

TOXI-SCRUB™

TOXI-SCRUB®

A NEW PROCESSING LINE TO REMOVE MYCOTOXINS

PEER HANSEN, BIOCHEMIST, iGRAIN, DENMARK

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TOXI-SCRUB®

BACKGROUND; A SHIFT IN TECHNOLOGY



- Experience from the last decade shows that problems to maintain stored grain quality is ever increasing
- Phosphine is no longer efficient to combat insects. Up to 30%+ resistance is reported from India, China and USA
- Increased awareness about the toxic effects of Mycotoxins ... and more testing requirements from authorities and traders has created serious problems in the entire food and feed supply chain. This also includes beans and nuts

NEW Technologies are urgently needed

- Ozon is a new and scientifically validated technology
- Ozon is the active reactant in the TOXI-SCRUB machine

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 other residues



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



OZONE STUDIES AT AARHUS UNIVERSITY, DENMARK



The study results in summary

- established that Ozone is a reliable alternative to traditional fumigation
- determined the lethal doses of ozone needed to control adults and immatures of eleven species of stored-product pests
- investigated the effect of temperature (and moisture) on the efficacy of Ozone for two species of stored-product pests

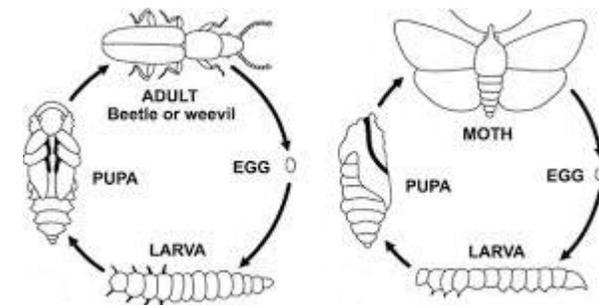


Ministry of Food, Agriculture
and Fisheries of Denmark
The Danish AgriFish Agency



This is the most extensive study of Ozone in Entomology ever:

- involved 12 different species and a total of 50.000 insects and mites
- went on for 4 years. All experiments in triplicate



Lethal doses of ozone for control of all stages of internal and external feeders in stored products

Lise S Hansen,^{a*} Peer Hansen^b and Karl-Martin V Jensen^a

Abstract

BACKGROUND: Gaseous ozone (O₃) has potential for control of insects in stored grain. Previous studies have focused on freely exposed insects. Immatures of internal pests (e.g. *Sitophilus* spp. and most stages of *Rhizopertha dominica* F.) are protected within kernels and probably require higher doses and/or longer treatment times for full control. A laboratory study determined the doses of ozone necessary for full control of freely exposed and internal stages of eleven stored-product pest species. Test insects were three species of *Sitophilus*, *R. dominica*, *Tribolium confusum* Jacquelin du Val, *T. castaneum* Herbst, *Plodia interpunctella* Hübner, *Sitotroga cerealella* Olivier, *Oryzaephilus surinamensis* L., *Ephestia kuehniella* Zeller and *Stegobium paniceum* L. Insects were exposed to continuous flows of ozone in doses of 10–135 ppm and exposure times of 5–8 days. Dose-mortality bioassays were conducted on three species of *Sitophilus* and *P. interpunctella*.

RESULTS: Freely exposed stages (with a few exceptions) were controlled with 35 ppm of ozone for 6 days. Full mortality of internal stages within kernels required exposure to 135 ppm for 8 days.

CONCLUSION: This study confirms that higher doses and/or longer treatment times are necessary for control of internal stages of stored-product pests.

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WHAT IS A MYCOTOXIN?



According to Wikipedia:

A **Mycotoxin** is a toxic secondary metabolite produced by organisms of the [fungus](#) kingdom. Examples of mycotoxins causing human and animal illness include [aflatoxin](#), [citrinin](#), [Fumonisin](#), [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 of Mycotoxin

Mycotoxins have the potential for both acute and chronic health effects. Are capable of causing disease and death in both humans and other animals.

