Stabilisation of slurry

SyreN Light for research

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Introduction

Stabilization of slurry is a most precise definition of acidification technology for animal slurry. Acidification adds sulphuric acid to slurry to control the pH value. This changes the chemical composition of the slurry, where ammonia gas is transformed to ammonium salt. The ammonia gas may evaporate from the slurry liquid, whereas the ammonium salt is stable, and it is the best plant nitrogen form available.

Without controlling the pH with acidification technology, the plant available utilization rate of ammonium in slurry varies from 20 % up to 80 % depending on the application technology, slurry type, climatic conditions and soil conditions at the time of application. This is a major problem for both farm economy, human health and the environment:

Farmer: In fertilization plans, farmers depend on a fixed utilization rate of the fertilizers they apply. If there is uncertainty of the dose rate effectiveness, a higher volume than necessary will be chosen in order to secure the maximum yield potential from the crop. This leads to increased cost and eutrophication

Human health: The ammonia emission reacts with Sulphur- and nitrogen oxides in the atmosphere. This forms particulate matter ($PM_{2.5}$ and PM_{10}) which is a major part of air pollution and causes deceases in the human respiratory system.

Environment: Eutrophication with nitrogen (overload of nutrients) is a serious environmental problem and it is causing destruction of valuable ecosystems everywhere with loss of biodiversity as the most noticeable effect. It also has an indirect effect on CO_2 emission through a higher production of nitrous oxide N_2O. With our newest employment of SyreN System, it is also possible to reduce GHG from agriculture with 30 % CO_{2e}.

The addition of sulphuric acid creates a stable nitrogen utilization rate of +80 % in the slurry. This increases the fertilization value for the farmer and allows him to reduce his application rate of mineral nitrogen, thus decreasing his cost but maintaining the optimal yield from the crop. The stable slurry and reduced application rate, reduces PM air pollution from agriculture with app. 40 %, leading to an overall reduction in PM of 20 %, saving thousands of human lives. The reduction in eutrophication – airborne and wet – is at world class level!

There is ample reason to believe that stabilization of slurry will become a standard with application of slurry. Denmark, with its intensive animal production, has pioneered this technology and is now being followed by other countries. Eventually, this will become a standard for agriculture everywhere. We try to think of this in the same manner as the automobile industry:

AdBlue is used to reduce nitrogen oxide from diesel engines. Stabilization of slurry has a much broader effect and with an economic incentive for the user.

With all the positive benefits, there is a safety issue with the use of sulphuric acid that must be address before stabilization of slurry can become a standard method. For this reason, we have designed the SyreN Light system to enable research facilities and plot trail slurry applicators to use acidification in a safe, precise and documentable manner. With the experiences and documentation from extension services, the farm contractor services, biogas digester plants and large farms may adopt the technology and be comfortable with its application for the benefit of farms, human health and the environment.

Think of Sulphuric acid as AdBlue for slurry

Morten Toft, Veerst- Denmark 2019

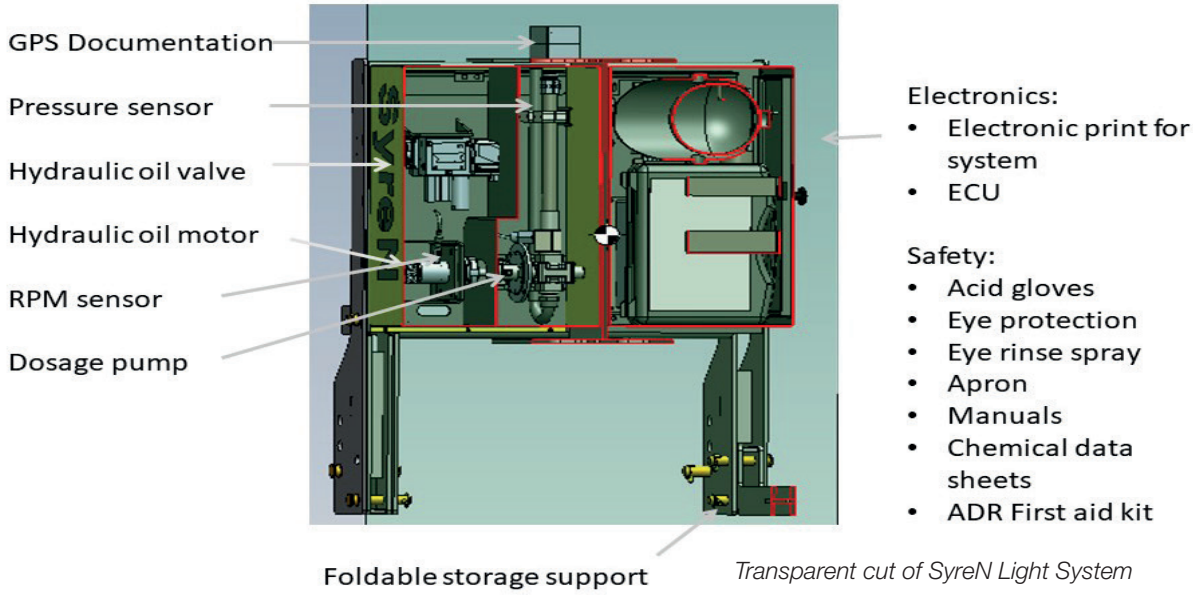
SyreN Light System for professional plot trail slurry application

