

TRAINING MATERIAL

Title:

The use of **struvite** in **Europe**.

Training:

Main features of the subcategory.

Struvite is an ammonia and magnesium phosphate hexahydrate ($\text{NH}_4\text{MgPO}_4 \cdot 6\text{H}_2\text{O}$). When ammonia and phosphate are found in solution, they can be removed by adding a magnesium salt, under controlled conditions, and white glowing crystals of struvite can then be recovered. One of the main advantages of recovering struvite from waste flows is the high selectivity of the reaction therefore the recovered product will not contain heavy metals either organic residues at significant concentrations. Struvite has low solubility in water but a high solubility in acidic solution, thus the humic acids are very efficient in increasing the solubility of struvite in the soil and this genuine slow-release fertiliser character prevents plant's roots from burning even if applied in excess. Besides, the low solubility in water will prevent P losses due to filtrations or runoffs. In addition, conventional fertiliser manufacturing processes are energy-intensive involving mining, long transport distances, thermal processes, and in some cases direct combustion of fossil fuels for product manufacture (e.g. urea production). In contrast, struvite recovery facility operates on a total installed electrical capacity of around 25 horsepower.

The main disadvantage of struvite is the lack of K, but it can be blended with other nutrients in order to provide an equilibrated nutrient ratio.

Input material.

Waste water, manure digestate or any other digestate dewatering liquor and P-rich industrial effluents.

How to produce?

Struvite can be produced accordingly to the following chemical reaction: $\text{Mg}^{2+} + \text{NH}_4^+ + \text{PO}_4^{3-} + 6 \text{H}_2\text{O} \rightarrow \text{NH}_4\text{MgPO}_4 \cdot 6\text{H}_2\text{O}_{(s)}$, so in the presence of ammonia, phosphate and magnesium in a mole ratio of 1:1:1, struvite will precipitate but, the precipitation of struvite is influenced by the temperature, the pH, the concentration of ammonia, phosphate and magnesium and the presence of calcium, which would react instead of magnesium to produce amorphous calcium phosphate. Either in urban WWTP centrates, specially WWTP where anaerobic digestion is combined with biological P removal, in manure digestate or in iWWTPs effluents, ammonia and phosphate are found at high concentration, but calcium from water hardness also appears therefore, in order to enhance struvite precipitation, a magnesium salt will be added in excess, to drive the reaction towards the struvite formation and a sodium hydroxide solution will be used to control the pH in between 8,5 – 10,0. All the four products (ID: 208-250-251-293) are produced according to this reaction, the only difference is the reactor used, while ID208 and ID293 use a simple continuous stir tank reactor, ID 250 and ID251 use a fluidized bed reactor, therefore the product obtained under any of the technologies is very similar.

Typical nutrient content and availability for plants.

The struvite usually contains 4.7-5.6% N (w/w), 28-29% P₂O₅ (w/w), <1.0% K₂O (w/w).

Examples for struvite products available on the NUTRIMAN Farmer Platform.

- https://nutrیمان.net/farmer-platform/product/id_208 (Spain)
- https://nutrیمان.net/farmer-platform/product/id_250 (Spain)
- https://nutrیمان.net/farmer-platform/product/id_251 (Spain)
- https://nutrیمان.net/farmer-platform/product/id_293 (Belgium).

The struvite selected in NUTRIMAN is available either at Spain or Belgium.

The struvite recovered from urban wastewater by “PHORWater” process (ID:208 – Figure 1) is made starting from the WWTP side streams. An elutriation process has been developed in order to increase the P availability. The struvite obtained contains 5% N (w/w), 29% P₂O₅ (w/w), < 1.0% K₂O (w/w) with a TOC < 0,8%.

The struvite recovered from pig manure digestate by “REVAWASTE” process (ID:250 – Figure 2) is made starting from the pig manure. The struvite obtained contains 5% N (w/w), 28% P₂O₅ (w/w), < 1.0% K₂O (w/w).

The struvite recovered from urban wastewater by “Canal de Isabel II S.A.” process (ID:251 – Figure 3) is made from the WWTP side streams. The struvite obtained contains 5% N (w/w), 28% P₂O₅ (w/w), < 1.0% K₂O (w/w).

