POWERING DOWN
REMOTE COMMUNITIES FIND EFFICIENCY

SPECIAL FEATURE
Taking the heat

Skills WORKSHOP
HVAC&R Optimisation – Ventilation and air flow Pt. 2
STRATEGY SUMMARY
The aim of the night purge strategy is to reduce the use of mechanical cooling in buildings by automatically flushing the building with cool outdoor air (O/A) using natural ventilation at night time or for mechanical ventilation preferably just prior to start-up.

By ensuring that the air in the building is displaced by cooler outside air just before the HVAC system starts up, energy consumption is minimised. In mechanically ventilated buildings, as fan energy is consumed, night purge must only be enabled when the air handling unit (AHU) average zone temperature is more than 1.5°C above the cooling space temperature set point and only shortly prior to morning start-up. This is to ensure that the fan energy used will exceed the savings in cooling energy. This is not an issue where natural ventilation is used for night purge.

Night purge is effective in climates that have lower overnight temperatures and where the O/A is not humid; typically when the dew point is less than 12°C.

Night purge requires an effective automated control strategy with appropriate control parameters, which enable the effective flushing of a building with O/A that is typically at least 3–5°C cooler than the indoor air.

If not controlled properly, night purge can negate its purpose and consume more energy than that required for mechanical cooling to remove the heated air accumulated in a building at night.

PRINCIPLE AND EQUIPMENT
Night purge is an energy-saving strategy employed through DDC or BMS controls to use O/A to remove residual heat from the building. Heated air, accumulated during hot summer nights and through any residual equipment operating overnight while HVAC systems are shut down, is replaced with cooler O/A during the early morning hours shortly before start-up.

In the case of mechanically ventilated systems, the operating hours for night purge must be carefully selected to ensure the energy consumption of the fans used to provide night purge does not exceed the cooling energy saved.

MINIMUM REQUIRED INFORMATION
The minimum required information for a night purge program includes:
- space temperatures
- space temperature set points
- occupancy time 365-day schedule
- O/A temperature and humidity sensor (dew point or enthalpy sensing)
- night purge enabling time
- night purge enabling criteria.

MINIMUM REQUIRED EQUIPMENT
The minimum required equipment for a night purge program includes:
- field temperature and humidity sensors
- controllers
- night purge software
- automated operation of outdoor, return and relief air provision.

DID YOU KNOW?
Night purge can provide energy savings from a reduction in both operating hours and load of HVAC plant.

Optionally, for natural-ventilation-based night purge systems, temperatures of the building materials can also be monitored if they are part of a control loop.

RECOMMENDATION
When considering a night purge program, several factors should be checked. These include local weather data, potential energy consumption of the ventilation fans, the thermal characteristics of the building and any optimum start features already enabled.

CURRENT PRACTICE
Many HVAC systems are controlled by a BMS with the existing night purge function either disabled or running longer than it should due to an inefficient control strategy or control parameters. There is also often conflict between night purge and the subsequent operation of central heating systems or re-heating, which leads to energy wastage. Inadequate maintenance practices such as infrequent calibration of sensors and ad hoc changes made to control set points in response to complaints, can exacerbate the problem.

OPPORTUNITY FOR OPTIMISATION
Using mechanical ventilation to attempt to cool the building core is generally not an energy-efficient practice; however, replacing the hot
For naturally ventilated buildings: activation parameters include:

- Options for the control strategy and control core temperature may be cost-effective. For natural ventilation night purge applications, of the year.
- Reduce HVAC startup energy use at certain times (within a given enabling time).
- Not managed well, it can fill the building with moisture-laden air that requires more energy from the economy cycle function). Night purge immediately reduces the energy consumption of the HVAC system by reducing the start-up load of HVAC plant. As such, this strategy can save up to 20 per cent of energy consumed by AC compressors during start-up time. Additional benefits include a morning flush of clean O/A to freshen the building and improve IAQ.

