ClorDiSys

Application Note #52

Chlorine Dioxide Gas Effect on Pest Insects

While preliminary tests have shown that chlorine dioxide (CD) gas, a registered sterilant, can be effective in the extermination of several pest insect species, it is not currently an approved pest fumigate with the US EPA. This Application Note is being used to highlight test results for various insect species to spread general knowledge about gaseous chlorine dioxide.

Bed Bugs

Figure 1: Bed Bugs

A study done by the University of Nebraska investigated the effectiveness of chlorine dioxide gas when used to exterminate bedbugs. Bedbug infestations can be very hard to eliminate as they are known to be immune to many common pesticides and can survive for months without food. The study performed used a laboratory setting to simulate CD gas's ability to kill bedbugs in hospital rooms. Several unique runs were done to observe the effects of the gas on a population of bedbugs, varying both the gas concentration and the exposure time. These tests determined the proper dosage to achieve a 100% mortality rate. Results from the study are shown in the table below. **Ref**: Gaseous Chlorine Dioxide as an Alternative for Bedbug Control. Shawn G. Gibbs; John J. Lowe; Philip W. Smith; Angela L. Hewlett. Infection Control and Hospital Epidemiology, Vol 33 No. 5, 2012.

CD Gas Cycle Info				Mortality After Exposure			
CD Gas Concentration (ppm)	Exposure Time (min)	Dosage (ppm-hrs)	Relative Humidity	0 Hours	6 Hours	12 Hours	18 Hours
1086	167	3024	82%	100%	-	-	-
724	94	1132	64%	100%	-	-	-
362	176	1029	43%	84.3%	100%	-	-
362	89	519	43%	59.8%	86.9%	98%	100%

Table 1: Effect of CD Gas on Bed Bugs

Stored Product Beetles

Figure 2: Confused Flour Beetle

The confused flour beetle is perhaps the most frequently intercepted pest of stored products. Adults and larvae feed on all cereal products, groundnuts, spices and other various dried goods. Adults live for one to two years. Because they are such a common concern in flour mills and food processing plants with limited control options, experiments were conducted exposing confused flour beetles to gaseous chlorine dioxide. The confused flour beetles were exposed to chlorine dioxide at different concentrations and at different lengths to see the effect of the gas on the survivability of the beetles. After these initial experiments, three similar species of beetle, which are all commonly found in stored

products, were also exposed to chlorine dioxide. The exposure of cigarette, red and merchant grain beetles to the CD gas all yielded similar results as those of the confused flour beetle tests. These tests concluded that a dosage of 3000 ppm-hours achieved 100% mortality rate of confused, red, cigarette, and merchant grain beetles.

Species of Beetle	CD Gas Cycle Info	Mortality After Exposure
	Dosage (ppm-hrs)	0 Hours
Confused Flour	3172	100%
Red Flour	3000	100%
Cigarette Beetle	3000	100%
Grain Merchant	3000	100%

Table 2: Effect of CD Gas on Stored Product Pests

German Cockroaches

The German cockroach (*blattella germanica*) is one of the most common types of pest cockroaches. Found throughout the world, the German cockroach occurs in all types of human dwellings, but is most commonly an issue in food facilities, hotels, and healthcare facilities. The German cockroach is small in size, and prefers confined spaces making control of infestations difficult. Gaseous chlorine dioxide's properties lend itself well to penetrating into cracks and crevices to potentially exterminate these cockroaches. To investigate the effect of CD gas on German cockroaches, groups of 5 roaches were exposed to various dosages all at a concentration of 1 mg/L. These tests concluded that a dosage of 3000 ppm-hrs achieved 100% mortality of German Cockroaches. Results of these tests are shown below.

CD Gas Cycle Info	Mortality After Exposure
Dosage (ppm-hrs)	0 Hours
360	0%
720	0%
1080	0%
1440	0%
1945	80%
3000	100%

Table 3: Effect of CD Gas on German Cockroaches

Mosquitoes

Mosquitos are a vector for the spread of infectious diseases, estimated to transmit disease to over 700 million people annually. Mosquito-borne diseases include Malaria, West Nile Virus, Yellow Fever and a host of others. A biotech company developing vaccines against malaria wished to test CD gas against malaria as well as against mosquitoes themselves. This was viewed as a failsafe in case the mosquitoes breached their primary containment. Testing showed that CD gas was able to achieve 100% morality of all mosquitos within the normal process conditions of 720 ppm-hours.

Figure 3: Mosquito

CD Gas Cycle Info			Mortality	
Relative Humidity	**Exposure time**	**Chlorine Dioxide Gas Dosage**	**Treated with CD Gas**	**Untreated (Positive Control)**
65%	2 hours	720 ppm-hours	100%	0%

Table 4: Effect of CD Gas on Mosquitoes

Pinworm Eggs

Figure 4: Pinworm

Pinworms are nematode parasites that can affect laboratory rodents. While pinworm infection rarely causes death, it can impact animal health and skew research results. The University of Tennessee at Knoxville performed a study on CD gas' effect on pinworm eggs to see if it was a viable option for treating contaminated spaces. Pinworm eggs are microscopic and have been found on equipment, shelving, in dust, and in ventilation air intake ducts. In a controlled study, *Syphacia* spp. ova were affixed to a slide and exposed to a set concentration of chlorine dioxide gas for varying amounts of time. Slides were randomly designated as either control or experimental for time points of 1, 2, 3 or 4 hours. After being exposed to CD gas, the ova were placed in petri dishes, covered with a hatching medium, and incubated at 37° C for six hours. Positive control ova not exposed to chlorine dioxide gas were also processed and incubated. After incubation they were observed microscopically. Duplicate runs were performed for all time points except 1 hour. It was found that a dosage of 1440 ppm-hours was needed in order to eliminate all viable ova from hatching. Below is a table showing the results of the study. **Ref**: Exposure to Chlorine Dioxide Gas for 4 Hours Renders Syphacia Ova Nonviable. Jane Czarra. Journal of the American Association for Laboratory Animal Science, Vol 53, No 4.

CD Gas Cycle Info		% of *Syphacia*, spp. ova hatched	
Exposure time	**Chlorine Dioxide Gas Dosage**	**Treated with CD Gas**	**Untreated (Positive Control)**
1 hour	360 ppm-hours	14%	71%
2 hours	720 ppm-hours	12%	82.5%
3 hours	1080 ppm-hours	2%	80.5%
4 hours	1440 ppm-hours	0%	83%

Table 5: Effect of CD Gas on Pinworm Eggs