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

OZONATION - EFFECTS ON FUNGUS



Effect of Ozonation at 50 ppm for 3 days

Aspergillus Flavus:

- 66% reduction in survival of surface Conidia
- hyphal growth and sporulation completely inhibited
- Aflatoxin production reduced 97%

Corn germination:

- no reduction



OZONATION VERSUS CONTROL FOR 5 DAYS - FUNGAL EFFECTS



| FUNGI | | OZON | Control |
|---------------------------------|---|------------------------|-----------------------|
| | | 5 ppm (600ppm*Hour) | |
| <i>Aspergillus flavus</i> | Conidiation (Conidia (spores)/plate) | 0 | 1.0 x 10 ⁹ |
| | Aflatoxin (ug/plate) | 32 | 1000 |
| <i>Fusarium verticillioides</i> | Conidiation (Conidia (spores)/plate) | 0 | 1.0 x 10 ⁸ |

CORN



ELSEVIER

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

Food Control

Volume 37, March 2014, Pages 171-176

Effect of ozone treatment on aflatoxin B₁ and safety evaluation of ozonized corn

XiaohuLuo. RenWang. LiWang. YongfuLi. YuanyuanBian. ZhengxingChen

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

Highlights

- AFB₁ 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 AFB₁ degradation in ACC.

Abstract

This paper studies the ozone treatment effect on degradation of aflatoxin B₁ (AFB₁) in corn with different moisture content (MC). The toxicity of the degradation products (DPs) of the ozone-treated AFB₁-Contaminated Corn (ACC) was also evaluated using the human hepatocellular carcinoma cell line (HepG2) as model cells. The degradation rate of AFB₁ in corn increases with ozone concentration and treatment time. The results showed that ACC

OZONATION

This Article looked at the general application of Ozone and concluded: “According to recent research, O₃ can degrade and reduce both mycotoxins and pesticide residues in food”

Ozone against mycotoxins and pesticide residues in food: Current applications and perspectives

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Keywords

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Gaseous ozonation

Abstract

Food safety may be compromised by the presence of chemical contaminants, such as mycotoxins and pesticide residues. Mycotoxins are natural contaminants produced by certain species of filamentous fungi and can cause toxic effects on human health. Pesticide residues are any specified substance in food resulting from the use of a pesticide with toxicological significance. To protect consumers from these toxic substances, different food regulatory agencies have set maximum levels permitted in different raw materials and processed foods. However, recent research has demonstrated a high incidence of both mycotoxins and pesticide residues (not simultaneously) in foods marketed all around the world, sometimes with levels above the regulated limits. One way to reduce such contaminants is to use ozone (O₃) in food processing. Due to its high potential as an oxidant, O₃ and the radicals generated in the ozonation

WHY IS OZONE EFFECTIVE?



Under laboratory conditions Ozone has demonstrated its ability to eliminate many different Mycotoxins.

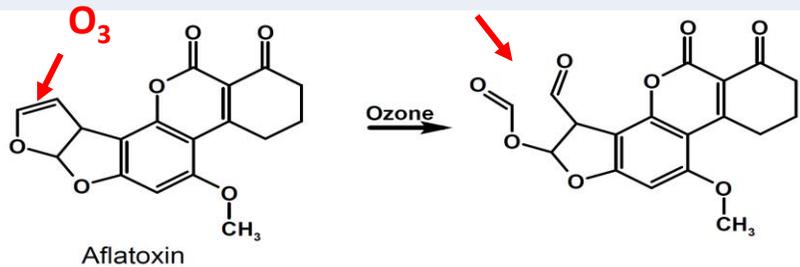
That has been proven for all of the most toxic Mycotoxins

What is the mechanism with which it works?

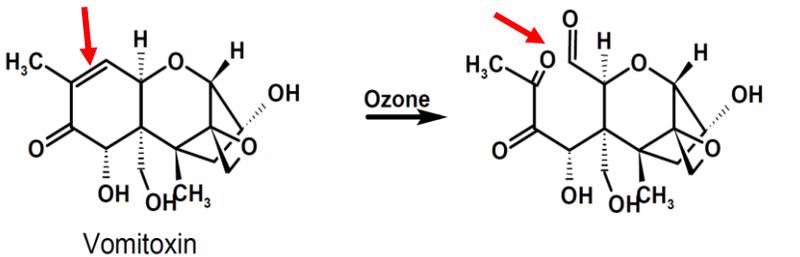
OZONATION OF MYCOTOXINS – REACTION MECHANISM