Where a well-optimised economy cycle is in operation, with O/A used as the first stage of cooling, the benefits of night purge are potentially small, except in naturally ventilated buildings. The benefit of night purge varies based on climate. If not managed well, it can fill the building with moisture-laden air that requires more energy to condition when the system starts. The major risks associated with night purge include:
- air brought in is too hot or too humid to provide cooling
- energy used in ventilation fans exceeds energy saved by reduced morning cooling load
- security or weather impacts for natural ventilation systems.

DID YOU KNOW?
If central heating is not disabled for a set period after night purge has occurred, it is possible that the benefits of night purge will be negated by the heating system.

indoor air of the building with cool O/A can reduce HVAC startup energy use at certain times of the year.

For natural ventilation night purge applications, which use no fan power to provide the cool O/A, longer operation times and reduction of building core temperature may be cost-effective.

Options for the control strategy and control parameters include:

- For naturally ventilated buildings: activation of night purge (within a given enabling time) when the ambient temperature is at least 2°C below the cooling temperature set point of the conditioned space and the conditioned space is at least 1.5°C above the cooling temperature set point.
- For mechanically ventilated buildings: activation of night purge (within a given enabling time) when the ambient temperature is at least 5°C below the cooling temperature set point of the conditioned space and the conditioned space is at least 1.5°C above the cooling temperature set point. It is also important for the ambient humidity to be low, typically below 12°C dew point or the ambient enthalpy is 18 kJ/kg below indoor enthalpy levels.

Figure 1 shows an activated night purge function, recommended control strategies and control parameters. Hot air accumulated in the building during warm summer nights when the HVAC system is off (and space temperature is over 25°C) can be purged by cooler early morning air (around 20°C or lower).

USING NATURAL VENTILATION FOR THE NIGHT PURGE PROGRAM

In the case of natural ventilation, the control parameters can be more flexible, including longer operating hours and smaller temperature difference between the outdoor and the indoor air temperature, as in this case, the energy consumption of night purge (fans) is zero.

When night purge is achieved without fans, full overnight operation could be considered, as it may help to reduce the building core temperature. Natural ventilation systems also need to consider weather and security issues. The installation of rain and wind sensors is recommended to override the system during inclement weather.

Figure 1: Activated night purge.

USING MECHANICAL VENTILATION FOR THE NIGHT PURGE PROGRAM

The control strategy and parameters for the night purge program should be carefully selected, taking into account the thermal mass of the building fabric, the AC ventilation arrangements and zoning. Night purge should also be integrated with any OSS programming (refer to Optimisation Opportunity 1).
These risks are mitigated by ensuring that the control parameters are regularly monitored and validated.

**APPLICATION NOTES**

Night purge typically applies to centralised HVAC systems with AHUs that have motorised O/A dampers connected to a central BMS or local HVAC DDC system. AHUs facilitate this energy conservation strategy as they are a source of mechanical ventilation for buildings.

Mechanical ventilation should only operate in the one-hour period immediately before normal plant operation. The intention is to flush the air, not reduce building core temperature; this usually occurs after three to five air changes have been completed. Care is required to not overcool the space.

Night purge after a long break or shut down should be considered differently, with longer cool-down periods allowed, ideally at low fan speeds, to enable the gradual cooling down of a building’s thermal mass.

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**GETTING STARTED**

The control strategy and parameters for the night purge program should be carefully selected, taking into account natural or mechanical ventilation opportunities. Facility managers/building owners will need to consider the following for implementation:

- whether there are opportunities for natural ventilation (consider security and weather issues)
- space temperatures and set points of the facility
- occupancy schedule of the facility
- O/A temperature and humidity sensor (dew point or enthalpy sensing)
- running time should be limited to no more than 30–60 minutes.
- only selected AHUs should operate in the night purge mode and at lower speed.
- any heating functions should be disabled during night purge.
- night purge is only enabled when the O/A dew point is below 12°C or the outdoor enthalpy is below 50 kJ/kg.

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**MORE INFORMATION**

This month’s Skills Workshop was adapted from the NSW Office of Environment and Heritage’s HVAC Optimisation Guide.

For more information, visit [www.environment.nsw.gov.au](http://www.environment.nsw.gov.au)

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Next month: HVAC Optimisation continued