Established in 1974

Hybrid Thermal Mixing Ventilation Systems

High-performance, low carbon ventilation

Hessle High School- Courtesy of DLA Architects
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Monodraught has been at the forefront of designing and manufacturing low energy, low carbon, and sustainable solutions for over 40 years. Our company is focused around three product sets in which we are recognised as market leaders: natural and hybrid lighting, natural cooling and natural and hybrid ventilation.

Our products can be found anywhere from a residential build looking to increase its natural light through to a high impact architectural building such as the Copperbox Arena (formerly the Olympics Handball stadium). A key sector for Monodraught is in Education where our products can deliver real dividends in terms of lower energy and carbon footprint and improved environments for students and teachers.

We design, manufacture, install and maintain natural ventilation, natural lighting and natural cooling systems to create low energy, low carbon and sustainable buildings for healthier and more productive occupants.
From R&D to Maintenance

Monodraught is proud of our history of developing products from R&D right through to installation and maintenance, all here in the UK and where possible using suppliers local to our head office base.

Our experience in installation means we can support your project wherever the location. With our own health & safety accredited installation personnel we are able to provide a complete package including commissioning and maintenance. We also have the experience to offer support and advice on installations to be carried out.

Manufacture

The large R&D team are continually challenging the boundaries developing new products to ensure customers continue to receive the market leading products for which Monodraught are renowned. These products are all manufactured within our High Wycombe factory and as R&D is in the same location as production then the highest levels of quality can be ensured.

Building Simulation

To help architects and consultants deliver low maintenance, energy efficient designs within the built environment, Monodraught and building performance analysis specialist IES have developed Performance Components – a revolutionary way of modelling natural ventilation systems using the Virtual Environment Suite.

Our Project Design Engineers are able to work with you to create the right design for your building.

Installation

We have a team of contract managers who will work with you and your clients from order creation through to delivery and beyond to maintenance if required. Our own team of installers work across England with partner agencies installing in Scotland, Ireland and worldwide. We will visit your site ahead of installation to ensure that all the details are covered and ensure that everything goes smoothly.

Maintenance

We can provide on-going service and maintenance of our installed products and this helps provide performance data for our customers and structured feedback that can assist product development, resulting in a system running at optimum performance and costs that are kept to a minimum.
Recognised as Industry Leaders

Monodraught are widely recognised as market leaders in sustainable low energy and low carbon solutions in natural ventilation, natural lighting and natural cooling. We are proud of our accreditations from prestigious independent organisations such as CIBSE and Ashden amongst others.
Corporate Citizenship

Monodraught are committed to working in an ethical and responsible manner. Our products and services are low-carbon and low-energy solutions, which help people be in a healthier natural built environment, and as such, we are also keen to extend these strong ethical credentials into ways to contribute to our local and wider community.

Monodraught: A place that benefits people

Our staff are one of our biggest assets and in 2015 we became a Living Wage Accredited Employer. This means that every member of our staff in our organisation earns not just the minimum wage but the Living Wage. We are always looking at ways to improve our impact on employee wellbeing and how we can help in our local community.

Community Relationships are vital and we are pleased to build on our relationship with Bucks Mind and support them in targeted strategic activities. We continue to source our materials within a 100 mile radius of High Wycombe, with 60% of our suppliers within a 50 mile radius, thereby investing in the local economy and supporting employment opportunities.

More skills, more opportunities

Our main focus in this area is in attracting, developing and retaining people through investment in skills. The Investors in People accreditation is a good example of this. Our Research and Development team also have close links with UK Universities, in particular Brunel University and Coventry University and we look forward to working with more placement students this summer.

Positive Environment

Our product set can help our customers create a more positive environment through reduced energy usage and carbon footprint. Across all our product sets we continue to look at ways to innovate and improve the built environment.
Hybrid Thermal Mixing Ventilation

**HTM Systems**

Hybrid Thermal Mixing (HTM) systems are designed to provide natural ventilation and hybrid ventilation incorporating mixed tempered air for winter periods. In addition, the systems have the ability to provide secure night time cooling, and boosted levels of ventilation during summer. The HTM systems are designed to work in conjunction with natural ventilation and can be used in single sided or cross flow ventilation strategies.

The HTM system is comprised of an intelligent and fully automatic control system coupled with a low energy ventilation system which switches between operational modes dependant on season, external/internal temperature conditions and indoor air quality (IAQ).

The Monodraught® HTM systems have exceptionally low specific fan powers and feature an intelligent control system, which is supplied as standard, with full data logging facility, temperature control and CO2 control. With the optional BACnet module, each unit has the ability to output key performance data to a central BMS.

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Following the release of the Facilities Output Specification for the Priority Schools Building Programme, Monodraught have utilised their extensive knowledge, product testing, and building simulation skills to develop low energy ventilation systems which meet the Facilities Output Specification requirements in a cost efficient manner.
Understanding PSBP

What is the Priority School Building Programme?

The Priority School Building Programme (PSBP) is a centrally managed programme set up to address the needs of the schools most in need of urgent repair.

Through the programme, 261 schools will be rebuilt or have their condition needs met by the Education Funding Agency (EFA). All schools within the programme will be delivered by the end of 2017.

