

PASSIVE/HYBRID VENTILATION STRATEGIES

INTRODUCTION

The 2nd edition of the IES - US Sustainable Impact Quantification (I.Q.) focuses on Passive/Hybrid Ventilation.

For projects to achieve higher levels of energy efficiency and to a greater extent substantial reduction in carbon footprint, implementing strategies that take advantage of what the local microclimate has to offer are crucial. Equipment efficiencies can only go so far, and project teams should be looking to the climate first. For moderate climates hybrid ventilation provides the potential to substantially reduce, if not eliminate, cooling loads and associated equipment, which translates to first cost and operational savings. This is a very intriguing topic, and the information included is only cracking the window open...

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SCENARIO:

It is a week until the second green workshop and the architectural team is beginning the process of synthesizing the analysis that was outlined during the first workshop, and that has been developed in the last two weeks. The main agenda item is reviewing the analysis of two passive/hybrid strategies (hybrid ventilation and night-time flushing) that have substantial influence on the building facade design, the overall energy performance and the carbon footprint for the building. The analysis pieces that have been brought together include:

- ▶ Hourly Data from weather station launched on site to compare to the analysis data for the nearest weather station.
- ▶ Filtered climate data highlighting the occupied hours for each month that meet the temperature, wind speed and relative humidity requirements to graphically convey which months are the best targets for different strategies. Wind roses incorporating this data have also been developed.
- ▶ The architectural team has done an initial building loads calculation on the (3) BIM models developed using the <VE> to compare the impact of the different facade designs.

- ▶ The engineer has taken the <VE> models developed from the architect's BIM model and done a series of natural ventilation analysis runs using the <VE> MicroFlo module to show when a system could be in full natural ventilation mode or when hybrid mode would be beneficial.
- ▶ The engineer has been asked to take the architect's output from the building loads calculation and shape the overall energy impact picture.
- ▶ Life-cycle cost picture for the hybrid ventilation strategies compared to traditional systems.

The majority of windows within the linear form are located on the north and south sides, which support the climate audit demonstrating that the predominant wind direction in the summer months is from the northwest. The wind data shows that this direction does not change substantially in the evening, so the night time flushing could work without mechanical assistance. The exposed concrete ceiling and the other thermal mass surfaces are providing enough surface area to absorb the heat gain during the day, while being exposed in the evening to the cooler breezes moving through the space.

Looking at the information, the energy efficiency percentage improvement may not seem as high as it should be for LEED EA1 - Optimize Energy Performance, based on the way the baseline has to currently be established.

However, when the kbtu/yr energy consumption and the operational energy costs are compared to the Architecture 2030 benchmark² and the aesthetic impact is shown, the feeling is the owner will be quite impressed when they realize that the project team is well on the way to a greater than 50% carbon reduction. The difficulty will be how to convey clearly the complexity of the analysis and current findings in a way that brings the project team to a common ground for the discussion. Is (2) hours enough...

WHAT ARE PASSIVE/HYBRID STRATEGIES?

- 1) Strategies that leverage the climate and site that a building is located in.
- 2) Strategies that integrate technology and what the climate has to offer to provide solutions for projects that provide multiple benefits in addition to energy efficiency.

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WHAT IS HYBRID VENTILATION?

(aka mixed mode ventilation)

What follows is an adaptation of the Principles of Hybrid Ventilation³ definition. Hybrid ventilation systems provide a comfortable interior environment using both natural ventilation and mechanical systems, but in an integrated fashion. In hybrid ventilation, mechanical and natural forces are combined in a two-mode system where the operating mode varies according to the characteristics of the individual days and season, and the system takes maximum advantage of ambient conditions at any point in time.

ONE OR THE OTHER?

Principles of Hybrid Ventilation³ presents a very interesting discussion on how there seem to be two camps, passive and mechanical, which limits consideration of hybrid ventilation as a strategy. Unfortunately, the design of energy-efficient ventilation systems in office and educational buildings has often become a question of

using either natural or mechanical ventilation. Natural and mechanical ventilation have developed separately over many years and the potential for further improvements [for both singularly] is limited.

INTEGRATIVE DESIGN PROCESS:

For hybrid ventilation to be successful it requires input, analysis and perspective from multiple stakeholders in the process, because it touches on the major areas of facade design, interface and design of HVAC systems, indoor air quality, acoustics, and controls. Meetings should be scheduled at different phases in the process to discuss progress, review analysis, shape financial impact (first cost and beyond) and unpack other issues which require more than one discussion to be fully addressed.