A safe System / technology

SyreN system has been on the market for 10 years. In this period, we have sold +100 systems and we have acidified more than 100 million m3 slurry and use more than 120.000 m3 of 96 % sulphuric acid.

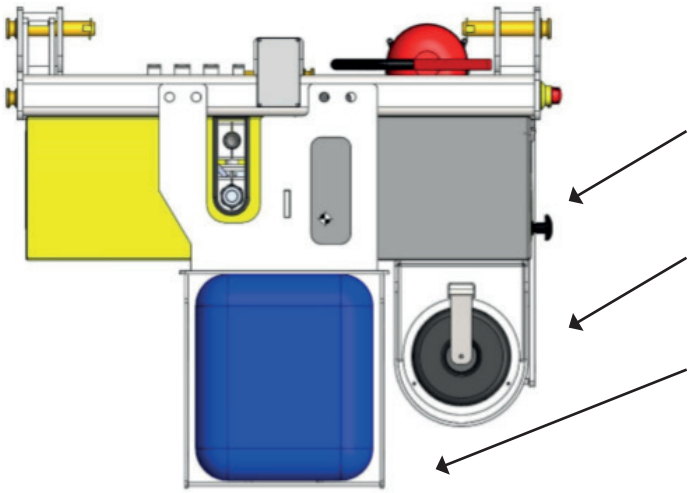
There have been no accidents involving person damage.

When designing SyreN System, Safety is our primary concern. We have a principle, that if safety can be improved, we will always do so. The system was created with ADR (dangerous goods) transport regulations in mind, even if it is not a requirement for use of under 333 litters containers like SyreN Light.



Transparent cut of SyreN Light System

A very important feature of SyreN Light, is that it is a closed system where no direct contact with the acid is possible. Easy accessibility to safety equipment will ensure that it is used.



Process advantages using in-field slurry stabilization

A most noticeable feature of stabilization of slurry is foaming. When sulphuric acid is added to slurry, the slurry will foam. As this is a question of the slurry chemistry, it cannot be avoided. As a minimum, the small bladder's in the slurry creates a most noticeable discolouring of the slurry and depending on the amount of sulphuric acid used and the buffer of the slurry. When heavy foaming takes place, 100 % of the slurry is transformed into foam. This ability may well cause the slurry pump to cavitate, making pumping or field application impossible until the foam settles again. This may take up to 48 hours.

