TEKNOLOGISK
INSTITUT

Notat: Pilottestforsøgene, kravspecifikationer og den resulterende prototype.

Projekt: *Reduceret kvælstoffordampning ved hjælp af bio-forsuring af gylle.*

Dette notat beskriver pilotanlægget og de indledende forsøg der ledte frem til en kravspecifikation og teknologivalget i den endelige prototype. En udførlig beskrivelse af teknologien (på engelsk) findes sidst i notatet.

Pilotanlægget

Pilottesten bliver udført på en malkekvægbesætning ved Lemvig. Forsøgsstalden var en naturligt ventileret stald med fast gulv og skraber, hvilket betød at vi kunne få helt frisk gylle til vore pilotanlæg.

Forsøget udføres i en ca. 10 m3 container (1,99 x 5,3 x 1 m3), som simulerer funktionen af en ringkanal. Gyllen i containerne havde en højde på mellem 40 og 60 cm. Containerne havde en trapez-form med et gyllevolumen på ca. 5 m^3.

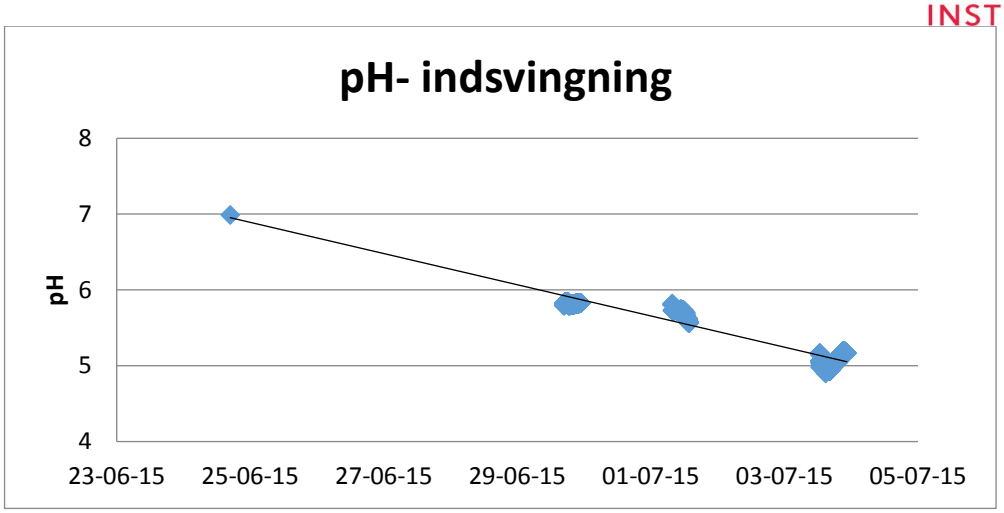
Frisk gylle svarende til dagsproduktionen fra 2 malkekøer, tung race, blev dagligt tilført pilotanlægget, ca. 160 kg. En delmængde af gyllen blev dagligt pumpet op i en opvarmet og omrørt reaktortank, hvor der blev tilsat melasse efter behov. Efter 8 timer blev den fermenterede melasse overført til den simulerede gyllekanal, hvorved pH sænkes.

Figur 1 Pilotanlæg med simuleret ringkanal til venstre og reaktortank til højre.

