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it's all about innovation

SFPint

- SFPint - Applicable test methods
  - Regulation
  - SFPint determination for VU where internal pressure measurements can be performed
  - SFPint determination for VU where internal pressure measurements cannot be performed
  - η_{fan} measured with/with out additional ventilation components

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Regulation

Units

Definitions and requirements:

- NRVU
  - **The minimum thermal efficiency *ηt_nrvu* of all HRS in BVUs shall be 67 % (RC 63 %)**
  - **UVU - The minimum fan efficiency for UVUs (*ηvu*) :**
    - 6,2 % * ln(P) + 35,0 %, if P ≤ 30 kW and
    - 56,1 %, hvis P > 30 kW. (P = fan nominal power input incl. reg. equipment at nominal flow and pressure).
  - **BVU - The maximum internal specific fan power of ventilation components (*SFPint_limit*)**
    - **for a BVU with run-around HRS** (acc. q_norm and internal static pressure)
      - 1 700 + E – 300*q_{nom}/2 – F, if q_{nom} < 2 m³/s og
      - 1 400 + E – F, if q_{nom} ≥ 2 m³/s
    - **for a BVU with other HRS**
      - 1 200 + E – 300*q_{nom}/2 – F, if q_{nom} < 2 m³/s og
      - 900 + E – F, if q_{nom} ≥ 2 m³/s
      - 250 for UVU intended for use with a filter.
  - **NOTE: All values acc. nominal flow rate specified by the manufacturer**
    - All ventilation units, except dual use units, must be equipped with a multi-speed drive or a variable speed drive.
    - All BVUs must have a HRS, and the HRS must have a thermal by-pass facility.

SFPint

Considerations about requirements for testing/ calculation methods :

1: The smaller mass-produced units.

- **Documentation is relatively easy** as they are mass-produced and the manufacturer can often measure on one unit that is applicable to all.
- The **internal pressure drop is difficult to measure** because the units are compact and with large disturbances.
- Important that there is **an alternative to measuring the internal pressure loss**

2: The larger customised modular units

- In these units, it is **easier to measure the internal pressure** because the face velocity is often lower. But the units are customized and manufactured in **many different configurations**.
- The manufacturers **rely on measurements of pressure loss of single components**, and assemble them in an overall performance, based on customer requirements in their product selection programme. **Units will not be measured separately** and only occasionally/randomly (if they are members of a certification scheme).
- Important that the method take in to consideration that manufacturers within some uncertainty is able to **calculate the internal pressure drop and efficiency by data from the individual components**.
- Important that there is **a relatively simple method for measuring inside the unit**

3: The very large units

- Here there is a **need for testing in situ for verification purposes.**

SFPint

DTI experience with measuring inside a ventilation unit:

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DTI has previously measured on units in many different ways to find a solution to how to measure correctly inside a unit:

- with a large number of measuring points inside the unit after each component;
- measurement with fans switched off and air pulled/pushed through the system from the outside, where it turned out that the lack of rotation had an strong influence and improved the performance unintendedly in relation to the true values;
- with pitot tube measurements in a grid with a large number of measuring points; and
- with anemometer measurements (to analyse the face velocity grid) in a grid with a large number of measuring points.

All measurements provided unequal results and it could not be determined whether one was more correct than the other. This resulted (for **Eurovent**) in an agreement that pressure was to be measured on **pressure taps placed by the manufacturer**. This is not an ideal method, but a way for laboratories and manufacturers to measure identically at low cost.

