ClorDiSys

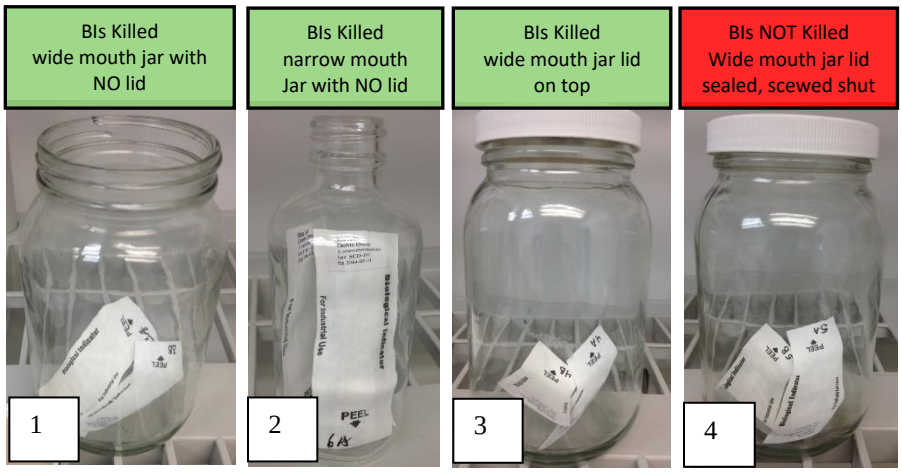
"The Chlorine Dioxide People"

Application Note:

Chlorine Dioxide Gas Penetration Examples

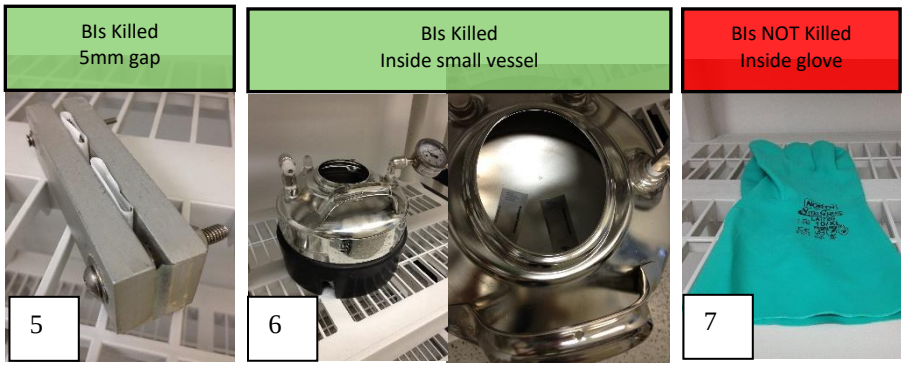
Chlorine dioxide gas penetration

Chlorine dioxide (CD) is a true gas at room temperatures. As such CD gas gets thorough distribution and penetration which is key for any decontamination to be effective. To test this, challenging studies were performed with various equipment, materials and loads. The below information documents the excellent penetration attributes of a true gas and highlights the limits.



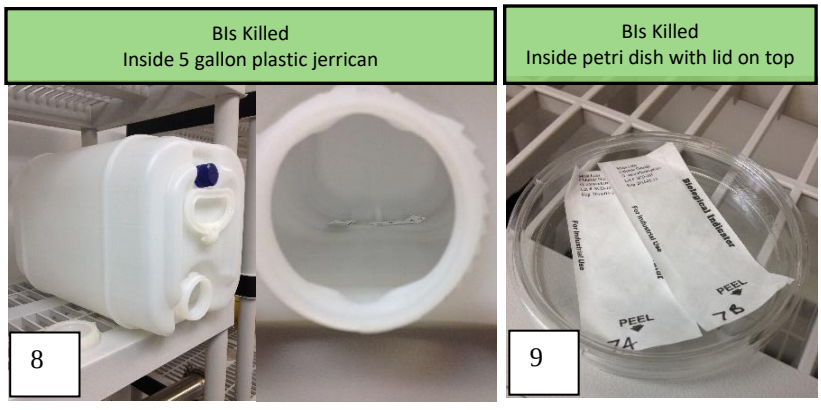
Method

An 850 cu ft. room was prepared with various items placed in the room and BI's placed inside the various parts (items 1-11). After observing the excellent penetration abilities of the gas, other tests were performed inside an isolator (glovebox) with clamped plates (items 12, 13, 14). Following those studies more tests were performed to determine how well CD gas penetrates into organic loads (15).



