Demonstrating the ASHRAE 62.1 IAQ procedure – Total Air Quality

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Abstract

This talk aims to demonstrate the benefits of utilizing the ASHRAE 62.1 Indoor Air Quality procedure to select the appropriate outdoor ventilation rates.

In combination with air cleaning technology, the IAQ procedure gives engineers an alternative method for selecting outdoor air flow rates.

Examples of the 62.1 calculations will be shown along with site testing on air quality where the IAQ procedure was used.

Keywords IAQ TVOC VENTILATION EFFICIENCY ENERGY

1.0 Introduction

ASHRAE defines acceptable Indoor Air Quality as “Air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction”

CO2 is not dangerous until levels exceed 30,000ppm, and yet it is regarded as the primary indoor air contaminant by many in the HVAC industry because it is not widely understood that CO2 is primarily a proxy for acceptable indoor air quality.

2.0 Main content

Trying to save energy by demand controlling ventilation rates purely on CO2 concentration is not an appropriate solution for much of the built environment.

Providing good IAQ by ventilating buildings with large quantities of outdoor air results in significant energy being used. In addition, the quality of outdoor air is decreasing to the point where it can seldom be called “fresh”.

during the 1979 oil crisis, ASHRAE developed the 62.1 standard. The standard defines two methods for determining the outdoor air rate required in order to provide acceptable indoor air quality.
Option one is the ventilation rate procedure (VRP), the second option is using air cleaning systems and the IAQ procedure.
The ventilation rate procedure simply calculates the amount of outdoor air required to dilute the contaminants to acceptable levels.
The IAQ procedure allows engineers to model the concentration of indoor pollutants once the air is cleaned by an air purification technology.

If the calculations show that the level of contaminants of concern are lower when using the IAQ procedure than when modelled with the VRP, then the lower outdoor air flow rates from the IAQ procedure may be used.

Selection of lower outdoor air flow rates at design stage will reduce plant size and the reduction in heating, cooling and dehumidification will result in significant energy savings.

If air cleaning is utilized as an alternative to outdoor during peak temperature spikes, it may be possible to design a free running building when using the IAQ procedure, compared to having to utilize mechanical cooling when using the VRP.

2.1 Case Study Tables and Figures

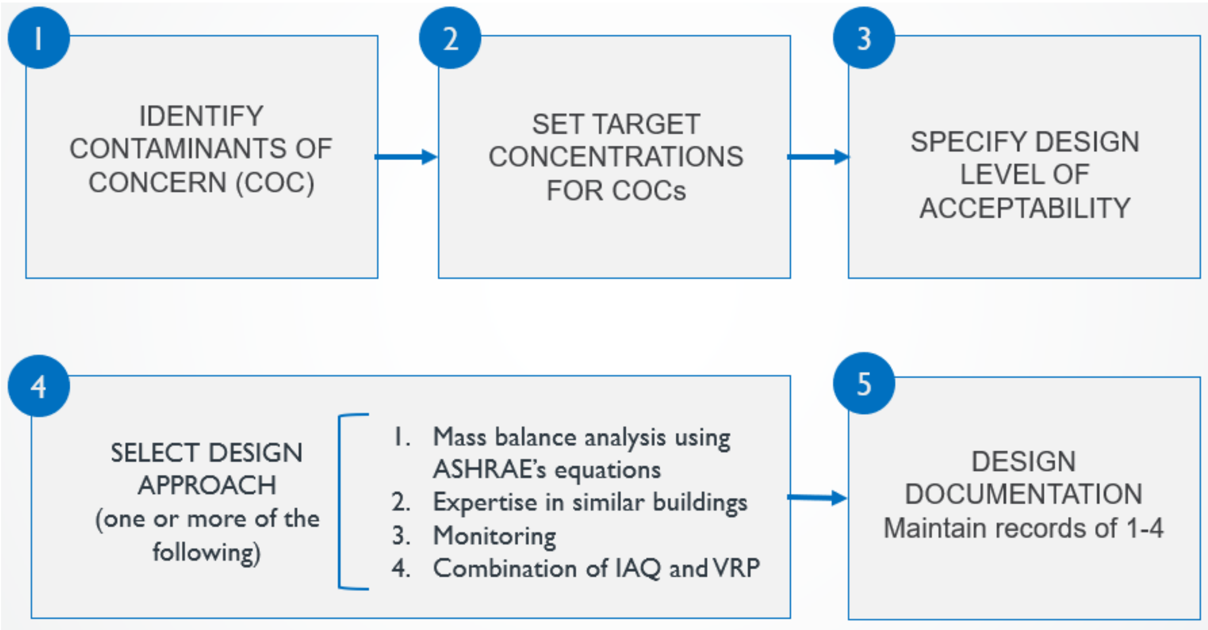

Figure 1 – How to design an IAQ project

Contaminant	Generation Rate per Person (ug/hr)
Ammonia	15,600
Carbon Monoxide	10,000
Hydrogen Sulfide	15
Methane	1710
Propane	1.3

Table 1 – Emission rates per person from ASHRAE

Contaminant	Concentration (ppm)
Ammonia	1.103
Carbon Monoxide	0.361
Hydrogen Sulfide	0.0005
Methane	0.098
Propane	0.00003