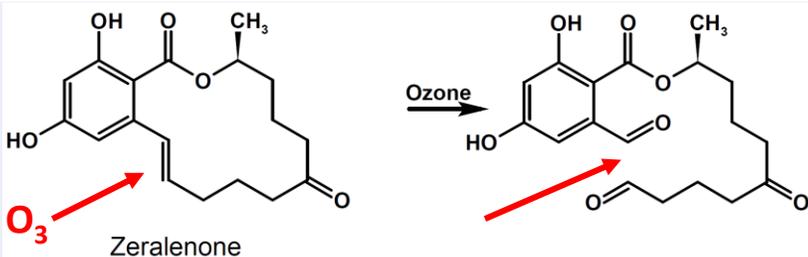
When Ozone react with Mycotoxins the resulting substances are not recognized as toxic compounds. Scientists have tried to look for toxic bi-products, but so far none have been identified



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.

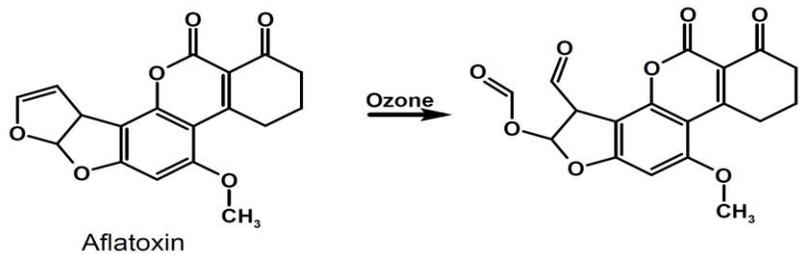


ZER or ZERALENONE – Is also Oxidized to a non toxic double Aldehyde.

OZONATION – REDUCTION OF MYCOTOXIN CONTAMINATION



For Ozone to reduce the Mycotoxin level it must penetrate the grain kernels to create the reduction. Basically it seems to be only a matter of time for the reaction to take place

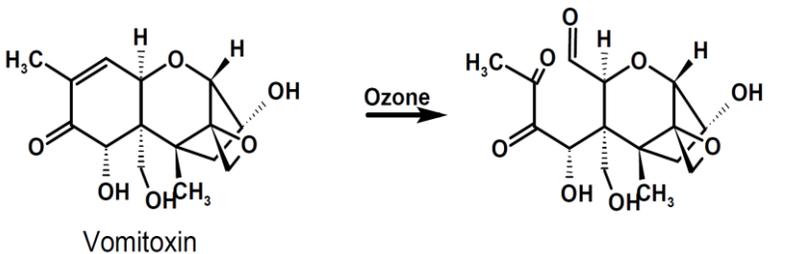


AFLATOXIN

70 - 96% Reduction

Ref.: Joel Leusink, Ozone Food Processing, May 4, 2013 (96%)

Ref.: Can ozone fumigation effectively reduce aflatoxin B1 and other mycotoxins contamination on stored grain? 10th International Working Conference on Stored Product Protection, 2010, Wang, S.*#, Liu, H., Lin, J., Cao, Y. (70%)

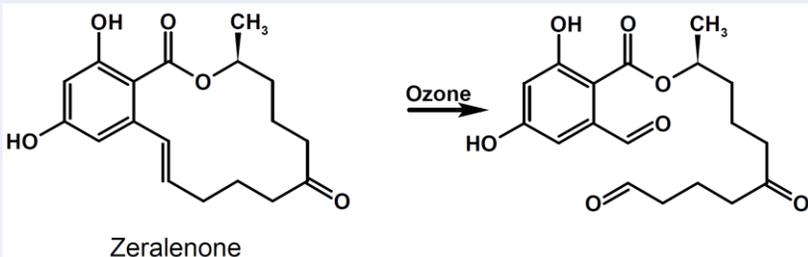


DON or VOMITOXIN

80% Reduction

Ref. 1: Effect of ozone treatment on deoxynivalenol and quality evaluation of ozonised wheat; MM Lia, E.Guana & K. Biana, Food Additives & Contaminants, Vol. 32 Iss 4, 2015

Ref 2.: Young, J. C., Zhu, H., Zhou, T., 2006. Degradation of trichothecene mycotoxins by aqueous ozone. Food and Chemical Toxicology 44, 417-424.