Material and Equipment

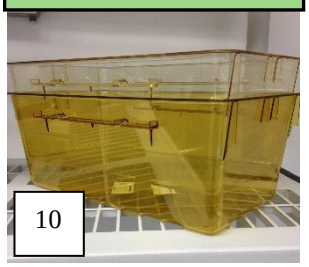
Various equipment was placed inside the gassing room and placed on shelves. A second set of tests utilized square plates which were used to clamp biological indicators (BI's) in between 2 plates. Six inch square plates were used with BI's placed between plates at various depths. These parts and plates were then exposed to CD gas to determine the penetration abilities of the gas.



- Minidox-M CD gas generator system (MM-10A-2009)
- 17 cu ft isolator – gassing chamber
- Gassing Room 850 cu ft. (24 cu m), 11.67ft L x 9.1ft W x 8ft H (3.6m L x 2.8m W x 2.4m H)
- Wide mouth jar (1,3,4)
- Narrow mouth jar (2)
- BI Challenge Fixture (test fixture to mimic small gaps (0.185" [4.7mm]) (5)
- Small pressure vessel (6)
- Gloves (7)

- 5 gallon plastic jerrican (8)
- Petri dish (9)
- 2 Nested small rodent cage with lid on (10)
- 6ft (2m) 2 glove La Calhene isolator (11)
- 6in x 6in 304 unpolished stainless steel plates with C-Clamps (12)
- 6in x 6in 304 unpolished stainless steel plates with C-Clamps (13)
- 6in x 6in 304 unpolished stainless steel plates with C-Clamps (14)
- Organic load (grain, powdered milk, protein powder sugar, flour, infant formula and vacuum cleaner dust) (15)
- Duct Tape
- Biological Indicators (BI) G. *stearothermophilus* spores (GS), NAMSA Code: TCDS-06, population10^6
- Prepared Culture Media (NAMSA Code: GMBCP-100)
- Incubator for incubating G. *stearothermophilus* spore strips (57°C)

BIs Killed in nested rodent cages

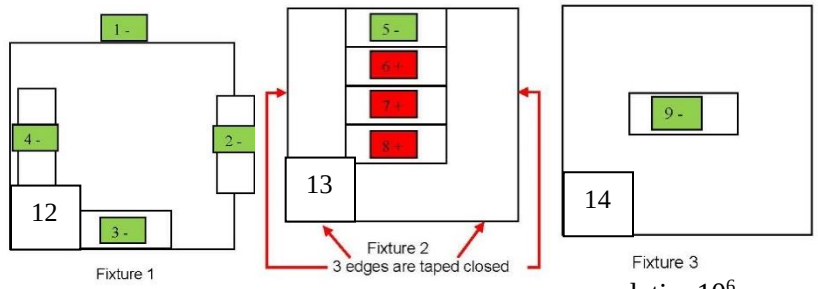


BIs Killed (qty 4) inside isolator (glovebox)