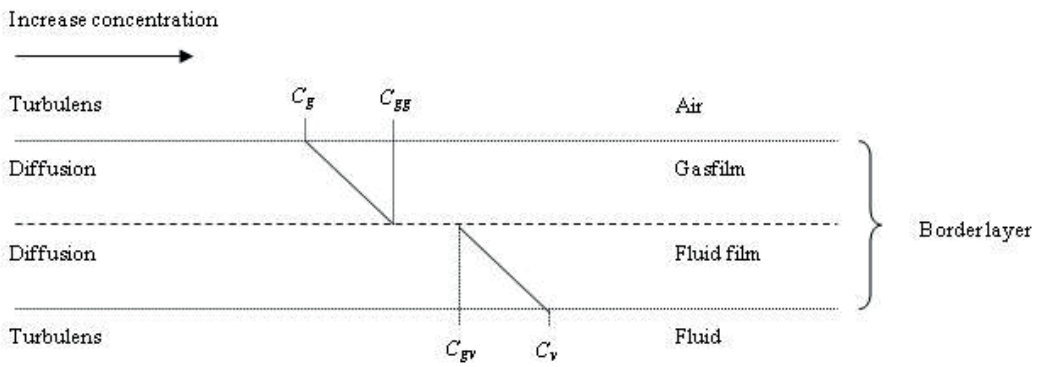
With barn- and storage stabilisation, the foam is a regular nuisance, but with in-field application, it is a major benefit. Since the acid is added after the pumping, it does not influence the slurry pumping ability and it adds pressure and thus accuracy to the flow. In the field, the foam is an advantage because it stops any movement of the slurry. Especially digested slurry has a very low viscosity. It takes a very small inclination for the slurry liquid and thus the nutrients, to move significantly within the field. It may even run off the field and cause a significant yield variation. This results in harvest difficulties and it has a very negative influence on the economy and the environment.

This also makes it impossible to simulate in-field stabilization by adding acid to slurry in a container before application.The difference in the volume of slurry applied between the container stabilized slurry and the in-field stabilized slurry, will distort any comparison between the two stabilized slurries – even though the same amount of acid may be used. The container stabilized with slurry must rest up to 48 hours before it has returned to a comparable viscosity to the in-field stabilized slurry. In this period, the efficiency of the acid will be reduced significantly, ending all comparison between the slurries.

The foam itself is also a barrier to emissions from slurry. The further away the ammonia is from the surface turbulence, the less likely is emission. Elevating the surface distance through foaming is thus a very efficient method of reducing emissions. The lack of foaming in the field with barn- or storage stabilization reduces the efficiency of the technology and increases the need for acid.

This is described in the formula:

The use of foam to reduce emissions is well documented and it is part of elevating the emission reduction effect from using in-field acidification



