Casals

VORTICE GROUP

FORAGE DEHYDRATORS

Fans for integration in machines for forage dehydration

AGRICULTURAL SECTOR

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Introduction

In agricultural production, the quality and availability of livestock feed are crucial elements to maintaining animal productivity and health. One of the most efficient methods to preserve the nutritional value of forage is dehydration. This process involves artificially drying forage crops, such as alfalfa and clover, to reduce their moisture content and facilitate storage. The process is conducted in specialised facilities known as forage dehydrators.

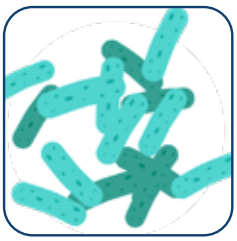
What are forage dehydrators?

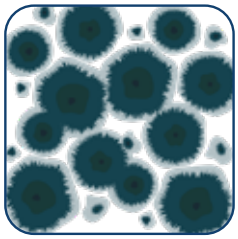
Forage dehydrators are industrial facilities designed to dry fresh forage, reducing its moisture content to optimal levels for storage and subsequent use as livestock feed.

Benefits

These drying processes allow the forage to **retain much of its nutritional value, prevent unwanted fermentation**, and reduce the **risk of mould** and other deterioration that can occur during **long-term storage**.


preserve nutrients


prevent fermentations


reduce mould risk


protect during long storage

Dehydration methods

Various techniques exist for dehydrating forage, both traditional and industrial. The most common methods are:

Natural drying:
- Forage is spread outdoors, allowing it to dry under sunlight and wind exposure.
- This method is economical but depends on weather conditions, is slower, and may compromise forage quality if exposed to humidity or rain.

Forced ventilation drying:
- Used in enclosed facilities where fans circulate hot air through the forage.
- This method speeds up the drying process and provides better quality control by protecting the forage from weather exposure.

Rotary dryer dehydration:
- Industrially, drying is often conducted in rotary dryers that combine hot air and ventilation to achieve uniform drying.
- This method is ideal for large volumes, allowing quick and controlled drying.

Oven or hot air chamber drying:
- Forage is placed in drying chambers where it is exposed to hot air without direct contact with fire, better preserving nutrients.
- Also used in the industry, although less common than rotary dryers.

In the industry, forage drying is almost exclusively performed using **hot air ventilation** (usually with rotary dryers or chambers), as it is the most efficient method to eliminate moisture without degrading forage quality. Other methods, such as microwave or infrared drying, are not common for large volumes due to their high cost and the difficulty of scaling them industrially.

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Fans in the dehydration process

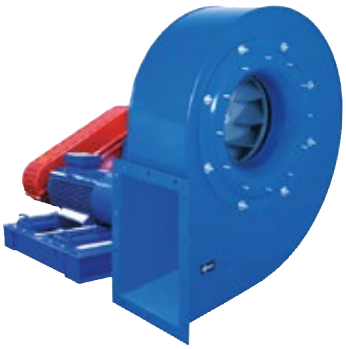
In rotary dryer dehydration, there are three stages that include a fan, each playing a specific role in contributing to the control and efficiency of the entire system.

1. Burner fan:
This fan takes air from the environment and introduces it into the burner, ensuring a constant and homogeneous oxygen supply. This optimises flame efficiency, ensuring controlled and stable combustion to generate the necessary heat for the process.
Proposal from Casals: MB.

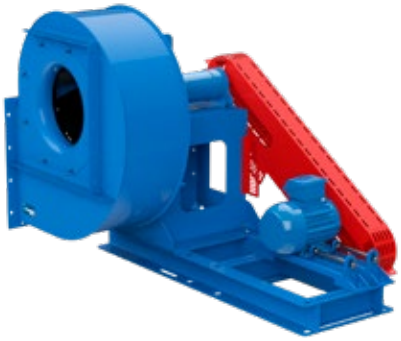
2. Drying cylinder fan:
In this stage, the fan drives the flow of hot air through the drying cylinder, ensuring uniform circulation throughout the circuit. This maintains a consistent temperature, fundamental for uniform forage drying until the residual air is expelled through the chimney. If working with air temperatures up to 250°C, a direct fan will be used; for higher temperatures, a transmission fan will be selected.
Proposal from Casals: MTRU, NIMUS-TR

3. Cooling process fan:
Once the forage is dry, this fan cools the product before packaging. This step is crucial to avoid issues such as spontaneous combustion during storage, ensuring the forage is conserved in optimal and safe conditions
Proposal from Casals: NIMUS

MB



MTRU



NIMUS-TR

NIMUS

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Industrial dehydratation process

1. Arrival of chopped product to the dehydrator plant with moisture above 30%. It can be stored for a maximum of 24 hours before processing.