In May 2014, the Government announced a further phase of school development, known as PSBP2, which is a five year programme operating between 2015 to 2021 and will undertake major rebuilding and refurbishment projects in schools and sixth form colleges in the very worst condition.

What is the Facility Output Specification?

This document forms the basis for the design of the PSBP Schools. It has become the definitive guide to school design.

In addition, to meet the required ventilation levels, whenever spaces are occupied, purpose provided ventilation should provide external air supply to all teaching and learning spaces of:

- A minimum of 3 l/s per person (90 l/s)
- A minimum daily average of 5 l/s per person at any occupied time
- Provide capacity to achieve 8 l/s per person for night time purge during summer
- Meet the acoustic requirements for BB93 - 35 dB(A) (mechanical ventilation noise plus an extra 5 dB(A) allowance for noise breakthrough from outside).

Further information on page 23
Why Choose Hybrid Thermal Mixing?

Ideal Environment
- The HTM is able to provide the ideal environment to school classrooms/areas.
- The HTM system is designed to provide mixed tempered air during winter, boosted levels of ventilation during summer and secure night time cooling.
- The HTM system works in conjunction with natural ventilation provided by manual or automatic windows/louvres.
- The HTM system can be used in single sided or cross flow ventilation strategies.

Exceptionally Low Power Consumption
- The HTM system has an exceptionally low specific fan power.
- The HTM system comprises an intelligent and fully automatic control system coupled with a low energy ventilation system which switches between operational modes dependant on season, external/internal temperature conditions and indoor air quality (IAQ).
- The HTM control system is supplied as standard with full data logging facility, temperature and CO₂ controls. With an optional BACnet module, each unit has the ability to output key performance data to a central BMS.

CFD analysis and site verification have demonstrated compliance with PSBP criteria with one HTM system per classroom.
Two versions of Monodraught’s HTM system are available, the HTM F and the HTM FS. The “F” type has been designed to have one unit per classroom, and the “FS” type two units per classroom. The HTM F system is able to produce 350 l/s of daytime ventilation and 530 l/s for night purge ventilation when required, while the HTM FS system is able to produce a daytime hybrid ventilation rate of 180 l/s (SFP 0.14) per unit and night time ventilation rate of 250 l/s (SFP 0.22) per unit.

A powder coated steel frame makes the system robust and easy to install. This frame supports a body constructed from specialist acoustic panels which when combined with a low energy fan means that the systems maximum daytime operation sound level is well below 35dB.

The low leakage external damper is integrated within the system and has a U-Value of 1.2Wm²K and when combined with the internal damper allows the system to supply tempered fresh air throughout the year.

A combination of an intelligent controls system and sensors measuring the room, external and mixed air temperatures & CO₂ levels allows the system to automatically control the internal environment. This control system can also be utilised for the operation of additional VENTSAIR façade systems and has a full data logging facility.

### Options

- Below ceiling, above ceiling or flush mounted installation
- Primary/ Secondary mode to synchronise multiple units in a single zone
- Inhibit input to enable/disable HTM from BMS or Fire Alarm circuit
- Up to 6kW LTHW heating coil module
- 1kW Electric heating element (5A rated current)
- BACnet, MODBUS or BMS connection
- The external weather louvre and transition can be provided by Monodraught, please contact us for more details.
- More colours available on request
Acoustics

Full acoustic testing has been conducted at SRL (Sound Research Laboratories).

Sound reduction Index Measurements:

Weighted Sound Reduction Index Rw (C:Ctr) = 31 dB

Tests were conducted with a standard 50 mm external louvre arrangement.

<table>
<thead>
<tr>
<th></th>
<th>HTM F</th>
<th>HTM FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation Rate</td>
<td>300 l/s</td>
<td>150 l/s</td>
</tr>
<tr>
<td>63 Hz</td>
<td>53.4</td>
<td>46</td>
</tr>
<tr>
<td>125 Hz</td>
<td>52.6</td>
<td>50.8</td>
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<td>250 Hz</td>
<td>50.4</td>
<td>44.4</td>
</tr>
<tr>
<td>500 Hz</td>
<td>43.5</td>
<td>39.7</td>
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<tr>
<td>1000 Hz</td>
<td>36.7</td>
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<td>2000 Hz</td>
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<tr>
<td>4000 Hz</td>
<td>24.7</td>
<td>17.9</td>
</tr>
<tr>
<td>8000 Hz</td>
<td>24.7</td>
<td>22.9</td>
</tr>
</tbody>
</table>

HTM F - Key Features

- Low energy fan
- Ducted or non-ducted
- Non vision high flow white linear angled grille

HTM FS - Key Features

- Low energy fan
- Spiral wound ducting into classroom with 4-way diffuser

Typical Installation - Operation Detail

- **Cross Flow:**

  ![Image of Cross Flow System](image-url)

  **Monodraught HTM** system mounted at the rear of a room to assist with cross flow ventilation using openable windows on the facade. System automatically provides secure night time cooling through natural ventilation opening or fan assisted if required. Winter ventilation automatically modulates dampers to mix re-circulated air with external air to ensure optimum ventilation temperatures.

