

Ventilation Rate Analysis

By: Erik Kentfield

This spreadsheet offers an analysis for the ventilation rates of the study rooms in HSU's library.

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Input Parameters:

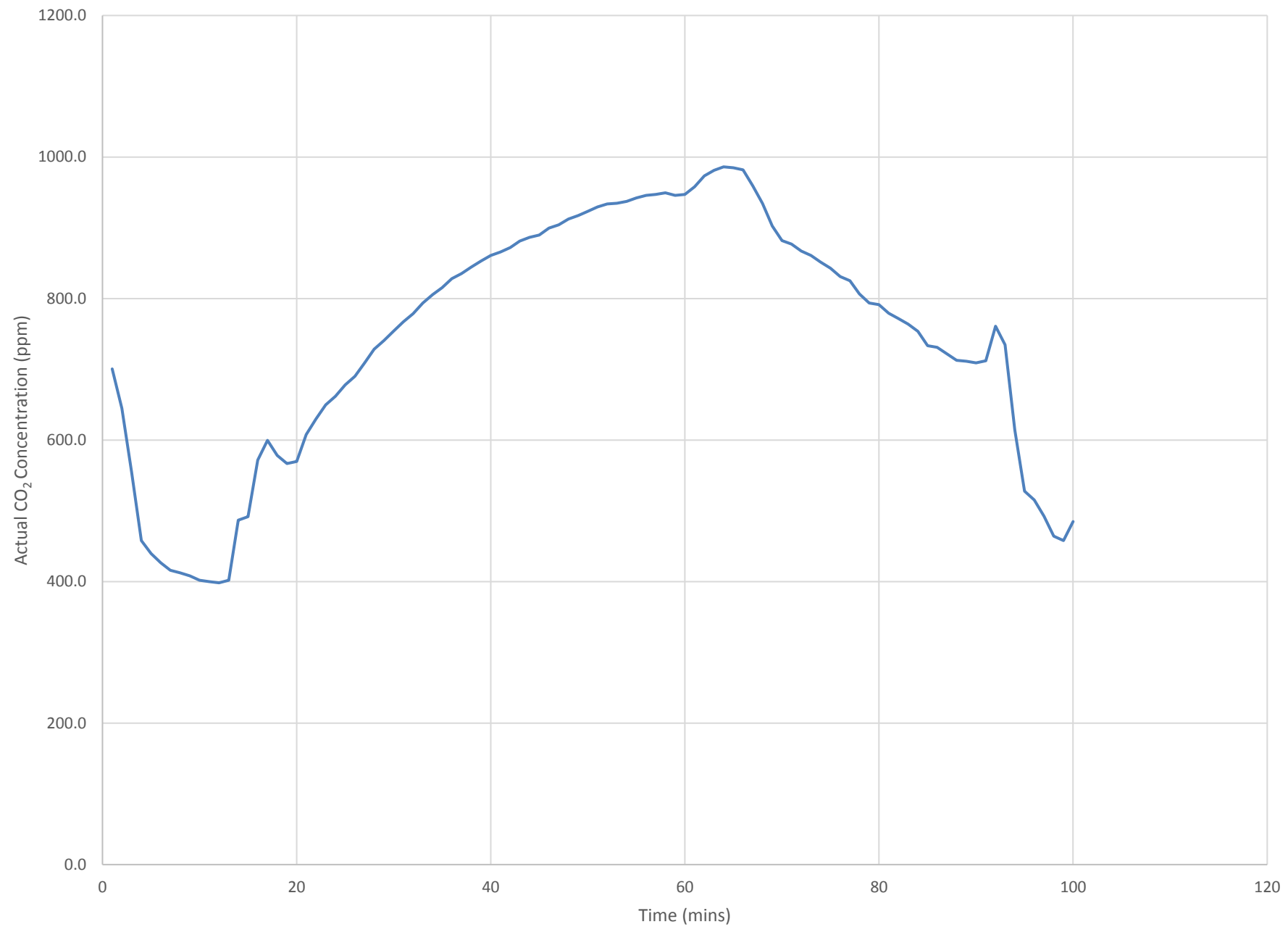
Measured CO _{outdoor}	456
Assumed CO _{outdoor}	400
Correction Factor	-56

Analysis:

Measurement	Date and Time	Hobo CO ₂ Concentration	Actual CO ₂ Concentration (ppm)
1	2/14/2014 14:43	756.4	700.4
2	2/14/2014 14:44	700.9	644.9
3	2/14/2014 14:45	610.5	554.5
4	2/14/2014 14:46	514.0	458.0
5	2/14/2014 14:47	495.7	439.7
6	2/14/2014 14:48	482.3	426.3
7	2/14/2014 14:49	471.9	415.9
8	2/14/2014 14:50	468.3	412.3
9	2/14/2014 14:51	464.0	408.0
10	2/14/2014 14:52	457.9	401.9
11	2/14/2014 14:53	456.0	400.0
12	2/14/2014 14:54	454.2	398.2
13	2/14/2014 14:55	457.9	401.9
14	2/14/2014 14:56	542.7	486.7
15	2/14/2014 14:57	547.6	491.6
16	2/14/2014 14:58	627.6	571.6
17	2/14/2014 14:59	655.7	599.7
18	2/14/2014 15:00	634.3	578.3
19	2/14/2014 15:01	622.7	566.7
20	2/14/2014 15:02	625.8	569.8
21	2/14/2014 15:03	663.6	607.6
22	2/14/2014 15:04	685.6	629.6
23	2/14/2014 15:05	705.7	649.7
24	2/14/2014 15:06	717.9	661.9
25	2/14/2014 15:07	733.8	677.8
26	2/14/2014 15:08	746.0	690.0
27	2/14/2014 15:09	765.0	709.0
28	2/14/2014 15:10	784.5	728.5
29	2/14/2014 15:11	796.7	740.7
30	2/14/2014 15:12	810.1	754.1
31	2/14/2014 15:13	823.0	767.0
32	2/14/2014 15:14	834.6	778.6
33	2/14/2014 15:15	849.8	793.8
34	2/14/2014 15:16	861.4	805.4
35	2/14/2014 15:17	871.2	815.2
36	2/14/2014 15:18	884.0	828.0

37	2/14/2014 15:19	891.3	835.3
38	2/14/2014 15:20	900.5	844.5
39	2/14/2014 15:21	909.0	853.0
40	2/14/2014 15:22	917.0	861.0
41	2/14/2014 15:23	921.9	865.9
42	2/14/2014 15:24	928.0	872.0
43	2/14/2014 15:25	937.1	881.1
44	2/14/2014 15:26	942.6	886.6
45	2/14/2014 15:27	945.7	889.7
46	2/14/2014 15:28	955.4	899.4
47	2/14/2014 15:29	960.3	904.3
48	2/14/2014 15:30	968.3	912.3
49	2/14/2014 15:31	973.1	917.1
50	2/14/2014 15:32	979.2	923.2
51	2/14/2014 15:33	985.3	929.3
52	2/14/2014 15:34	989.6	933.6
53	2/14/2014 15:35	990.8	934.8
54	2/14/2014 15:36	993.3	937.3
55	2/14/2014 15:37	998.2	942.2
56	2/14/2014 15:38	1001.8	945.8
57	2/14/2014 15:39	1003.1	947.1
58	2/14/2014 15:40	1005.5	949.5
59	2/14/2014 15:41	1001.8	945.8
60	2/14/2014 15:42	1003.1	947.1
61	2/14/2014 15:43	1014.0	958.0
62	2/14/2014 15:44	1029.3	973.3
63	2/14/2014 15:45	1037.2	981.2
64	2/14/2014 15:46	1042.1	986.1
65	2/14/2014 15:47	1040.9	984.9
66	2/14/2014 15:48	1037.9	981.9
67	2/14/2014 15:49	1015.3	959.3
68	2/14/2014 15:50	990.2	934.2
69	2/14/2014 15:51	958.5	902.5
70	2/14/2014 15:52	937.7	881.7
71	2/14/2014 15:53	932.8	876.8
72	2/14/2014 15:54	923.1	867.1
73	2/14/2014 15:55	917.0	861.0
74	2/14/2014 15:56	907.2	851.2
75	2/14/2014 15:57	898.7	842.7
76	2/14/2014 15:58	887.1	831.1
77	2/14/2014 15:59	881.0	825.0
78	2/14/2014 16:00	862.6	806.6
79	2/14/2014 16:01	849.8	793.8
80	2/14/2014 16:02	847.4	791.4
81	2/14/2014 16:03	835.2	779.2
82	2/14/2014 16:04	827.8	771.8
83	2/14/2014 16:05	819.9	763.9
84	2/14/2014 16:06	809.5	753.5
85	2/14/2014 16:07	789.4	733.4
86	2/14/2014 16:08	786.9	730.9