Injection of sulphuric acid to slurry reacts with heavy foaming

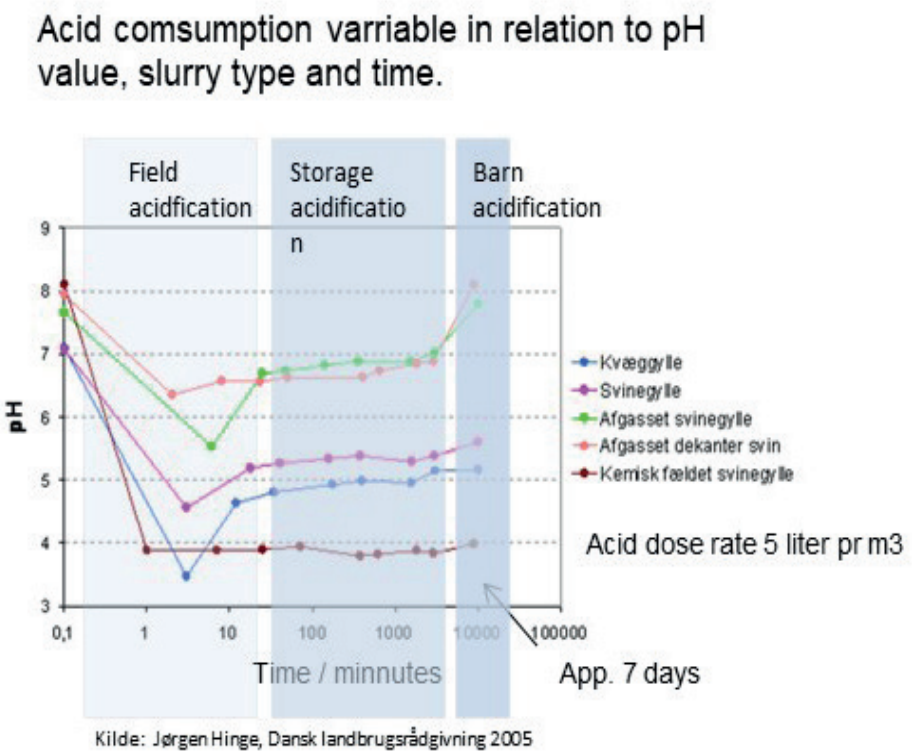
Time vs. effect

Even if the foam has disappeared from the slurry, it will be non-comparable because some of the acid effect will disappear in the storage period. With ref. To below graphic, there is a significant pH lowering of the slurry in the first 5 minutes, after which pH recovers to a higher value. This low pH period represents almost 25 % of the time in which the slurry is exposed direct to the atmosphere and where it has the highest level of emission.

If in-field stabilization is to be monitored, there is no option but to use an in-field acidification system.

Amount of sulphuric acid used

As a part of the slurry buffer, the dry matter in the slurry influences the consumption of acid. The liquid reacts instantaneous to the acid with a pH change, but the dry matter is slow to react. Thus, the longer the liquid is in contact with the dry matter, the two will even out the pH difference and the collective pH will increase. This leads to an increased consumption of acid. The short time exposure of in-field stabilization will have less acid consumption than barn- or storage stabilization.



