
Preventing and Extinguishing Silo Fires

Posted on June 3, 2023 by Christine O'Reilly, OMAFRA Forage & Grazing Specialist

Key Points:

- Most silo fires occur because the silage is too dry
- Silo fires frequently smoulder undetected for a while; the forage bursts into flames when it comes in contact with the air
- Call the fire department immediately if you suspect a silo fire

What Causes Fires?

- Silage and haylage that is too dry (below 40% moisture content) will enter the spontaneous combustion cycle
- A large mass of forage can allow heat to build up (fuel + heat)
- A slow trickle of air moving into the material adds oxygen (fuel + oxygen)
- Old silage (2+ years) in the silo is at risk of drying down to the critical level

The process of forage heating up and then burning is typically called spontaneous combustion. In silos, forage can dry down if air enters the silo through leaks in walls or doors; this results in the potential for fires throughout the whole year.

Spontaneous heating and combustion occur when sufficient moisture (above 25% and below 45% moisture content for forages), oxygen (air) and organic matter are present together to support the growth of bacteria and moulds. This growth results in an initial temperature peak of 54°C–65°C. When the forage reaches this temperature range, a chemical process called the Maillard Reaction may occur, causing additional heat generation. This reaction can be self-sustaining and does not require oxygen (air) to continue. The gases produced will ignite if they have reached a high enough temperature and are exposed to oxygen (air).

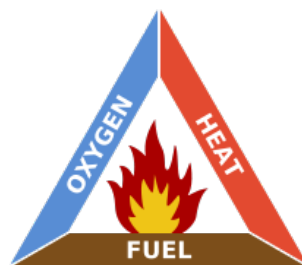


Figure 1. The Fire Triangle. Stored forage is fuel. If it heats and is exposed to oxygen, the result is a fire.

Fire Prevention

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The moisture of the silage or haylage is the main factor in forage fires (Figure 15-16). To reduce this burning issue, know the crop moisture content. Buy a moisture tester or use your microwave oven to determine the moisture content.

The key to fireproofing silos lies in eliminating the combination of dry silage and fresh air. The following components of a silage storage are necessary to make silage and to prevent fires:

- Check doors on tower silos regularly and if loose-fitting or damaged, repair so air does not enter the silage.
- Air can also enter through damaged silo walls. Empty silo completely every 2 years. Check walls for damage and repair if necessary.

Most silo fires occur because the silage is too dry. Silage should be between 45% and 65% moisture content. Silage below 40% moisture content, coupled with extra air from poor packing or leakage of air into the silo creates a risk of heat damage or fire.

The Fire Danger Zone

- If the silo warms up.
- If you see wisps of water vapour (steam).
- If you smell a slight caramel odour.
- If you smell a pungent, scorched stench like burning baler twine call the fire department.
- If you see smoke or flames call the fire department.

Temperature	Action
65 C	Check temperature daily. Below this point, temperatures are not considered abnormal, although anything above 52 C is unusual.
70 C	Danger! Check the temperature every 4 hours.
80 C	Call the fire department! Keep all doors and other openings closed to prevent drafts which add oxygen to the fire. Forage above 82 C may burst into flame when exposed to air.

Table 1. Critical temperatures for spontaneous combustion of stored forage.

For silage, temperature readings above 82°C indicate that the material will eventually char, smoulder or burn. Probing silage is mainly used to find the location of the fire, since **in most cases a fire is burning before anyone notices the signs of heating**. Typically, the fire will be in the top 3 m (10 ft) or around poorly sealed silo doors. Infrared scanning can also be used to indicate the hot spot location. Access to this equipment may be obtained through your farm safety officer, the Ontario Fire Marshal's Office in Toronto or local insulation companies.

Extinguishment Procedures

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self-contained breathing apparatus due to dangerous silo gases.

In conventional open-top silos, they will locate the hot spots with a probe and put it out by injecting small streams of water through the probe right to the seat of the fire. Gases may be produced when injecting water into a hot silage fire. However, there is no containment of gases since the silo is open and not sealed, which practically precludes the occurrence of an explosion. In conventional open-top silos, unloading of fire-damaged silage is recommended:

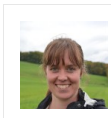
- Since there is very little nutritional value left
- Water has leached the acids allowing moulds to grow and spoil the silage
- Re-ignition of silage material may occur

Thorough dousing of the top layers of forage before unloading and running the unloader intermittently will minimize unloading problems due to fire and motor overheating.

In oxygen-limiting silos, a fire is potentially very dangerous, since there is containment of explosive gases. The method of control will be to inject liquid nitrogen or carbon dioxide into the silo to cool the fire. See Table 2 for the amounts needed. Every oxygen-limiting silo should have valves specifically designed to inject gases for fire control. Check the owners' manual for specific information about extinguishing a silo fire.

Silo Size (diameter x height)	Carbon Dioxide (CO₂)	Liquid Nitrogen (N₂)
6 m x 18 m (20 ft x 60 ft)	20 cylinders	40 cylinders
6 m x 21 m (20 ft x 70 ft)	22 cylinders	44 cylinders
6 m x 24 m (20 ft x 80 ft)	30 cylinders	60 cylinders
7 m x 18 m (24 ft x 60 ft)	30 cylinders	60 cylinders
7 m x 21 m (24 ft x 70 ft)	35 cylinders	70 cylinders
7 m x 24 m (24 ft x 80 ft)	40 cylinders	80 cylinders
9 m x 18 m (30 ft x 60 ft)	45 cylinders	90 cylinders
9 m x 21 m (30 ft x 70 ft)	50 cylinders	100 cylinders
9 m x 24 m (30 ft x 80 ft)	60 cylinders	120 cylinders
Source: Murphy, Dennis J. and William C. Arble. Extinguishing Silo Fires and (NRAES-18). Pennsylvania State University.	Note: gas cylinders are size large	

Table 2. Estimate amounts of carbon dioxide or liquid nitrogen for control of silo fires

**About Christine O'Reilly, OMAFRA Forage & Grazing Specialist**

Areas of Focus: - Production and storage strategies to improve the productivity and profitability of forages - Benefits of forages and grazing within cropping systems - Forage production and grazing systems in northern Ontario

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