ZER or ZEARALENONE

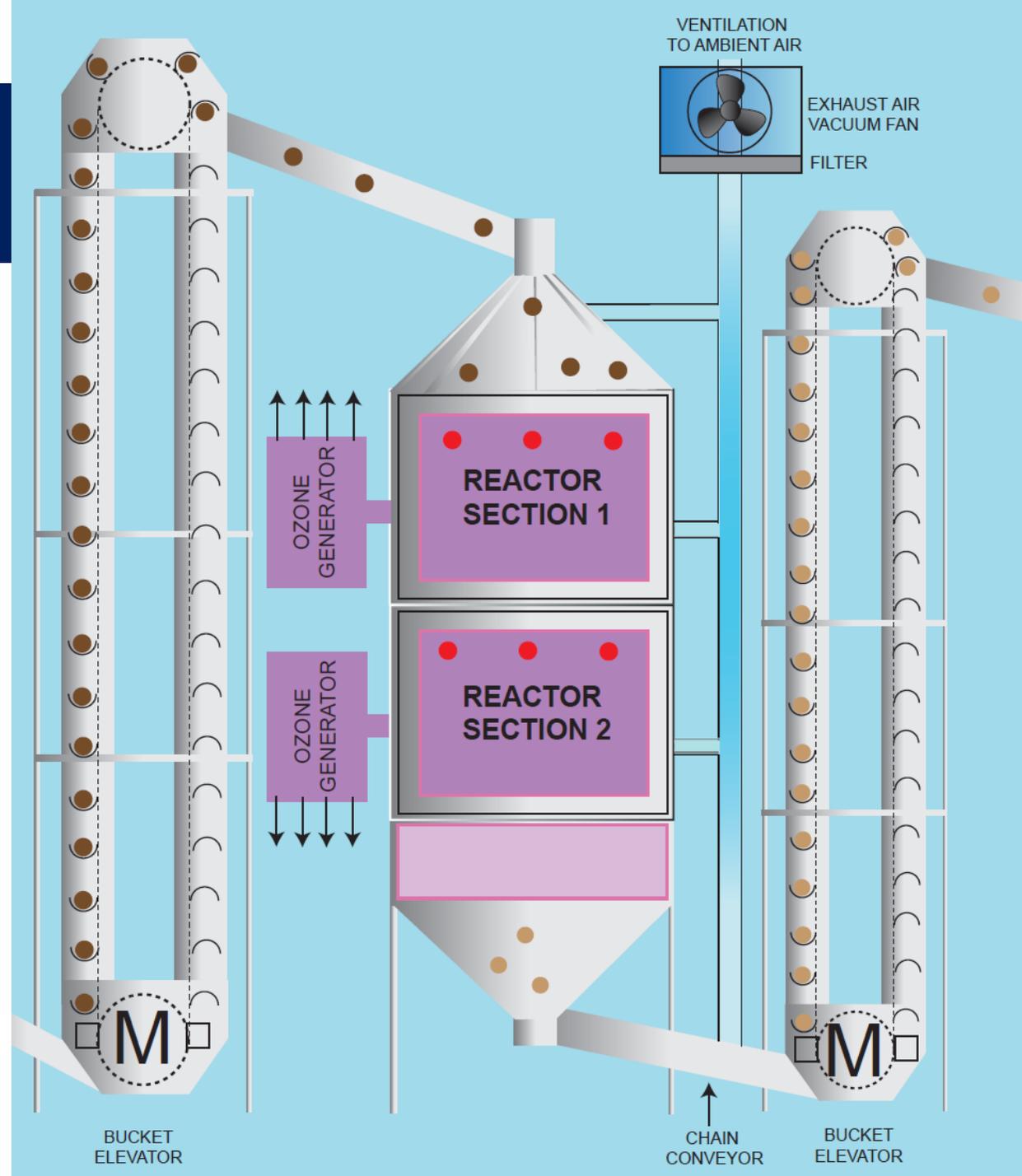
Significant Reduction

Ref.: Can ozone fumigation effectively reduce aflatoxin B1 and other mycotoxins contamination on stored grain? 10th International Working Conference on Stored Product Protection, 2010, Wang, S.*#, Liu, H., Lin, J., Cao, Y.