Therefore, DTI's focuses on finding:

1. An alternative to the measurements inside unit (using external values)
2. A relatively simple method for measuring inside the unit

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Definitions and different methods proposed:

- **Input:**
  - Helios, Uniclima/Cetiat & Aldes (CEN/EVIA), EuroVent
  - Transitional Methods of 2013 (Biermann/Kemna)

- **Definitions:**
  - $SFP_{int} = \frac{\Delta p_{int\,SUP}}{\eta_{fan\,SUP}} + \frac{\Delta p_{int\,EHA}}{\eta_{fan\,EHA}}$ $SFP_{int} = \frac{\Delta p_{int\,SUP}}{\eta_{fan\,SUP}} + \frac{\Delta p_{int\,EHA}}{\eta_{fan\,EHA}}$

  - **'fan efficiency (ηfan)'** means the static efficiency including motor and drive efficiency of the individual fan(s) in the ventilation unit (reference configuration) determined at nominal air flow and nominal external pressure drop; and
  - **external or internal fan efficiency?**: Internal fan efficiency is correct, but very difficult to measure.

SFPint - a simple method for measuring inside the unit.

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- SFPint determination for VU where internal pressure measurements can be performed - Approach

Simple method for measuring inside

DTI experience with measuring inside a ventilation unit:

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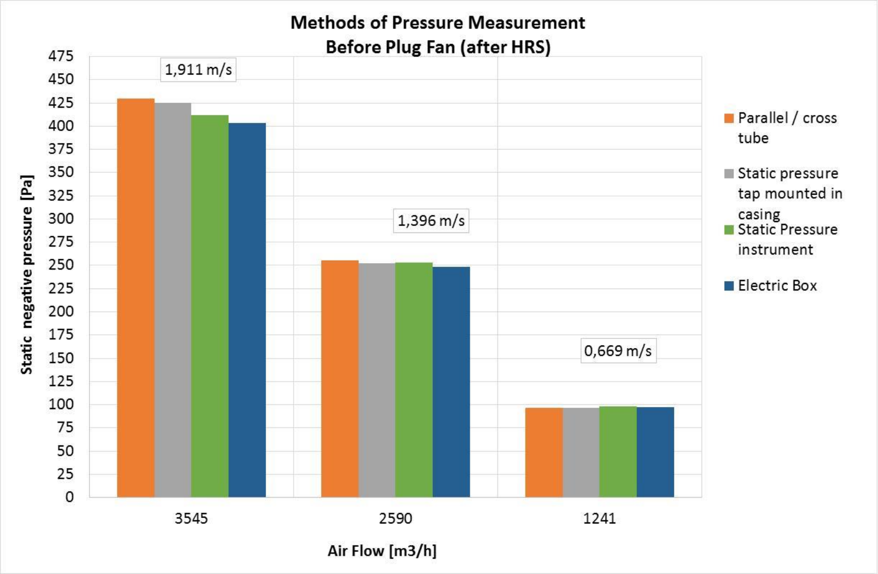
- To analyse which method is applicable, DTI has conducted a series of measurements in the unit and in idealised airflow respectively. The following methods have been tested for the analysis:

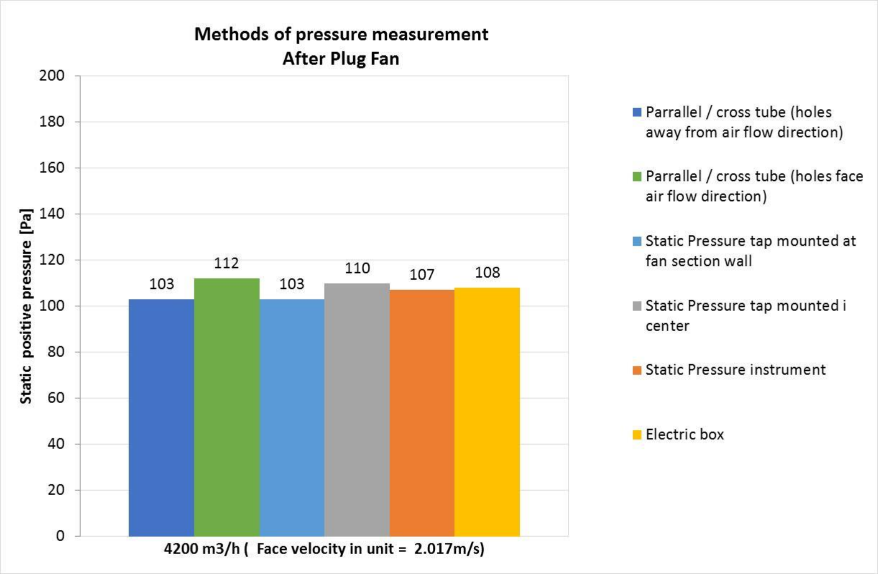
				
Parallel / cross section tubes	*Pitot*	*Static pressure instrument*	*Pressure relief box*	*Pressure taps*

- The cross tubes/parallel tubes are made with a distribution of pressuring holes according to experience from *'NVG - metoder för mätning av luftflöden I ventilationsinstallationer T9:2007'*. Tubes in both 4 and 10 mm with 1 mm pressure holes pointing 180 degrees opposite to the direction of airflow.

Simple method for measuring inside

DTI experience with measuring inside a ventilation unit:

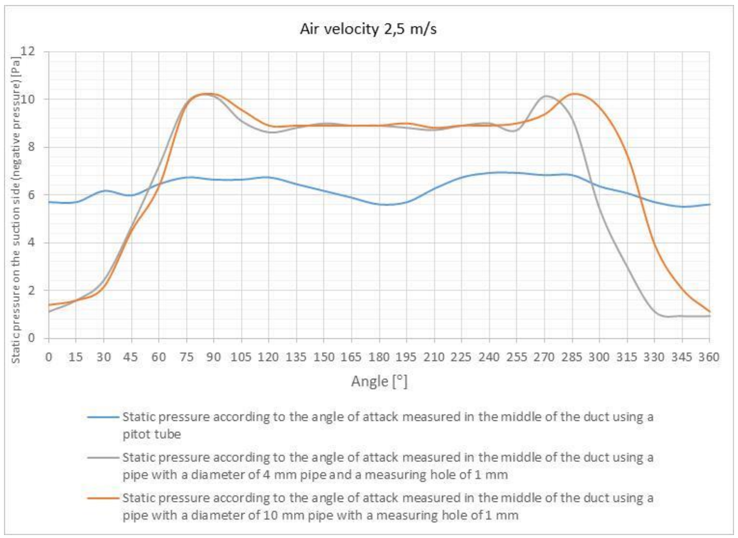


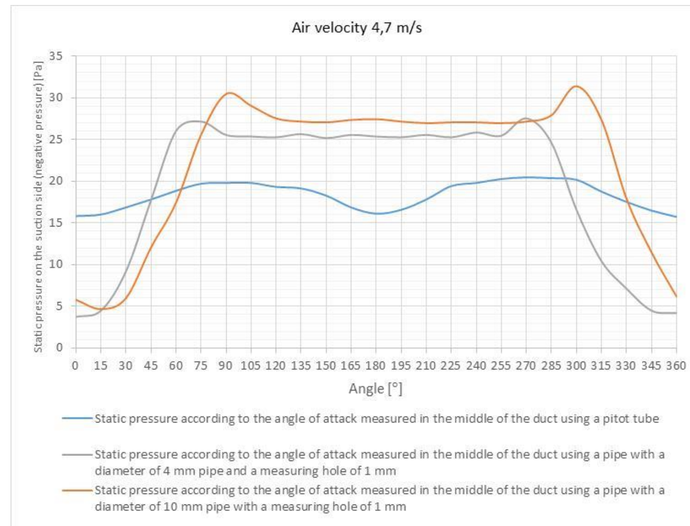


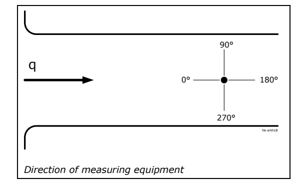
- The experience is that you think that you know the air direction and movement in the unit and you can therefore perform a reference measurement with traversing pitot tube measurement.
- However, this is not the case, even at low face velocities, as local internal disturbances accelerate and rotate the airflow, which can result in an incorrect reference.
- The difference in the results depends on the location and direction of the different measuring equipment, resulting in a variation in the results from positive to negative local maximum dynamic pressure.

