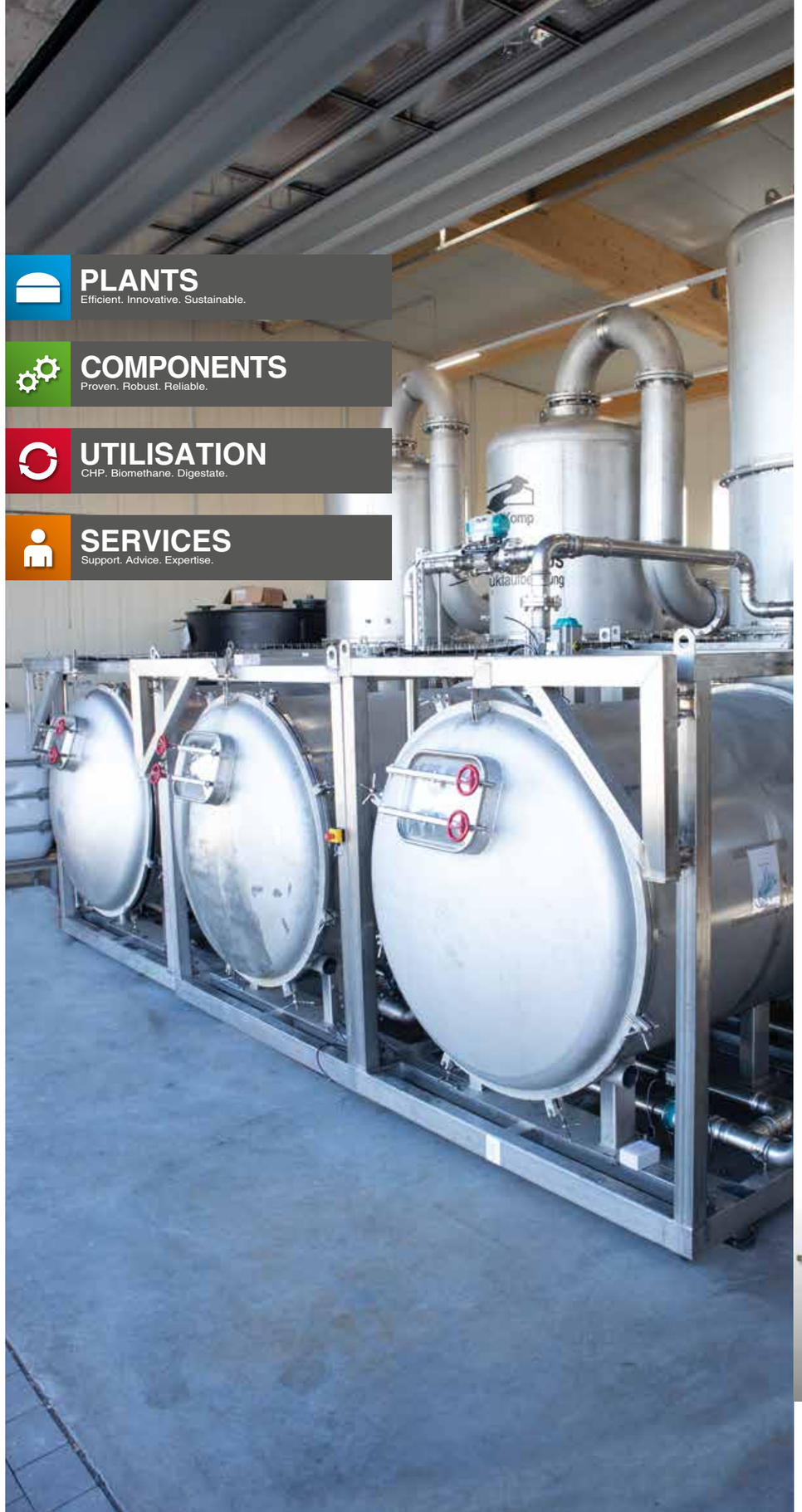

PLANTS
Efficient. Innovative. Sustainable.

COMPONENTS
Proven. Robust. Reliable.

