How to purchase Demand Controlled Ventilation with energy optimal functionality?

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1 Introduction

Demand controlled ventilation (DCV) can significantly reduce the need for heating, cooling and electrical energy for air distribution compared to CAV systems (Maripuu, 2009). Well-functioning DCV is probably a prerequisite to achieve the ambitious energy-goal for new and existing commercial buildings (OECD/IEA, 2008)

However, evaluation of real energy use demonstrates that this energy saving potential is seldom met. This unfortunate experience have many causes, but the following key factors are identified: wasted energy use because of unnecessary throttling, inadequate specifications and balancing report, and lack of clearly defined and placed responsibility for the overall functionality (Mysen et al. 2010).

A prerequisite for purchasing DCV with energy optimal functionality is to define what it is and manage to ask for it and perform necessary control of the deliverance.

There are in principle three different DCV-systems: “Pressure Controlled DCV”, “Static Pressure Reset DCV”, and “Variable Air Supply Diffusor DCV” defined and described by Mysen and Schild (2011).

Pressure Controlled DCV (PC-DCV) is the traditional DCV systems. The purpose of static pressure control is to indirectly control the airflows by controlling the pressure in a strategic duct position. PC-DCV requires installation of active VAV-units controlling supply and exhaust air flows to each VAV-room/zone. Controlling fan speed to maintain a constant static fan pressure rise, will result in unnecessary throttling along the critical path during most of the air-handling-units (AHUs) operating time, and therefore unnecessary fan energy use. The duct path with the greatest flow resistance from the AHU to any terminal, is called the ‘critical path’ dimensioning necessary fan pressure rise. The covariation between airflow rate and SFP (Specific Fan Power) is believed to be close to "Normal" in Figure 1.
One unfortunate experience of pressure controlled DCV system is that minor changes in room demand just redistribute airflow in the duct system with the airflow in the AHU being more or less constant, and no energy saving is actually achieved, or the supply air is insufficient.

Static Pressure Reset DCV (SPR-DCV) is used to make pressure controlled systems more energy-efficient by emulating direct flow control functionality.
SPR constantly tries to satisfy all air flow requirements with a minimum of the fan speed drive by ensuring that the VAV damper(s) along the present critical path are in a maximum open position.
SPR-DCV requires additional controls (relative to Pressure controlled DCV) for continuously optimising the VAV-damper-position.
Well-functioning SPR represents the ideal case (Figure 1) in terms of energy use, and air flow rate accuracy.

Variable Supply Air Diffuser DCV (VSAD-DCV) are based on air terminal units with a built-in VAV-unit and an occupancy and temperature sensor, hence there is no need for additional active control dampers in the duct system. Each VSAD covers the area beneath the air-terminal-device. Required air flow rate, actual air flow rates, temperature and corresponding opening percentage of the VAV-unit is communicated to the BMS regulating the fan speed drives in the AHU so that all the terminal devices are satisfactorily close to requirements and there is at least on fully open air terminal device at any time.

2 Materials/Methods

A Norwegian interdisciplinary expert group has developed necessary definitions with corresponding requirements and control procedures to improve DCV-functionality and reduce fan energy use to a minimum based on identified success criteria's by Mysen (Mysen et al. 2010).

3 Results and Discussion

Here are some of the recommended new requirements:

- Specific Fan Power (SFP) is normally required and controlled at maximum air flow. However a DCV system will typically have air flows between 30 and 80% of maximum air flow, depending mainly on diversity factor for dimensioning and base ventilation level. At design level, there are only small differences between the system's SFP (Figure 1, r=1), but at lower airflow rates there are major differences depending on the control strategy. It is important to require maximum SFP-value for two operating scenarios, maximum airflow and defined reduced airflow, to ensure an energy efficient control strategy.

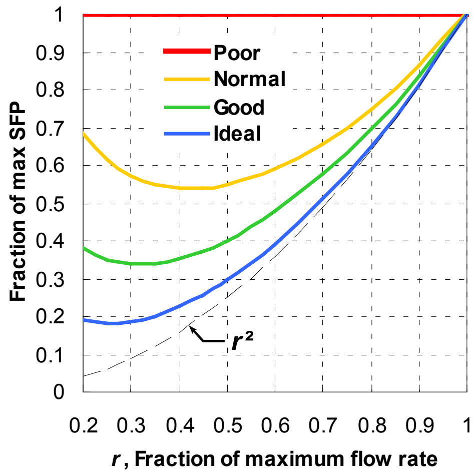

Figure 1: Illustration of covariation between airflow rate and SFP-value for Poor, Normal, Good, and Ideal DCV-systems (Schild and Mysen 2009).

- Fitting a DCV-system, typically involves several contracts including BMS (Building Management System), Ventilation system and Electrical Equipment. However, the overall responsibility for the system functionality must be clearly defined and placed in one contract.
- Adequate specifications, hand-over documentation and balancing report suitable for DCV-systems must be used.
- Critical components, such as sensors, must have proper functionality and acceptable measurement uncertainty throughout their predicted lift expectancy, for instance:
  - CO_2-sensors +/- 50 ppm
  - Temperature sensors +/- 0.5 ^oC
- Some of the critical components like CO_2-sensors should be controlled at site.
- An airflow change in any room should give approximately the same change of the total airflow in the AHU.
- There should be an inspection, function test and review of the DCV- system after a period of normal operation, e.g. 1 year.

4 References

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