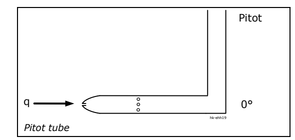
Simple method for measuring inside

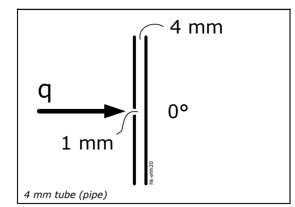
Phenomenon studied by additional measurements at a steady velocity field (equipment rotated in relation to a known air direction









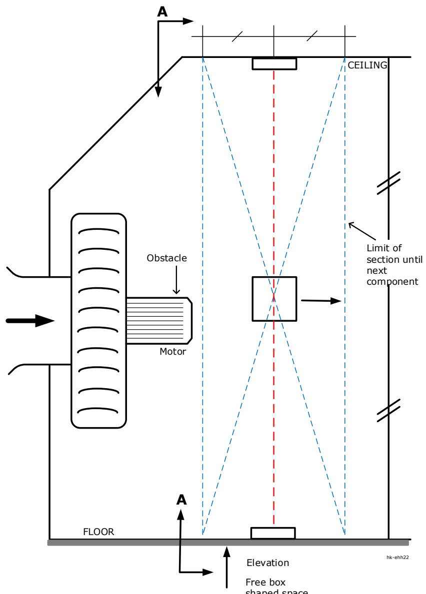


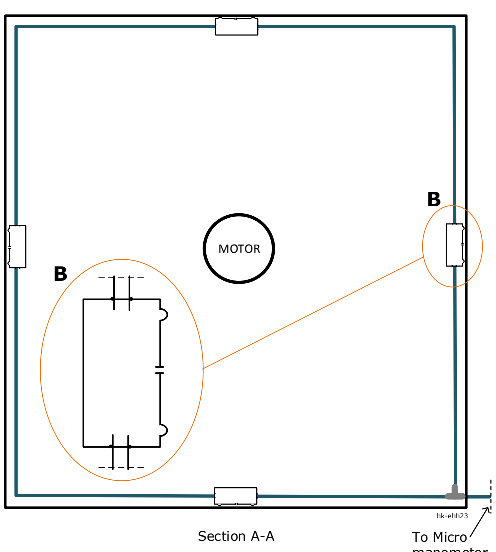
- The angle of attack has a significant influence on the static pressure.
- The measurements indicate that tubes with a hole in one direction are not suitable for measurements of static pressure even with a ring line, cross or parallel tubes with multiple holes.
- Probably because negative pressure (suction) occurs across the hole when the air is directed from the opposite side of the hole (in these experiments 180°).

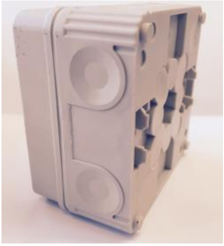
- When measuring inside the unit, we recommend using a pressure relief box.
- Alternatively, a ring line with holes located at both 0° and 180° (positioned as relief boxes). The total area of holes must be smaller than half the tube's inner area (not tested)

Simple method for measuring inside
Conditons:

- Conditions for use of pressure relief box.
  - Placed in a fluidically quiet location away from stagnation regions
  - Located on plane surface, connected with a ring line.
  - Prepare with only one hole in the bottom of the box (centre)
  - The back of the box of must be equipped with spacers (distance buds) that secure a distance between the box and the casing of approximately 1-2 mm.
  - The fan must not blown directly on the box
  - Pressure measured external according to ISO 5801
    - ISO 5801 uses long transitions to idealised measurement ducts (airways) that is difficult to accommodate, and it should be considered developing an alternative method that can also apply to in situ measurement.