UTILISATION
CHP. Biomethane. Digestate.

SERVICES
Support. Advice. Expertise.

AGRIFER® PLUS
Next generation of digestate treatment

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Member of the German Biogas Association

aK agriFer® Plus INTL

bestore . Group

agriKomp GmbH: Certified acc. to ISO 9001

Photo Page 5
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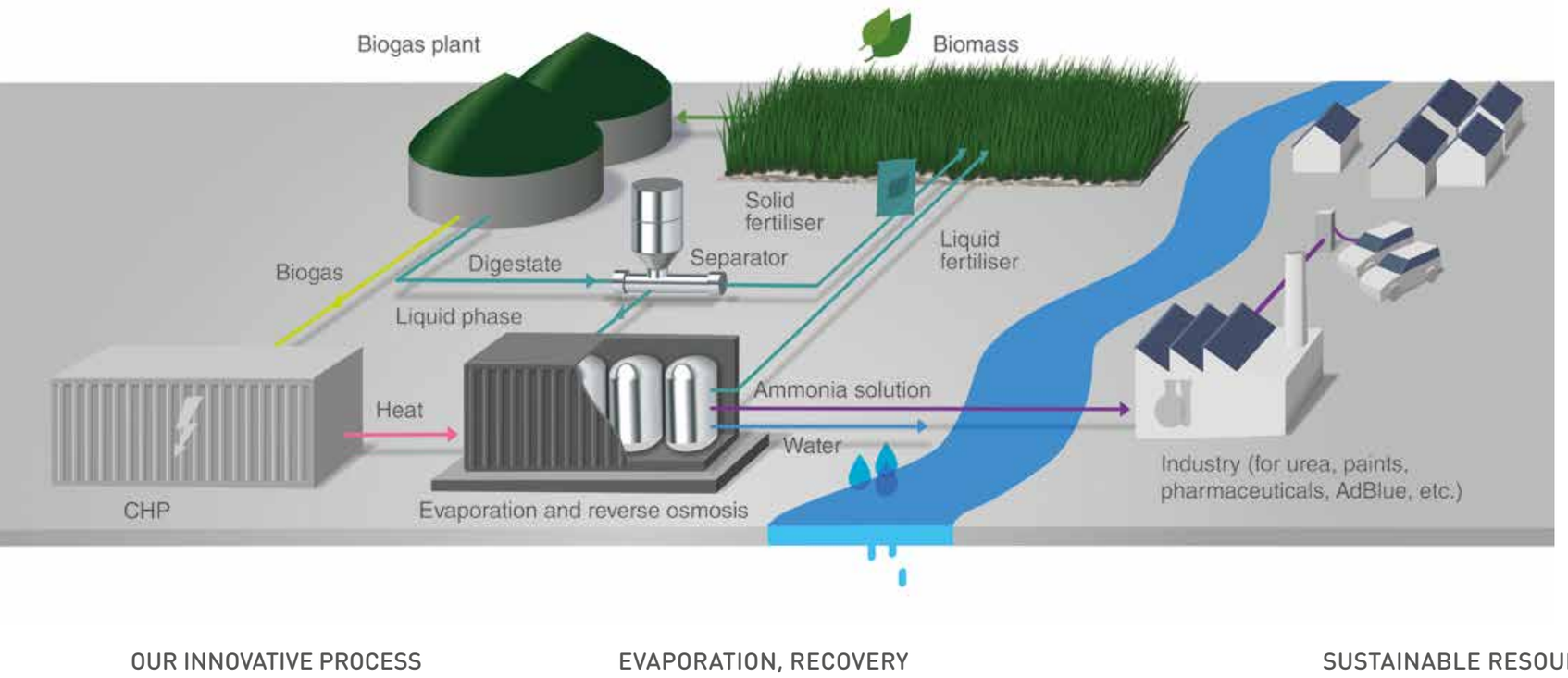
The next generation
of digestate treatment.

AGRIFER® PLUS



OUR INNOVATIVE PROCESS FOR DIGESTATE TREATMENT

The storage and use of slurry and digestate is leading to an increasing financial burden for biogas plant operators. Most of the processes currently available on the market work on volume reduction and concentration of nutrients.

