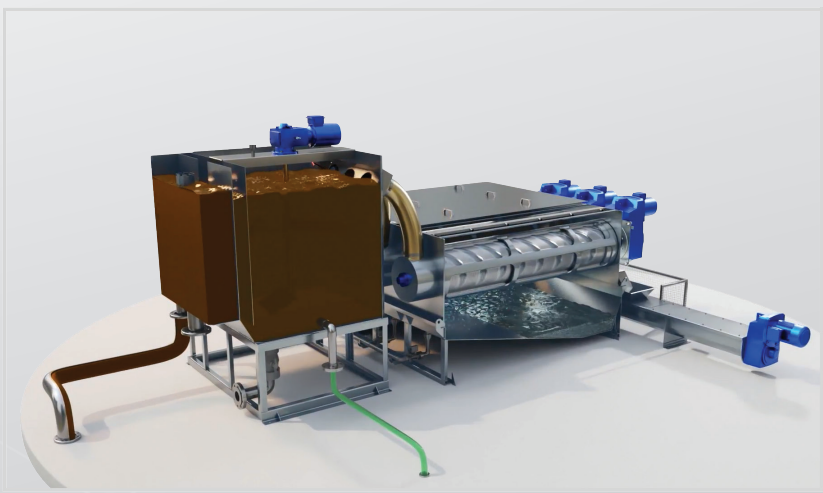
Expertise Conditioning

The process starts with lab analysis to determine the digestates composition. This informs precise chemical selection via jar tests and adjustments such as temperature, dilution, coagulation, flocculation, mixing speed and reaction time. Coagulants destabilise particles, while polyacrylamides (PAA) or organic flocculants build large, stable flocs ideal for dewatering. Esmil's system includes an in-line flocculator and maturation chamber to ensure proper mixing and retention time. The compact design uses a single feed pump, minimising energy use, maintenance and operational costs.

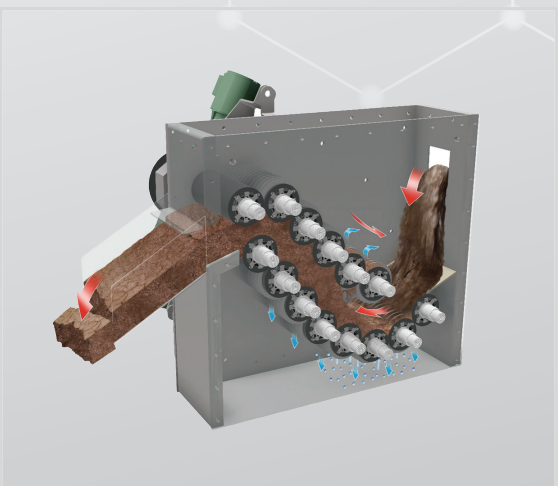
Highly Efficient Solids-Liquid Seperation

Dewatering is key to reducing digestate volume and separating solids from liquid efficiently. Esmil's roller press achieves up to 98–99% solids capture, producing a stackable, phosphorus-rich cake with 25–30% dry matter. This significantly lowers downstream volumes, transport and storage costs, while improving plant efficiency. The system is low-energy, reliable and forms the foundation for advanced filtration.

Esmil's Dewatering Equipment



Multi-Disc Screw Press MDQ

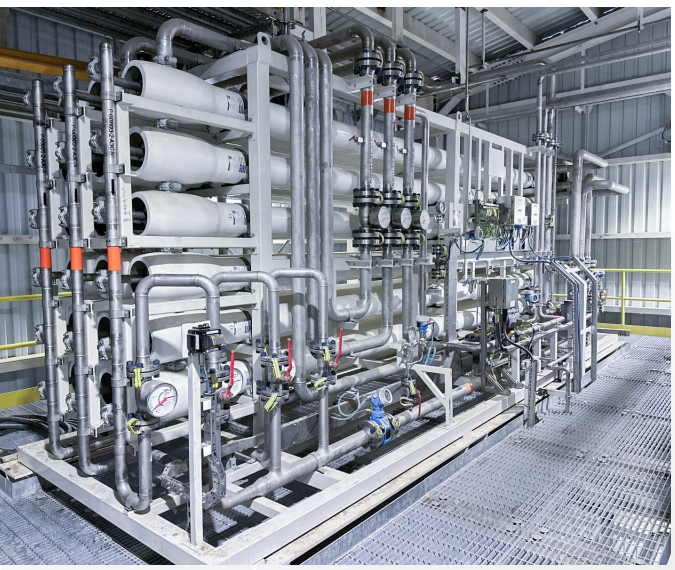


Roller Press JD

Organic Load Reduction

Superfiltration targets fine particles, colloids, and high-molecular-weight organics missed during dewatering. When using SF Membranes with pores from 0.001 to 0.01 microns, the membranes filter the water whilst retaining the larger contaminants. Esmil's crossflow system with a fouling-resistant zwitterionic membrane reduces cleaning and downtime. SF removes over 99% of suspended solids, cuts COD by up to 40% and concentrates insoluble nitrogen. The permeate can be further treated or reused as technical water, while the nutrient-rich concentrate can be applied as fertiliser.