The struvite recovered from wastewater by “NuReSys” process (ID:293 – Figure 4) is made from the side streams from either industrial or urban WWTP. The struvite obtained contains 5% N (w/w), 29% P₂O₅ (w/w), < 1.0% K₂O (w/w).



Figure 1. PHORWater struvite (ID:208).



Figure 2. REVAWASTE struvite (ID:250).



Figure 3. Canal de Isabel II S.A. struvite (ID:251).



Figure 4. NuReSys struvite (ID:293).

Fields of application in agriculture: crop, dosages, application method and practical recommendations.

The struvite (ID:208-250-251-293) is usually applied at 0,1 t/ha to provide P and N to the soil, according to soil quality, season and crop uptake. It is specially recommended for permanent grassland, cereals for the production of grain, root crops and plants harvested green from

arable land by area. The product is very suitable for top-dressing application and can be blended with other solid fertilisers but, it can also be dissolved in a slightly acidic solution. Therefore, traditional agricultural machinery can be used for the application and it is recommended to be applied before seeding/planting.

Benefits for farmers.

Struvite (ID: 208, 250, 251 and 293) are white solids, odorless and easy to handle, even though they come from residual flows.

Due to its genuine slow release property, nutrients are efficiently used by crops because it meets nutritional demands of crops in a better way and prevents the burning of plant roots, even when applied in excess quantities. Struvite guarantees a slow but steady nutrient supply and reduces nutrients runoff, consequently is not only good for the economics of the farm, but also for its sustainable agronomy.

In addition, Cd has not been detected and the amount of organic matter is very low, so it is a secure environmentally friendly product.

Finally, struvite is a recovered product with steady composition. Most of the commercial phosphates have variable composition and do not constitute a defined chemical entity instead they are mixtures of monocalcium phosphate, bicalcium phosphate, phosphoric acid, calcium carbonate and impurities but struvite offers a very steady composition, even though the recovery technology used may be different.

Bottlenecks of application. Potential risk or limitation.

The main bottleneck for the application of struvite is the end of waste national criteria. Nowadays, in Europe is approved to be used in agriculture in Belgium, Netherlands and Germany but it is still consider a residue in other countries, nevertheless the new European Fertiliser Regulation opens the door to its use in all of the European Countries and this Regulation shall apply from 16 July 2022.

Legal framework for using.

Specific national legal conditions

ID: 293 has the end of waste status (Flanders)/ Fertiliser (Flanders and Wallonia)/ NF U 42-001-1 (France).

ID: 251, since it is produce in Spain, it has the status of residue, but Crystal Green can be applied as fertiliser in Belgium, Netherlands and Germany, besides UK.

ID: 208 and 250 are also produced in Spain, therefore they have the status of residue and, till the day, they are not produce at industrial scale, nevertheless the new European Fertiliser Regulation opens the door to its use in all of the European Countries and this Regulation shall apply from 16 July 2022.

Economic evaluation of the application of the products.

NuReSys struvite is being sold at 80-120 €/t ex works.

Based on the market study and the economic feasibility, it has been estimated a price range in between 200-400 €/ha.

Best management practice guideline, taking into account of specific conditions of the given territory, for the use of the product to the specific applications (soil improvers, growing media, organic fertilisers etc.).

Struvite belongs to PFC:1.C. I. a “Solid inorganic macronutrient fertiliser”. It is easy to handle mineral fertiliser and has no specific storage requirement.

The application dose is usually around 0,1 t/ha, anyhow it will depend on the soil quality, season and crop uptake.

The low level of nitrogen makes it useful as a ‘starter’ fertiliser. As there are no free ammonia or phosphoric acid, there is no risk of affecting germinating seeds.

The product is very suitable for top-dressing application and can be blended with other solid fertilisers but, it can also be dissolved in a slightly acidic solution.

Traditional fertilizer spreader can be used for the application and it is recommended to be applied before seeding/planting.

For more information:

- https://nutriman.net/farmer-platform/product/id_208 (Spain)
- https://nutriman.net/farmer-platform/product/id_250 (Spain)
- https://nutriman.net/farmer-platform/product/id_251 (Spain)
- https://nutriman.net/farmer-platform/product/id_293 (Belgium)