Information for the Dairy Industry
AMINODairy®

K-pron® does not generate heat when mixed into feed, contrary to the anhydrous form of potassium carbonate

Potassium carbonate supplementation to dairy cows has several benefits. In the rumen, the buffering effect of carbonate helps to prevent a drop in pH which further supports microbial activity. Additional potassium (K) may also reduce the activity of specific bacterial species responsible for the production of intermediates of lipid biohydrogenation that causes a drop in milk fat production. At the metabolic level, increasing the dietary cation-anion difference (DCAD) by K supplementation helps to maintain the acid-base balance and related physiological and cell functions, which is essential during heat stress periods.

Potassium carbonate can be supplemented to ruminants in the anhydrous (K_2CO_3) or sesquihydrate form such as K-pron® (K_2CO_3 • 1.5 H_2O). As it is usually mixed into the fresh ration, questions may be raised regarding the stability of these two forms in the feed.

What is the stability of the anhydrous and the sesquihydrate forms of potassium carbonate?

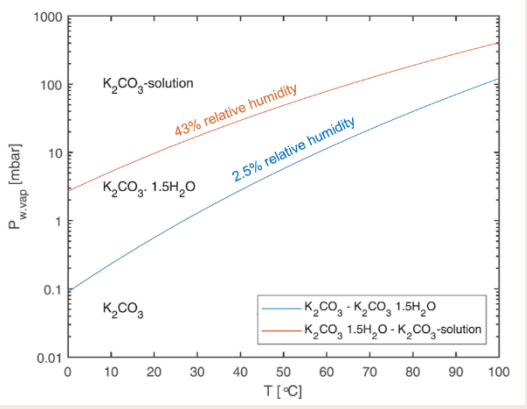

Figure 1: Forms of potassium carbonate according to temperature and relative humidity (Adapted from Gaeini et al., 2019)

The anhydrous form will naturally convert into the sesquihydrate form when relative humidity, expressed as the ratio between vapor partial pressure (mbar) and saturation vapor partial pressure (mbar) at a given temperature, is about 3%. In other words, in most conditions including when mixed in a silage-based ration (Table 1), the anhydrous form of potassium carbonate will always undergo a hydration process.

The sesquihydrate form of potassium carbonate, such as K-pron®, has an equilibrium relative humidity of approximately 43% (Gaeini et al., 2019). Above this threshold, the sesquihydrate will slowly start to hydrate and turn into a K_2CO_3 solution.

Table 1: Indicative yearly average relative humidity in different areas of the world (https://www.worlddata.info/)

	%		%
Europe - South	60	Asia - East	70
Europe - North	70	Asia - South	60
America - North	65	Africa	65
America - South	80	Middle East	30
America - Central	60		

What happens during the hydration of the anhydrous form of potassium carbonate?

The reaction of anhydrous potassium carbonate with water is exothermic, which means that heat will be progressively produced. For instance, the temperature of a dairy ration (55 kg as fed; 45% DM) is expected to increase by close to 0.5 °C when mixed with 150 g of anhydrous K_2CO_3. This rise of temperature already contributes to the lack of aerobic stability of silage, defined as "the number of hours that silage is exposed to air before a 2 °C increase in temperature above the ambient temperature" (Borreani and Tabacco, 2010).

55 kg fresh dairy ration (55% water, 45% DM) supplemented with 150 g of anhydrous K_2CO_3:

- Molecular weight of K_2CO_3 = 138.2 g/mol
- Hydration energy of K_2CO_3 = 46.22 kJ/mol (Gaeini et al., 2019) = 334.4 kJ/kg
- 150 g of K_2CO_3 = 50.2 kJ added

Change in water temperature of the ration: $q = mc\Delta T$, with

- q = 50.2 kJ = 50,200 J
- m = 55% water x 55 kg intake = 30 kg water = 30,000 g water
- c = specific heat capacity of water = 4.18 J/g/K
- ΔT = 0.4 K

→ If the initial temperature is 293.15 K (20 °C), the final temperature will be 293.55 K (20.4 °C).

What happens during the hydration of K-pron®?