REACTOR DESIGN

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

The design is patent pending



TOXI-SCRUB™ - 2 MAJOR APPLICATIONS



The TOXI-SCRUB Machine was developed as a spin off product from machines developed for sanitation and reduction of Insects in grain bins.

- Eradication of Mycotoxines, and almost complete sterilization of the grain (not including internal feeders)
Machine capacities: 6, 12, 20 and 30 ton/hour
- Sterilization of grain – Disinfesting all Protozoa (Insects, Fungus etc., Including internal feeders (eggs))
Machine capacities: 3, 6, and 20 ton/hour

Both process are trough the flow-through reactor

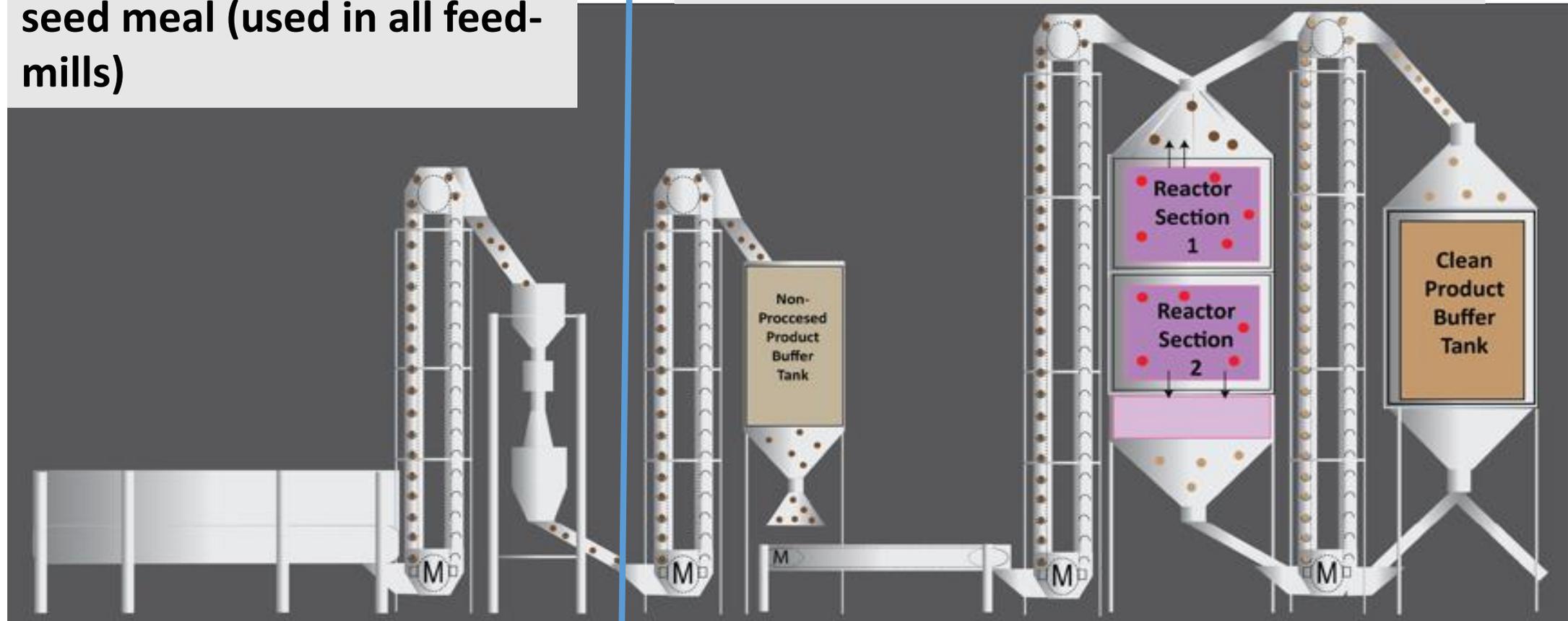
Applying Ozone directly in the silos did not always work very well direc