So far, however, no process has been able to remove excess nitrogen from agriculture. The high nitrate levels in the soil and groundwater are due, among other things, to over fertilisation with ammonium-containing slurry, digestate and solid manure. A large part of the ammonium used becomes nitrate in the soil.

EVAPORATION, RECOVERY AND DISCHARGE

The innovative agriKomp complete treatment process offers an economical solution to the nitrate problem with simultaneous volume reduction. In this process, nitrogen-containing digestate is treated by an evaporation process in combination with reverse osmosis. The nitrogen is converted into marketable ammonia solution that is used in the chemical industry (e.g. in flue gas cleaning).

In the agriFer® Plus process, the input material is separated into approx. 3 % ammonia water (which contains up to 50 % of the total nitrogen from the input), approx. 49 % water, 21 % solid phase from separation and approx. 27 % NPK (Nitrogen, phosphate and potassium) concentrate, which can be used as fertiliser.

SUSTAINABLE RESOURCE MANAGEMENT

Compared to existing processes, valuable nutrients are obtained in the form of marketable products. The concept is also characterised by high environmental compatibility, as the addition of chemical additives have been reduced by 90 %.

Our treatment process significantly improves profitability, protects groundwater and offers sustainable resource management.

YOUR ADVANTAGES AT A GLANCE

- So far the only process for removing nitrogen from agriculture
- Higher process yields due to low treatment costs
- Stable market demand for process products (outside agriculture)
- Plant operator can extract important basic chemicals from digestate avoiding potential environmental liability
- Reduction (approx. 90 %) of costly, process chemicals such as sulphuric acid, minimising environmental site storage risk (e.g. sulphuric acid)
- No additional pollution of soils and groundwater due to sulphate additions
- No acid scrubbers (reduction of investment costs: approx. 13 %, of operating costs: approx. 10 %)
- Gives operator control in adjusting nitrogen content of NPK fertiliser

In the future:
Tightening of legal requirements.

NEW REQUIREMENTS

The requirements of the European Nitrates Directive 91/676/EEC are currently being implemented in national legislation. The resulting regulations pose new challenges, especially for producers of ammonium-containing wastewater and sludge.

In addition, there is the “Ordinance on Facilities Handling Substances that are Hazardous to Water“, which classifies digestion residues as hazardous to water across the board and thus increases storage costs.

Management and treatment of ammonium-containing wastewater and sludge are therefore becoming increasingly important, especially in the biogas industry, but also in livestock farming (agricultural processing industry) and waste treatment.

ENVIRONMENTAL ISSUES

The high nitrate levels in the soil and groundwater are mainly due to overfertilisation with ammonium-containing slurry, digestates and solid manure.

A large part of the ammonium applied is converted to nitrate in the soil. The majority of the processes currently available on the market work on volume reduction and concentration of nutrients.

So far, however, no process has been able to convert the surplus nitrogen into an industrially usable resource and remove it from the agricultural sector. Currently, the nitrogen is mostly removed from the digestate as ammonium sulphate solution and mainly used as fertiliser. This returns the nitrogen to the agricultural cycle and does not help to alleviate the nitrate problem.

FINANCIAL PRESSURE

In particular, the treatment costs for digestate and slurry have risen sharply in recent years. In 2016, prices in germany were around 10 – 15 €/m³ and are now around 15 – 20 €/m³. Conventional treatment processes do not provide options in the reuse of recovered nutrients, such as controlled reintroduction in agriculture as fertiliser or direct sale of recovered chemicals to industry.

STATE OF THE ART

The treatment of nitrogenous digestates is a key technological development for the industry. Many of the previous technical innovations in biogas production were adopted from the field of wastewater purification and exhaust air treatment. None of the available processes enables a cost-effective discharge of nitrogen from the agricultural sector.

In the agricultural sector, treatment increasingly consists of a combination of evaporation and acid scrubbing. In these processes, concentrated sulphuric acid is added in the second treatment stage, producing ammonium sulphate as a product.

