MYCOTOXIN REMOVAL TECHNOLOGY
OZONATION AND THE SCIENTIFIC BASIS

Mycotoxins are considered by many scientists to be the largest food- and feed supply issue of our time.
Many solutions are in use … none of them are considered a “final” solution …

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What is a Mycotoxin?

A **Mycotoxin** is a toxic secondary metabolite produced by organisms of the fungus kingdom and is capable of causing disease and death in both humans and other animals. The term 'mycotoxin' is usually reserved for the toxic chemical products produced by fungi that readily colonize crops.

Examples of mycotoxins causing human and animal illness include aflatoxin, citrinin, Fumonisins, ochratoxin A, patulin, trichothecenes, zearalenone, and ergot alkaloids such as ergotamine.

One mold species may produce many different mycotoxins, and several species may produce the same mycotoxin.

Effects on Humans

Mycotoxins have the potential for both acute and chronic health effects.

They inhibit protein synthesis, damage macrophage systems, inhibit particle clearance of the lung, and increase sensitivity to bacterial endotoxin.

The symptoms of mycotoxicosis depend on the type of mycotoxin; the concentration and length of exposure; as well as age, health, and sex of the exposed individual.

The most carcinogenic molecule known is Aflatoxin and responsible for Liver Cancer and possibly other forms of cancer.

Creation of Mycotoxins: First you have Fungus

Nature is incredible … and some fungi are very aesthetic

They multiply abundantly via the spores … that's why grains are already "contaminated" with spores on the surface in the field