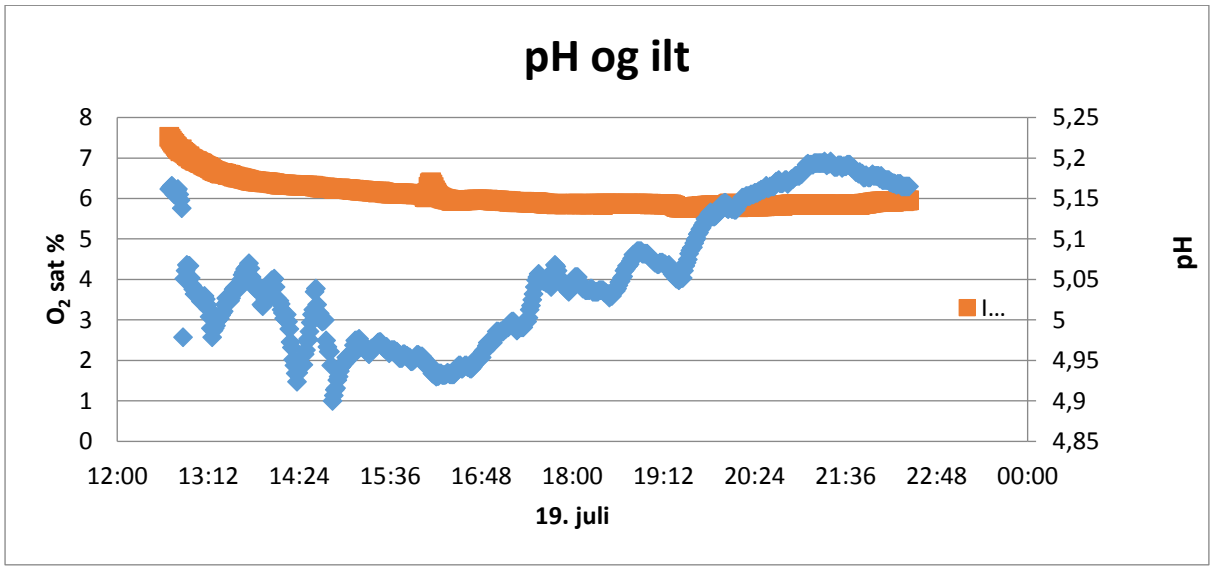
Opstart af pilotanlæg

- Melassen har et pH på 4. Melasse fra palletanken tilsættes i fermentatoren/reaktortank manualt den første dag. 20 % melasse. Mængde af væske i fermentatoren tjekkes til 100%. Mængden i fermentoren måles via. tryktransmitter. Styring kalibes.
- Den simulerede ringkanal fyldes op med vand. Ca. 2000 l vand.
- Gylle pumpes fra fortanken til pilotsanlæg, 160 kg per dag.
- Der tilsættes max, 32 liter sojamelasse dagligt fordelt på 3 doseringer.
- Der styres efter pH. Når pH er over 5,5 tilsættes melasse fra fermentoren.
- Der forbliver altid 10 % tilbage i fermentoren til podning af næste batch
- Det forbrugte fermentat erstattes af en ny frisk blanding
- Efter ca. en uge var pH er under 5,5.

Anlægget fungerede stabilt med nogle afbrydelse efter en måned. pH var stabil 10 dage efter opstart, se figur 2. pH elektroderne drev og voldte problemer i starten. Melassepumpen havde desuden problemer med de mange fibre.

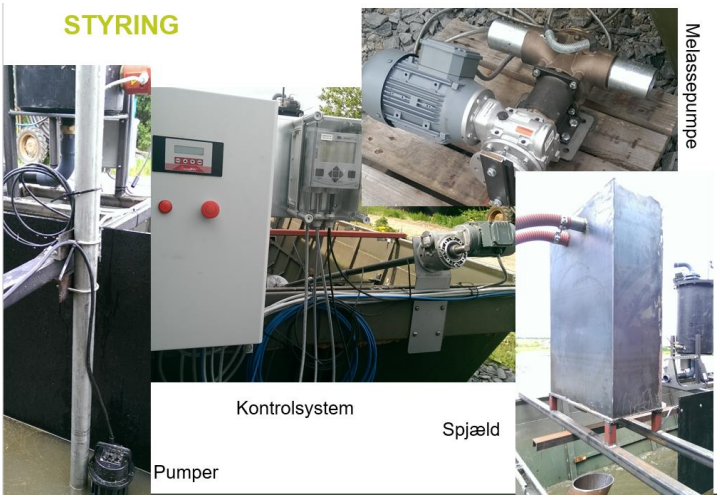


Figur 2 pH udvikling de første 2 uger.



Figur 3 pH og [O2] over 12 timer.

På figur 3 ses hvordan iltkoncentrationen falder som funktion af iltforbrug i forbindelse med omsætning af melasse. pH regulering starter over pH 5,2 og slutter ved pH 4,9.



Figur 4 viser de forskellige enheder i pilotanlægget.

Kravspecifikation for prototype

- Max 20 % soja melasse tilsætning, 2 % roemelasse
- Melassen skal være pumpbar
- God omrøring essentiel, ingen beluftning
- Opformeringstank/fermentor ikke nødvendig
- pH sensor skal serviceres med hyppige intervaller eller backup installeres
- Anlægget kan startes op på under en uge
- Aftale med biogasanlæg →stor gevinst

Description of technology

Functional description of JH Staldservice bio-acidification system for dairy farms

The ammonia emission is reduced using the bio-acidification system. JH Staldservice has developed a new technique called Bio-acidification. The current acidification system has been developed for dairy production with a circular pit system.

The idea of the bio-acidification system is to acidify the manure in the pits with an organic acid or a pre-fermented carbon rich biomass (such as molasses) to acidify and to stimulate naturally occurring fermentation of the manure in the pits, resulting in a decline of pH. in comparison to acidification with an inorganic acid, bio-acidification uses an acidifying source that can both be consumed and produced in the manure pit. This process is very depended of the temperature. Bio-acidification has the advantage that all acid produced is biodegradable hence higher biogaspotential and reduced sulfate leaching.