- **Single Sided Flow:**

  ![Image of Single Sided Flow System](image-url)

  **Monodraught HTM** system mounted on the façade (can be ducted to provide ventilation to the rear of deep plan rooms) to assist with single sided ventilation using openable windows. System automatically provides secure night time cooling through natural ventilation opening or fan assisted if required. Winter ventilation automatically modulates dampers to mix re-circulated air with external air to ensure optimum ventilation temperatures.
**Operational Modes**

HTM can run in various operational modes dependant on the conditions of the environment in which it is installed, this is usually determined by the two sensors which monitor the room’s temperature and CO₂ levels from the wall mounted controller.

**Natural Ventilation Mode**

The system’s primary function is to provide Natural Ventilation in conjunction with openable windows. If CO₂ rises above 900 ppm or the temperature rises above 18°C*, the system will operate in natural ventilation mode by opening both the external and recirculation damper in staggered increments allowing fresh air into the space.

**Boost Mode**

During daytime periods in the spring, summer and autumn seasons, if the internal room temperature exceeds 22°C* or the CO₂ level goes above 1100 ppm, the system will provide a boosted level of ventilation until which time optimum conditions are met.

**Mixed Mode**

During winter periods, if the CO₂ rises above 900 ppm but the external temperature drops below 15°C, the system will operate under a mixed mode strategy. This is achieved utilising the fan to mix and recirculate mixed fresh external air with warm room air to create a fresh and tempered indoor environment.

**Night Time Cooling Mode**

During summer periods between 23:30 and 06:30 and when the internal temperature is above 18°C, the system will provide night time cooling providing a peak ventilation rate of 500 l/s until such time that internal temperature goes below 18°C.

* Figures based on summer time operation
Control Strategy

The HTM incorporates a fully automatic control system based on a seasonal control strategy. The seasonal strategy is determined by time and date but is weather compensated to pick up unseasonal conditions. The system provides natural ventilation as the default method of ventilation indicating when manual windows or automatically opening dampers should be utilised to maximise IAQ and maintain comfort levels.

The control system incorporates a number of temperature sensors integral to the unit to monitor external temperature, mixed air temperature and supply air temperature. In addition, a wall mounted controller fitted with an internal temperature, CO₂ sensor and user override are included as standard.

Data is stored per minute on an integral data card for data analysis and compliance requirements.

During daytime periods in the spring, summer and autumn seasons, if the internal room temperature exceeds 26 °C or the CO₂ level goes above 1500 ppm, the system will provide a boosted level of ventilation until which time optimum conditions are met. If the external temperature is below 15 °C, the system will operate under a hybrid ventilation strategy as per winter mode.

During summer periods, when the internal temperature is above 18 °C, the system will provide night time cooling providing a peak ventilation rate of 500 l/s.

During winter periods the system will operate under a hybrid ventilation strategy utilising the fan to mix and re-circulate warm room air to minimise cold draughts.

All settings are customisable during commissioning phase.

Power Consumption

- Rated Voltage: 230 V AC
- Rated Frequency: 50 Hz
- Rated Current 3A (5amp Heater Unit)

EU Regulation No 1253/2014 and No 1254/2014

These regulations came into force on the 1st January 2016 and set out minimum heat recovery efficiencies for mechanical ventilation products. Due to the ultra low energy consumption of the HTM, these systems are exempt from these standards as they are below the 30W minimum power requirement threshold.
Controls and user interface

Monodraught offer three wall controller options, each dependent on the room design and layout and the user's requirements. One wall controller is required to be mounted within each room and will give the user certain functionality over the systems. Each controller houses temperature and CO₂ sensors, with the exception of the Smart Screen Controller which requires a modular unit.

**Openable Window:** Allows the user to control the fan speed but will also indicate when they need to open windows to aid the system in providing ventilation.

**Louvre Override:** Allows the user to not only control the fan speed of the units but also regulate the amount that the VENTSAIR Façade system opens by if fitted.

**Smart Screen Controller:** A high quality interface that provides a graphical insight into the operation of Monodraught ventilation systems via a 4.3” capacitive touch LCD display. The controller indicates the Room Temperature, Air Quality and Fan Speed and whether manual windows require opening. A user is also able to explore how the systems work, adjust settings and find out information on the system in order to maintain a comfortable environment with minimal energy use.

Control Strategy

The following control strategy comes as a standard default but can be customized.

<table>
<thead>
<tr>
<th>Occupied Hours (Day time)</th>
<th>Natural Ventilation provided if internal temperature rises above 18 °C* or CO₂ rises above 900 ppm.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mixed Mode Ventilation provided if CO₂ rises above 900 ppm but external temperature drops below 15 °C.</td>
</tr>
<tr>
<td></td>
<td>Boost Mode Ventilation provided if internal temperature rises above 22 °C* or CO₂ levels reaches 1100 ppm.</td>
</tr>
<tr>
<td>Un-Occupied Hours (Night time)</td>
<td>Night Time Cooling mode and pre-cooling of the space between 23:30 - 06:30 if internal temperature is &gt; 18 °C (Summer Mode Only, including weekends).</td>
</tr>
</tbody>
</table>

* Figures based on summer time operation
Smart Screen Option

Self-Test Mode
The Louvre Override and Smart Screen wall controllers also have the ability to perform a self-test operation. The wall controllers are able to run a diagnostics test on the HTM to search for any faults with the system. If any faults are found, they will be indicated to the user. This test can be initiated by either a Monodraught engineer or a facility manager.

