SYSTEMIC
Circular solutions for biowaste

Ammonium Sulphate solution

EU fertilising product (2019/1009)[1],
RENURE material (proposed by JRC)[2]

CHEMICAL ANALYSIS
(Ammonium sulphate obtained via FiberPlus with use of gypsum)

Ammonium sulphate solution 5 (+6)

5 % (± 0.5 %)	N water-soluble ammonium nitrogen
6 % (± 0.5 %)	S water-soluble sulphur

Solution: typical properties

Density:	1,1 kg/l
pH:	6.5 bis 7.8

CHEMICAL ANALYSIS
(Ammonium sulphate obtained via other type of stripping and/or scrubbing with H_2SO_4)

Ammonium sulphate solution 8 (+9)

8 % (± 0.5 %)	N water-soluble ammonium nitrogen
9 % (± 0.5 %)	S water-soluble sulphur

Solution: typical properties

Density:	1,2 kg/l
pH:	4 bis 7

Description

Ammonium sulphate solution - $(NH_4)_2SO_4$ solution - is a mineral nitrogen/sulphur fertiliser derived from anaerobic digestate using calcium sulphate ($CaSO_4$) or sulphuric acid (H_2SO_4) as a scrubber agent.

$(NH_4)_2SO_4$ solution contains all nutrients in a fully water-soluble form, which are therefore directly available to the plants. The combination of N and S enables a demand-based supply for the plants with both nutrients, suitable for all kinds of agriculture (except organic farming). $(NH_4)_2SO_4$ solution is an ideal fertiliser for plants that are in need of high S amount, such as grassland, rapeseed, maize, rye, wheat, cabbage, onions, celery and sugar beets.

Application

The $(NH_4)_2SO_4$ solution is a N containing S fertiliser. Meaning, N fertilisation limits must be taken into account during its application, and the use should be guided by the fertility status of the soil. It is recommended to apply $(NH_4)_2SO_4$ solution during the early growth phase of the plant, e.g. for maize this will be at the stage that the plant has 3-4 leaves.

(1) Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003, will apply from July 7th 2022.

(2) Criteria proposed by Joint Research Centre (JRC) for potential categorisation of so called RENURE materials is a proposal and not active legal framework. For more information on this study please see : Huygens D, Orveillon G, Lugato E, Tavazzi S, Comero S, Jones A, Gawlik B, Saveyn HGM, Technical proposals for the safe use of processed manure above the threshold established for Nitrate Vulnerable Zones by the Nitrates Directive (91/676/EEC), EUR 30363 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-21539-4, doi:10.2760/373351, JRC121636.

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For application methods, row placement and injection are considered to be better than broadcast spraying for the following reasons:

- broadcast spraying is not advisable – especially on alkaline soil, as it increases the risk for ammonia volatilisation;
- the local placement of $(NH_4)_2SO_4$ solution (through row placement or injection) leads to local elevated concentrations of ammonium N, and elevated concentrations reduce the nitrification rate;
- it is advised to apply $(NH_4)_2SO_4$ solution in the vicinity of the roots as this reduces the potential volatilisation and plant burning. However, the fertiliser should not be placed too close to the roots as ammonium toxicity can occur.

Another option is to apply $(NH_4)_2SO_4$ solution (5% N and neutral pH) directly to the leaves, e.g. with a plant sprayer, because the plants tolerate the neutral pH value well and the fertiliser salt concentration of 25 % avoids crystallisation by evaporation. This, however, is not applicable for $(NH_4)_2SO_4$ solution with other characteristics (e.g. 8% N and acidic pH) as risk of scorching (or etching) would be high. Finally, is not advised to apply $(NH_4)_2SO_4$ solution on days where there is rain, in autumn or in winter to avoid potential leaching of sulphur and nitrate.

In general, the lower pH of $(NH_4)_2SO_4$ solution does not influence the soil pH since soil has a buffer capacity which is determined by the organic matter content and the clay content in the soil that counteracts sudden pH fluctuations. In optimal soil management, a farmer can maintain his soil pH, for example through liming. Furthermore, the $(NH_4)_2SO_4$ solution might stimulate P absorption by the more acidic environment in the root zone. Since P stimulates root development, this is an added benefit of the product if applied in the vicinity of plant roots.

Blends of $(NH_4)_2SO_4$ solution with other fertilisers like ammonium nitrate, urea, potassium salts and ammonium phosphate are possible. These blends have to be treated differently as $(NH_4)_2SO_4$ solution contains lower concentrations of N, and hence application with machinery should be done at a slower rate (i.e. driving slower with machinery) or $(NH_4)_2SO_4$ solution should be applied several times to reach the desired application rate. Therefore this product is especially interesting in combination with other fertilisers such as urea or as top dressing. However, possible chemical reactions must be taken into account. When adding dissolved calcium salts, gypsum can crystallise out. Moreover, ammonia gas is released by adding strong alkaline substances or by the alkalinity of the soil. **Finally, never mix $(NH_4)_2SO_4$ solution with animal manure as this would create dangerous H_2S gas, which is toxic and can be lethal to humans and animals even in low concentrations.**

A combination with pesticides is possible in individual cases, but needs to be checked on a case-by-case basis. Adding micronutrients to $(NH_4)_2SO_4$ solution in low quantities is possible. To avoid problems it is recommended to make tests with low amounts of micronutrients.

Recommendation

Recommendations of the fertiliser ordinance and official advice have priority.

The application rate of ammonium sulphate solution depends on:

- the S requirement of the crop or crop rotation
- the N requirement of the crop or crop rotation
- the amount of mineral N present in the soil (N_{min} method)
- the quantity of nutrients applied through organic fertilisers.

