Modelling the e-stack A-500 atrium system in IES

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Introduction

This document is to allow IES users to model the e-stack ventilation system.

The main advantage of the e-stack system over other natural ventilation systems is that in the winter, we do not bring in air via opening windows, as this requires a large amount of preheating energy. Instead we operate in 'mixing mode' where we bring in air at high level and mix it with warm room air to create a tempered air stream which is comfortable for occupants.

To accurately model conventional natural ventilation systems, preheating at the low level openings would have to be incorporated. However as IES and building regulations do not take account of thermal comfort in relation to draughts; therefore any energy input to mitigate cold draughts does not need to be included. So the e-stack system will look the same as any other natural ventilation system in terms of heating energy consumption, because the need for preheating is disregarded by IES which just takes into account the bulk air temperature.

Downloads

The easiest way to model the e-stack ventilation strategy accurately is to download the relevant files from our website. One file is required to model the e-stack atrium system;

1. The profiles database from the .cab file which can be downloaded here:
   http://breathingbuildings.com/products/modelling-e-stacks -in-ies
   All profiles are for full occupation 9am-4pm, this should be amended if necessary.

Summary of the Strategy

External Temperature	Internal Temperature	Strategy
< 16 degC	-	Winter Mixing Mode Minimum ventilation on CO_2
> 16 degC	<24 degC	Upwards Displacement Mode No Fans
> 16 degC	>24 degC	Upwards Displacement Mode Fan Assistance
>25degC	-	Nightcooling operates that night

Geometry

For the atrium system, each room surrounding the atrium is provided with a pair of e-stack A-500 units. In order to accurately model the aerodynamic free area of each e-stack unit a door should be created between the space and the atrium which measures 500mm(H) and 600mm(W). The door should be assigned with 50% free area in MacroFlo. In order for the atrium system to work, the system also requires opening windows within the space and also openings (windows or louvres) atop the atrium itself.

Air Exchanges

The e-stack system is not a heat exchanger, and therefore cannot be modelled as a mechanical system with heat recovery. The system saves energy in the winter by tempering the cool external air within the atrium and bringing air into each space, by using low powered fans. The casual gains produced inside the atrium and surrounding spaces by the occupants lighting and equipment, keep the surrounding spaces warm on all but the coldest days (<5-10degC). The low powered fans can also be used to boost ventilation flow rates when the space is experiencing particularly high temperatures during the day and can provide secure ventilation for nightcool.

The following auxiliary ventilation rates are required to effectively simulate the operation of the e-stack unit and should be assigned to each surrounding room;

1. **Winter** – In winter the system aims to control CO_2 to meet a daily average of 1500ppm. This means providing 10l/s/p of atrium air. This should be assigned as an Auxiliary Ventilation and should use the variation profile *"e-stack Winter Mode (Y)".* The adjacent condition should be assigned at the atrium. Any specific fan power assigned to this Auxiliary Ventilation should be set at 0.15 W/l/s for the A-500 unit.
2. **Boost** – Boost mode is initiated in summer when internal temperature is greater than 24°C. The boost mode should be assigned as an Auxiliary Ventilation at 200l/s to represent both A-500 units in the space and should use the variation profile *"e-stackA-500 Fan boost (Y)".* The adjacent condition should be external air. Any specific fan power assigned to this Auxiliary ventilation should be set to 0.45 W/l/s for the A-500 pair.
3. **Nightcool** – In nightcool mode, one A-500 fan runs to bring fresh atrium air into each surrounding room. This should be assigned as an Auxiliary Ventilation rate of 320l/s and should use the variation profile *"Atrium to Room nightcool (Y)".* Any specific fan power assigned to this Auxiliary Ventilation should be set at 0.15 W/l/s for the A-500 unit.

The following auxiliary ventilation rates should be assigned to the atrium;

1. **Winter & Nightcool** – In winter, the atrium should receive 320l/s from each surrounding room. This is also applicable for nightcool and therefore the profile of *"Winter e-stack A-500 Room to Atrium (Y)"* should be assigned to a number of auxiliary ventilation rates of 320l/s – one per surrounding room. The adjacent condition should be assigned at as the relevant surrounding room. Any specific fan power assigned to this Auxiliary Ventilation should be set at 0.15 W/l/s for the A-500 unit.
2. **Boost**- Boost mode is applicable in summer when the internal room temperature is greater than 24°C in any surrounding room. Each A-500 unit is capable of 100l/s in boost mode and therefore a pair of units can be represented by an auxiliary ventilation rate of 200l/s. An Auxiliary Ventilation should be assigned for each surrounding space referencing the internal

temperature of that space using profiles such as *"A-500 Pair Fan Boost from (Room Ref)".* The adjacent condition should be assigned at as the relevant surrounding room. Any specific fan power assigned to this Auxiliary ventilation should be set to 0.45 W/l/s for the A-500 pair.

MacroFlo

This mode relies on natural buoyancy and wind to drive air through the space and the fans are not required. In this mode, the unit consumes minimal power. It is important that all the windows and other openings are positioned correctly in the space as this will affect the natural ventilation flow.

Two profiles should be created separately for the low level openings in each surrounding space, and the same profile for the A-500 doors and a separate profile for the high level openings in the atrium. The low level openings and A-500 doors should only open for daytime operation when external temperature is greater than 16°C, and therefore should be assigned the Degree of Opening Profile *"Low Level Openings"*. The atrium high level openings will open for both daytime and nightcool operation and therefore should be assigned the Degree of Opening Profile *"Atrium HL Openings (Y)"*.