Through the capacitive touchscreen interface a user can explore how the systems work, adjust settings and find out information on the system in order to maintain a comfortable environment with minimal energy use.

Openable Window Option

Left hand side provides control and indication of the current operation mode of the HTM ventilation system.

1. **Boost mode**: Will provide a boosted level of ventilation
2. **Auto mode**: Allows the HTM system to operate within its 3 automatic modes
3. **Off mode**: Closes the high level exhaust damper and stops the fan from operating
4. **LED**: Illuminates to notify users when it is necessary to open windows

Override settings last 1 hour before defaulting to Auto mode

Louver Override Option

Left hand side provides control and indication for the opening level of the Ventsair wall louvres.

5. **Louver LED’s**
   - No LED = Closed
   - 1 LED = 10% open
   - 2 LED = 25% open
   - 3 LED = 60% open
   - 4 LED = 100% open

6. **Louver Plus** - Opens the Ventsair louvre by 1 setting
7. **Louver Minus** - Closes the Ventsair louvre by 1 setting
8. **Temperature and air quality sensor**
Monodraught's HTM is designed to work with and control a range of VENTSAIR Façade Ventilation System (VAF). These systems typically comprise of an external aluminium louvre, a high specification volume control damper and an internal grille. The system can be specified to suit glazed frames or fitted with a flange to suit wall openings.

VAF is a high specification louvre system used extensively in education facilities, health facilities as well as retail schemes to provide controlled fresh air during the day and secure night time cooling via cross flow and stack ventilation principles.

The HTM can be specified to control a VAF to act solely as an exhaust. By sizing the exhaust at roughly the same size as the systems intake arrangement an air path of less resistance is created with the space allowing possible increases in the systems performance. These benefits are most noticeable when the system runs in Natural Ventilation or night time cooling modes.

Additional VAFs can also be used in conjunction with the HTM to provide additional façade ventilation. Depending on their location within a room they can assist in Stack, Cross Flow and Single Sided Flow ventilation. The HTM will automatically control these additional vents and the dampers can also be opened and closed manually via the systems control panel. These additional ventilation openings are often used in lieu of manual windows adding the benefit of secure night time cooling.

### Ventsair Modes

#### Manual Mode

The dampers can be opened and closed manually using the plus and minus buttons on the wall controller. The level of opening is shown on the LED indicators.

- 1st setting = 10%
- 2nd setting = 25%
- 3rd setting = 60%
- 4th setting = 100%

#### Automatic Mode

During the Summer seasonal control period the HTM system will automatically open the Ventsair dampers if the internal room temperature exceeds 21°C.

For every further 1°C temperature rise the systems will open by 20% until they are fully open at 25°C.

#### Night Cooling Mode

An important aspect of the ventilation design is the automatic provision of summer night time cooling.

During the summer seasonal control period the HTM system will automatically open the Ventsair dampers from midnight to 7am. This cools the fabric of the building and purges the room for the following day minimising heat build up.
**HTM® F**

**Wiring Diagram**

- **Wall Controller**
  Supplied with RJ45 cable for connection to wall controller

- **Power Supply**
  Supplied with 1.5 m main cable for connection to 3A fused spur

- **Secondary System (optional)**
  RJ45 cable supplied by Monodraught (fitted by others)

**Auxiliary Connections**

- **Exhaust Arrangement**
  Link cable provided by others

- **Additional Vents (optional)**
  Link cable provided by others

**Additional Connections**

- BACNET BMS Connection
- Fault Output Signal
- System Inhibit - Allows user to remotely turn the systems On/Off for circumstances such as holiday periods or fire alarms

**Material**

- Powder coated mild steel frame
- Specialist acoustic panels

**System Requirements**

- Connection to clean outside air source
- 240V 3A (5A for electrical heating system) fused switched spur mounted with 1 m of Primary unit
- Class A external weather louvre is required for external connection of system (Louvre panel to be supplied fitted with anti-bird Mesh)

**Sensors**

- External temperature sensor
- Recirculation temp sensor
- Mixed air supply temperature sensor
- Room temperature sensor housed within wall controller
- Room CO₂ sensor housed within wall controller
- Data logging functionality inbuilt as standard

**Dimensional Diagram**

- [ HTM® F Dimensional Diagram ](image)
HTM® FS

Material
- Powder coated mild steel frame
- Specialist acoustic panels
- 2 N° 3 m spiral ductwork with acoustic lining per unit

System Requirements
- Connection to clean outside air source
- 240V 3A fused switched spur mounted with 1 m of primary unit
- White 4 way diffuser and eggcrate recirculation grille are provided as standard
- Class A external weather louvre is required for connection to units
- Louvre panel to be supplied fitted with anti-bird mesh

Sensors
- External temperature sensor
- Recirculation temp sensor
- Mixed air supply temperature sensor
- Room temperature sensor housed within wall controller
- Room CO₂ sensor housed within wall controller
- Data logging functionality inbuilt as standard

Overall Dimensions

Dimensional Diagram

Wiring Diagram

Power Supply
Supplied with 1.5 m 3 core mains cable to be wired to a switched fused spur (3A) by others

HTM Openable Window Wall Controller
Supplied with RJ45 cable for connection to wall controller

Primary System

Secondary Fan Power Connection
3 Core mains cable (0.75 - 2.5 mm²), by others

Secondary Signal Connection
8-Core LSZH cable, 0.35 mm², by others

Secondary System
Low Temperature Hot Water Heating Module

General Description

The HTM LTHW Heating Coil is an innovative development to the HTM system. The low temperature hot water (LTHW) coil is encased with the HTMs casing and is installed directly over the supply opening of the system providing the primary heat source within the space removing the requirement for additional radiators. The system is designed to preheat the room before the occupied periods keeping noise to a minimum. The space is actively heated by recirculating room air through the HTM system which is then blown across the LTHW coil. The system is also able to directly heat fresh air and therefore actively ventilate the indoor space keeping CO₂ levels to within a range of specific set points without chilling the occupants.

