



Management and Control of Water in Dry Fertilizer Product Blends

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Key Concepts

- Absorption of water by fertilizer can lead to problems during storage and application.
- Fertilizer salts can directly absorb atmospheric water, depending on relative humidity of the air and the type of fertilizer or fertilizer blend.
- Condensation of atmospheric water may occur when warm air is rapidly cooled. This will lead to direct deposition of water on fertilizer, surfaces of storage sheds and application equipment.
- If the edges of fertilizer prills dissolve due to water absorption or deposition, crystal bridges may form between particles. This is called 'caking' and can lead to problems in storage, and in application.
- In equipment where static electricity develops on surfaces, dust from fertilizer, grain or soil may collect, which in turn may absorb water. This can then lead to collection of caked material in tubes, manifolds or on augers in fertilizer application equipment.
- ESN, a polymer coated urea product (44-0-0), can provide an effective tool to reduce risk of all fertilizer storage.

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Direct Absorption of Atmospheric Water by Fertilizers

Fertilizers that are very soluble in soil are valuable in their ability to quickly supply crop nutrients. Crops require nutrients in their ionic 'salt' form in soil water for uptake by roots, so products like ammonium sulphate are very effective. However, these highly soluble fertilizers can also absorb water from the atmosphere, which can degrade the integrity of the product.

The ability of air to hold moisture is measured by the relative humidity (RH). A higher RH means there is more moisture in the air. At the same RH, warm air will hold more water than cold air.

Above a 'Critical RH (CRH)' each fertilizer will begin to absorb water directly from the air. Each fertilizer has a different CRH as outlined below. For example, urea will absorb moisture if the air RH is about 73%.

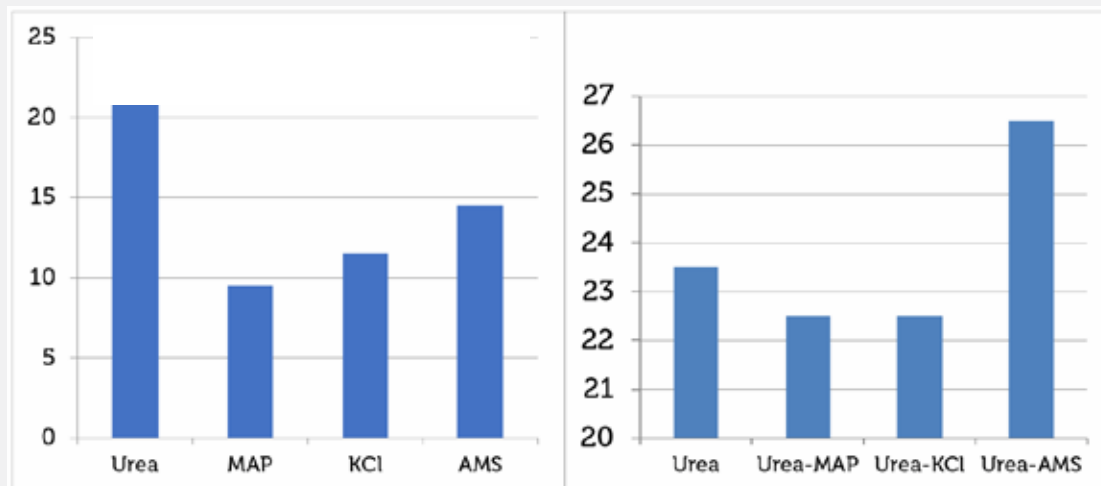
Blends of fertilizer have a lower Critical RH – for example a blend of urea with ammonium sulphate has a CRH of 56%. Blends of three or more fertilizers will have even lower CRH. Note that if the RH of air in fertilizer storage is kept well below 50%, the risk of water absorption by fertilizers becomes low for nearly all fertilizers and fertilizer blends.

Critical Relative Humidity of Common Fertilizers				
	Urea	MAP	Potash	Ammonium Sulphate
Urea	73	65	60	56
MAP		92	73	76
Potash			84	72
Ammonium Sulphate				79

From: (https://www.fertilizerseurope.com/wp-content/uploads/2019/08/Guidance_for_compatibility2.pdf).