87	2/14/2014 16:09	777.8	721.8
88	2/14/2014 16:10	768.6	712.6
89	2/14/2014 16:11	767.4	711.4
90	2/14/2014 16:12	765.0	709.0
91	2/14/2014 16:13	768.0	712.0
92	2/14/2014 16:14	816.8	760.8
93	2/14/2014 16:15	790.6	734.6
94	2/14/2014 16:16	670.3	614.3
95	2/14/2014 16:17	583.6	527.6
96	2/14/2014 16:18	571.4	515.4
97	2/14/2014 16:19	548.2	492.2
98	2/14/2014 16:20	520.1	464.1
99	2/14/2014 16:21	514.0	458.0
100	2/14/2014 16:22	540.9	484.9



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Input Parameters:

Measured C_{outdoor} (ppm)	456
Assumed C_{outdoor} (ppm)	400
Correction Factor (ppm)	-56
Room Volume (ft^3)	2221
Room Capacity	5

(assumed 5 people from given data)

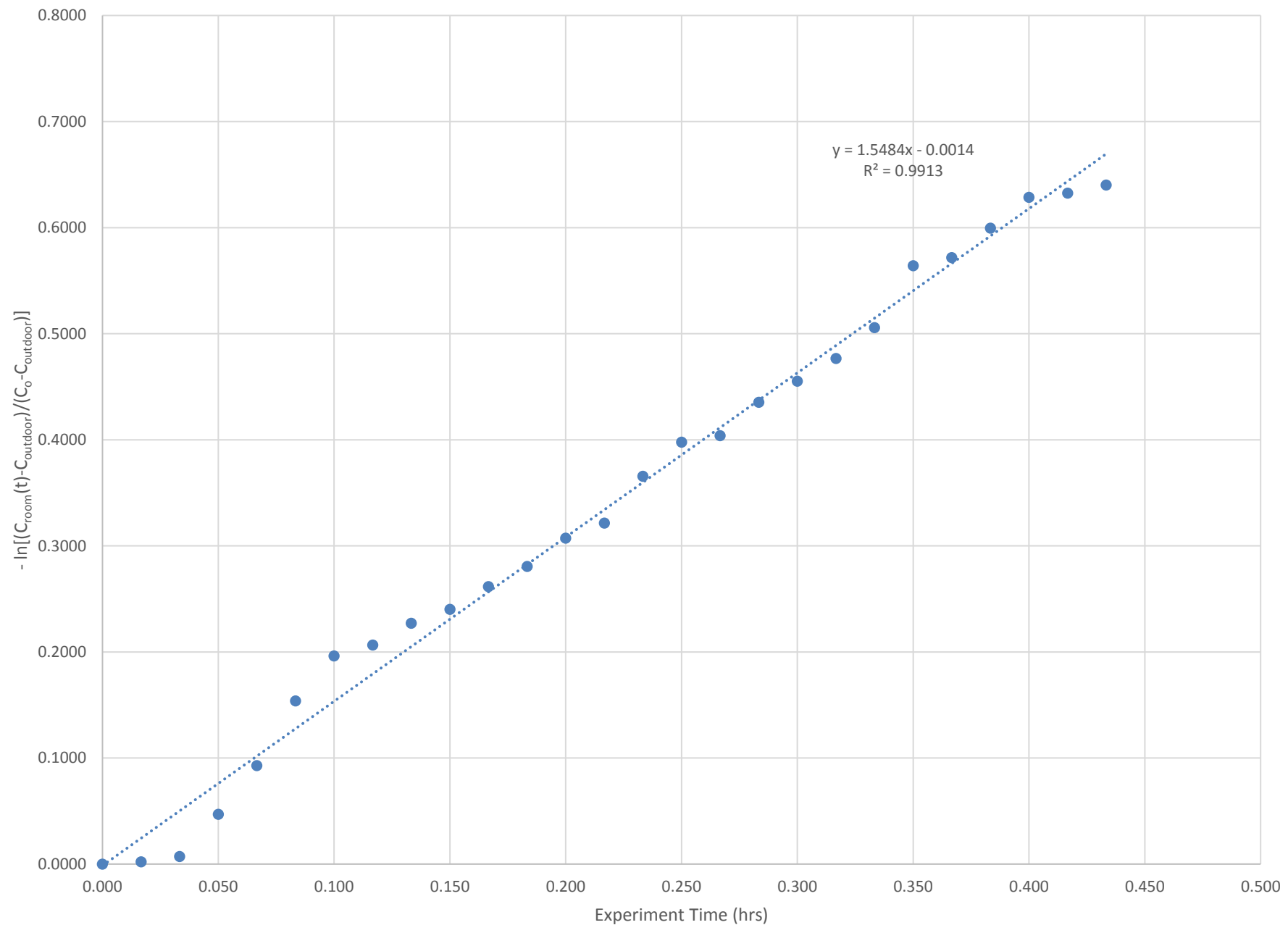
Calculations:

Air Exchange Rate (1/hr)	1.5484
Time to remove non-reactive chemical ($3/\lambda$)	1.9375
Ventilation Rate ($\text{ft}^3/\text{min}/\text{person}$)	11.4648

Analysis:

Measurement	Date and Time	Hobo CO_2 Concentration	Actual CO_2 Concentration (ppm)	Experiment Time (hr)	$-\ln[(C_{\text{room}}(t) - C_{\text{outdoor}})/(C_0 - C_{\text{outdoor}})]$
0	2/14/2014 15:46	1042	986	0.000	0.0000
1	2/14/2014 15:47	1041	985	0.017	0.0020
2	2/14/2014 15:48	1038	982	0.033	0.0072
3	2/14/2014 15:49	1015	959	0.050	0.0468
4	2/14/2014 15:50	990	934	0.067	0.0927
5	2/14/2014 15:51	959	903	0.083	0.1539
6	2/14/2014 15:52	938	882	0.100	0.1962
7	2/14/2014 15:53	933	877	0.117	0.2064
8	2/14/2014 15:54	923	867	0.133	0.2269

9	2/14/2014 15:55	917	861	0.150	0.2401
10	2/14/2014 15:56	907	851	0.167	0.2616
11	2/14/2014 15:57	899	843	0.183	0.2806
12	2/14/2014 15:58	887	831	0.200	0.3072
13	2/14/2014 15:59	881	825	0.217	0.3214
14	2/14/2014 16:00	863	807	0.233	0.3657
15	2/14/2014 16:01	850	794	0.250	0.3976
16	2/14/2014 16:02	847	791	0.267	0.4038
17	2/14/2014 16:03	835	779	0.283	0.4354
18	2/14/2014 16:04	828	772	0.300	0.4551
19	2/14/2014 16:05	820	764	0.317	0.4766
20	2/14/2014 16:06	810	754	0.333	0.5056
21	2/14/2014 16:07	789	733	0.350	0.5641
22	2/14/2014 16:08	787	731	0.367	0.5717
23	2/14/2014 16:09	778	722	0.383	0.5996
24	2/14/2014 16:10	769	713	0.400	0.6286
25	2/14/2014 16:11	767	711	0.417	0.6324
26	2/14/2014 16:12	765	709	0.433	0.6401



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1) $\lambda = 1.5484/\text{hr}$
2) I would recommend that multiple occupants stay for a minimal amount of time. It takes 1.9375 hours to remove non-reactive chemicals and the air exchange rate is 1.5484/hour. Based on these figures, CO_2 concentration will build up faster than it is released from the room. Individuals should wait at least 2 hours for the non-reactive chemicals to dissipate before re-entering.
3) The ASHRAE recommended ventilation rate is 15 scfm. The ventilation rate of the library study room is $11.4648 \text{ ft}^3/\text{min}/\text{person}$. This ventilation rate is too low and the school should increase funding for ventilation to reduce CO_2 concentration buildup.
4) I would only recommend that 3 people stay in the room. If there are 4 people in the room, the ventilation rate is $14.3311 \text{ ft}^3/\text{min}/\text{person}$ which is below the standard. If there are 3 people in the room, the ventilation rate is $19.1081 \text{ ft}^3/\text{min}/\text{person}$ which is above the standard.