The system is supplied with an intelligently controlled actuated bypass valve to ensure the space is not over heated and the user is allowed control over the temperature, between 19°C and 23°C, within the space via the Smart Screen Controller. The system is easily connected into the buildings heating system via the two male connections (3/4” BSPT) and is programmed with active learning.

Controls

HTM LTHW heating systems must be used in conjunction with Monodraught Smart Screen display interface that indicates the Room Temperature, Air Quality and Fan Speed and allows a user to adjust settings such as fan speed and Temperature Offset.
### Dimensions

#### HTM F

- **Overall System Length**: 1000 mm
- **Airflow (l/s)**: 200
- **Standard System Length**: 500 mm

#### HTM FS

- **Overall System Length**: 1000 mm
- **Airflow (l/s)**: 200
- **Standard System Length**: 500 mm

### Specification

#### HTMF LTHW

<table>
<thead>
<tr>
<th>Fan Speed</th>
<th>Airflow (l/s)</th>
<th>Output (kW)</th>
<th>Air Off Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>188</td>
<td>6.2</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>222</td>
<td>6.4</td>
<td>43</td>
</tr>
<tr>
<td>5</td>
<td>266</td>
<td>6.6</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>291</td>
<td>6.7</td>
<td>38</td>
</tr>
<tr>
<td>7</td>
<td>341</td>
<td>6.8</td>
<td>35</td>
</tr>
<tr>
<td>8</td>
<td>430</td>
<td>6.9</td>
<td>32</td>
</tr>
</tbody>
</table>

- Based upon 16°C air supply to system and 50°C water supply to coil.
- 0.69m³/h water flow recommended (1.03 m³/h Max.), Coil ΔP 34.7kPa, 2No. 3/4” pipe connection

#### HTMFS LTHW

<table>
<thead>
<tr>
<th>Fan Speed</th>
<th>Airflow (l/s)</th>
<th>Output (kW)</th>
<th>Air Off Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>133</td>
<td>5.9</td>
<td>51</td>
</tr>
<tr>
<td>4</td>
<td>160</td>
<td>6.2</td>
<td>47</td>
</tr>
<tr>
<td>5</td>
<td>184</td>
<td>6.6</td>
<td>44</td>
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<td>6</td>
<td>210</td>
<td>6.9</td>
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<td>7</td>
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<td>7.1</td>
<td>39</td>
</tr>
<tr>
<td>8</td>
<td>263</td>
<td>7.7</td>
<td>39</td>
</tr>
</tbody>
</table>

- Based upon 13°C air supply to system and 50°C water supply to coil.
- 0.38m³/h water flow recommended (0.57 m³/h Max.), Coil ΔP 10.5kPa, 2No. 3/4” pipe connection
HTM Case Study

Thomas Hickman School

- System installed on 02/09/2014 and data logged until 02/03/2015
- Classroom is approximately 5 m x 9 m (area = 45 m²)
- Ceiling height 3.2 m (volume = 144 m³)
- East facing glazing approximately 7 m x 2 m which cannot be opened due to external noise
- Occupancy of 30 children and 2 adults

On a winter day:

<table>
<thead>
<tr>
<th>Data</th>
<th>Max</th>
<th>Min</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room Temperature</td>
<td>23 ºC</td>
<td>21 ºC</td>
<td>22 ºC</td>
</tr>
<tr>
<td>External Temperature</td>
<td>7 ºC</td>
<td>0 ºC</td>
<td>5 ºC</td>
</tr>
<tr>
<td>Mixed Air Temperature</td>
<td>25 ºC</td>
<td>15 ºC</td>
<td>19 ºC</td>
</tr>
<tr>
<td>CO₂</td>
<td>1780 ppm</td>
<td>435 ppm</td>
<td>1300 ppm</td>
</tr>
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</table>

Results between 8:30 - 15:30

On a spring day:

<table>
<thead>
<tr>
<th>Data</th>
<th>Max</th>
<th>Min</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room Temperature</td>
<td>24 ºC</td>
<td>21 ºC</td>
<td>23 ºC</td>
</tr>
<tr>
<td>External Temperature</td>
<td>17 ºC</td>
<td>6 ºC</td>
<td>13 ºC</td>
</tr>
<tr>
<td>Mixed Air Temperature</td>
<td>24 ºC</td>
<td>13 ºC</td>
<td>20 ºC</td>
</tr>
<tr>
<td>CO₂</td>
<td>1580 ppm</td>
<td>505 ppm</td>
<td>1145 ppm</td>
</tr>
</tbody>
</table>

Results between 8:30 - 15:30
HTM Building Simulation

Within the IES-VE software, Monodraught has developed a performance model of the HTM, utilising the data that has been collected from component tests and on site monitoring, to produce an accurate representation for modelling.

