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Historical Corner - IAQ

The following paper on indoor air quality was originally read before the World's Congress of Chemists August 26, 1893. The imbalance between spending on water *vs* air continues today. The findings are almost identical to IAQ guidelines we use today. I have added the conversion to ppm in square brackets. I had one lecture room that rose to 1,500 ppm CO_2 and the students were drowsy. Surprise!
David Bromwich, Griffith University.

Carbon Dioxide as a Measure of the Efficiency of Ventilation

By Ellen Richards. Instructor in Sanitary Chemistry. Massachusetts Institution of Technology. Boston Mass.

From the time of Hippocrates who gave as the sanitary maxim "pure air, pure water and pure soil," air has been placed first among the requirements of good sanitation. It is nevertheless a lamentable fact that, as Mr. Woodbridge has well expressed it, "the city which spends millions in water works for pure water supply and for sewerage for foul water removal is still found tightening its purse strings while a few thousands are asked for to provide for pure air supply to, and foul air discharge from its school rooms."

The reason of this apathy is riot far to seek. Chemists and sanitarians have seriously disagreed among themselves as to what constituted “bad air.”

People live and apparently thrive among the most nauseous odors, while under more favorable conditions they sicken and die. One theorist has given a reason only to be forced to the wall by another quite as plausible. Between them the advocate of pure air finds slight hearing. It is only within recent years that a knowledge of the significant fact that not to air itself nor even to the bad odors it carries, but to the dust particles bearing living germs and spores is to be attributed the spread of disease, therefore filtered air like filtered water has become a necessity where dust cannot be avoided by scrupulous care.

And now with our increased knowledge of all the causes which lead to liability to disease it seems probable that the chemist and sanitarian may at 1ast unite in winning fight for pure air.

In a word, the new standpoint relates to the *resistance* which healthy blood and tissue present to the attacks of disease. This resistance is, we believe to the perfect nutrition of the blood corpuscles and this is largely dependent on the inhalation of air containing sufficient oxygen.

In vitiated air the blood becomes quickly loaded with imperfectly oxidized products which cause derangement more or less serious and finally render the individual, who is poisoned from within rather than front without, more liable to succumb to disease

If this view is in any measure correct it is important that chemists combine to urge upon the community the importance of a sufficient supply of air, especially in school rooms, and it is to be hoped that these views will command more respect than heretofore. It is notorious that even college halls and fine public buildings which should be examples are in fact the worst of any buildings.

The Laboratory of Sanitary Chemistry at the Massachusetts Institute of Technology has had, for the past nine years, exceptional opportunities for the study of the relation of the amount of carbon dioxide to the efficiency of the ventilation, in that the Walker building is supplied with mechanical ventilation under the direction of an expert and in full control of the engineer who has records for all these years of the amount and temperature of air supplied to each room, and of the temperature of these rooms taken four times each day.

During these nine years some 5000 determinations of the amount of carbon dioxide have been made in these rooms by some 200 students.

Many problems have been studied and several reports published; without burdening this paper with details, to state a few of the conclusions reached may stimulate others to add to our too meager knowledge on this subject.' [1]

The outside air of the space around the Massachusetts Institute of Technology, Boston, varies from 3.7 to 4.2 parts carbon dioxide per 10,000 [370 to 420 ppm].

The deterioration of the air as shown in the empty rooms is about 0.1 part [100 ppm], due to the decomposition of the organic matter present in the flues, the floors and in the walls.

The air of the building in general, halls and drawing rooms, reading rooms, etc. which are open and in which people are constantly moving, is maintained at about 5.0 parts [500 ppm] as an average age of examinations during eight years. In the ninth year there has been an increase due to an increased number of lecture rooms on the second floor.

The air of most of the lecture rooms has contained from six to eight parts [600 to 800 ppm]; of the larger crowded halls for 200 or more students, ten to twelve parts [1,000-1,200 ppm] according to weather, whether it is clear and dry and with a strong wind or whether the air is loaded with moisture and is still.

From this experience it would seem that students can work well in a clean room with about seven parts per 10,000 [700 ppm] of carbon dioxide; much more than this causes dullness and anything over thirteen parts [1,300 ppm] causes dullness, and anything over

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[1] Papers relating to the points discussed, contributed in whole or in part from the Laboratory of Sanitary Chemistry:

"On the Determination of Organic Matter in Air." Thesis, by Marion Talbot. Technology Quarterly, 1 1887-8.

"The Number and Distribution of Micro-organisms in the Air of the Boston City Hospital with some Carbon Dioxide Determinations." By Greenleaf N. Tucker in the twentieth annual report of the State Board of Health of Massachusetts.

"A Critical Study of the Heating and Ventilation of the Walker building, Massachusetts Institute of Technology." By S. H. Woodbridge. Technology Quarterly, 2 p. 76 and 192, 1888-9.

"The Determination of Carbon Dioxide in the Air of Building." By A. H. Gill. Journal of Analytical and Applied Chemistry, 6, 1892. This paper gives the method in detail which is used in the laboratory.

thirteen parts [1,300 ppm] causes in most cases almost impassable barrier to the fill acquisition of knowledge.

When churches, halls and lecture rooms usually show from fourteen to eighteen parts per 10,000 [1,400 to 1,800 ppm] in twenty minutes after the audience assembles, it is not strange that eloquence often fails to arouse enthusiasm.