

CHLORINE CONCENTRATION IN ROOM WITH SCRUBBER

PROBLEM:

The chlorine concentration due to a release from a one ton container of chlorine that is located in a room that has a scrubber is determined.

DISCUSSION:

The release of chlorine from the one ton container to the room is assumed at a constant level for a given period of time. The release is detected and the scrubber is activated at the time of the release. The volume of air flow into the scrubber is constant. The release of air out of the scrubber to the ambient atmospheric air outside of the room is at ½ IDLH or 5 ppm.

The time rate of change of chlorine concentration in the room is given by:

$$dx/dt = m/V - xv/V = (m-xv)/V$$

where: m = rate of chlorine addition to the room, lb/min
 v = rate of air flow into the scrubber, acfm
 V = volume of the room, cu ft
 x = concentration of chlorine in the room, ppm
 dx/dt = rate of change of chlorine concentration in the room, ppm/min

Have $dx = (1/V)(m-xv)dt$

and $V \int_{x_0}^x dx/(m-vx) = \int_0^t dt$ or $V[(-1/v)\ln(m-vx)] = [t]_0^t$

with $\ln [(m-vx)/(m-vx_0)] = -tv/V$ And $m-vx = (m-vx_0) \exp (-tv/V)$

then $x = (m/v)[1 - \exp (-tv/V)] + x_0 \exp (-tv/V)$

RESULT:

The chlorine concentration in the room, x, is given by the above equation, is used to determine the time variation of the chlorine concentration in the room. The chlorine concentrations outside of the room as a result of the release from the exhaust of the scrubber is determined. The release from the scrubber exhaust is considered under the conditions of the RMP worst case.

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SUMMARY:

The chlorine concentration in a room with a UFC Article 80 treatment system is considered. This system uses a scrubber to process the exhaust ventilation to $\frac{1}{2}$ IDLH or 5 ppm. The concentrations, in the rooms considered, produce extremely high levels of chlorine in the thousands of ppm for the 10 minute worst case release and for a duration of over 18 minutes after the release.

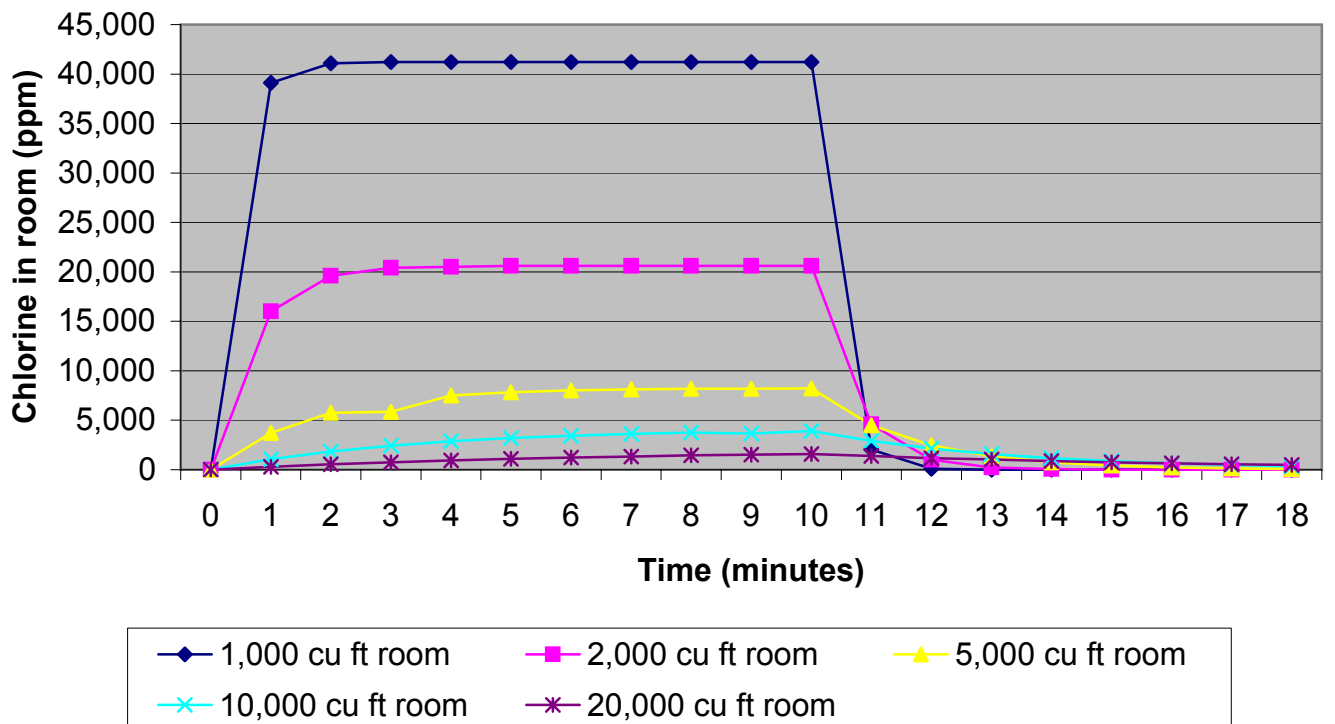
The exhaust from the scrubber still constitutes a health hazard outside of the room with chlorine concentrations above 3 ppm up to 42 ft away from the outside of the room with a scrubber and above 1 ppm up to 90 feet away from the outside the room.