Bio-acids is defined as fermented biomass that can be stored safely until it is added to the manure. Bio-acid can for example be molasses that have spontaneous been fermented by naturally occurring microorganism, which brings the pH down to around 4 and stabilising the product. Bio-acid contains therefore both a high density for fermenting bacteria's, organic acids from fermentation and a carbon rich biomass that are relatively easy degradable. Organic acid such as acetic acid can be used to start up the process because development of foam can be controlled with slow addition. If an easy degradable carbon rich biomass is added when starting up a new system, uncontrollable foaming can occur. Startup with bio-acids is safest in spring with gradually increasing temperatures and with as few manure in the pits as possible. The possibility of adding an organic acid is not obligatory for the technology but practical in startup and also as a safety mechanism if bio-acid addition is insufficient.

The bio-acidification system for dairy farms includes the following key elements.

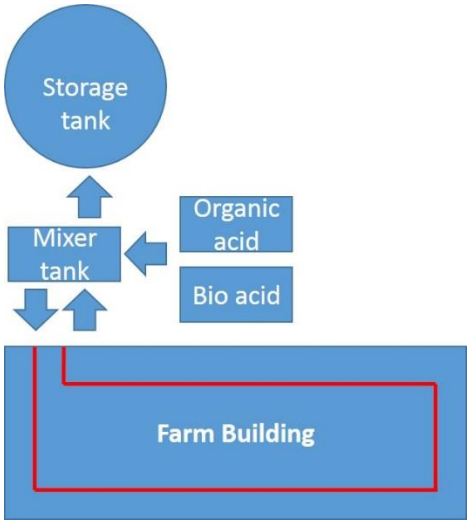


Figure 5 shows schematic overview of the bio-acidification system.

The manure acidification system for cattle farms includes the following key elements:

- Tanks with bio-acid and optionally organic acid, from where the bio-acid or organic acid is added.
- Mixing tank/ pumping well in which stirring, acid addition and pumping take place. The mixing tank is generally an existing tank.
- Fresh manure is mixed with bio-acidified manure and returned to the barn in the circular pit below the slatted floor.
  Storage tank, where acidified manure is stored after surplus manure is pumped from the mixing tank.
- Parameters such as pH, temperature and amount og bio-acid added, is being logged in a control unit used for controlling the process.

The bio-acidification works as follows:

At a present time, every day of the year acidification takes place in the following chronological order:

1. The two pH electrodes which are placed in the mixer tank are flushed with water.

2. Stirring of the manure in the mixing tank/tanks begins and manure from the mixing tank is propelled into the circular pit in the barn and recycled to the mixing tank. pH is measured after approximately 10 minutes of stirring.

3. After 10-20 minutes of stirring, a bio-acid is added from the acid tank to the manure in the mixing tank. A metering pump is used for this purpose. Bio-acid is added directly into the

mixing tank at a programmed time. The addition time, which equals the acid amount, is calculated from the pH drop and the added bio-acid the provirus day/days.

4. The stirring stops, when all manure is acidified (depends of pit length and pump capacity normally after 30-60 minutes of stirring). Just before the stirring stops pH is measured and the value stored.

5. The process is repeated the day after and pH is again measured in the mixing tank. The amount of bio-acid added is calculated on the basis of the previous added amount and the effect on pH. If pH is reached no further bio-acid is added. If maximum bio-acid is added with no effect the system can be set to switch to an organic acid.

Dependent on the time when the daily acidification is set to run, manure is pumped into the storage tank. The manure is pumped to the storage tank until a preset minimum level in the mixing tank is reached. In case the farm delivers to at biogas facility, manure can be collected directly in the mixing tank/pumping well.

All processes such as stirring, pumping, addition of bio-acid and pumping to the storage tank are controlled automatically to reach the decried pH level. A PLC based control unit is controlling the acidification process. Logging of all measured pH and temperature values are uploaded to a web server, which can be accessed by a web interface. This gives an opportunity to continuously monitor and verify that the installation works properly.

The bio-acid used for acidification of the manure can contain organic acids such as acidic acid, lactic acid, formic acid, benzoic acid or an/or pre-fermented organic carbon rich such as molasses, beet pulp, ensilage or milk residues that can be further fermented to organic acids in the manure pit.

In this verification, pre-fermented beet molasses is used.

Online data logging

JH Staldservice control system logs all actions by the bio-acidification system including:

- temperature
- pH
- acid consumption