A typical school has been prepared, considering all aspects of occupancy, solar gain, and sensible and latent heat gains, based around the design requirements stated within the Facilities Output Specification.

Monodraught’s standard approach is to consider the total heat gains in the area and provide a natural ventilation strategy to dissipate this heat gain. Furthermore, the aim is to provide sufficient fresh air to the occupants of the area so that indoor air quality and thermal comfort are maintained.

The suitable CIBSE DSY weather file for the project location is utilised to provide the expected local environmental conditions to the building being modelled.

1. Building Construction Inputs

<table>
<thead>
<tr>
<th>Item</th>
<th>Construction Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction U Values &amp; Thermal Mass (Cm)</td>
<td></td>
</tr>
<tr>
<td>Walls</td>
<td>0.26 W/m².K, 180 kJ/(m².K)</td>
</tr>
<tr>
<td>Floor</td>
<td>0.22 W/m².K, 100 kJ/(m².K)</td>
</tr>
<tr>
<td>Roof</td>
<td>0.18 W/m².K, 180 kJ/(m².K)</td>
</tr>
<tr>
<td>Glazing</td>
<td>0.16 W/m².K</td>
</tr>
<tr>
<td>Glazing g-Value</td>
<td>0.4</td>
</tr>
<tr>
<td>Infiltration Rate</td>
<td>0.25 Air Changes per Hour</td>
</tr>
<tr>
<td>Floor Area</td>
<td>55 m²</td>
</tr>
<tr>
<td>Internal Room Height</td>
<td>3.1 m</td>
</tr>
<tr>
<td>Glazing Area</td>
<td>9.3 m²</td>
</tr>
<tr>
<td>Effective Low Level Opening</td>
<td>0.93 m²</td>
</tr>
<tr>
<td>Heating Set Point</td>
<td>18.0 °C</td>
</tr>
<tr>
<td>Occupancy (people)</td>
<td>34 No.</td>
</tr>
<tr>
<td>Occupancy Heat Gain</td>
<td>75 W(sensible), 55 W(latent)</td>
</tr>
<tr>
<td>Occupied Hours</td>
<td>08:30 - 12:30, 13:30 - 16:00</td>
</tr>
<tr>
<td>Lighting</td>
<td>10.0 W/m²</td>
</tr>
<tr>
<td>Equipment</td>
<td>15.0 W/m²</td>
</tr>
</tbody>
</table>

2. Natural Ventilation Performance

With a combination of the ModelIT Building Modeller and MacroFlo Air Movement modules of IES-VE, Monodraught can demonstrate the natural ventilation performance of the system within the modelled room, during the non-heating season.

Monodraught’s HTM fully automatic control strategy is replicated within the MacroFlo module of IES, to provide a continuously regulated flow of natural ventilation through the system, dependent on the conditions of the internal classroom. During occupied periods of the non-heating season, the HTM system will also work in conjunction with additional openings to the external façade of the room, to provide a greater level of ventilation.

3. Hybrid Ventilation Performance

The HTM system is designed to operate in a Hybrid mode, utilising the internal low energy fan, during peak summer day time periods and summer night time periods.

Working within the ApacheHVAC System Simulation Interface module of IES-VE and utilising test data of Monodraught’s low energy fan, Monodraught have developed an accurate modulating profile for the fan assisted natural ventilation strategy, to provide a boost of external fresh air through the HTM system and into the Classroom.

4. Analysis of Winter Performance

For the HTM operation during the heating season, Monodraught are able to utilise the ApachePro module to demonstrate tempering of the incoming fresh air. The detailed design of Monodraught’s system, allowing for the mixing of external air and re-circulated room air, ensures that even with an external air temperature of 0°C, Monodraught’s HTM system is able to provide a supply air temperature into the room at approximately 13°C.

By locating the HTM system at high level within the room, the supply air benefits from further air mixing. Mixed supply air is directed towards the ceiling through angled louvres, entraining additional room air within the air flow and allowing further mixing to take place.

Monodraught’s HTM system was installed within a climatic test chamber and a special heat sensitive membrane was fitted running through the centre of the system. An insulated chamber fitted below the HTM system was heated to 23°C to represent an internal room condition.

During December 2013 an HTM system was installed within a climatic test chamber with a special heat sensitive membrane fitted running through the centre of the system. An insulated chamber fitted below the HTM system was heated to 23°C to represent an internal room condition.

Thermal imaging video cameras were used to record the temperature profile of the mixing of air in real time. The thermal imaging cameras were set to record three zones with averaged temperature readings within each zone: external air temperature, internal room air temperature and mixed supply air temperature. The system was then set to provide 200 l/s of mixed ventilation air to represent maximum daytime ventilation rates.

Climate Testing

- Zone 1 is recording the external air temperature with an average temperature within the measured zone of 11.7°C
- Zone 2 is recording an internal room temperature with an average temperature within the measured zone of 22.7°C
- Zone 3 is recording the mixed air supply temperature with an average temperature within the measured zone of 16.4°C

During December 2013 an HTM system was installed within a climatic test chamber and a special heat sensitive membrane was fitted running through the centre of the system. An insulated chamber fitted below the HTM system was heated to 23°C to represent an internal room condition.