TOXI-SCRUB OVERVIEW WITH MILLING TOWER



This is the added processing section for contaminated oil seed meal (used in all feed-mills)

Standard section for decontamination of grain like rice and wheat



HOW CAN THE USER CHECK THE TOXIN REDUCTION



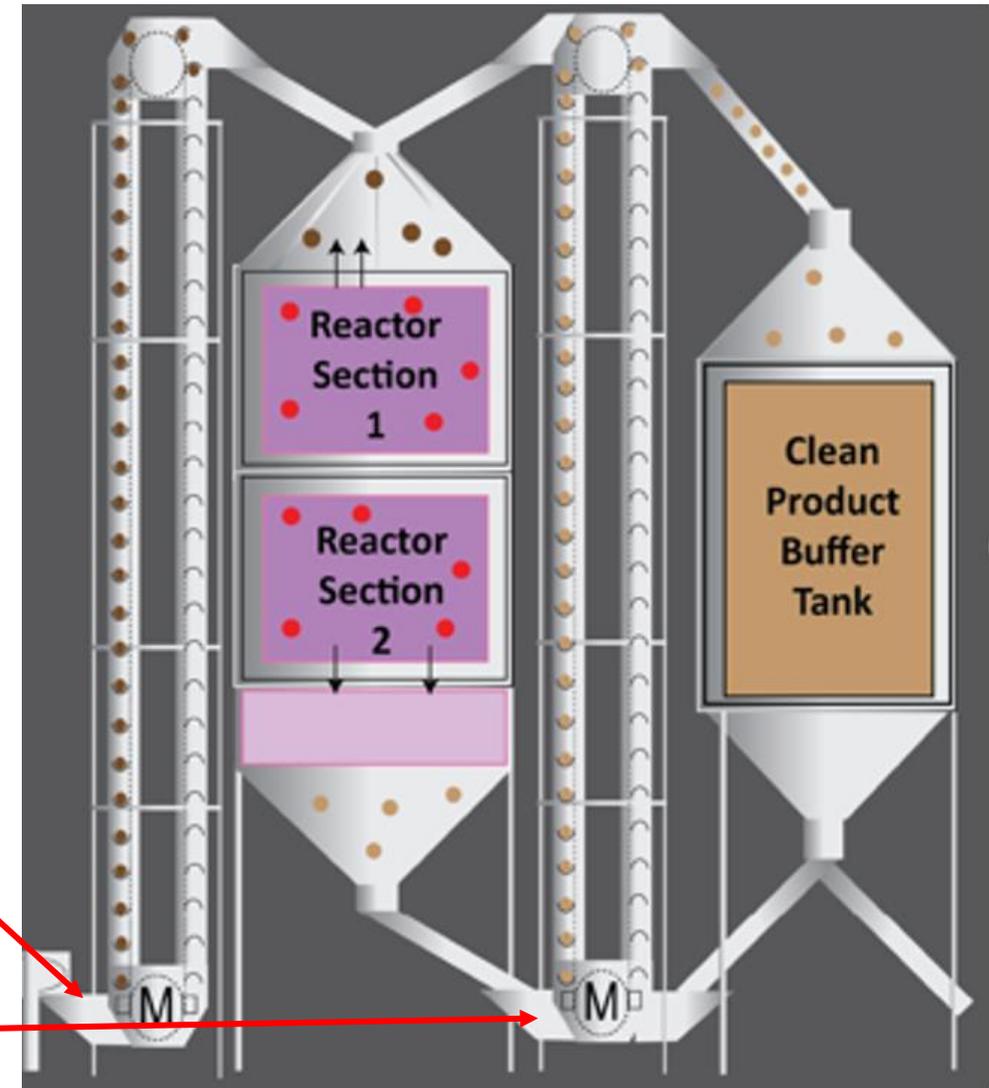
All machines will come with a Mycotoxin test equipment

We use the American CHARM tester in our own laboratory and provide it to the user.