η_{fan}

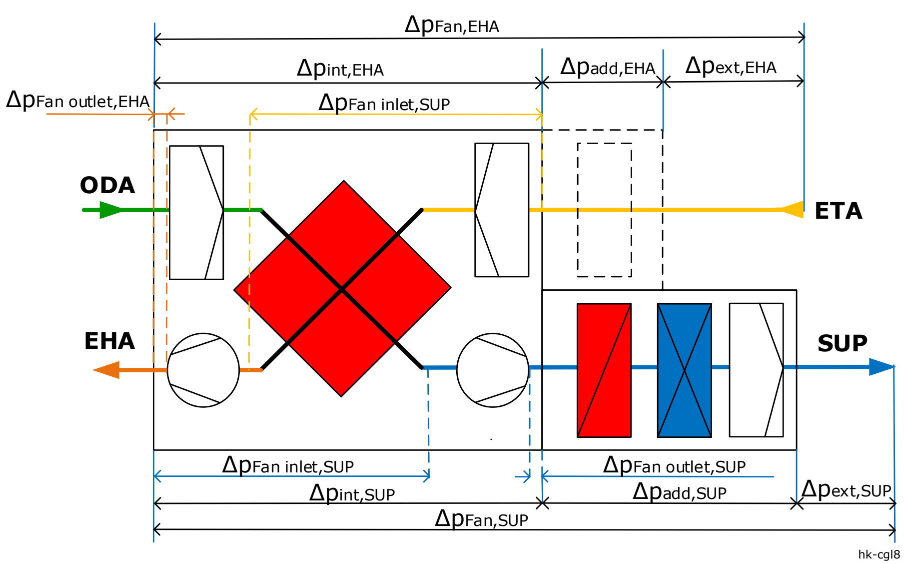
Measured with/without additional ventilation components

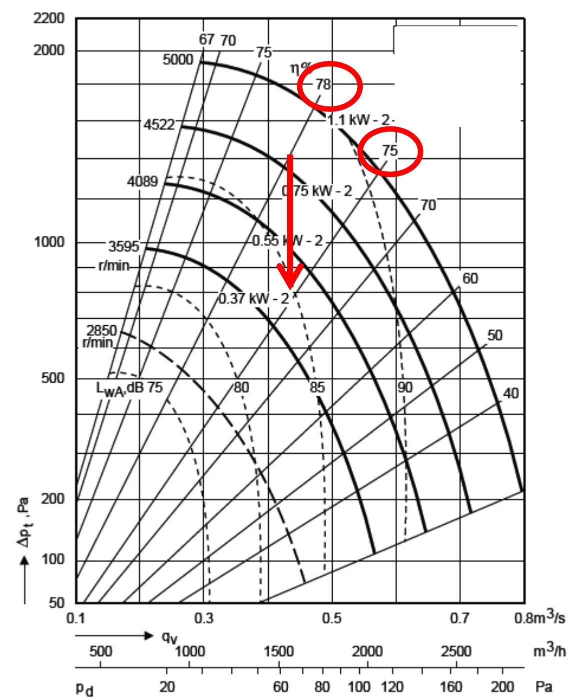
- Regulation:
  - **'fan efficiency (ηfan)'** means the static efficiency including motor and drive efficiency of the individual fan(s) in the ventilation unit (reference configuration) determined at nominal air flow and nominal external pressure drop;.
    - '**nominal flow rate (qnom)**' (expressed in m3/s) means the declared design flow rate of an NRVU at standard air conditions 20 °C and 101 325 Pa, whereby the unit is installed complete (for example, including filters) and according to the manufacturer's instructions;
    - '**nominal external pressure** (Δps, ext)' in (expressed in Pa) means the declared design external static pressure difference at nominal flow rate; and
    - '**reference configuration** of a BVU' means a product configured with a casing, **at least** two fans with variable speed or multi-speed drives, a HRS, a clean fine filter on the inlet-side and a clean medium filter on the exhaust-side;
  - '**internal pressure drop** of ventilation components (Δps,int)' (expressed in Pa) means the sum of the static pressure drops of a reference configuration of a BVU or an UVU at nominal flow rate;
  - '**internal pressure drop of additional** non-ventilation components (Δps,add)' (expressed in Pa) means the remainder of the sum of all internal static pressure drops at nominal flow rate and nominal external pressure after subtraction of the internal pressure drop of ventilation components (*Δps,int*);