Direct Absorption of Atmospheric Water by Fertilizers



Relative % weight gain of water by fertilizer products and blends after 55 days at 70% RH, 21°C (Cowell, 2019, <https://harvest.usask.ca/items/007bdef0-cce9-458e-95d0-124356da4e71>)

Circulating warm air with a low RH in fertilizer storage will help remove moisture and reduce risk storage problems. This is very similar to drying grain, where warm air with a low RH is forced through stored grain. Cold air or air with a high RH will not be able to effectively remove atmospheric water.

Note that direct absorption of atmospheric moisture is largely a problem during fertilizer storage and not during application. This becomes critical to understand and manage when storing fertilizer and fertilizer blends for an extended period of time. During storage it is also important to not inadvertently mix fertilizers. If adding fertilizer

to storage be sure the bin is completely cleaned out first. In sheds, keep the floor clean so to not allow fertilizer to collect and create wet floor conditions.

During storage and handling, prevent damage to the fertilizer to minimized dust. When dust collects on the surface of storage buildings and equipment it increases risk of damages by absorbed water.

In some storage situations such as farm bins it may be helpful to add an absorbent product on the top and bottom of the fertilizer product such as 'kitty litter'.



The Formation of Fertilizer Bridges and Cakes

When the surface of fertilizer prills or granules absorb moisture, a small amount of the product may dissolve. A cycle of dissolving and recrystallization can lead to the prills or granules forming crystalline bridges. The fertilizer then may form a solid cake on the surface. The risk is lower for product that is prilled as the round pellets have fewer points of contact to form bridges.

Formation of fertilizer bridges in storage can create unstable walls of fertilizer that can suddenly collapse. This can pose a safety risk to people in sheds and can damage both sheds and bins. Stored fertilizer must be monitored weekly throughout storage to assess the risk and formation of bridges. If you suspect that the fertilizer has bridged, very carefully relieve the bridge so that it slowly breaks apart. This is often done with a long pole attached to a loader.

For best safe practices refer to the Fertilizer Canada Bin Storage Guide https://fertilizercanada.ca/wp-content/uploads/2023/03/SPARK-FC-BIN_STORAGE-2022-EN_Final.pdf

Condensation of Moisture on Fertilizer

Unlike water absorption by fertilizer, condensation can affect fertilizer both during storage and during application.

As previously noted, warm air can hold more water than cold air at the same RH. If warm air suddenly cools, the water in the air will drop out as condensation, and the droplets of water may be absorbed by fertilizer. This often occurs in storage in spring when the warm sun quickly warms the air in storage bins or sheds over top of cold fertilizer. Water droplets may then form on the storage surface and essentially 'rain' on the stored fertilizer. This can create bridges of caked fertilizer very quickly.

Rapid temperature changes of air can occur in movement of fertilizer in storage, entry of warm moist air into cold storage, when very warm fertilizer contacts very cold fertilizer and when warm moist air is forced into an applicator compartment full of cold fertilizer. In each of these scenarios condensation of atmospheric water may occur, and this can affect any fertilizer type or blend no matter what the CRH may be.



Increased Risk During Fertilizer Application

Condensation is a high risk in spring during fertilizer application. Several factors can contribute which may impede fertilizer flow and require significant time to clean out.

During spring seeding, warm and moist air is often pushed into air drill systems. If this air cools very quickly, condensation may occur directly on the surface of the fertilizer or application equipment. This leads to caking quickly in delivery lines and manifolds which may restrict or block movement of fertilizer and seed.

In some application equipment static electricity can form on surfaces such as tanks, pipes, manifolds and augers. The problem of static electricity will be worse on plastic than steel surfaces.

During seeding dust from seed, soil and fertilizer may collect on equipment surfaces where static electricity has formed. This dust may then collect moisture through condensation or if liquid is directly added to the flow of products as fertilizer additives, seed treatments or inoculants. If additional products are added to a fertilizer or fertilizer blend, the added risk to storage or application quality cannot be attributed to the fertilizer.