Thermal imaging video cameras were used to record the temperature profile of the mixing of air in real time. The thermal imaging cameras were set to record three zones with averaged temperature readings within each zone: external air temperature, internal room air temperature and mixed supply air temperature. The system was then set to provide 200 l/s of mixed ventilation air to represent maximum daytime ventilation rates.
2.6 Environment and Fabric

2.6.1. The Contractor shall ensure that external envelope and structure should be used to achieve the internal environment required based on a passive approach. The principles being for a passive approach to assist the achievement of the internal environment by:

2.6.1.5. Optimising the benefits of daylight and natural, or hybrid ventilation. Hybrid ventilation strategies are stated as an approved method of ventilation within FOS.

2.8 Indoor Environmental Requirements

2.8.1. The Contractor shall ensure that the design provides suitable, comfortable environmental conditions for all occupied spaces, including good lighting with optimum use of daylight, good air quality and acoustics, unobstructed ventilation and suitable temperatures throughout the year. Monodraught ensure that products meet the requirements of the specification throughout the whole year with summer overheating requirements proving to be the most difficult aspect of the FOS.

2.8.16 Thermal Comfort

2.8.16.1. The Contractor shall demonstrate by thermal modelling how all parts of the buildings will comply with the minimum and maximum temperature requirements as shown in the ADS. Monodraught provide full dynamic thermal modelling using IES, as standard, free of charge, for every project for PSBP. When approaching a school design up to three classrooms are modelled which represent the worst case scenarios for the classroom designs.

2.8.16.2. The Contractor shall ensure that there are sufficient temperature control mechanisms provided to enable the staff and Pupils to adjust their environment and maintain a satisfactory level of thermal comfort. HTM systems have the ability to provide boosted levels of ventilation when natural ventilation is unable to meet thermal and/or air quality requirements.

2.8.16.3. In naturally ventilated spaces, the Contractor shall provide mixing of ventilation air with room air to avoid cold draughts in the occupied zone during winter-time. In winter-time the minimum air temperature of air delivered to the occupied zone at 1.4 m above floor level shall be not more than 5°C below the normal maintained air temperature. Monodraught systems utilise air diffusion and thermal mixing to ensure temperature compliance. A number of sensors provide full control regulation.

2.8.17 Maximum Summer-time Temperatures

2.8.17.1. The Contractor shall design the building so as to limit the maximum internal temperature. The Contractor shall assess its design for overheating using the most relevant weather files from CIBSE’s Summer Design Reference Years. Monodraught provide this service, free of charge.

2.8.17.2. The Contractor shall ensure that mechanical ventilation is not the sole method of summer-time ventilation in occupied spaces and that occupied space should wherever possible also have opening windows or vents. HTM systems are designed in conjunction with natural ventilation openings and can provide full automatic control of additional natural ventilation openings to ensure optimum operation.

2.8.17.3. The Contractor shall design the building to allow the air movement to be increased during the summer through opening windows or vents, switching on fans, or increasing the rate of mechanical ventilation systems. HTM systems automatically vary the fan speed and fresh air rate based on temperature and air quality. At any time the users of the room can override the automatic controls. After a set period the controls will default (1 hour) back to an automatic mode.

2.8.17.5. The Contractor shall calculate the indoor temperature for each of the months where the building is in free-running mode. The simulation tool used should be capable of calculating Operative Temperature, Top and Running Mean Temperature, Trm. Calculations should realistically account for the occupancy pattern of the building and the adaptive behaviour of the building occupants. Conducted as part of Monodraught’s building simulation services using full dynamic analysis.

2.8.17.10. Criteria 1 - Hours of Exceedance (He): For schools, the number of hours (He) that ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 40 hours.

2.8.17.11. Criteria 2 – Daily Weighted Exceedance (We): To allow for the severity of overheating the weighted Exceedance (We) shall be less than or equal to 6 in any one day.

2.8.17.12. Criteria 3 - Upper Limit Temperature (Tupp): To set an absolute maximum value for the indoor operative temperature the value of ΔT shall not exceed 4K.

The building will be deemed to fail the overheating design criteria if any two of the three criteria are exceeded.

This analysis forms the sizing requirements for Monodraught systems. At the same time advice is given based on occupancy levels, usage patterns or thermal mass requirements to ensure that the building passes.
Meeting the Facilities Output Specification

2.8.17.17 Overheating - Performance in Use

2.8.17.17.1. The Contractor shall demonstrate within spaces that are occupied for more than 30 minutes at a time that, during the Required Period, the average internal air temperature does not exceed the average external air temperature by more than 5°C, both temperatures being averaged over the time period when the external air temperature is 20°C, or higher. The HTM system provides high level of night time ventilation to ensure night cooling conditions are met. This design method ensures that greater levels of reliability against real world weather patterns.

2.8.21 Ventilation

2.8.21.2.1. Where natural ventilation is used, the system is capable of providing enough fresh air so that the average concentration of carbon dioxide during the Required Period is less than 1500 ppm and so that the maximum concentration does not exceed 2000 ppm for more than 20 minutes each day. The EFA have confirmed that the control strategy for HTM products maximise the level of natural ventilation provision and only provide boosted levels of ventilation when the room conditions are not met by natural means. On this basis the EFA have agreed to consider the HTM products as natural ventilation systems.