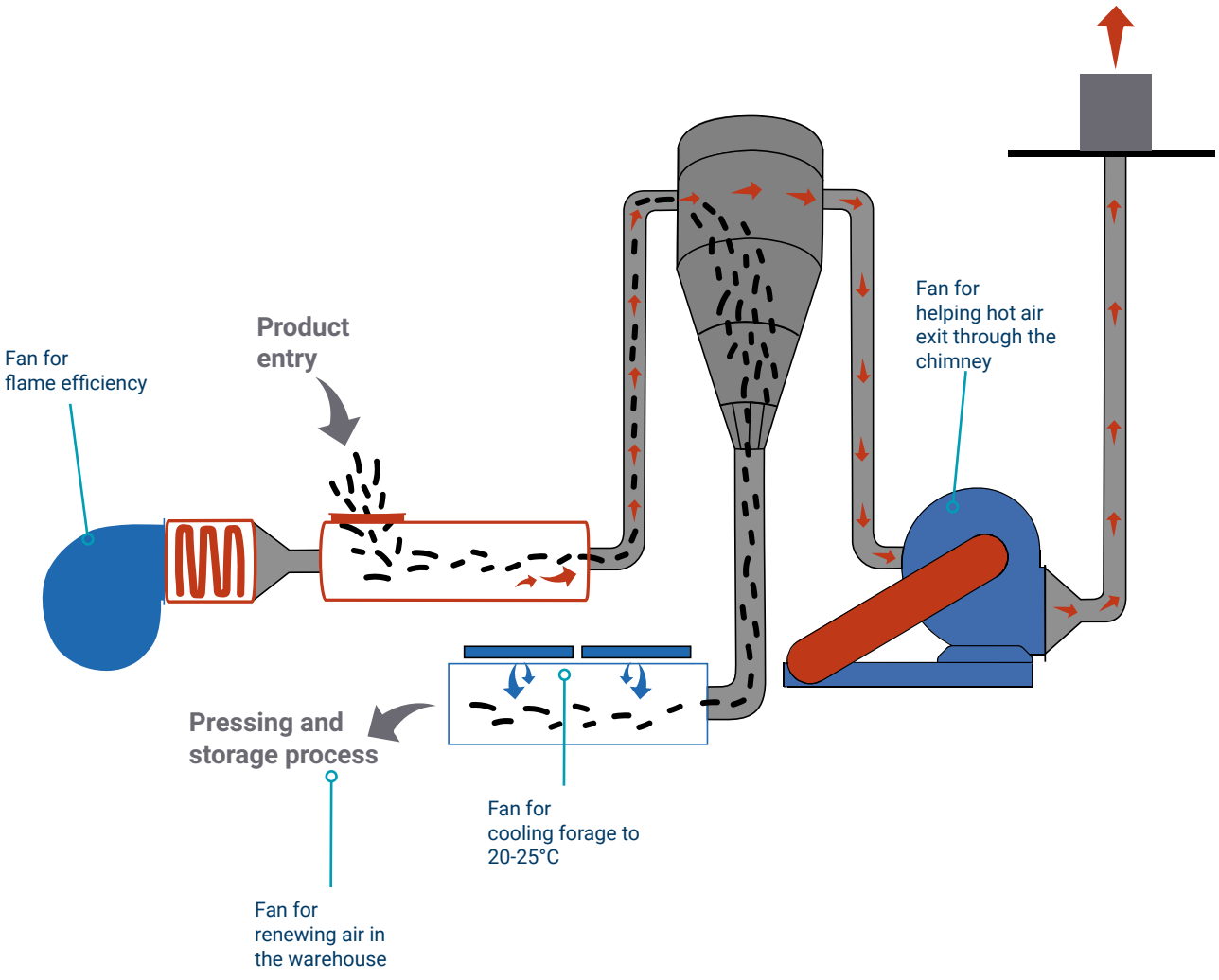
2. Entry into the rotary drum to evaporate the litres of water it contains. It remains for about 7 or 8 minutes, with a humidity of 40% and an entry temperature of 450°C. A fan will aid flame efficiency.