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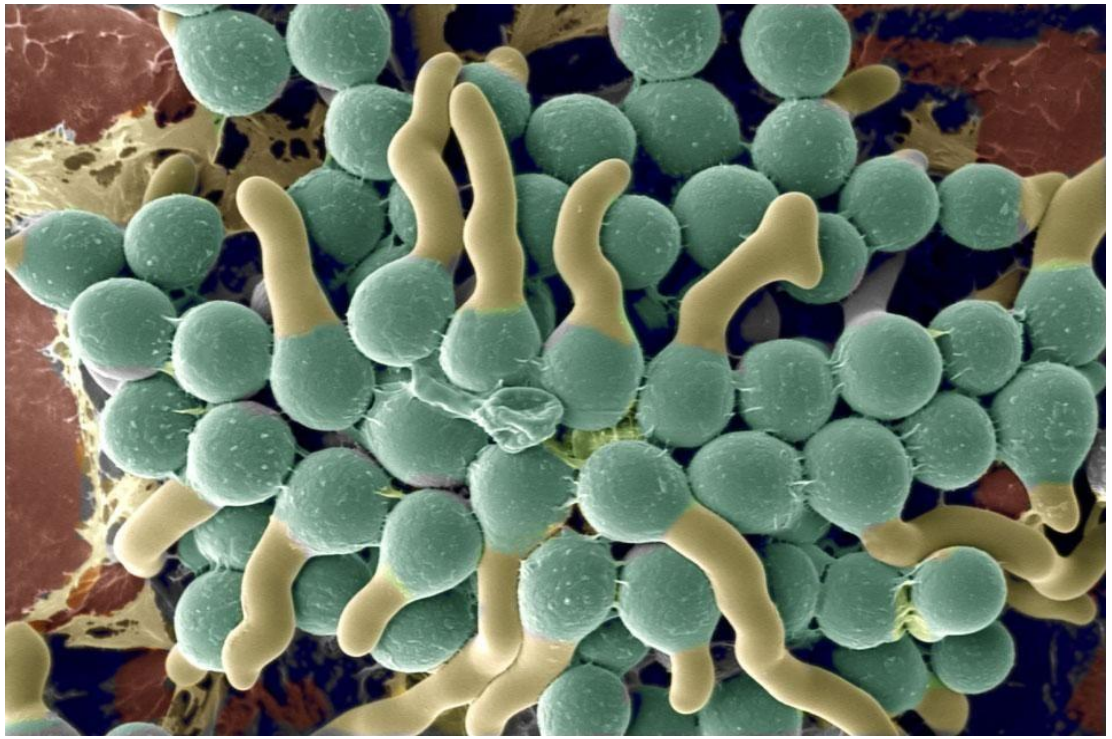
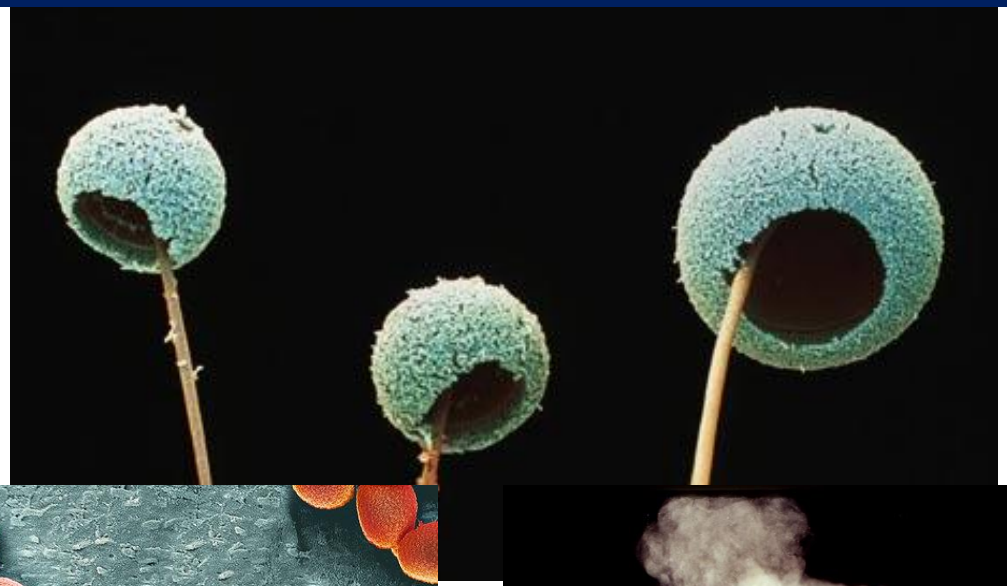