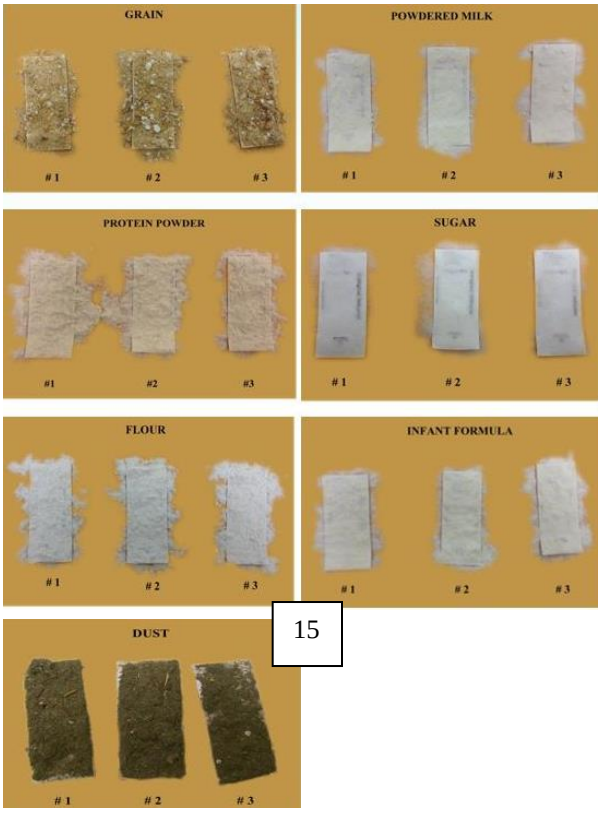
BIs Killed

1 out of 4 BIs Killed

BI Killed



BI's Under Organic Load all Killed



Results

The chlorine dioxide cycles used for all runs were 65% RH for 5 minutes of condition time, charge to a concentration of 1mg/L and hold until a dosage of 720 PPM-Hrs. was reached. At the end of exposure (720 PPM-Hrs.), aeration was initiated. Upon aeration completion, the BI's were removed then incubated for 36 hours according to manufacturer's instructions and CSI protocols.

The table below documents all the results of the BI's

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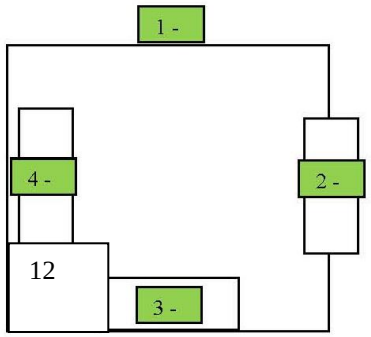
BI #	Location	Result (+ or -)	BI #	Location	Result (+ or -)
1	wide mouth jar, no cap	-	13-5	½ in from the edge of the plate	-
2	narrow mouth jar, no cap	-	13-6	1 ¾ in from the edge of the plate	+
3	wide mouth jar, lid placed on top	-	13-7	2 in from the edge of the plate	+
4	wide mouth jar, lid torqued down	+	13-8	4 in from the edge of the plate	+
5	BI Challenge Fixture (test fixture to mimic small gaps (0.185" [4.7mm])	-	14-9	In the middle of the plate, approximately 3in from either edge of the plate	-
6	small pressure vessel	-	15-1	Grain	-
7	inside gloves	+	15-2	Powdered Milk	
8	Bottom of 5 gallon plastic jerrican	-	15-3	Protein Powder	-
9	Petri dish with lid on	-	15-4	Sugar	-
10	2 Nested small rodent cage with lid on	-	15-5	Flour	-
11	6ft (2m) 2 glove La Calhene isolator with 2 BI's inside isolator and 2 BI's on isolator door	-	15-6	Infant formula	-
12-1	outside the clamped plates	-	15-7	Vacuum cleaner dirt	-
12-2	half clamped	-			
12-3	fully clamped / covered	-			
12-4	approximately 1-3mm inwards from edge, fully covered	-			

Fixture 1 Preparation

The following diagram shows the BI locations. The below descriptions describe the actual paper BI substrate location and not the envelope.

BI-1 is outside the clamped plates	BI-3 is fully clamped / covered, just at the edge of the steel, fully covered
BI-2 is half clamped	BI-4 is approximately 1-3mm in from the edge, fully covered.



Fixture 1

The below pictures show the actual test setup.