Generating Pure Water

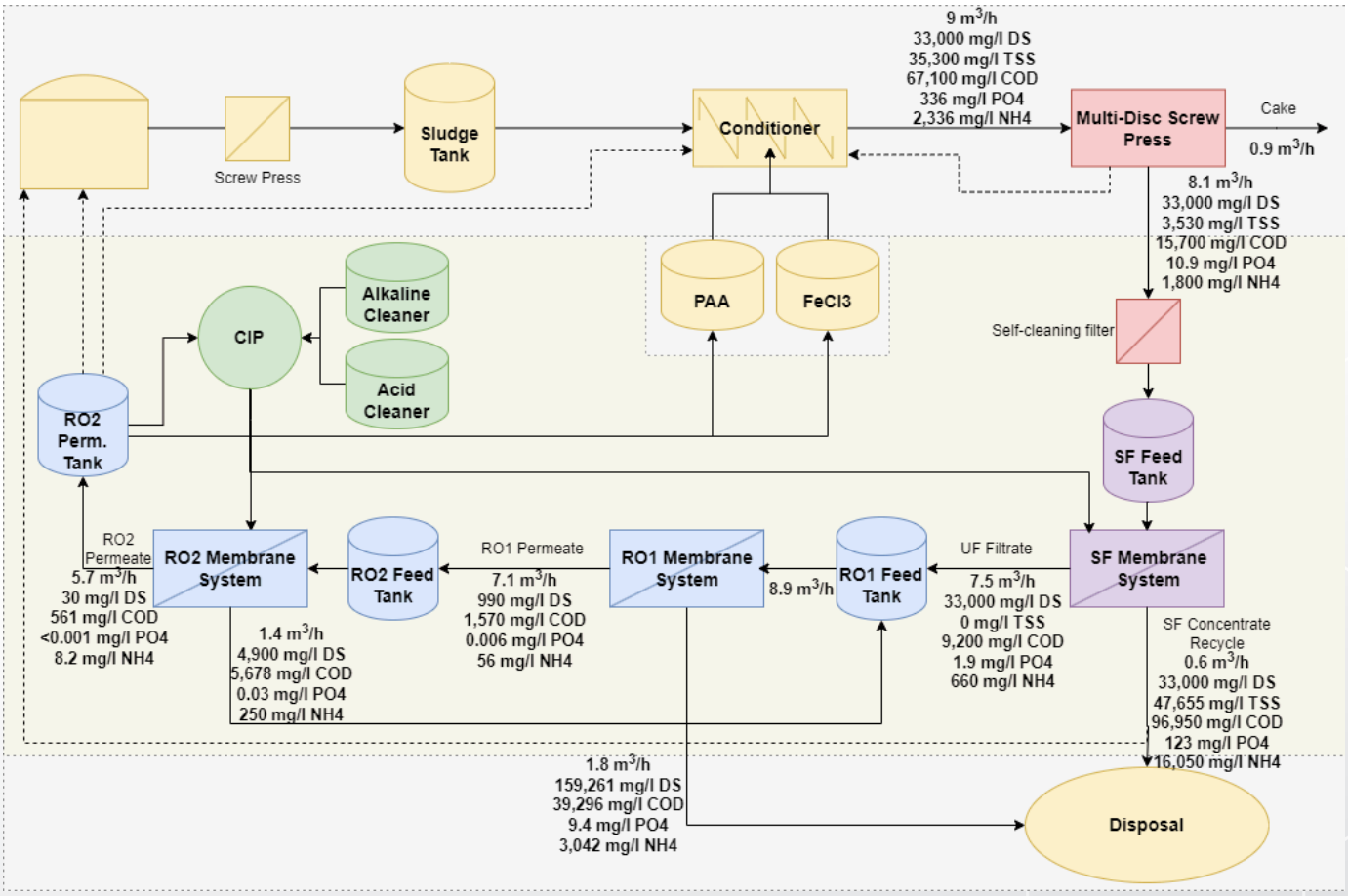


RO is the final polishing step, turning treated digestate into clean water. Under high pressure, semi-permeable membranes remove salts, residual organics, ammonia and metals, achieving up to 95% reduction in COD, ammonia, and conductivity. The resulting clean permeate is suitable for reuse or safe discharge. The RO also concentrates nutrients like potassium and ammonia into a liquid fertiliser, either combined with SF concentrate or used separately. This closes the treatment loop, transforming digestate into clean water and converting waste into valuable fertiliser.