The one ton container in a room with a treatment system that has a scrubber has chlorine concentration levels from a release that are extremely high in magnitude and duration with respect to the low chlorine concentration levels and short duration that are associated with a release from a one ton container in a TGO Total Containment Vessel.

See Chart 6 and Chart 7.

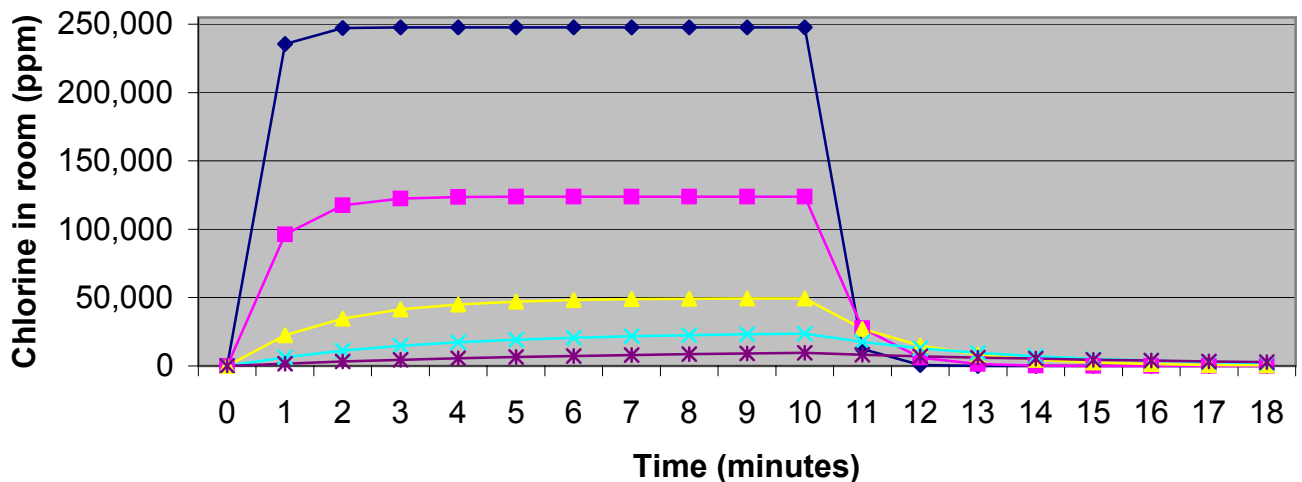
CHLORINE BUILDUP IN ROOM WITH SCRUBBER WITH GAS RELEASE