Kilde: Jørgen Hinge, Dansk landbrugsrådgivning 2005

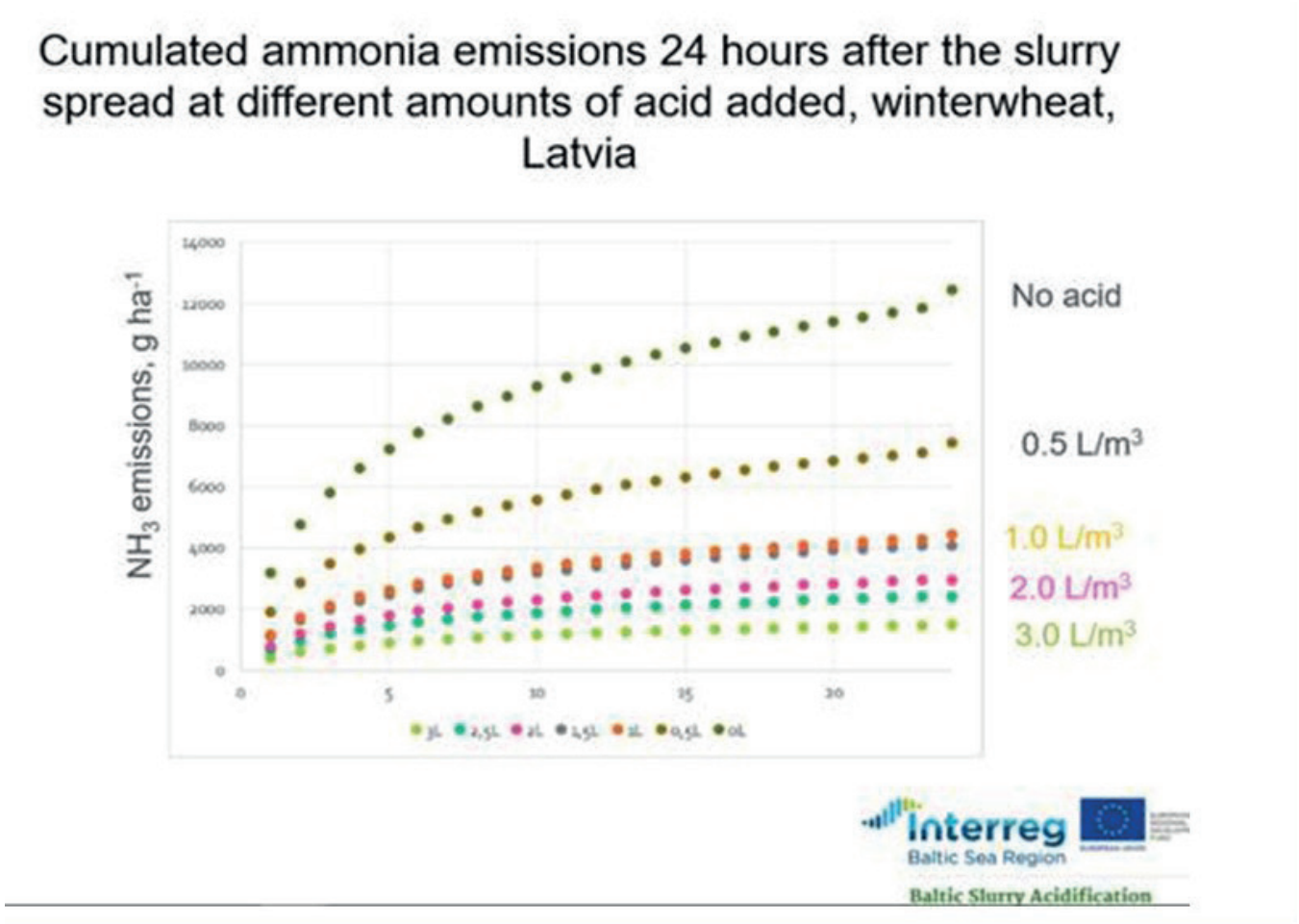
Flexibility of pH

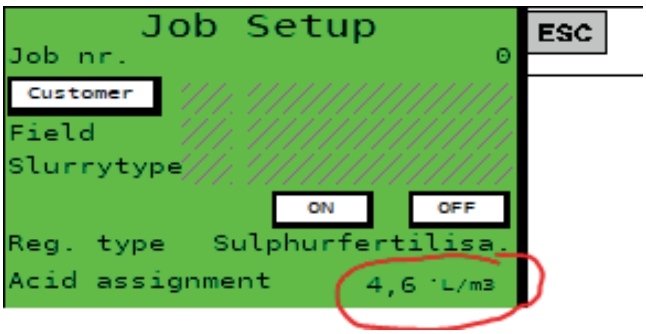
A most difficult issue is how much the pH should be lowered? SyreN Light offers the flexibility to individually decide on the pH level depending on slurry, climatic or soil features. A stable pH in the slurry is not a requirement like in a storage situation and the SyreN Light VERA verification has documented a 49 % emission reduction from cow slurry, using 2.7 liter of acid pr. m^3 at pH 6.4

The acid / emission g/ha consumption graphic gives a clear indication that the emission reduction effect is reduced with increase rate of acid injection.

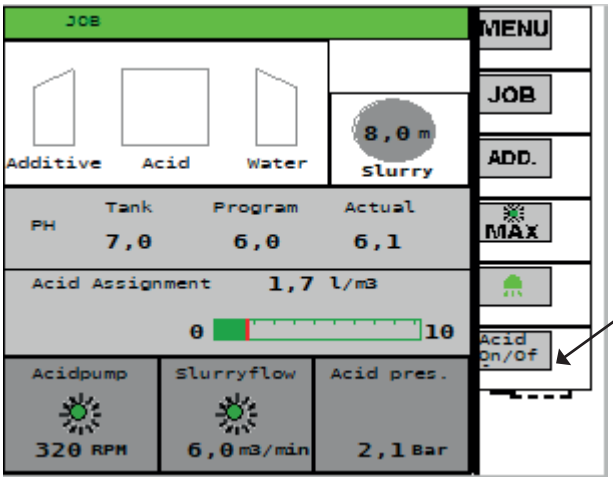
The price of sulphuric acid is the most important cost factor. There is an "international commodity" price with a local variation around 0.30 Euro cent pr. liter. It is instinctively attractive for farmers to save money on the consumption of acid, but it is also imperative that the pH threshold is not compromised. Thus, if research / extensions services set the pH target too low, it will not be respected because of cost. In Denmark, a dosage rate of 1.5 liter with 30 m^3 slurry is often chosen because it is close to the plant need of sulphur and it corresponds well to the consumption of one IBC tank of acid pr. day. This gives a convenient logistic. However, each slurry has an individual buffer. That makes it important to communicate the message of reaching the pH target value despite a difference in economics and logistic. Considering the economic and logistic factors, a pH target of 6.4 is often the economic optimal level and lowering pH below 6.0 is negative for economy and logistics.