The user will test both the incoming and the outgoing toxin level on both sides of the reactor every 30 min.

Sample point IN

Samplepoint OUT



THE KEY COMPONENTS IN TOXI-SCRUB



The Toxi-Scrub Machine consists of the following functional units:

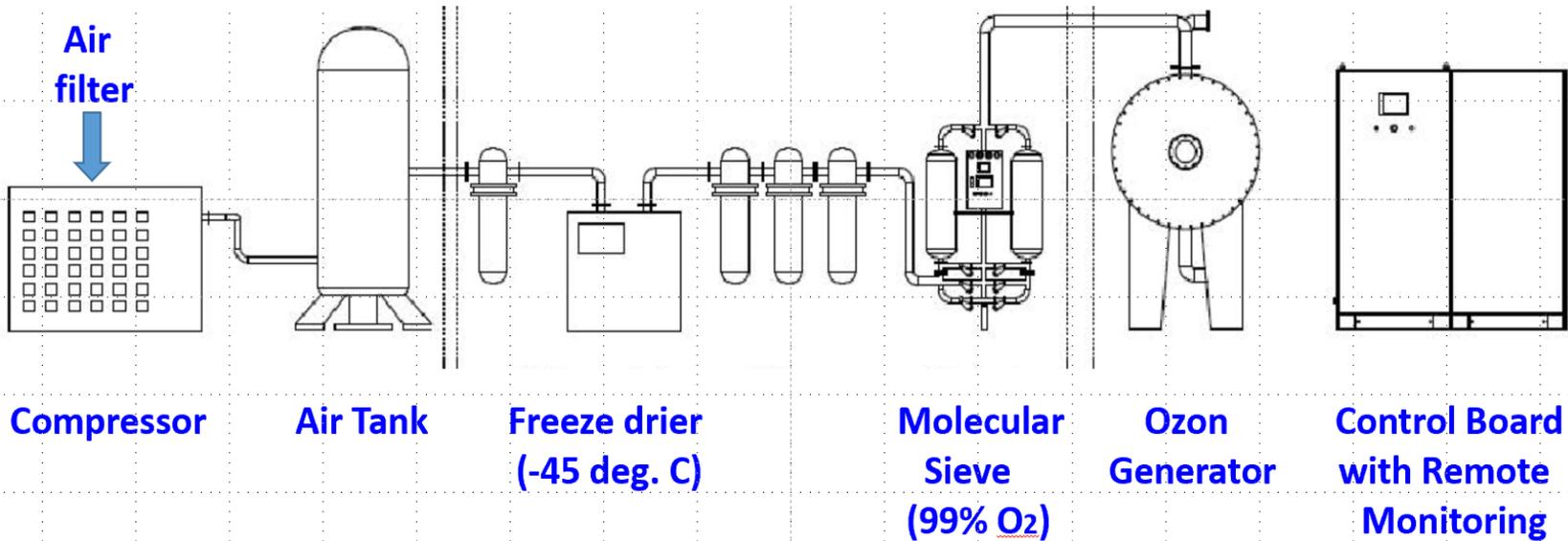
- 1. Air preparation section to prepare Oxygen from the air to be converted to Ozone in the High Voltage generator – Lots of Clean air is needed**
- 2. Ozone Reactor (Patent. Pending) as developed by Eye-Grain in Denmark**
- 3. All associated material handling and buffer silos**
- 4. Advanced AUTOMATIC Control System based on a Siemens PLC and HMI**
- 5. It may include a milling tover for handling of peanut cake/soy bean meal etc.**