K-pron® will remain stable as long as the relative humidity stays below 43%. Above this value, a very slow hydration process will happen, which does not change the final properties of the product. Hydration of most salts, such as $K_2CO_3 \cdot 1.5\ H_2O$, requires energy (endothermic reaction), which means that the final feed will slightly cool down during the reaction.

In summary, contrary to the anhydrous form of potassium carbonate, K-pron® will not generate heat when mixed in feed.

References

- Gaeini M. et al., 2019. Characterization of potassium carbonate salt hydrate for thermochemical energy storage in buildings. Energy & Buildings 196: 178-193
- Borreani G. and Tabacco E., 2010. The relationship of silage temperature with the microbiological status of the face of corn silage bunkers. Journal of Dairy Science 93: 2620-2629

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Product Information

K-pron®

DESCRIPTION

K-pron® is a pure form of potassium carbonate hydrate with a minimum content of 47 % potassium (K).

K-pron® delivers potassium, the principal intracellular cation of most tissues, in a highly concentrated form. Potassium maintains the osmotic potential within cells and is an active component of nerve impulse transmission. It is important for enzyme reactions in cellular metabolism and crucial in cardiac, skeletal and smooth muscle function. Potassium maintains kidney function and controls the excretion of urine and feces. In rations of early lactating dairy cows, the potassium balance is likely to be negative. The mineral is a component of the DCAD calculation (Dietary Cation-Anion Difference). Lactation diets can benefit from a more positive DCAD with increased feed intake and higher production what can easily be achieved by adding K-pron®. In conditions of heat stress, a higher level of potassium in the diet as well as a higher buffering capacity is indicated.

FEEDING INSTRUCTIONS

K-pron® is added to the diets of dairy cows according to the potassium content of the feeds relative to the requirements of the animals for potassium in the respective phase in lactation.

SPECIFICATION

Specified value	
Potassium Content (calculated*)	47 % (min.)

* from Total Alkalinity Assay 83 % (min.)

APPEARANCE

White crystals
Bulk density: 1,200 kg/m^3 ± 10 %
Angle of repose: 35° ± 15 %
Particle size distribution: max. 5 % > 1,400 µm
max. 5 % < 100 µm
Solubility: max. 1,680 g/l water at 20 °C

MOLECULAR DATA

Molecular formula: $K_2CO_3 * 1.5\ H_2O$
Molecular weight: 165.2 g/mol

PRODUCTION

K-pron® is manufactured by carbonation of potassium hydroxide solution.

K-pron® is produced having safety and a high feed quality in mind. This is enabled by an implemented quality system with HACCP concept that conforms to feed hygienic requirements of the EU. Therefore, from the beginning, corresponding quality and safety is produced into K-pron®.

TYPICAL VALUE

Characteristic Value	
Potassium (K)	47 %
DCAD value	+ 12,000 meq/kg

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Product Information

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PROCESSING

K-pron® can be included in mineral and compound feeds by common technical procedures. Its technical properties guarantee homogeneous mixability and stability against demixing.

STORAGE AND STABILITY

K-pron® should be kept in unopened original packaging in a cool and dry place, with no direct exposure to the sun. Storage conditions of 5 – 30 °C and 40 – 75 % rel. humidity are recommended.

Under these conditions, its active content is guaranteed for 2 years from the first day of the month of manufacture. The manufacturing date is printed on the package.

REGULATORY AFFAIRS

25 kg net plastic / poly bag
1,000 kg net bulk bag / FIBC
Full bulk shipment

CAS-No.: 6381-79-9
Customs tariff number: 283640

According to the European Feed Law, K-pron® is listed in the catalogue of feed materials as potassium carbonate (11.5.3) and labeled correspondingly.

In general potassium carbonate is globally well accepted as feed material. However, the individual registration status and covered species can be country specific. Please contact your Evonik expert for more information.

K-pron® is not subject to dangerous goods regulations.

SAFETY AND ENVIRONMENT

K-pron® can be handled safely. However, in its pure form, it is classified as hazardous substance. Please consider the handling instruction of the safety data sheet.

For additional information, please contact us directly.

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