	Room Volume 1,000 CU FT	Room Volume 2,000 CU FT	Room Volume 5,000 CU FT	Room Volume 10,000 CU FT	Room Volume 20,000 CU FT	
SCRUBBER FLOW RATE (acfm)	3000	3000	3000	3000	3000	
ROOM VOLUME (cu ft)	1,000	2,000	5,000	10,000	20,000	
EXP (-t vdot/V)	0.0495	0.2231	0.5488	0.7408	0.8607	
TIME (MIN)	LEAKAGE RATE (LB/MIN)	DENSITY IN ROOM (PPM)	DENSITY IN ROOM (PPM)	DENSITY IN ROOM (PPM)	DENSITY IN ROOM (PPM)	DENSITY IN ROOM (PPM)
0	7.46	0	0	0	0	0
1	7.46	39,100	16,000	3,720	1,070	287
2	7.46	41,100	19,600	5,760	1,860	534
3	7.46	41,200	20,400	5,870	2,440	746
4	7.46	41,200	20,500	7,490	2,880	929
5	7.46	41,200	20,600	7,830	3,200	1,090
6	7.46	41,200	20,600	8,010	3,440	1,220
7	7.46	41,200	20,600	8,110	3,610	1,340
8	7.46	41,200	20,600	8,170	3,740	1,440
9	7.46	41,200	20,600	8,200	3,640	1,530
10	7.46	41,200	20,600	8,220	3,910	1,600
11	0	2,051	4,590	4,510	2,900	1,380
12	0	102	1,000	2,470	2,150	1,180
13	0	5.1	229	1,360	1,590	1,020
14	0	0.3	51	745	1,180	878
15	0	0	11	409	873	746
16	0	0	3	224	647	650
17	0	0	1	123	479	560
18	0	0	0.1	68	355	482



CHLORINE BUILDUP IN ROOM WITH SCRUBBER WITH LIQUID RELEASE

		Room Volume 1,000 CU FT	Room Volume 2,000 CU FT	Room Volume 5,000 CU FT	Room Volume 10,000 CU FT	Room Volume 20,000 CU FT
SCRUBBER FLOW RATE (acfm)		3000	3000	3000	3000	3000
ROOM VOLUME (cu ft)		1,000	2,000	5,000	10,000	20000
EXP (-t vdot/V)		0.0498	0.2231	0.5488	0.7408	0.8607
TIME (MIN)	LEAKAGE RATE (LB/MIN)	DENSITY IN ROOM (PPM)	DENSITY IN ROOM (PPM)	DENSITY IN ROOM (PPM)	DENSITY IN ROOM (PPM)	DENSITY IN ROOM (PPM)
0	44.9	0	0	0	0	0
1	44.9	235,500	96,300	22,370	6,420	1,726
2	44.9	247,200	117,600	34,640	11,180	3,212
3	44.9	247,800	122,500	41,360	14,710	4,491
4	44.9	247,800	123,600	45,070	17,320	5,592
5	44.9	247,800	123,900	47,100	19,260	6,540
6	44.9	247,800	123,900	48,220	20,690	7,350
7	44.9	247,800	123,900	48,830	21,750	8,060
8	44.9	247,800	123,900	49,160	22,540	8,660
9	44.9	247,800	123,900	49,350	23,120	9,180
10	44.9	247,800	123,900	49,450	23,550	9,630
11	0	12,343	27,650	27,140	17,450	8,290
12	0	615	6,200	14,890	12,920	7,130
13	0	30.6	1,376	8,170	9,570	6,139
14	0	1.5	307	4,485	7,090	5,284
15	0	0.1	68	2,462	5,254	4,548
16	0	0	15	1,351	3,892	3,914
17	0	0	3	741	2,883	3,369
18	0	0	0.6	407	2,136	2,900



◆ 1,000 cu ft room
 ■ 2,000 cu ft room
 ▲ 5,000 cu ft room
× 10,000 cu ft room
 * 20,000 cu ft room