η_{fan}

Measured with/without additional ventilation components

- Regulation:
  - 'fan efficiency (ηfan)' means the static efficiency including motor and drive efficiency of the individual fan(s) in the ventilation unit (reference configuration) determined at nominal air flow and nominal external pressure drop;.
- Approach 1 – ηfan measured <u>with</u> add. components (qnom = installed complete)
- Approach 2 – ηfan measured <u>without</u> add. components (ref. configuration)





Simple method for measuring inside

Definitions:

- Unidirectional ventilation unit (UVU):
- $SFP_{int} = \frac{\Delta p_{s,int}}{\eta_{fan}}$
- For bidirectional ventilation units (BVUs):
- $SFP_{int} = \frac{\Delta p_{s,int\,SUP}}{\eta_{fan\,SUP}} + \frac{\Delta p_{s,int\,EHA}}{\eta_{fan\,EHA}}$
- All values is calculated for SUP or EHA for UVU's depending on whether it is a SUP or EHA fan unit and calculated values for SUP and EHA for BVU's.
- No Additional components:
- $\Delta p_{s,int} = \Delta p_{fan} - \Delta p_{s,ext}$
- Measured with additional ventilation components as a part of $\Delta p_{s,int}$:
- $\Delta p_{s,int} = \Delta p_{fan} - \Delta p_{s,ext} - \Delta p_{Add}$
- Where the fan efficiency is determined as:
- $\eta_{fan} = \frac{q_{nom} \cdot \Delta p_{fan}}{P}$ where $\Delta p_{fan} = \Delta p_{s,ext} + \Delta p_{s\,int} + \Delta p_{s\,add}$

Simple method for measuring inside

Definitions:

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$\Delta p_{s,int}$	***$\Delta p_{s,int}$** is the internal pressure drop of ventilation components (Δps,int) (expressed in Pa)* means the sum of the static pressure drops in a reference configuration of a BVU or an UVU at nominal flow rate. **Reference configuration of a BVU** means a product configured with a casing, at least two fans with variable speed or multi-speed drives, a HRS, a clean fine filter on the inlet-side and a clean medium filter on the exhaust-side **Reference configuration of an UVU** means a product configured with a casing and at least one fan with variable speed or multi-speed drive, and — in case the product is intended to be equipped with a filter on the inlet-side — this filter must be a clean fine filter The NRVU **inlet and outlet losses must be included** in the 'the internal pressure drop of ventilation components ($\Delta p_{s,int}$). If a ducted air-handling unit has full size openings (the internal cross section of the duct systems is equal to the cross section of the NRVU), it mostly experiences no additional pressure losses at the inlet and outlet opening.
$\Delta p_{s,add}$	*'internal pressure drop of additional non-ventilation components ($\Delta p_{s,add}$)' (expressed in Pa)* means the remainder of the sum of all internal static pressure drops at nominal flow rate and nominal external pressure after subtraction of the internal pressure drop of ventilation components (Δps,int);
Δpf_{an}	*The static pressure difference between the fan outlet and inlet section.*
η_{fan}	*The fan efficiency η_{fan}* is the 'overall static efficiency drive' at nominal airflow and nominal external pressure drop to be measured at the fan section, in %, according to ISO 12759 but for the fan when it is placed in intended casing i.e. considering system effects. It is the **static efficiency** including motor and drive efficiency of the individual fan(s) in the ventilation unit (reference configuration) determined at nominal airflow and nominal **external pressure drop** (and internal pressure drop). It is the ratio between the nominal airflow multiplied with the static pressure rise of the fan (equal to the sum of pressure drops of all ventilations components, clean and dry, and the nominal external pressure) divided by the electrical power of the fan drive. Placement of a fan in a casing will affect both the fan pressure rise (less pressure rise due to system losses) and the power consumption. The fan efficiency is to be measured/calculated with in the BVU and with the external (and internal and additional) pressure loss at nominal airflow (defined by the manufacturer) according to the definition of SFP even though the calculation of SFP_{int} only uses the internal pressure drop. **For BVU calculated for both airstreams respectively, the supply air stream (SUP) and the extract air stream (ETA) for determination of SFP_{int}. For UVU calculated for one airstream.** For measurement see the containing parameters of the formula