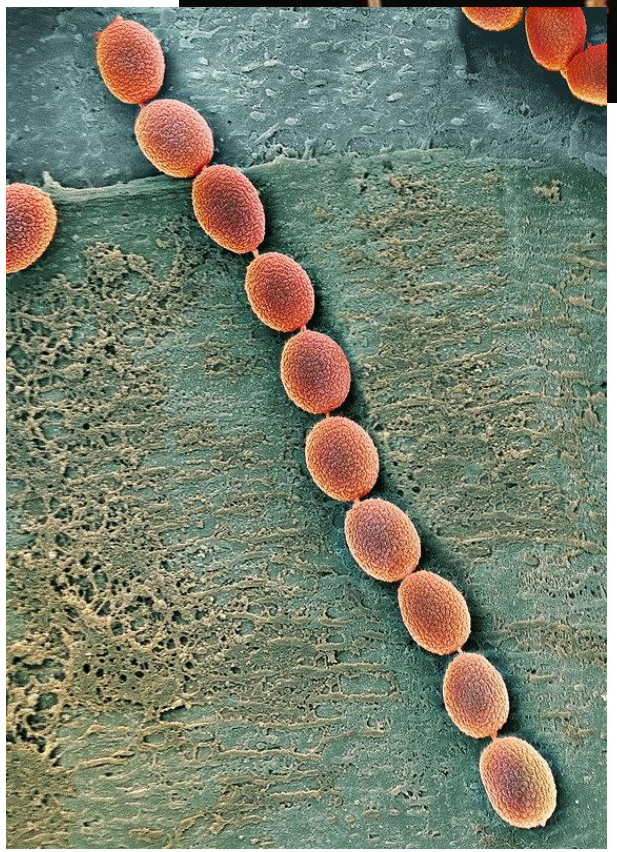
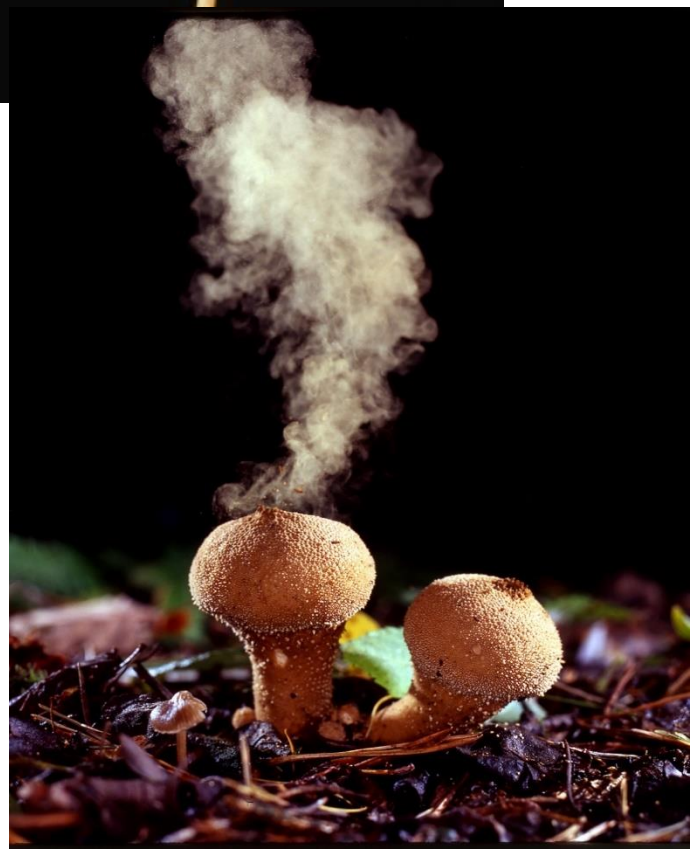
Fungi and Fungus Spores