So far, no treatment method has been able to gain widespread acceptance in the practice. This was due primarily to the following reasons:

1. High specific treatment costs
2. High use of concentrated acid
3. Problematic product marketing

From digestate to valuable resources.

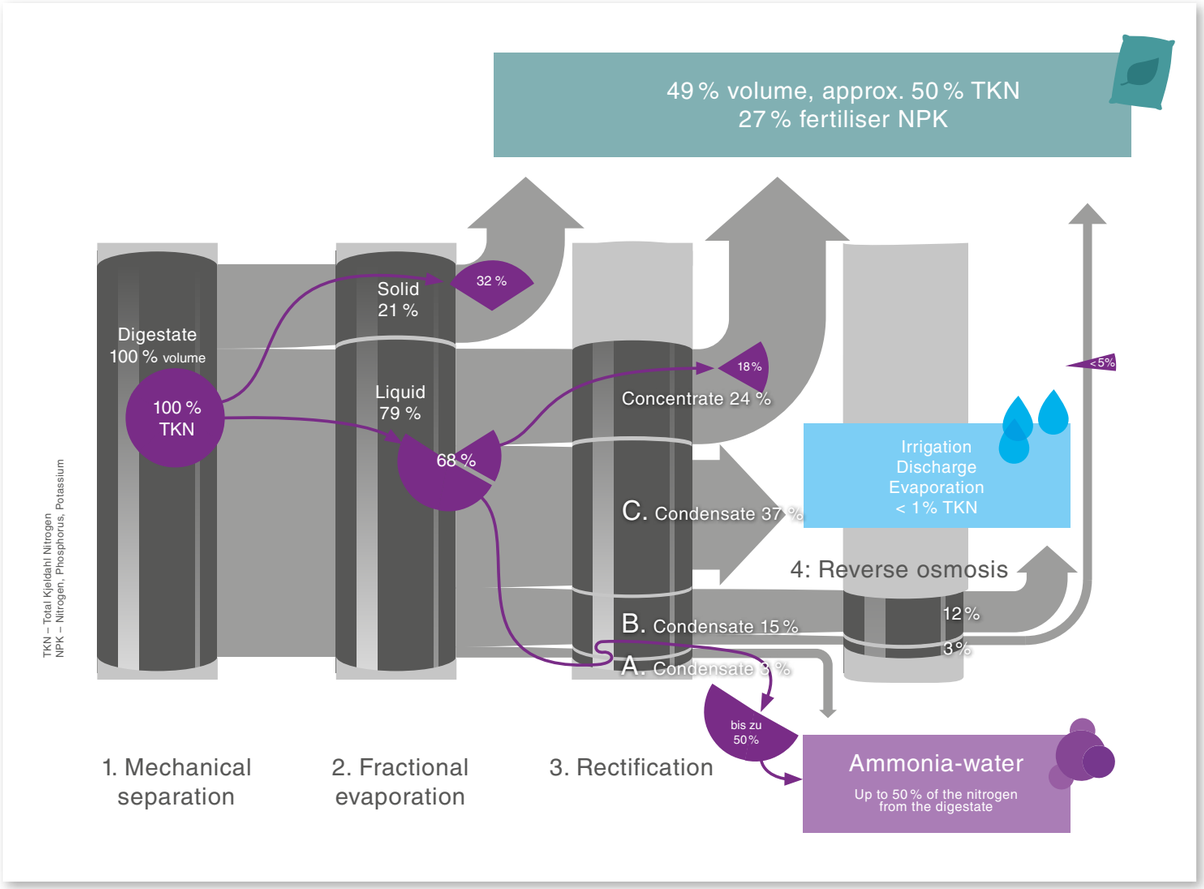
THE BIG PICTURE CONSISTS OF FOUR SUB-PROCESSES

1. Separation of digestates

In the agriFer® Plus process, the digestate is first mechanically separated into a liquid phase (press water) and a solid phase (pressed material). While the liquid phase, filtered through a sieve, is fed to the evaporators, the separated solid phase can be temporarily stored on a suitable storage area.

As a separator, we recommend our proven Quetschprofi® or the new powerful Quetschprofi® Plus, which impress with their robust design and ease of maintenance.

