Treatment of livestock manure for the fixation of ammoniacal nitrogen (NH_4^+-N) usinf magnesium by-products

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01. Rationale

This project set out to solve the current problem of the management and treatment of livestock manure, mainly from the pig sector, due to the limitation in the application of nitrogen (N) and phosphorus (P) as fertiliser, through the application of a new environmentally sustainable technology patented by the University of Barcelona (ES2332300B1 / WO2010 / 018260A1).

The objectives of this project were:
- Demonstrate the applicability and feasibility of a low-cost continuous process for reducing the concentration of ammoniacal nitrogen (N-NH_3) in pig manure (between 70-90%).
- Develop different formulations, in order to favour their replicability and transferability.
- Obtain different solid products precipitated during the recovery of free N-NH_3 contained in livestock manure, and assess the possibility of reusing them as a slow-release organo-mineral fertiliser.
- Validate the new technology at the technical and economic levels in different treatment scenarios.
- Minimise soil and water pollution.

To achieve the objectives, work was carried out in parallel at laboratory scale, pilot scale and in the construction of a real plant for the treatment of pig manure from a livestock farm.

At laboratory scale, the formulation of the reagent was improved and subsequently used in a physical-chemical process for reducing ammoniacal nitrogen (N-NH_3). The reagent was formulated with low magnesium oxide by-products in order to decrease the reagent costs and increase the sustainability of the treatment process.

A, B and C: images of the SAT La Vall 100 m^3 pilot plant. D: 1 m^3 pre-pilot slurry treatment plant. Photos: Operational Group.

The work of the pilot plant consisted of formulating the reagent used for the initial tests on the treatment of pig manure. In these initial tests, reductions in N-NH_3 content of up to 70-75% were achieved, depending on the addition of the formulated reagent.

Finally, a treatment plant was built on the livestock farm, with a treatment capacity of up to 100 m^3. As well as the initial operational tests, it is planned to carry out initial tests for the treatment of the manure generated on the farm itself with the additive formulated in the pilot plant.

02. Results and conclusions

The actions carried out in the project have resulted in the possibility of a new low-cost alternative process for reducing the ammoniacal nitrogen concentration of livestock manure, mainly from the pig sector, which could also be implemented in other waste effluents with a high ammoniacal nitrogen content.

The feasibility of using low magnesium oxide by-products for the formulation of a reagent that can be easily handled and added during the treatment of pig manure in a physico-chemical plant has been demonstrated. This opens up the possibility of reducing the concentration of ammoniacal nitrogen according to specific needs and treatment costs, and slow-release fertilisers can be obtained from the N-NH_3 initially contained in livestock manure.

Thus, it has been possible, firstly, to optimise at laboratory scale the most efficient formulation of the reagent used, and secondly, in the pilot plant, to determine the technical specifications for the elimination of ammoniacal nitrogen in an efficient and easy-to-install manner.

Specifically, from the results obtained at the laboratory and pilot plant scales (500/1000 L), it has been possible to draw the following conclusions, in line with the initial objectives of the project:
- It is feasible to formulate a magnesium-phosphate compound (Fixasol) based on a secondary and more economical source of magnesium oxide.
- It is feasible to formulate a solid precursor based on newberyite which, when added to an aqueous solution with a high ammoniacal nitrogen content, allows the reduction of the NH_4 concentration and the formation of struvite that may be recovered by means of a basic filtration operation.
- The Fixasol formulation is scalable, with pH, stirring and reaction time again being the main parameters controlling the formation of the desired mineral phase (newberyite).

In short, the tests carried out at the laboratory and pilot plant scales (500/1000L) lead us to conclude that it is feasible to reduce the concentration of ammoniacal nitrogen contained in pig manure by up to 70-75%. The technical, economic and environmental optimisation that justifies the replicability of the technology developed has therefore been demonstrated.

The technical and economic feasibility, according to environmental requirements, of the new best available technology (BAT) within the livestock sector for the management of organic waste, for low-cost processes for the reduction of ammoniacal nitrogen concentration, using MgO by-products with struvite precipitation, still needs to be demonstrated so that it can be replicated on a regional, state, European and world scale.

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