3. Separation of hot air from the forage and entry into the decanter. Thanks to another fan, the hot air rises to the chimney along with the water vapour.

4. Cooling process of the forage to avoid spontaneous combustion during storage. A fan ensures an ambient temperature of 20 to 25°C.

5. Passage through a press for bale production or granulation process for meal production.

6. Storage for subsequent distribution. There must be natural or forced ventilation through an exhaust fan.



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EXAMPLE OF VENTILATION CALCULATION IN A FORAGE DEHYDRATOR

To calculate the ventilation system in a forage dehydrator, we must determine the type and quantity of fans required to meet the airflow and temperature requirements of the drying process.

Consider a practical case where we want to dry **10 tonnes of forage per hour** in a rotary dryer using hot air at a temperature of 250°C.

1. EXAMPLE DATA

Suppose we have a dehydrator with the following parameters:

- Drying capacity: 10 tonnes/hour of fresh forage.
- Initial moisture content: 65%.
- Final moisture content: 12%.
- Drying air temperature: 250°C.
- Type of dryer: rotary dryer.
- Fan considered: medium-pressure centrifugal.

2. CALCULATION OF WATER REMOVAL RATE

First, determine the amount of water to be removed from the forage to reduce its moisture content from 65% to 12%.

1. **Initial water weight in forage:**
   Initial water = 10 tonnes × 0,65 = 6,5 tonnes of water
2. **Final water weight in forage:**
   Final water = 10 tonnes × 0,12 = 1,2 tonnes of water
3. **Water to be removed:**
   Water removed = 6,5 tonnes - 1,2 tonnes = 5,3 tonnes of water

This means we need to **remove 5.3 tonnes of water in an hour** to reach the desired moisture level..

3. CALCULATION OF HOT AIR FLOW RATE

To determine the required airflow, consider that air at 250°C can carry a certain amount of water as vapour. For simplicity, assume approximately 4.000 m³ of air at 250°C is needed to remove 1 tonne of water.
Airflow needed to remove 5.3 tonnes of water:

1. **Flow rate** = 5,3 tonnes of water × 4.000 m³/tonne = 21.200 m³/hour

These **21.200 m³/hour is the airflow that the fans must generate** for the drying process.

4. FAN SELECTION

Based on this airflow, we will evaluate the use of medium-pressure industrial centrifugal fans with a capacity of 21.200 m³/h and a pressure of 2.500 Pa, as they must overcome significant resistance in the dryer. This can be achieved with a single fan or two fans reaching the required flow, providing greater flexibility in the system since only one can operate during reduced loads or maintenance.

5. FINAL SELECTION

In this case, we opt for a single high-efficiency medium-pressure fan with transmission drive (to withstand temperatures above 250°C).

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Casals Ventilación proposes an **MTRU 710 37kW 2450rpm + R/R** (see in Fanware)
This is a medium-pressure reaction centrifugal fan, for duct installation with a self-cleaning system, cooling impeller, and suitable for multiple industrial processes both for intake and extraction.

Additionally, we will use a frequency converter, **SFC 400 III 77A** (see in Fanware), to balance performance and energy efficiency.

6. ESTIMATED ENERGY CONSUMPTION CALCULATION

The selected fan, for the indicated working point (Q = 21.200 m³/h P = 2.500 Pa), has an effective power of 20,29 kW. It will operate continuously during the drying process (1 hour). The energy consumption calculation is straightforward:

Energy consumption = 20,29 kW × 1 hour = 20,29 kWh

In this system process, Casals MTRU fans will be used in the drying process to uniformly move hot air through the forage. By employing these fans with **frequency control**, the airspeed can be adjusted according to the specific needs of each forage batch, enabling controlled and efficient dehydration. Additionally, frequency regulation saves energy, especially during phases where maximum power is not required.

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