As with all agriKomp components, high-quality materials and sophisticated technology ensure maximum reliability for the Quetschprofi® variants.



2. Fractional evaporation

The agriFer® Plus design is based on a newly developed fractional evaporation process.

Fractional evaporation uses the different vapour pressures of ammonia and water to separate them in several stages by evaporation.

In the evaporators, the press water is heated under negative pressure, which evaporates a large part of the water and thus thickens the press water. This process can take place in 1 – 3 evaporators in parallel at different temperature and pressure levels. In this way, the heat can be used several times and with each additional stage a larger amount of water can be obtained per unit of heat used.

The thickened press water, the concentrate, is usually discharged semi-continuously from the process. The evaporated water is cooled in the condensers and is thus available in liquid form again.

This mode of operation ensures that the available thermal energy is used in the most energy-efficient way possible with very low emissions..

The concentrate produced is a highly concentrated fertiliser containing all the NPK nutrients of the press water and the desired load of ammonia.

The fractionated evaporation results in three condensate fractions:

1. **Concentrated ammonia** (approx. 8 % NH_4-N) – is processed further by (rectification)
2. **Low concentration ammonia** (< 1 % NH_4-N) – is processed further by (reverse osmosis)
3. **Water fraction - only trace levels of NH4-N** – can be used in operation, evaporated or discharged

From digestate to valuable resources.

3. Rectification

The task of rectification within the agriFer® Plus plant is to increase the concentration of the ammonia water as required. This reduces storage and transport costs and generates income from the sale of ammonia water.

The first condensate fraction (ammonia solution) from the vacuum evaporation is concentrated by rectification.

The result is an ammonia solution with up to 25 % NH_4-N content. This concentrate contains up to 50 % of the total nitrogen from the original digestate.

Thus, up to 50 % nitrogen can be diverted from the agricultural sector and made available for other applications.

The ammonia water is stored in suitable, certified containers and finds a market in the chemical industry or can be used for agricultural purposes as needed.

The rectification column can be operated electrically or with biogas and is a key process step in to the agriFer® Plus system enabling surplus nitrogen is to be discharged from agriculture.

WHAT IS RECTIFICATION?

Rectification, also called countercurrent distillation, is a thermal separation process for separating a homogeneous solution of two or more substances.

