

08081

Air - for Health and Comfort

An Analysis of HVAC Systems' Performance in Theory and Practice

Fredrik Engdahl

Report TVBH-1013 Lund 2001
Department of Building Physics



LUND INSTITUTE OF TECHNOLOGY
Lund University

Abstract

One part of the objective of this study is to analyze different mechanical ventilation principles with respect to their ability to maintain designed airflow rates in different outdoor and indoor conditions, and from the perspective of durability. The other part is to propose and analyze methods to improve the ventilation systems' impact on the indoor climate, taking energy use into consideration. To investigate the technical status of ventilation systems, the result from the compulsory testing and examination of ventilation systems (OVK) is used. A multi-zone model based on the mass balanced equation is used to study the airflows in a multi-family building. Two ventilation systems are analyzed combined with the same building; the mechanical exhaust air and the mechanical exhaust and supply air system. A theoretical analysis with, among other things, pressure loss equations, is used to describe the system functions of a branch pressure controlled VAV system. A model is developed and tested to determine the optimal supply air temperature with respect to HVAC energy use. The energy use for a 100% outdoor air VAV system dependent on control strategies of the supply air temperature is analyzed with climate data. An average of 34% of the studied systems performed as intended. Both the mechanical exhaust and the mechanical exhaust and supply air system showed sensitiveness to outdoor temperature, building air tightness and wind influence. By keeping the static pressure constant at the branch duct level it is possible to vary the flow to different zones without measuring the individual flow and without affecting other zones. If the fan pressure set point is optimized, the fan energy use will decrease during partial loads. When using 100% outdoor air in a VAV system the IAQ will be improved during much of the year. There is great potential in controlling the supply air temperature optimally to reduce the HVAC energy use.

Keywords: Ventilation, buildings, infiltration, variable air volume, indoor climate, indoor air quality, thermal climate, energy, HVAC, optimization.

Contents

1. Introduction	1
1.1 <i>Indoor Air Quality and ventilation</i>	1
1.2 <i>Ventilation systems</i>	2
1.3 <i>Energy and ventilation</i>	3
1.4 <i>Other aspects of ventilation systems</i>	4
2. Objectives	5
3. Methods	5
4. Results	5
5. Discussion	10
5.1 <i>Influence of users on ventilation systems</i>	10
5.2 <i>Indoor climate</i>	11
5.3 <i>Energy</i>	12
6. Future work	13
References	14
Paper I Evaluation of Swedish Ventilation Systems	17
Paper II Stability of Mechanical Exhaust Systems	27
Paper III Stability of Mechanical Exhaust and Supply Systems	47
Paper IV Pressure Controlled Variable Air Volume Systems - Theory	61
Paper V Optimal Supply Air Temperature with Respect to Energy Use in a Variable Air Volume System	85