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CASE STUDY
Carleton University + Delta Controls

Implementing RP-1747 Demand-Controlled Ventilation and Advanced Fault Detection & Diagnostics at Carleton University

Carleton University is a public comprehensive university in Ottawa, Ontario, Canada. Founded in 1942 as Carleton College, a private, non-denominational evening college to serve veterans returning from World War II, the institution was chartered as a university by the provincial government in 1952 through The Carleton University Act. The legislation was subsequently amended in 1957 to give the institution its current name. The university moved to its current campus in 1959, expanding rapidly throughout the 1960s amid broader efforts by the provincial government to increase support to post-secondary institutions and enhance access to higher education.

Background

The proposed updates to ASHRAE Guideline 36 signifies a leap forward in HVAC system performance optimization and advanced control sequence integrations to significantly improve building energy efficiency and indoor air quality (IAQ).

Embracing this pursuit of excellence, Carleton University initiated a groundbreaking project implementing Demand-Controlled Ventilation (DCV) system RP-1747 inside an occupied building situated in a cold climate, aiming to test and validate its effectiveness in real-world conditions.

This case study details the challenges, solutions, and outcomes of integrating this advanced DCV algorithm into the university's Delta Controls system, providing a comprehensive overview of the practical applications and benefits.

The Challenge

Carleton University set out to evaluate the stability and benefits of the RP-1747 DCV approach under real-world conditions and contribute data to support its adoption of ASHRAE Guideline 36. The Carleton team faced several technical and operational challenges in its implementation efforts, such as:

- Energy Efficiency:
  - Reducing cooling and ventilation energy use without compromise maintaining indoor air quality.
  - Achieving significant energy savings by optimizing the HVAC system's performance.
- Indoor Air Quality Standards:
  - Ensuring compliance with ASHRAE 62.1-2022 standards for indoor air quality.
  - Balancing energy efficiency with adequate ventilation needs in varying building zones.
- Scalability and Adaptability
  - Developing a scalable and adaptable DCV system for different building types.
  - Integrating different sensors and control logic to handle occupancy and CO_2 levels dynamically.

- System Integration and Control:
  - Integrating VAV terminal units, CO_2 sensors, and occupancy detectors with the air handling unit (AHU) outdoor air ratio (OAR).
  - Implementing Python-based control and analytics server for dynamic monitoring and adjustments.

Design and Technical Challenges

The Carleton University case study demonstrates the significant potential of RP-1747 Demand-Controlled Ventilation in improving energy efficiency and IAQ. The integration of advanced algorithms and Delta Controls' automation systems provided a scalable and effective solution for modern buildings. The insights gained from this project will inform future implementations and support the widespread adoption of ASHRAE Guideline 36.

- **Initial Setup:** The process of configuring the VAV terminal units started by adjusting the minimum airflow setpoints based on occupancy and CO_2 levels in defined zones of the EDC building. (fig. 1.1) This effort required integrating VAV airflow, eZNT CO_2 sensors, and Delta Controls O3 Sense for binary PIR occupancy sensor data with the air handling unit (AHU) outdoor air ratio (OAR).
- **Probabilistic Setback:** Motion Detection data temperature setpoints were adjusted during unoccupied hours, using a learning algorithm to understand and predict occupancy patterns accurately.
- **Supervisory Control Integration:** A dedicated local server running Python-based control and analytics was implemented to manage the system for continuous monitoring and dynamic adjustments to maintain system performance.
- **Data Analysis:** The Carleton research team monitored steam energy use, cooling coil load, and fan energy use to determine energy savings from these implemented methods.

The Solution

To address these challenges, Carleton University and Delta Controls implemented a series of advanced technological solutions.

- **Advanced DCV Algorithm:** The RP-1747 DCV system utilized Trim and Respond (T&R) logic to dynamically adjust VAV terminal units' minimum airflow setpoints based on real-time CO_2 sensor and occupancy detector data.
- **Fault Detection and Diagnostics (FDD):** Integrated proactive FDD algorithms to identify and correct faults at both zone and system levels, ensuring continuous system optimization and reliability.
- **Energy Management Optimization:** The system was optimized to reduce energy use for cooling and ventilation by improving ventilation efficiency and reducing duct static pressure.

- **Temperature and Occupancy Control:** Implemented probabilistic setback strategies, adjusting temperature setpoints during unoccupied hours based on motion detector data, supported by a learning algorithm to accurately predict occupancy patterns.

Outcomes and Benefits

The implementation of the RP-1747 Demand-Controlled Ventilation (DCV) system at Carleton University's EDC building led to significant energy savings across multiple systems.

- Cooling Coil Load Reduction:
  - Energy Saving: 13%.
  - How: By optimizing ventilation rates based on occupancy and CO_2 levels, the system reduced the need for mechanical cooling.
- Fan Energy Use Reduction :
  - Energy Saving: 74%.
  - How: The system lowered fan speeds by reducing unnecessary air movement in areas with low occupancy, significantly cutting energy use.
- Heating Energy Load Reduction :
  - Energy Saving on Heating Coils: 43%.
  - Unexpected Baseboard Load Increase: -86%.
  - How: The system used probabilistic setbacks during unoccupied periods, reducing the energy needed for heating, though it slightly increased the baseboard heating load due to adjusted temperature controls.
- Overall Energy Savings:
  - Total Energy Saving: 52% .
  - How: The combined reductions in cooling, fan, and heating loads resulted in significant overall energy savings for the building. temperature controls.
- Maintained Indoor Air Quality (IAQ) :
  - Outcome: Increased energy savings and IAQ remained high, meeting or exceeding ASHRAE 62.1-2022 standards.

Conclusion

The Carleton University case study demonstrates the significant potential of RP-1747 Demand-Controlled Ventilation in improving energy efficiency and IAQ. The integration of advanced algorithms and Delta Controls' automation systems provided a scalable and effective solution for modern buildings. The insights gained from this project will inform future implementations and support the widespread adoption of ASHRAE Guideline 36.

References

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