All of the factors above can combine to form fertilizer cakes (with other products) in pipes and manifolds. In high-risk conditions the equipment should be checked daily or more often to ensure there is no plugging of the seed and fertilizer stream.

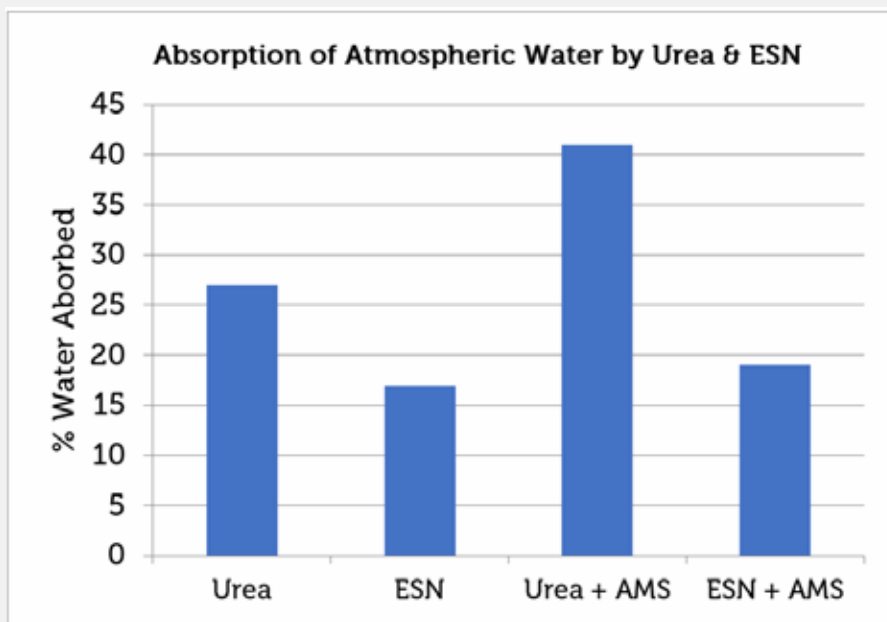
Restriction of airflow may lead to uneven or reduced rates of fertilizer and seed application, significant downtime in cleaning, and frustration during the stressful time of seeding.



ESN and Fertilizer Storage

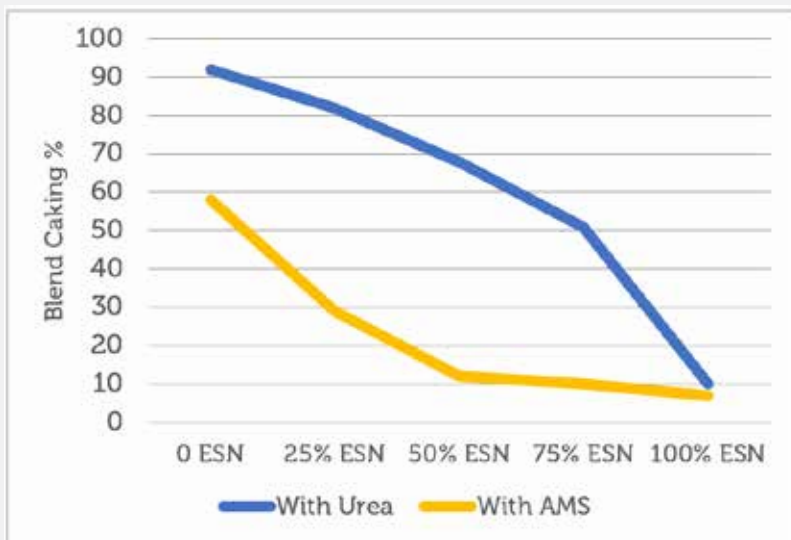
ESN is used for many agronomic reasons, but it is also valuable in managing fertilizer storage. The polymer coating of ESN resists water absorption so allows the enclosed urea to be stored with very little risk of absorbing atmospheric water and lower risk of condensation in storage or during application.