2.8.21.6. The Contractor shall ensure that when outside air is introduced into a teaching space ventilation air and room air will be mixed to avoid cold draughts during winter-time. The HTM systems ensure that ventilation air is mixed during winter-time.

2.8.21.12. The Contractor shall ensure that the School is designed so that the air speed flowing across occupants in winter is <0.3 m/s in all teaching spaces. Monodraught provide CFD analysis to ensure these criteria are met. By correct placement of ventilation diffusers, air is directed against the ceiling and projected to the depth of the classroom minimising duct work requirements and ensuring even distribution of air within the room.

2.8.21.14. The Contractor shall ensure that the rejection of energy laden warm or cool air is minimised in the building through the use of ventilation systems which limit the pre-heating of ventilation air and exploit the heat gains from occupancy and equipment. HTM systems mix re-circulated room air with fresh ventilation air, automatically regulating the level of opening between volume control dampers. Control algorithms ensure optimum internal air quality and minimise heating requirements.

2.8.21.15. The Contractor shall ensure that HVAC systems are easily accessible for maintenance, so that measures can be taken to ensure children are not exposed to the bacteria found in moist conditions in ductwork. HTM products have been designed to minimise the level of ductwork required. Large format grilles and diffusers are used with angled deflection to ensure mixing of ventilation air.
HTM® Supply Only

NOTE: The HTM units can weigh up to 70 kg and therefore should always be lifted by a suitable number of people. The unit will be delivered within a protective cardboard box, complete with nylon straps. The box is designed to be lifted with these handles positioned toward the bottom on the box. It is recommended that the unit and its components are positioned close to their final install point to avoid damage.

1. Ensure external louvres and external connection spigot are positioned and installed correctly to Monodraught specifications. Using the correct detail, mark the location for the support fixings and fasten the correct support fixings for the ceiling construction. Note: the external spigot will protrude by 30 mm into the rear of the system.

2. **HTM F units:** Two Internal Front Fixings must be installed along with 1 or 2 Internal Rear Fixings to ensure the system is suitably balance and supported. **HTM FS units:** Standard Fixing method is via the 4No. 90° External Fixings, if these are used all four must be utilised. Note: It is also possible to install the HTM FS units using the Additional Front & Rear Fixings, as per the HTM F unit. Should these fixing point be required this must be stipulated at point of order.

3. Cut the required number of M8 drop rods to length for supporting the unit.

4. Position the system as close to the final position as possible and tear the box away from the unit and remove the front grille if installed.

5. Ensure all of the required fixing points are clear of debris.

6. **Only if using Internal Rear Fixings:** Insert drop rod lengths, into the pre-tapped rear fixing points of the system as required. Wind the length into the system until approximately 20 mm of thread is left protruding. Run 2No. nuts down this length until they are flush with the system.

7. Using a suitable mechanical lift raise the system into position so that the system is clear of the spigot. Once level with the spigot move the system so that the spigot protrudes into the system by 30 mm making sure that the gap is consistent on all edge and that no weight is being exerted onto the spigot. The support fixings should now align with the fixing points.

8. **Only if using Internal Rear Fixings:** Wind the rear drop rod out of the system and fully into the support fixings until tight. Use the two nuts to lock the drop rod in place.

9. Insert a drop rod through each fixing point being used and attach a washer and followed by two M8 nuts. Wind the drop rods fully into the support fixings until tight and lock with the top nut.

10. Feed a washer and nut onto the bottom of each of the drop rods and wind up until flush with the system. These nuts are then to be wound further to level out the system. Once the system is level, tighten the remaining nut and washer on top of the system to lock it in place.
Ducting Install HTM FS Only

1. Connect the Duct Spigot Plate to the HTM FS Supply Spigot.
2. Ensure correct duct length have been supplied and trim to length as necessary.
3. Using the detail mark the location for the support fixings for the Diffuser Box and Ducting and fasten the correct support fixings for the ceiling construction. Ensure the Diffuser will align with the ceiling grid and HTM FS unit.
4. Cut four M8 drop rod lengths to a suitable length that will allow the Diffuser Box to sit flush with the ceiling raft. Wind a nut onto the end of each drop rod length then wind the drop rods fully into the support fixings until tight and lock into place with the nut.
5. Feed another nut onto the bottom end of each drop rod and wind up by approximately 50 mm.
6. Offer the Diffuser Box up to the drop rods and wind a washer and nut onto each drop rod to support and then level the box. Once the box is level, wind down and tighten the top nuts on top of the Diffuser Box to lock the box in place.
7. Attach flexible ducting to the end of each spiral duct length and secure in place with band-clamp.
8. Secure the ducting to the ceiling via a suitable fixing method and adjust the ducting to correct height. Slip the duct ends fully over the HTM spigots and draw each flexi ducting over the Diffuser Box Spigots, securing at both end with a band clamp.
9. Attached 4-way diffuser.

System Connections

For Monodraught’s HTM wiring details please refer to document “Monodraught HTM General Wiring Detail”. To obtain the correct document please contact us at: info@monodraught.com