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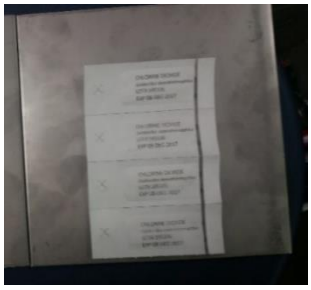
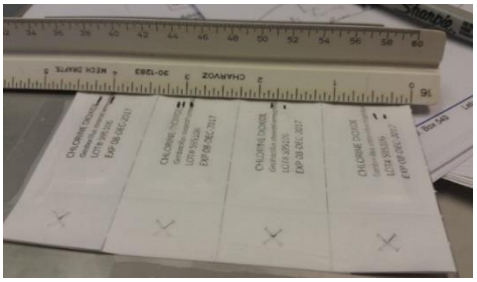
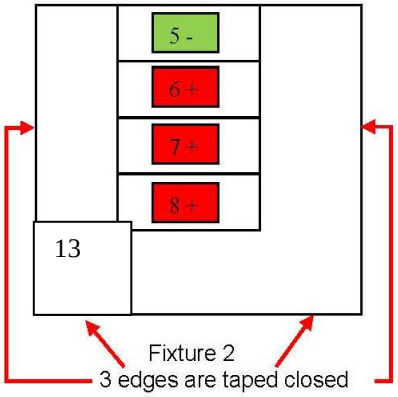
Fixture 2 Preparation

The following diagram shows the BI locations. The below descriptions describe the actual paper BI substrate location and not the envelope. Three of the four edges were sealed with duct tape. CD gas can only penetrate on top (one) side of the fixture.

BI-5 is ½ in from the edge of the plate	BI -7 is 3 in from the edge of the plate
BI- 6 is 1 ¾ in from the edge of the plate	BI-8 is 4 in from the edge of the plate



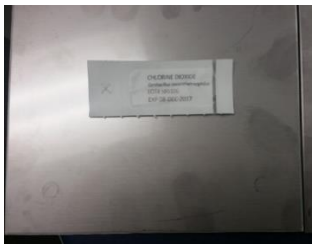


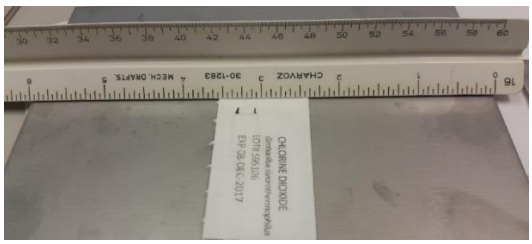


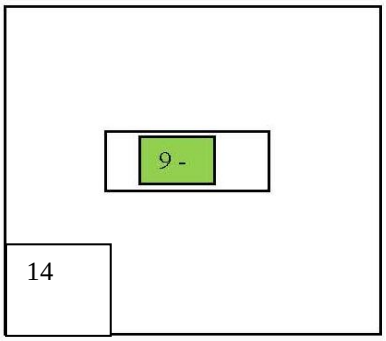
Fixture 3 Preparation

The following diagram shows the BI locations. The below descriptions describe the actual paper BI substrate location and not the envelope. CD gas is able to penetrate all four sides.

BI-9 is in the middle of the plate, approximately 3in from either edge of the plate. No edges were sealed with tape.







Fixture 3

Organic Load Preparation

The diagram (15) above shows the BI covered by various organic loads. The BI's were placed into the isolator then they were covered with various loads to determine the penetration abilities of CD gas. The organic load (grain, powdered milk, protein powder sugar, flour, infant formula and vacuum cleaner dust) was sprinkled onto the BI package. The only way the gas can get into the package is to go through the organic load. The layer was minimal and was not measured. The only point is to show penetration into a dusting of organic loads.

Conclusions

Chlorine dioxide is a true gas at room temperatures. As such it gets good distribution and excellent penetration. The results of the above tests verify that CD gas does penetrate well. It was shown to penetrate into bottles, tanks, equipment and components and more surprising it does penetrate well between clamped plates. Another aspect of penetration is penetration into organic load or to achieve kill through organic layers. The first part of any decontamination is to clean. After that, how clean is clean. The studies performed with organic load show CD gas penetrates through organic load to achieve kill under organic loads.

With clamped plates and gas access limited to only from one edge, CD gas is capable of penetrating a ½ inch (BI 5 was killed and BI 6 was positive), see figure 13. When access is from multiple edges, figure 14 (fixture 3) gas is capable of penetrating 3 inches (BI 9 was negative) between clamped plates. Efficacy is also shown for BI's close to the edge (1/2 inch clamped) and little penetration two inches between clamped plates (BI 6, 7, & 8 were positive), see figure 12.

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