CONTAMINATION EXAMPLE: CORN/MAIZE

Maize is most likely the biggest problem, because it has a very high moisture content on its own.

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CONTAMINATION EXAMPLE: SOY BEAN

High value commodity – high risk if not dried and stored properly – easy to see fungus infestation

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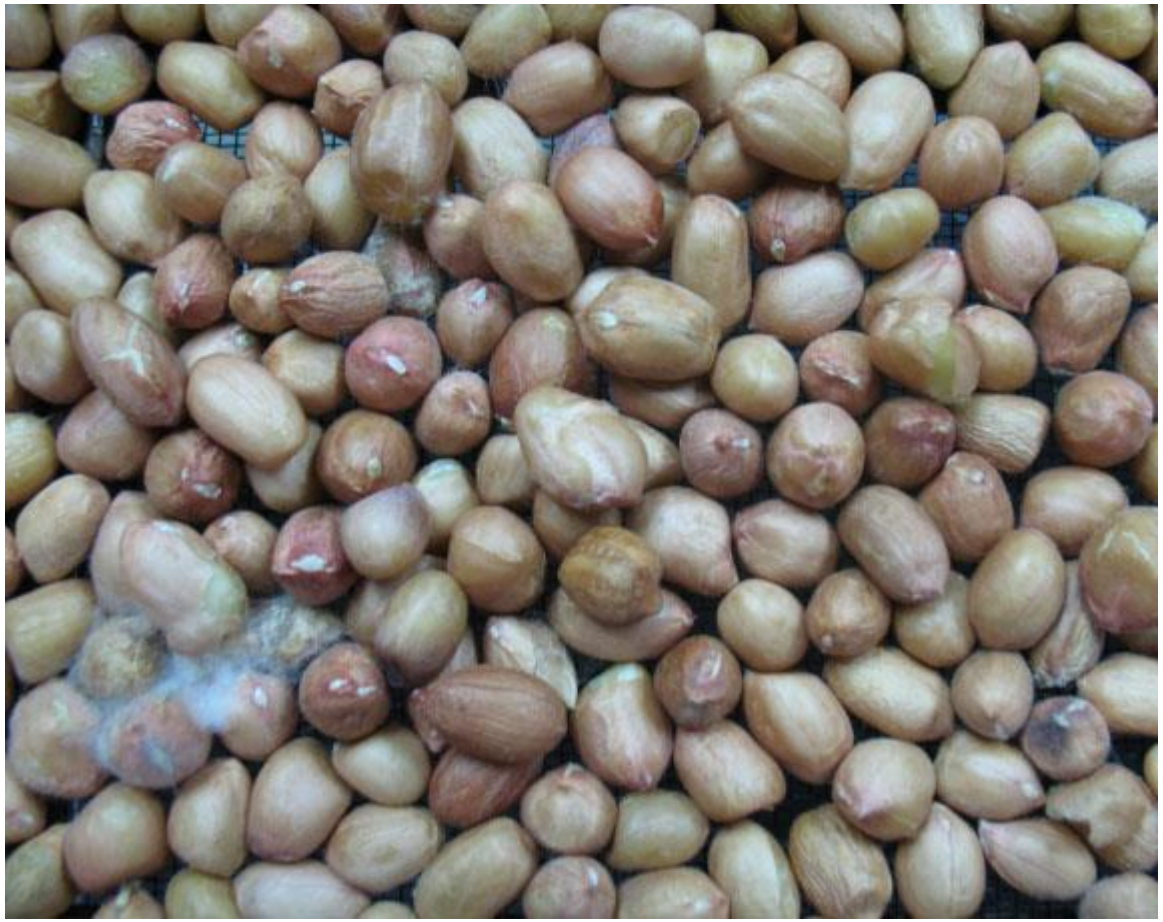
Contamination example: Peanuts

All nuts are subject to risk of fungus



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CONTAMINATION EXAMPLE: BARLEY

Barley will contaminate beer and whisky if infested with fungus

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OZONE

Ozone is used to decontaminate grain contaminated with Aflatoxin, Vomitoxin and other Mycotoxins.

The scientific community has documented over the last decades that Ozone is very potent to remove mycotoxins.

Ozone has GRAS approval (Regarded As Safe) and is approved even for organic food in America.

Main Applications are: Grain, Beans like Soy Beans, Coffee and Nuts like pistachio and peanuts.

Feed Milling ingredients are also an important application

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Introduction to Ozone

Ozone

- is a gas with 3 Oxygen atoms: O_3
- is a powerful disinfectant
- is generated by high voltage: $O_2 + O\cdot \longrightarrow O_3$
- is *highly oxidative* and unstable, and decomposes in less than 20 min to oxygen without leaving ANY residue

$$2\ O_3 \longrightarrow 3\ O_2$$

- half-life time is dependent on temperature, relative humidity, specific surface on the grain, dust load and other factors

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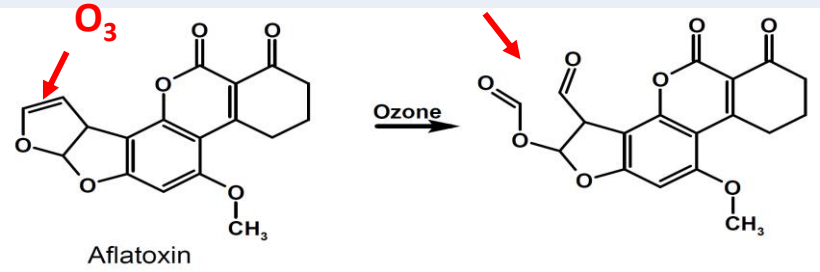
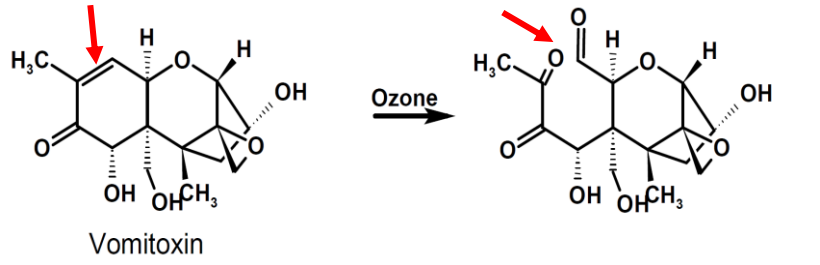
Ozonation of Mycotoxins – Reaction Mechanism