With digested slurry, where the pH and the buffer are very high, failing to consider the amount of acid, may render the technology unsuitable because of logistical problems with an acid consumption above 5 liters. Such a situation has been tested with Lüneburg university, where lowering a digested slurry from pH 8.4 to pH 6.0 had a consumption of 13 liter acid. However, reducing pH to only 7.0 yielded a 34 % emission reduction with a 5-liter acid consumption.
With SyreN light, it is possible to adjust the pH on the fly to test different acid dose rates and decide on the economical optimal level of acid / effect combination.





The setup for l / m3 is easy – simply enter the volume in the system.



The system is operated by using the trail plot function as a simple on / off switch.

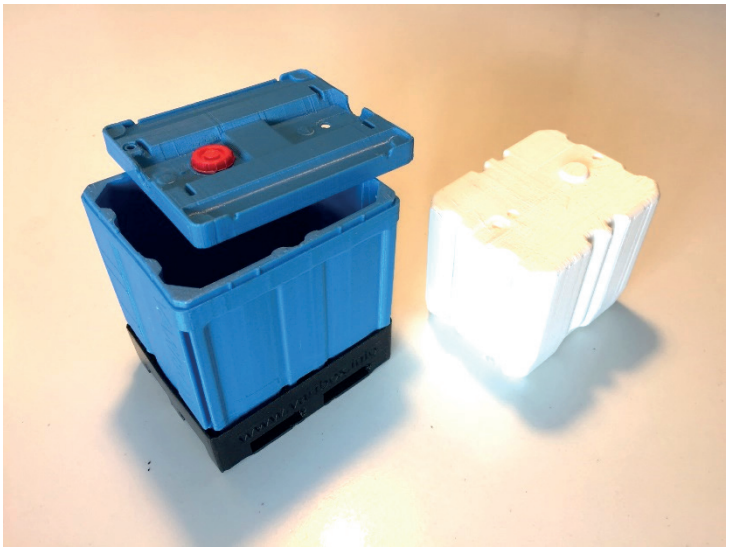
NB! Normally, SyreN System stops automatically when the flow sensor impulse is below 2 m^3, PTO stops, or 3-way valve sensor is in return slurry– or stop mode. In the trail plot mode, SyreN System has no automatic cut-off function other than the manual on/off. This mode can only be used with a code that is exclusively available for Syren Light when used as a trail plot application system and it leaves a lot of responsibility for safety on the pilot.

As the start/stop is manual, it is important to monitor the precise dose rate of each of the trail plots. This can be monitored on a weigh cell scale, that can be delivered with a wire connection or via a Bluetooth connection. A small printer can also be added. The dosage pump may also be used to monitor the acid consumption but the acid volume must be above 0.5 liter / min to be precise.

Scale weight for acid consumption recording.

As an important feature of the system, SyreN can fill smaller cannisters from a large IBC tank. The hose that normally feeds the slurry tanker mixer, is simply re-positioned to the IBC tank and the slurry tanker hose is positioned on the cannister. In this configuration, the cannister is filled from the IBC.

NB! In this mode SyreN System is operated with a manual on / off function only. Visual inspection and monitoring from the scale weight are a must to prevent overflow when filling. The pump must be operated at low- to medium speed. It is possible to fit an audible sensor as a filling alarm, but the cut off is still manual.



SyreN System uses either a standard IBC tank or a double walled IBC tank. Although the double walled is more expensive, the extra cost is easily justified by the ease of storage as the double wall feature excludes the IBC from having to be stored at a waste containment area and potential rainwater filling of containment area (indoor storage). In addition, it is a lot safer, as it is much less subject to damage from a lift handling.

Both couplers on the system are equipped with a safety check valve and with a very powerful closing mechanism to prevent any dripping from the repositioning of the couplers.

The system is the same design as is used on a pressurised draft beer system and it is very robustly built. Made from glass poly propenyl and Viton, they are lifetime approved with sulphuric acid with a UN 1830 certification.

When not in use, the couplers are positioned in a special drip protection holder that locks the coupler and protect it form any physical objects during transport.

