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Servicekoncepter for ventilation

Novozymes Bagsværd
Laboratorier og kontorer

Udarbejdet af Teknologisk Institut

Intro

- Servicekoncept hos Novozymes
  - Ventilation
  - Køling
- Formål
  - Udjævnede vedligeholdelsesomkostninger
  - Overblik over installationer
  - Energibesparelser
  - Præventiv drift
- Resultater
  - Forbedret drift
  - Øje for energibesparelser
  - Bedre driftsøkonomi

Projektets opgave

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- Behovsbaseret service frem for tidsbaseret
- Servicekonceptet
  - Servicerapport
  - Fakta ark
  - Baggrundsmateriale
- BMS koncept
  - Målepunkter
  - Alarmer
- Energiscreening af udvalgte anlæg

Udgangspunkt

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- Konstant drift
- Nye og gamle anlæg
- Varierende stand
- Ca. 1/3 af ventilationsanlæggene er på BMS
- Begrænset dokumentation
- Der er formentlig et betydeligt energieffektiviseringspotentiale

Servicerapport

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- Fungerer som dokumentation
- Basisdata
- Kontrolskemaer
- Måleskemaer
  - Tryktab
  - Effektforbrug
  - Luftmængder
  - Temperaturer
  - Virkningsgrader
  - mm..

		New service		Reference state	
		Inlet	Exhaust	Inlet	Exhaust
Air flow (FS 11: Measurements)					
Design flow ($q_{v, design}$) **[11.2]**	[m³/s]				
Measured flow ($q_{v, meas.}$) **[11.2]**	[m³/s]				
Comments					
Static pressure drop across the following components (FS 11: Measurements)					
Duct – Suction/pressure side (before AHU) **[11.3]**	[Pa]				
Filter **[11.3]**	[Pa]				
Heat recovery unit **[11.3]**	[Pa]				
Humidifier **[11.3]**	[Pa]				
Heating coil **[11.3]**	[Pa]				
Cooling coil **[11.3]**	[Pa]				
Other **[11.3]**	[Pa]				
Comments					
Static and dynamic pressures before and after the fan [1)] (FS 11: Measurements)					
Suction side (static), P_{s1} **[11.3]**	[Pa]				
Pressure side (static), P_{s2} **[11.3]**	[Pa]				
Suction side (dynamic), P_{d1} [2)]	[Pa]				
Pressure side (dynamic), P_{d2} [2)]	[Pa]				
Inlet area [2)]	[m²]				
Outlet area [2)]	[m²]				
Comments					

Fakta ark

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- Forklarer og dokumenterer:
  - Kontrol
  - Registreringer
  - Målinger
  - Præsentation af resultater
  - Brug af instrumenter

FS 11: Measurement equipment

11.1 How to measure (data spreadsheet)

Measurements of, air velocity, pressure, temperature and electrical power input must be carried out with measuring equipment that meets certain requirements for measuring range, accuracy and calibration. The requirements could be the ones of the Danish Energy Agency for measuring equipment in connection with the statutory energy inspection of ventilation and air conditioning systems or the requirements for measuring equipment of the ventilation scheme (in Danish "VENT-ordningen").

The measurements must be carried out without prolonged interruptions, and in one day. Control measurements and consequent corrections of measured values can be carried out later, provided that the operating conditions of the ventilation system are unchanged. In VAV systems the speed of the fan (frequency) should be locked during all measurements, unless it causes that the zone dampers change position so that the pressure conditions change. In this case, lock of the fan speed can be omitted, but the fan speed during measurements should be noted.

11.2 Airflow

The flowrate is usually measured with a calibrated hot-wire anemometer. The flowrate can be measured and calculated by different methods that are further described below.

Figure 1. Hot-wire anemometer (measuring air velocity)

Baggrundsmateriale

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- Beskriver og forklarer:
  - Beregning af virkningsgrader
  - Beregning af energibesparelser
  - Komponentkrav
  - Levetider
  - mm..