PROVIDING SOLUTIONS - THE <VE> NOW:

The IQ Tip identifies the <VE> modules that are incorporated in analyzing different degrees of hybrid ventilation. The key module for analysis at the building level is MacroFlo, and it has the capability to quantify:

- > Mixed-mode solutions
- > Single-sided & Cross-ventilation
- > Natural ventilation as a whole-building strategy
- > Temperature-controlled window opening
- > Night ventilation of thermal mass
- > Infiltration

The key module for at the detailed space level is MicroFlo (simplified CFD). Computational Fluid Dynamics (CFD) is concerned with the numerical simulation of fluid flow and heat transfer processes. The objective is to provide the designer with an understanding of the likely air flow and heat transfer processes occurring within and around building spaces given specified boundary conditions which may include the effects of climate, internal energy sources and HVAC systems. The results are not only graphically interesting, but there is a lot of useful information inside!

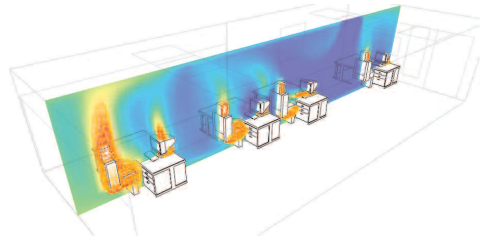
IQ TIP: STEPS TO NATURAL VENTILATION

- 1) Import BIM model or develop in <VE>
- 2) Within MacroFlo - set opening parameters & assign to the room/s
- 3) Link the MacroFlo and boundary data
- 4) Run MacroFlo
- 5) Analyze results parameters and different time ranges using Vista module to identify scenarios to investigate further
- 6) Identify a specific date and time
- 7) Export boundary conditions to MicroFlo module

DETAILED ANALYSIS USING CFD

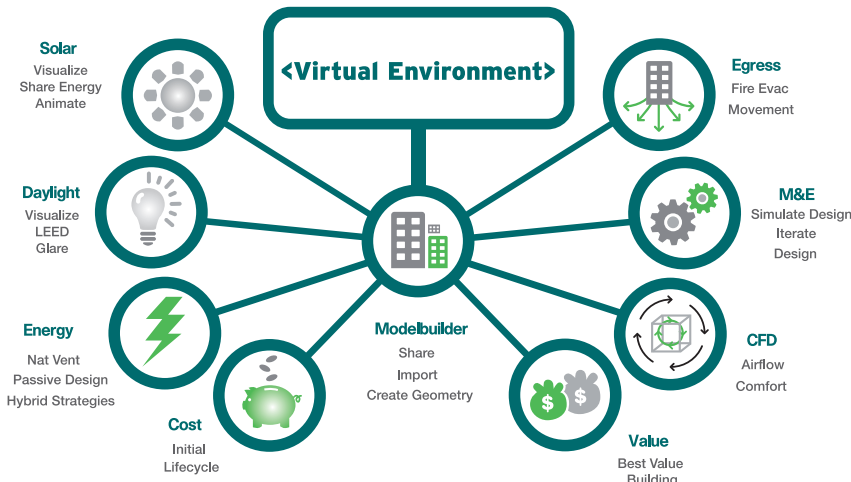
- 1) Import boundary data and specify opening locations
- 2) Select room to analyze and run
- 3) Go to MicroFlo viewer to view results and create avi files for velocity, temperature and particle tracking

➤ IQ3 LOOKS AT INTEGRATING BIM + PERFORMANCE ANALYSIS.



Reference Sources:

- 1) Center for the Built Environment - <http://www.cbe.berkeley.edu/mixedmode/index.html>
- 2) Architecture 2030 benchmark - www.architecture2030.org/2030_challenge/targets.html
- 3) Principles of Hybrid Ventilation - Edited by Per Heiselberg - IEA Energy Conservation in Buildings and Community Systems Programme Annex 35: Hybrid Ventilation in New and Retrofitted Office Buildings
- 4) CIBSE Applications Manual AM10: 1997 - Natural ventilation in non-domestic buildings
- 5) CBE Natural Ventilation Database (<http://www.cbe.berkeley.edu/mixedmode/index.html>): The Center for the Built Environment (CBE) website provides an excellent source of information on natural/hybrid ventilation systems, and provides detailed information on 53 projects in the U.S. and substantially more in other parts of the world.



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