VSEP Based Process Option

In the case where chemicals cannot be used for any treatment process (e.g. due to by-products reuse requirements), the conditioning, dewatering and super filtration stages may be substituted with a single stage specialised Reverse Osmosis unit. This replacement is called Vibratory Shear Enhanced Processing (VSEP). The patented VSEP process keeps the filter surface clean even when handling untreated digestate.

System Performance and Economics



Reduction rates of key contaminants when using a single pass system

Key Parameter	Feed (mg/l)	Effluent RO1 (mg/l)	Percentage Reduction
Chemical Oxygen Demand	67,100	1,570	97.6%
Ammonia	2,336	56	97.6%
Phosphates	336	0.006	99.9%
Potassium	3,810	138 (ppm)	97%
Dissolved solids	33,000	990	97%
Total suspended Solids	35,300	0	100%

Disclaimer: The reductions outlined are subject to testing because results are dependent on multiple variables. The table above illustrates results obtained from site, where conditioning, dewatering, SF and reverse osmosis was utilised

Unit	Expected Individual Hydraulic Recovery Rates
MDQ	80%
SF	95%
RO1	80%
RO2	95%
Overall Hydraulic Recovery	57% - 72%

Disclaimer: These values are dependend on feedstocks.

Operational Performance

This section covers a case study for a 10m/h process plant. The aim of the study is to provide our customer with a ballpark figure for capital costs, operating costs.

	No treatment	Dewatering Treatment only	Dewatering,SF & RO Treatment
Stream Management Cost	£944,000	£188,000	£188,000
WWTP Costs	£0	£140,000	£0
Esmil Solutions Opex	£0	£482,000	£563,000
Total Annual Costs	£944,000	£810,000	£751,000
Annual Savings	-	£134,000	£193,000
Payback Time (Years)	-	1.5	3.9

Disclaimer: Operating time for the process is assumed to be 24 hours per day, for 12 months a year. The payback period is subjective to the feed quality and hence will vary between sites. The information provided above is to be taken as estimates.

Selected references:

2018 – Quaser Energy Group LLC, Municipal Sludge, USA (MDQ)
2018 – Renergy Inc, wastewater Treatment Plant, USA (MDQ)
2021 – Biogas Distillery Plant, UK (VSEP, RO)
2023 – Biogas Distillery Plant, USA (VSEP, RO)
2023 – Biogas Distillery Plant, UK (UF, RO)
2024 – Granville EcoPark ltd., Food Waste, Northern Ireland (Engineering)
2024 – Biogas Distillery Plant, UK (VSEP, RO)
2025 – ZUO Promnik, Food Waste, Poland (JD)

Main advantages of the Esmil Process

Maximum Water and Product Recovery - Designed for efficiency, our systems recover up to 90% of feedwater while minimising waste. By concentrating organics and dissolved solids, the concentrates generated through membrane separation produce liquid and solid fertilisers. Converting waste into valuable by-products and increasing economic performance of the plant.

High Dewatering Efficiency - The MDQ Screw Press delivers stable performance even with variable feedstock composition, producing a solid fraction with average dry matter content between 15-25%.

Durability and Reliability - Our equipment is built at one of our own fabrication facilities, our equipment is engineered for durability and reliability. We use high quality, corrosion-resistant materials designed to perform in demanding conditions.

Custom Design – Our fully customisable membrane skids offer scalable solutions tailored to your digestate management needs.

Low Maintenance & Servicing Requirements - A limited number of moving parts and a design that prevents debris buildup help reduce the risk of breakdowns and minimise servicing needs.

Compact and Mobile Design - Our fully integrated skid units are delivered pre-assembled, factory-tested, and ready for immediate operation. With a compact footprint, all components are seamlessly housed within a sleek, unified frame. Installation and commissioning are fast, simple, and cost efficient. For even greater flexibility, our containerised design enhances mobility and accelerates project delivery timelines.

Sequential Design – The process is designed so that the treatment stages can be added in succession. Allowing investors to make a return before implementing new phases.

Advanced Automated Control – Developed and thoroughly refined, Esmil software automatically adjusts operating parameters to current conditions, ensuring continuous and optimised sludge treatment process. Remote access via 3/4/5G or Wi-Fi using web or mobile app allows monitoring and control from any location minimising labour involvement.

Minimise Freshwater Consumption – filtrate from the different treatment stages will is reused internally to minimise fresh water consumption and achieve sustainable goals.

ESMIL GROUP

ESMIL PROCESS SYSTEMS

Esmil Process Systems Ltd

Unit 5, the Courtyard, Glory Park, High Wycombe, UK, HP10 0DG

+44 (0) 1494 526 155

www.esmil.co.uk