Dynamic pressure

The dynamic pressure p_d in the inlet and the outlet of the fan can be calculated by this formula:

$$p_d = \frac{1}{2} \cdot \rho \cdot v^2 = 0{,}6 \cdot v^2 \text{ [Pa]}$$

as air density ρ is app. 1,2 kg/m^3

Specific fan power (SFP)

The calculation of the specific fan power is based on measurements of:

- The power input of the inlet fan motor (P_{inlet}) [W]
- The power input of the exhaust fan motor ($P_{exhaust}$) [W]
- The design airflow rate through the system, which should be the greater of either the supply or exhaust airflow (q_v) [m^3/s]

$$SFP = \frac{P_{inlet} + P_{exhaust}}{q_v}$$

Fan efficiency (η_{total})

The calculation of the total efficiency is based on measurements of:

- The total increase of pressure across the fan (Δp_{total}) [Pa]
- The airflow (q_v) [m^3/s]
- The power input of the motor (P_m) [W]

$$\eta_{total} = \frac{\Delta p_{total} \cdot q_v}{P_m}$$

When calculating Δp_{total} the difference between suction side static pressure P_{s1} and pressure side static pressure P_{s2} can be used, i.e. $\Delta p_{total} = P_{s2} - P_{s1}$.

Temperature efficiency (η_t)

The calculation of the efficiency is based on measurements of:

- The outdoor air temperature (T_1)
- The outdoor air temperature at the exit of the heat recovery / after recycling (T_2). This temperature is measured after the supply air fan (remember to subtract 1ºC to compensate for the warming through the fan). If the heating coil, cooling coil or humidifier is placed between the heat recovery / recycling and the measuring point, this has to be closed and closed for so long that the temperature of the measuring point is stable.
- Temperature of the exhaust air (T_3)

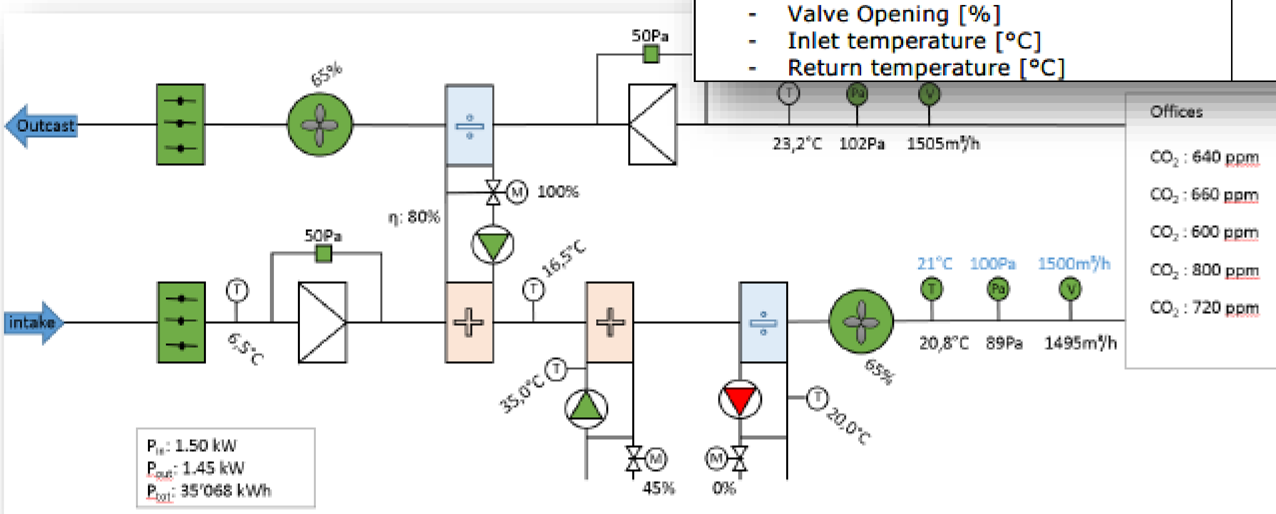
The calculation is done by using this formula:

$$\eta_t = \frac{T_2 - T_1 - 1}{T_3 - T_1}$$

BMS

- Visualisering af de relevante målepunkter

Points	**Reasons**
Airflow in and out [m³/h] or [l/s]	Balance and indoor climate
Fan speed (both) [%]	Errors
Electric consumption on motors [kWh]	To calculate SEL and energy savings
Efficiency of the heat exchanger; $\eta = \frac{t_{sup} - t_{in}}{t_{exh} - t_{in}}$ [%]	For maintenance and malfunctions
Duct pressure [Pa]	For maintenance and malfunctions
CO_2 level in rooms (offices only) [ppm]	Indoor climate optimization, work efficiency
Moisture level (optional - offices only) [%]	Indoor climate optimization
Intake temperature [°C]	To calculate efficiency
Supply air temperature [°C]	Indoor climate optimization
Exhaust air temperature [°C]	Indoor climate optimization
Return air temperature (optional) [°C]	Indicator of indoor temperature
Damper positions [open/closed]	Recirculation, operation mode, errors
Pressure drop across the filter [Pa]	Maintenance
Heating coil/cooling coil - Pump [on/off] - Valve Opening [%] - Inlet temperature [°C] - Return temperature [°C]	Energy savings, operation mode control, maintenance



BMS

- Relevante alarmer

category	In operation [I/O]	Fan [I/O]	P_{duct} [Pa]	V [m³/h]	T_{sup} [°C]	P_{room} [Pa]	$\eta_{exchange}$ [%]	Heat /cool	CO_2 [ppm]	Power cons. [kWh]
Lab1	X	X	X	X	X	X	X			
Lab2	X	X	X	X	X	X	X	X		X
Lab3	X	X	X	X	X	X				
Lab4	X	X	X	X	X	X		X		X
Mixed1	X	X	X	X	X	X	X		X	
Mixed2	X	X	X	X	X	X	X	X	X	X
Mixed3	X	X	X	X	X	X			X	
Mixed4	X	X	X	X	X	X		X	X	X
Office1	X	X			X		X		X	
Office2	X	X			X		X		X	X
Office3	X	X			X				X	
Office4	X	X			X				X	X
Exhaust1	X									
Exhaust2	X	X								

Energiscreening

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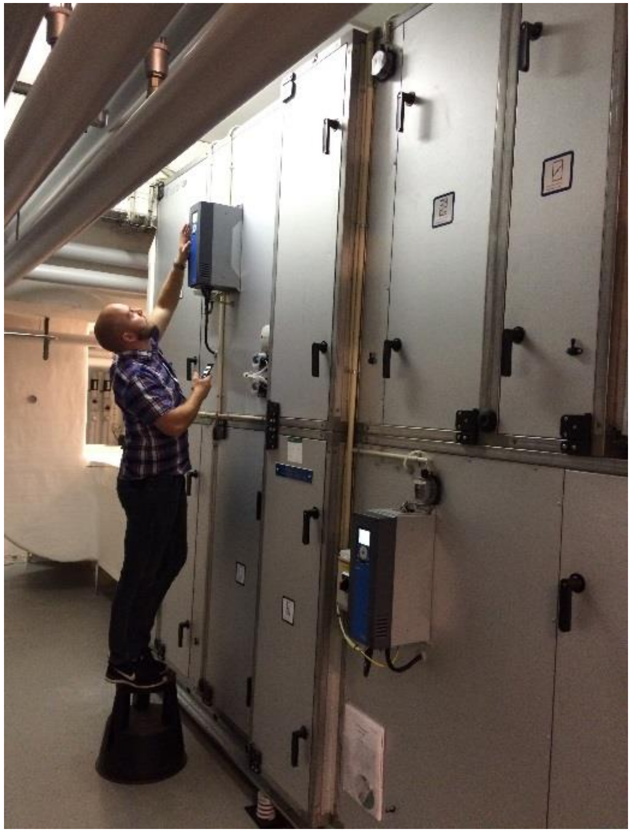
- Undersøgelse af tre anlæg
  - Laboratorie
  - Kontor
  - Kombination
- Identificerede energibesparelser
  - Installation af varmegenvinding
  - Udskiftning af blæser
  - Reduktion af luftmængder
  - Zoneinddeling
- Tilbagebetalingstid 0-16 år



Resultat og perspektiver

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- Medarbejderne er glade for projektet
- Potentielle energibesparelser identificeret
- Forbedret drift
- Identificerede energibesparelser
  - Varme: 767 MWh årligt
  - El: 70 MWh årligt
- Version 2.0:
  - Digitalisering
- Mulighed for udbredelse til firmaets øvrige faciliteter

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Tak for opmærksomheden

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