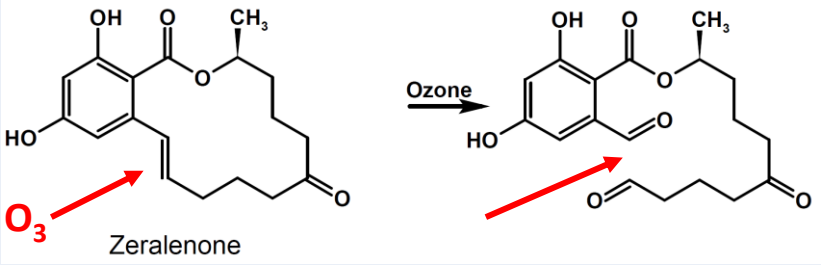
When Ozone react with Mycotoxins the resulting substances are not recognized as toxic compounds. Scientists have tried to look for toxic bi-products, but so far none have been identified



AFLATOXIN B1 – Aflatoxin exists in different versions, but they all have the same double bond that Ozone can attack. The resulting compounds can be different, but none are recognized as toxic. The main reaction shown creates a non toxic double Aldehyde.



DON or VOMITOXIN – Is also Oxidized by Ozone into a non toxic Aldehyde.



ZER or ZERALENONE – Is also Oxidized to a non toxic double Aldehyde.

BASIC FUNCTIONAL MECHANISM OF THE TOXI-SCRUB®

Ozone interact with the fungus and has 3 basic effects:

1. **It kills the fungus**
2. **It destroys the spores**
3. **It reacts with the metabolites … the Mycotoxins and changes the Mycotoxins into harmless molecules**

This is the reason Ozone can effectively eradicate fungus spores and Mycotoxins (and insects and their eggs and larvae)

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CORN

One of the scientific articles describing reduction of Aflatoxin B1 in corn (maize) during exposure to Ozone

ELSEVIER

Food Control

Volume 37, March 2014, Pages 171-176

Effect of ozone treatment on aflatoxin B_1 and safety evaluation of ozonized corn

XiaohuLuo. RenWang. LiWang. YongfuLi. YuanyuanBian. ZhengxingChen

https://doi.org/10.1016/j.foodcont.2013.09.043Get rights and content

Highlights

- AFB_1 in corn could be efficiently degraded by ozone.
- The toxicity of the ozone-treated ACC was evaluated by the HepG2 cell line.
- Ozonation is an effective, fast and safe method for AFB_1 degradation in ACC.

Abstract

This paper studies the ozone treatment effect on degradation of aflatoxin B_1 (AFB_1) in corn with different moisture content (MC). The toxicity of the degradation products (DPs) of the ozone-treated AFB_1-Contaminated Corn (ACC) was also evaluated using the human hepatocellular carcinoma cell line (HepG2) as model cells. The degradation rate of AFB_1 in corn increases with ozone concentration and treatment time. The results showed that ACC