The pH sensor monitors the slurry after the injection of sulphuric acid. The sensor is individually positioned depending on the slurry tanker and application system, but it must be after the slurry distributer and as close to the application site as possible. The sensor head has a normal lifespan of 1 year and must be changed every season. A Bluetooth connection between sensor and sensor head facilitates changing it and protect the plug elements from the harsh environment. The pH reaction in the slurry is instantaneous and can be monitored on the screen as the system operates. However, the pH reaction continues up to 2 minutes after acid injection, so the final pH value can only be monitored after a few minutes. It normally corresponds well to the on-line monitoring, but with trail plot work, it should be checked that the acid dose rate also reaches the target pH value. The pH sensor is positioned in a flow box, where it is always kept moist. Checking the pH value against the target pH value is simply to wait a few minutes after application and monitor the screen to see if there is any change to the pH value in the box.

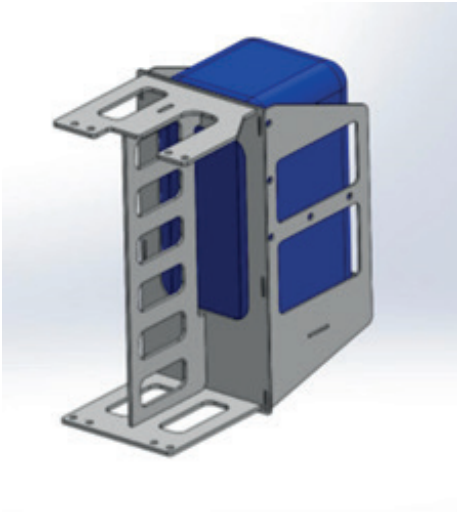
Bluetooth contact connection and digital chip for quick pH monitoring

Rear- or front position

SyreN Light may be equipped with one-or two 60 l cannisters holders to match the research station needs.

There may be slurry tankers that does not allow the cannisters to be positioned in the tractor rear three-point link because of slurry pump position etc. In such an event, the correct position for the cannister is identified and an individual holder- as well as hose length is manufactured individually.

Alternatively, the system can be positioned in the front tree point link, where hoses must be permeant installed underneath the tractor.



Holder for one 60 l Cannister

Individual holder for cannister

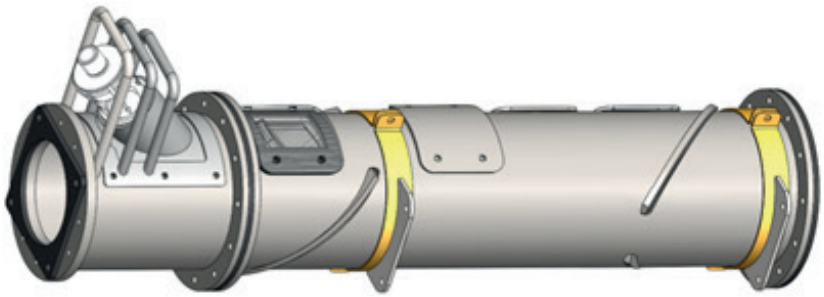
SyreN Light installed in the front hitch

Mixing of slurry and acid

Mixing of slurry and acid is potentially an explosive and a dangerous operation. The heat from the chemical process of dissolving the acid can make the water boil and escaping vapor can create pressure and be acidic and very corrosive.

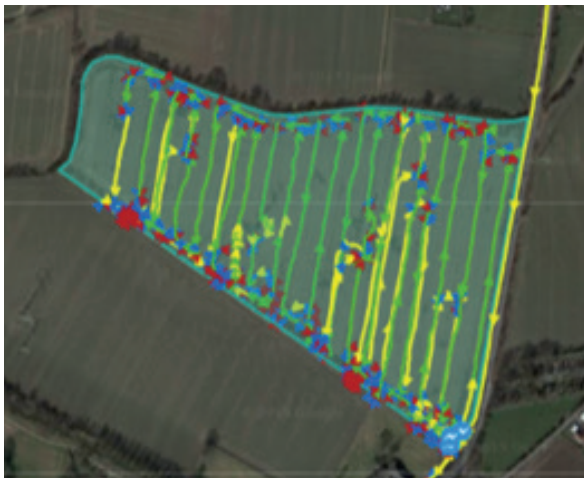
However, when the acid is dissolved into a large volume of moving liquid such as slurry, it is harmless and serves only to lower the pH from average neutral pH 7.2 to pH 6.4. It is very important that acid is only injected after the slurry application has started. This is the reason why a plot trail application must be manual. The requirements for plot trails are that acid and slurry meets at exactly point 0. This does not meet the safety requirements of SyreN System, where safety margins are built into the system, so this operation has been modified to become manual.