THE OZONE GENERATOR



Rugged Design of the Ozone generator for 24/7 use



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 – 30 ton/hour.**

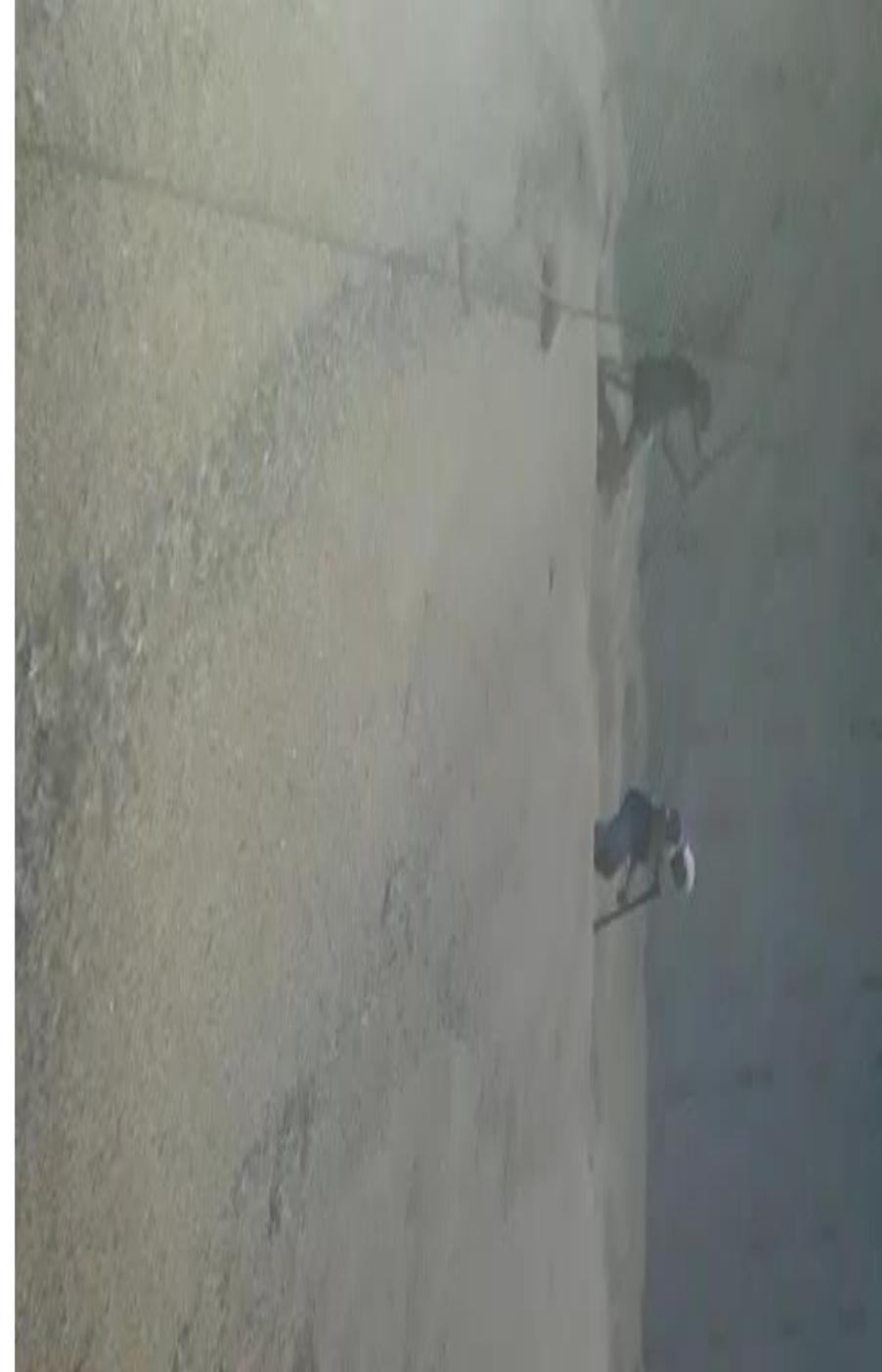
**We have demonstrated that the reduction of Mycotoxin concentration is
primarily dependent on the treatment time.**

Example: PROBLEM in a Silo

- Silo (D= 27m) Soy Beans
- iGRAIN Online Center discovers the problem and recommends to unload the silo immediately
- Product reaches Temperature of 98° C - Client starts the fans
- 3 Days later unloading is only 50% possible
- Difficult digging ... Very bad conditions

A CO2 sensor would have alerted much earlier

This loss amounted to minimum 1 mio. \$



TOXI-SCRUB™

A NEW PROCESSING LINE TO REMOVE MYCOTOXINS



Thank you for listening

Please contact us if you have issues with Mycotoxins
info@crop-protector.com

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