Table 2 – Typical contaminant concentrations in a classroom using VRP

Filter Location	Flow	Outdoor Airflow	Required Outdoor Airflow	Space Contaminant Concentration
None	VAV	100%	$V_o = \frac{N}{E_v F_r (C_s - C_o)}$	$C_s = C_o + \frac{N}{E_v F_r V_o}$
A	Constant	Constant	$V_o = \frac{N - E_v R V_r E_f C_s}{E_v (C_s - C_o)}$	$C_s = \frac{N + E_v V_o C_o}{E_v (V_o + R V_r E_f)}$
A	VAV	Constant	$V_o = \frac{N - E_v F_r R V_r E_f C_s}{E_v (C_s - C_o)}$	$C_s = \frac{N + E_v V_o C_o}{E_v (V_o + F_r R V_r E_f)}$
A	VAV	Proportional*	$V_o = \frac{N - E_v F_r R V_r E_f C_s}{E_v F_r (C_s - C_o)}$	$C_s = \frac{N + E_v F_r V_o C_o}{F_r E_v (V_o + R V_r E_f)}$
B	Constant	Constant	$V_o = \frac{N - E_v R V_r E_f C_s}{E_v [C_s - (1 - E_f) C_o]}$	$C_s = \frac{N + E_v V_o (1 - E_f) C_o}{E_v (V_o + R V_r E_f)}$
B	VAV	100%	$V_o = \frac{N}{e F_r [C_s - (1 - E_f) C_o]}$	$C_s = \frac{N + e F_r V_o (1 - E_f) C_o}{e F_r V_o}$
B	VAV	Constant	$V_o = \frac{N - E_v F_r R V_r E_f C_s}{E_v [C_s - (1 - E_f) C_o]}$	$C_s = \frac{N + E_v V_o (1 - E_f) C_o}{E_v (V_o + F_r R V_r E_f)}$
B	VAV	Proportional	$V_o = \frac{N - E_v F_r R V_r E_f C_s}{E_v F_r [C_s - (1 - E_f)(C_o)]}$	$C_s = \frac{N + E_v F_r V_o (1 - E_f) C_o}{E_v F_r (V_o + R V_r E_f)}$

Table 3 – Selecting the appropriate mass balance equation.

Project Information

Project Name	ABC School	Number of People	25	Plasma Air Model	101 D
Classroom No.	123	Emmission Rate/Person (L/min)	0.00037	Ionization Setting	3
Area (Sq. Ft.)	1000	Ionization Efficiency (E_I)	0.680	Space Contaminant	Ammonia
Ceiling Ht (Ft)	9.25				
Volume (Ft^3)	9,250				

Calculation of Space Contaminant Using Ventilation Rate OA

Outside Airflow Rate per Person 14.8 CFM

Classroom Airflows	CFM	L/min
Supply Air	1080	30586
Outside Air	370	10478
Return Air	710	20107

For constant supply air and constant outside air, use:

$$Cs = \frac{N + Ev\ Vo\ Co(1 - Ef)}{Ev\ (Vo + R\ Vr\ Ef)}$$

Where:

Factor	Description	Value	Units
N	Contaminant Generation Rate	0.00925	L/min
Ev	System Ventilation Efficiency	0.8	
Vo	Outdoor Air Flow Rate	10478	L/min
Ef	Filter Efficiency	0.000	
Co	Contaminant Concentration, OA	0	ppm
R	Recirculation Flow Factor =Vr/(Vo+Vr)	0.66	
Vr	Return Air Flow Rate	20107	L/min
Cs	Contaminant Concentration, space	1.103	ppm

Calculation of Space Contaminant Using IAQ Procedure OA

Specified Outside Airflow Rate per Person 7.4 CFM

Classroom Airflows	CFM	L/min
Total Supply Air	1080	30586
Outside Air	185	5239
Return Air Flow Rate	895	25346

For constant supply air and constant outside air, use:

$$Cs = \frac{N + Ev\ Vo\ Co(1 - Ef)}{Ev\ (Vo + R\ Vr\ Ef)}$$

Where:

Factor	Description	Value	Units
N	Contaminant Generation Rate	0.00925	L/min
Ev	System Ventilation Efficiency	0.9	
Vo	Outdoor Air Flow Rate	5239	L/min
Ef	Filter Efficiency	0.680	
Co	Contaminant Concentration, OA	0	ppm
R	Recirculation Flow Factor =Vr/(Vo+Vr)	0.83	
Vr	Return Air Flow Rate	25346	L/min
Cs	Contaminant Concentration, space	0.526	ppm

Figure 2 – Software calculation comparing VRP and IAQ procedures.

3.0 Testing

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Lab   Parameter        Volume    Amount      LOQ        Concentration  Analysis

-001 1 (ROOM 237)  Samp Date: 10/02/08     Silica Gel Tube Trtd with Sulfuric
Acid
 -      NH3 Front                < 2.5 ug    2.5 ug
10/08/08
 -      NH3 Rear                 ND          2.5 ug
10/08/08
 -      NH3 Total       19.4 L   < 2.5 ug    2.5 ug        < 0.185 ppm
10/08/08

-002 1 (ROOM 227)  Samp Date: 10/02/08     Silica Gel Tube Trtd with Sulfuric
Acid
 -      NH3 Front                < 2.5 ug    2.5 ug
10/08/08
 -      NH3 Rear                 ND          2.5 ug
10/08/08
 -      NH3 Total       19.8 L   < 2.5 ug    2.5 ug        < 0.181 ppm
10/08/08

-003 3 (ROOM 218)  Samp Date: 10/02/08     Silica Gel Tube Trtd with Sulfuric
Acid
 -      NH3 Front                < 2.5 ug    2.5 ug
10/08/08
 -      NH3 Rear                 ND          2.5 ug
10/08/08
 -      NH3 Total       18.5 L   < 2.5 ug    2.5 ug        < 0.194 ppm
10/08/08

-004 4 BLANK  Samp Date: 10/02/08     Silica Gel Tube Trtd with Sulfuric Acid
 -      NH3 Front                < 2.5 ug    2.5 ug
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4.0 Types of Air cleaning technology

Bi-Polar Ionisation

Carbon Filters

Catalyst filters

Re-generative adsorbent filters