The need for mixing is individual, as a long distance from injection point to slurry distributer reduces the need for mixing. With smaller slurry tankers, the mixing must be very efficient as there is normally little distance for the natural turbulence to aid the process.



SyreN static mixer with check valve and internal turbulence elements.

SyreN telematric system



Exatrek as a applied map

Exatrek telemetric system

SyreN System has a build in system for documentation of the environmental effect. This is a GSM-GPS wireless transmission, that also monitors the working data of the slurry tanker and tractor. As it is not a requirement for a plot trail system, this feature is an option, but it may be of help to demonstrate the transparency of documentation of effect that is part of public requirement for environmental protection systems.

With the creation of SyreN Light, BioCover has made every effort to enable research- and extension stakeholders to engage in the introduction of Stabilization of slurry. Safety in all parts of the chain for introduction of a new technology is of outmost important.

Without a reliable and safe system, it is hard to recommend an introduction to a broad and diverse market like agriculture.

SyreN Transporter

The transport of sulphuric acid from storage to field, has different requirements for road safety. With a SyreN Light system, most needs are covered below the 333 liters. This relieves the driver from having a dangerous goods certificate (ADR) but the transport must still be signposted as ADR groupage. The containers must be UN 1830 approved.

With a 1000-liter IBC tank, the transport is subject to ADR and the system must be equipped with the needed safety equipment and warning tables. For this purpose, BioCover offers the SyreN transporter system, which is a de-spec SyreN front system. This fulfills all the ADR regulations and enables safe- and easy transport of an IBC tank with a tractor.

SyreN transporter system with a slurry feeder tanker

SyreN System Verifikation

The SyreN System has been extensively tested by several research facilities. Among these are the international accredited VERA Verification.

The Verification is for slurry stabilized at:

pH 6.4, 2.7-liter acid and with 49 % ammonia emission reduction.

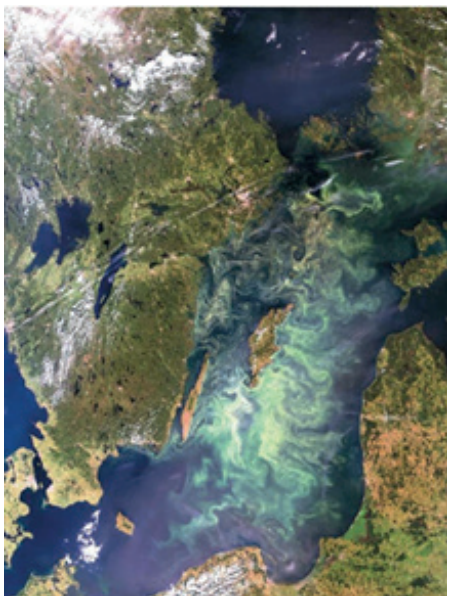
VERA Verificated

SyreN System for Sustainability

The SyreN System has been created with sustainable use of animal slurry as its primary function. Its ability to change ammonia gas into ammonium salt is a world class reduction in eutrophication and biodiversity protection of both land- and aquaculture environments. A significant increase in nitrogen utilization rate is an urgent global requirement.

In addition, an indirect effect from ammonia emission reduction, is a 20 % reduction in PM2.5 air pollution, that every year contributes to many thousand early death of humans.

It was chosen by 6 out of 7 projects in the EU Baltic slurry acidification project - http://balticslurry.eu, where all aspects of the technology have been scientifically reviewed. It is currently being scaled-up to become a standard in both Denmark and Germany.



Baltic see bluegreen alge grows can be reduced with the use of SyreN system

SyreN System has won 6 international awards. The flexibility of the system to match all farm requirements for both storage- and in-field stabilizing of slurry is unmatched.

SyreN System has been awarded as contributing to 9 out of 17 world sustainable goals by Stockholm University

Direct positive

Indirect positive

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Sulphuric acid is AdBlue for slurry