Unlike urea, ESN will not decrease the CRH of a blend, plus the ESN prills provide a separation between other prills to reduce the risk of bridging. ESN blends with other fertilizers such as urea or ammonium sulphate will be more stable during long term storage.



ESN Absorbs Less Atmospheric Moisture Less Urea (70% RH, 55 days) (Cowell, 2019, <https://harvest.usask.ca/items/007bdef0-cce9-458e-95d0-124356da4e71>)





Increasing the ratio of ESN with urea or ammonium sulphate reduces the blend caking during storage (Nutrien Pilot Plant).

Trials at the Nutrien Pilot Plant demonstrate that as the ratio of ESN with urea or ammonium sulphate increase, the risk of water absorption and caking of a blend is reduced.



92%
Caking

100% UREA



68%
Caking

50% UREA/
50% ESN



10%
Caking

100% ESN

Blends	Average% Caking
100% Urea	92%
75% urea/25% ESN	82%
50% urea/50%ESN	68%
25% urea/75% ESN	51%
100% ESN	10%

Caking of urea, ESN and blends under 70% humidity and 30 psi compression (Nutrien Pilot Plant trials)

The value of ESN extends to multi-fertilizer blends as in the example below which compares caking of urea, a 29-13-5-3S blend using urea to a similar blend using a 50:50 ratio of urea and ESN as the primary nitrogen fertilizer



UREA



29-13-5-3S



**29-13-5-3S
+25% ESN**

<i>Nutrien Pilot Plant (79% humidity, 30 psi compression)</i>	Analysis	Average% Caking
	Urea (46-0-0)	68%
	29-13-5-3	50%
	29-13-5-3 + 25% ESN	18%



Final Comments

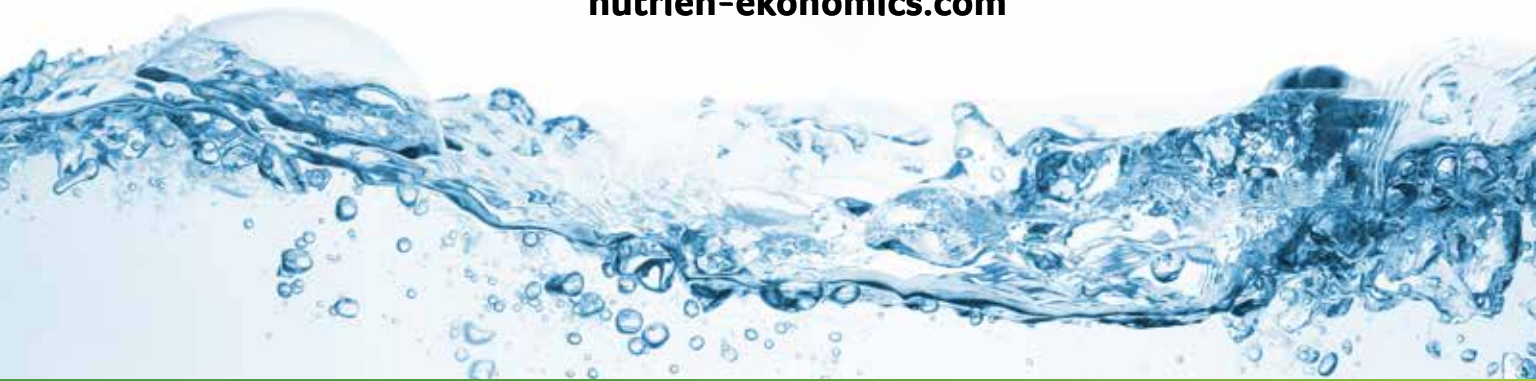
- Fertilizer can gain water through water absorption from air, and from condensation of water on fertilizer and application equipment.
- Good storage facilities, practices and weekly monitoring are essential for long term storage.
- ESN can play an essential role in better fertilizer storage and application

Further guidelines can be found in Fertilizer Canada's publication Bin Storage Guide https://fertilizercanada.ca/wp-content/uploads/2023/03/SPARK-FC-BIN_STORAGE-2022-EN_Final.pdf





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