For the measurement and calculation of SFP_{int} all characteristics/values are converted from the ambient temperature and pressure measured at the time of the test, to standard air conditions 20°C and 101325 Pa approximately equal to an air density of 1,2 kg/m³.

Simple method for measuring inside

Definitions:

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p_{sf}	*Fan static pressure* means the fan total pressure (p f) minus the fan dynamic pressure at nominal airflow for one airstream in respect to the face area. **Stagnation pressure** is only a mathematical / thermodynamic calculated values that require expert knowledge to calculate. The use of stagnation pressure is only relevant at air velocities above 40m/s why this should not be used. **The measured pressure difference is the value used to calculate SFPint, the external static pressure etc.**
$\Delta_{ps, ext}$	*Nominal external pressure* (expressed in Pa) means the declared design external static pressure difference at nominal flow rate; To be **measured in connected ducts** so the consumers receive consistent values of pressure and flow. The nominal external pressure is the static pressure difference between inlet and outlet, for BVU both airflows. For BVU the test is overall described in EN 13141-7 (6.2.2) (and the other standards in the 13141-series regarding type of unit) which describes that the test shall be conducted in all 4 ducts. EN 13141-7 refers to EN 13141-4 (5.2.2), where the installation of the ducts is defined. But how the pressure is measured in the duct (measurement ducts) and the permissible deviation is not described in all standards. This could be designed and tested according ISO 5801. But ISO 5801 uses long transitions to idealized measurement ducts (airways) which is difficult to accommodate, and **it should be considered to develop an alternative method that can also apply to in situ measurement.** To which connection the pressure is delivered is only described in EN 13053. **For ducted VU to be distributed with 50 Pa on the outside (12 21). For no-ducted with 100% on the building side.**
q_{nom}	*Nominal flow rate* (expressed in m³/s) means the declared design flow rate of an NRVU at standard air conditions 20 °C and 101325 Pa. The nominal airflow and pressure must be **seen as the maximum airflow of the NRVU** in the sale ~~of which the NRVU can fulfil the requirements according to the definitions in the regulation~~. For BVU test the airflow shall be balanced mass airflow within 3% (acc. to experience with EN 13141-7 cap. 6.3 thermal testing). **The value for q_{nom} used to calculate the n_{fan} for BVU's is the current in respect to the air flow side (SUP/ETA) and not value is the sum of both supply and extract airflow divided by 2.** **The declared information value for q_{nom} is the sum of both supply and extract airflow divided by 2.** Can be measured according to EN 13141-4,5,6,7,8,11 regarding type of unit and ISO 5801. Also EN 13053 and ISO 5801.
P	*'Nominal electric power input (P)'* (expressed in W and not as stated in the regulation in kW as SFP_{int} is W/m3/s) means the effective electric power input of the fan drive, including any motor control equipment, at the nominal external pressure and the nominal airflow; Can be measured according to EN 13141-4,5,6,7,8,11 regarding type of unit and ISO 5801. EN 13053 insufficiently described in this area.