The values shown in the table can be taken as a guideline for the fertilisation of some important crops. Organic manures are not taken into account.

Crop	Application rate	
	kg N ha^{-1}	kg S ha^{-1}
Cereals	150 - 230	10 - 20
Oilseed rape	200	70
Corn, maize	180	25
Sugar beet	160	34
Grassland	200 - 400	0 - 40
Cauliflower	251 - 300	50
Cabbage	340 - 350	50-80
Leek	227 - 240	24

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Storage

Storage tanks are to be designed in accordance with water regulations. They must be designed in such a way that uncontrolled leakage of liquid can be ruled out.

$(NH_4)_2SO_4$ solution has a corrosive effect on concrete. Copper, brass or zinc, which are used for example as corrosion protection on sheet steel, can get damaged by $(NH_4)_2SO_4$ solution and are therefore unsuitable for storage and transport. Galvanized iron is also not suitable for the $(NH_4)_2SO_4$ solution. Steel alloys, plastics (PVC, nylon, PE, Polyester), nozzles (ceramic, plastic or stainless steel) are suitable materials for storage and application of the product.

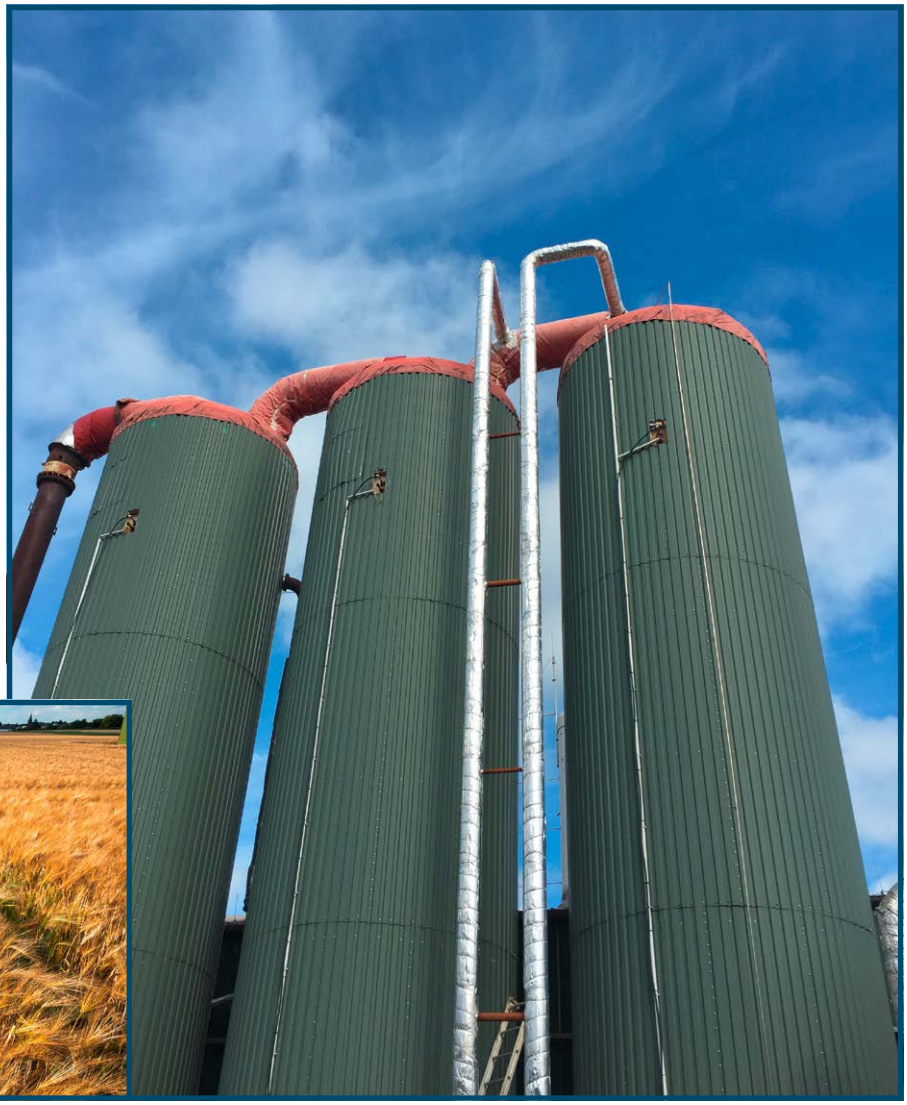
$(NH_4)_2SO_4$ solution with a concentration of 25% is storage-stable down to -5 ° C. At lower temperatures, solid $(NH_4)_2SO_4$ can crystallise. The process is reversible, meaning the precipitate will dissolve again when the temperature increases.

Relevant regulations

No suitability for organic farming, because $N_{mineral} > 90\ \% N_{total}$. Fertilisers for organic farming cannot have more than 15% of the total N in easily soluble form (i.e. the sum of nitrate, ammonium and urea ≤ 15%).

In some European regions, such as Flanders (Belgium), the Netherlands and Germany, $(NH_4)_2SO_4$ solution from chemical air scrubbers has been recognised as a fertilising product: meaning, it can be applied on top of the 170 kg N / ha / y coming from animal manure.

In Germany $(NH_4)_2SO_4$ solution from end-of-pipe stripping/scrubbing technology has also been recognized as a fertilising product. This is not the case for Flanders (Belgium) and the Netherlands where solution from end-of-pipe stripping/ scrubbing technology is designated as an animal manure and falls under the limit of 170 kg N / ha/ y. Similar legal interpretation would be considered for the mixture of $(NH_4)_2SO_4$ solution and animal manure, plus this would lead to generation of a toxic and dangerous H_2S gas.



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