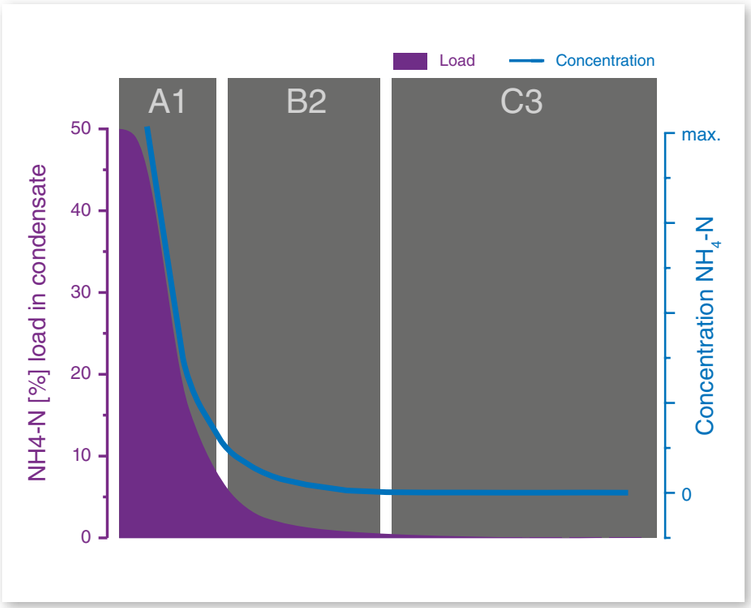
4. Reverse osmosis

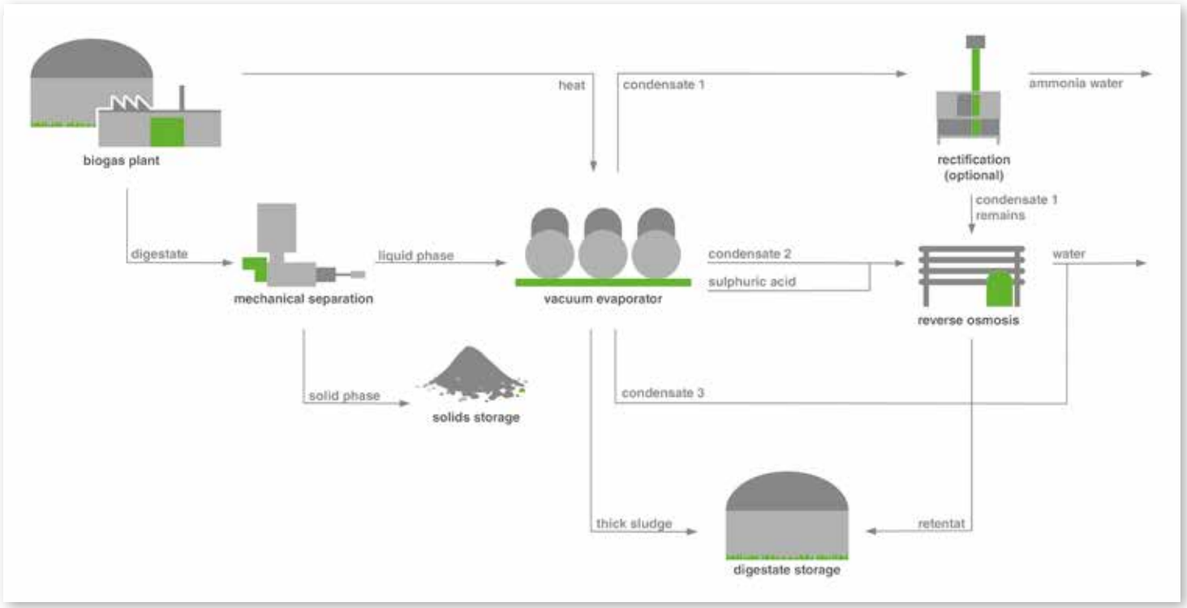
The second condensate from the fractional evaporation is then fed into the reverse osmosis stage. It is a physical process that enables substances dissolved in liquids to be concentrated in the molecular range. In this process the natrual osmosis process is reversed with pressure.

The condensate produced in evaporators is pressed against the semi-permeable reverse osmosis membranes. In this way, the water molecules and the impurities remain in the form of a concentrate in front of the membranes.

The system, which consists of several filter stages, leads to optimum cleaning of the condensate. The resulting permeate (water) has less than 90 mg/l COD, less than 10 mg/l BOD_5, less than 15 mg/l ammonium and can be used for operational purposes or discharged into receiving waters without further treatment.

The retentate (concentrate) is either returned to fractional evaporation or can be applied as a high-quality mineral NPK fertiliser as required.





agriFer® Plus:
Many advantages!