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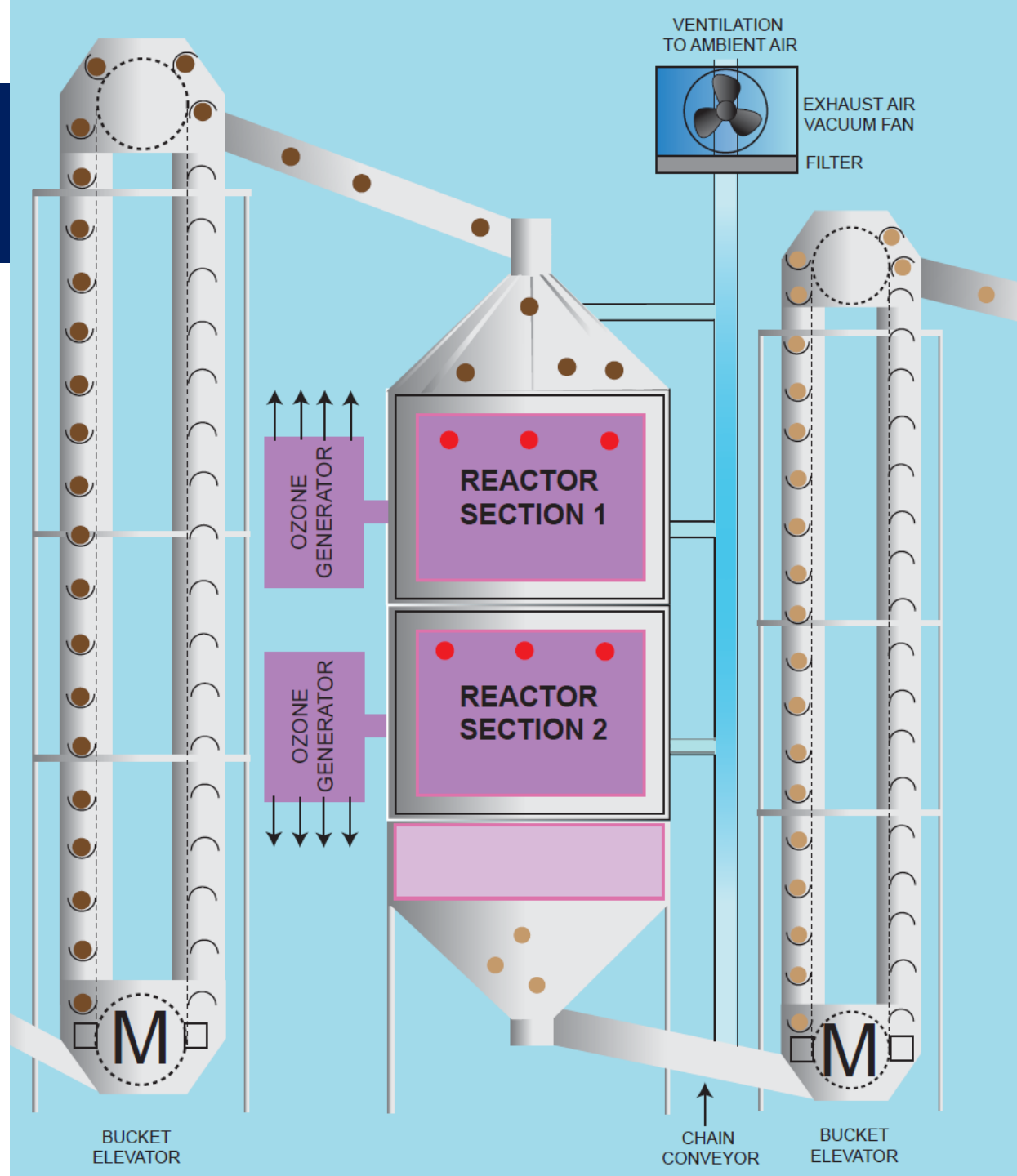
Reactor Design

- The reactor design consists of 2 reactor sections where Ozone reacts with the Mycotoxins.
- This secures a very high removal-efficiency, up to 95%+

Why a Reactor??



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TOXI-SCRUB APPLICATION POTENTIAL

OZONE can be used to decontaminate all types of grain, beans and nuts This is scientifically very well validated.

What we have done is to take the technology to the next level and designed a reactor that can treat from 4 – 50 ton/hour.

We have demonstrated that the reduction of Mycotoxin concentration is primarily dependent on the treatment time (exposure to ozone)

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