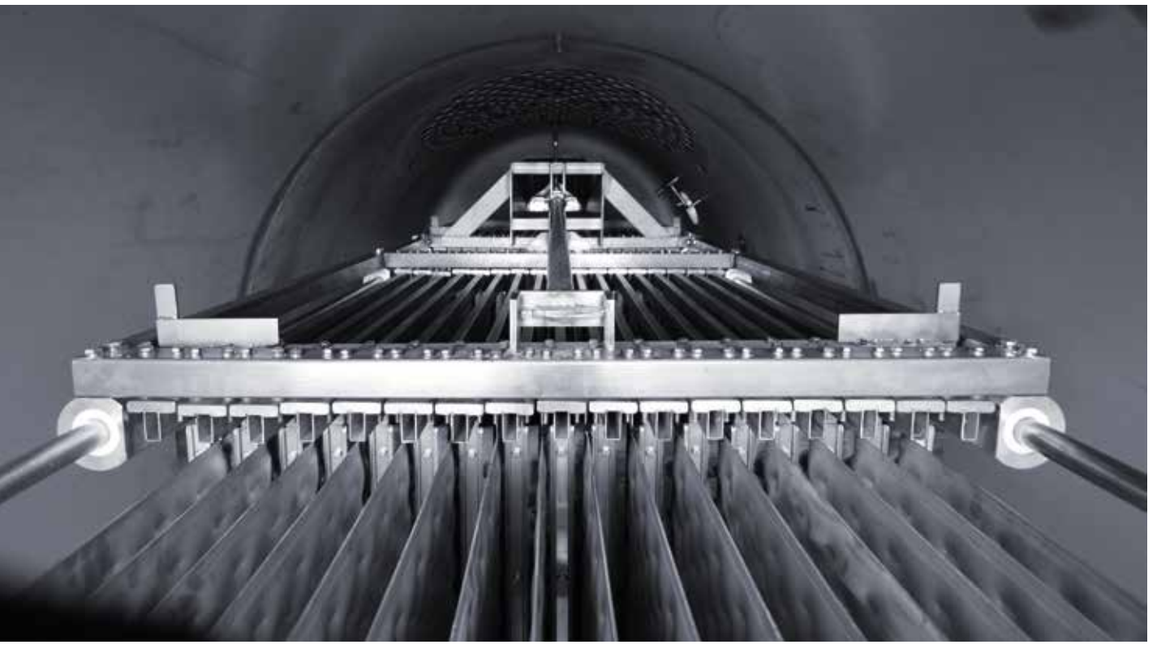
THE DESIGN: ROBUST AND RELIABLE

The agriFer® Plus system is a very well thought-out system that consists of several components that fully compliment to each other.

Thus, in addition to main components such as the vacuum evaporator, rectification tower and reverse osmosis, the agriFer® Plus system also includes an upstream separation step with (press water tank, condensate tank, intermediate tank, etc.).

Only high-quality materials are used in the production. All main parts of the evaporators are made of stainless steel (SS 304). The heat exchanger plates are equipped with robust scrapers, which guarantees the high evaporation performance and long service life of the system. The complete system is modular allowing installation in an existing building and also future expansion.

TECHNICAL SPECIFICATIONS	2-STAGE	3-STAGE
Heat extraction capacity	400 kW_{th}	400 kW_{th}
Liquid digestate input	approx. 13.000 m^3/a	approx. 15.000 m^3/a
Distillate output	2.4 L/kWh_{th}	3.3 L/kWh_{th}
Digestate volume reduction	50 %	50 %
Electrical power consumption	approx. 33 kW_e	approx. 35 kW_e



THE BENEFITS OF OUR INNOVATIVE PROCESS

- Removal from the agricultural sector of up to 50 % of the nitrogen as a valuable base chemical
- The recovery and sale of ammonia water from digestate can significantly increase biogas plant profitability
- The use of costly process chemicals such as sulphuric acid, are reduced by up to 90%, minimising environmental site storage risk
- Gives operator control in adjusting nitrogen content of NPK fertiliser
- No acid scrubbers, thus a reduction in investment and operating costs

SAVINGS ON DIGESTATE STORAGE

- The digestate volume is significantly reduced
- Up to 80 % digestate storage can be saved
- Additional capacity will be available in existing digestate storage.

INCREASE IN FERTILISER VALUE

- High quality NPK fertiliser produced
- Nutrients in liquid fertiliser are more available to crops with better uptake
- Purchase of additional mineral fertiliser is significantly reduced

INCREASING ECONOMIC EFFICIENCY

- Increased the efficiency of the biogas plant will use of the CHP excess heat
- Possible CHP bonus through own use of heat
- Cost savings in using the clean water produced by agriFer® Plus for general farm purposes

REDUCTION IN SPREADING COSTS

- Lower transport costs – Significantly fewer trips to spread the digestate
- Lower fuel consumption

MINIMISING EMISSIONS

- By converting the highly volatile ammonia present in the digestate into ammonia solution and stable ammonium sulphate, ammonia emissions are virtually eliminated.
- Production of clean water with the use of reverse osmosis

REDUCED IMPACT ON LOCAL RESIDENTS

- Less traffic
- No odour nuisance