SFPint Alternative

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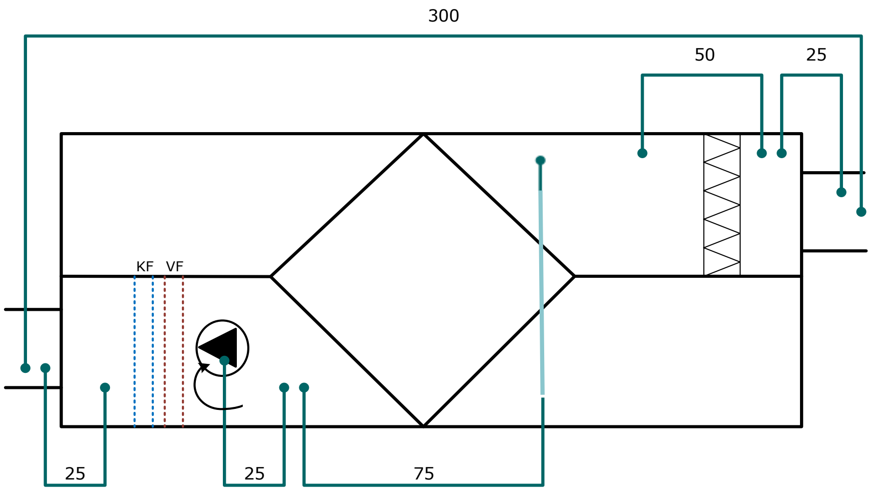
- SFPint determination for VU where internal pressure measurements cannot be performed - Approach

SFPint Alternative

SFPint determination for VU where internal pressure measurements cannot be performed - Approach

- Sketch of a **fictive ventilation unit** with pressure losses of components as if it were possible to measure the pressure loss for each component separately.
- Unit external pressure 300 Pa



The ideal measuring of the fan ($\Delta p_{fan,ext}$ =500 Pa)

	From measuring on the unit	If the fan were measured outside the unit (under ideal conditions, according to the fan regulation, but not in BEP, corresponding to nominal flow)
η_{fan}		80%
q_{nom}	3600 m3/h	3600 m3/h
$\Delta p_{s\_external}$	300 Pa	500 Pa
P	625 W	625 W
rpm	1800 rpm	1800 rpm

- The unknown is :
  - Pressure drop caused by **integration of the fan**, expressed in the 'internal efficiency of the fan'.
  - Pressure drop caused by **integration of the individual components** 'casing system pressure loss'
- The DTI approach consider, that the $SFP_{int} = \frac{\Delta p_{fan,outside,SUP} - \Delta p_{unit,ext,SUP}}{\eta_{fan,outside,SUP}} + \frac{\Delta p_{fan,outside.EHA} - \Delta p_{unit,ext,EHA}}{\eta_{fan,outside,EHA}}$
- For one side it becomes: $\frac{\Delta p_{fan,outside} - \Delta p_{unit,ext}}{\eta_{fan,outside}} = \frac{500\ Pa - 300\ Pa}{0,8} = 250$

SFPint Alternative

Different power consumption

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- A problem is that the electric power input can change when installing the fan in the unit (i.e. pre-rotation or poor installation can change the velocity profile into the fan and thereby reduce the efficiency).
- There may be system losses not related to an asymmetric inlet to the fan, but due to other flow conditions in the casing between the pressure measuring point and fan. These will be reflected in the difference in pressure between the two measurements (inside/outside) and will not lead to different power consumption.
- This problem can be solved by using a correction between the power:
- $SFP_{int} = \frac{\Delta p_{fan\ outside} - \Delta p_{s\_ext}}{\eta_{fan\ outside}} \cdot \frac{P_{unit}}{P_{Fan\ outside}}$
- Rewritten to standard terms it becomes:
- $\mathrm{SFP}_{int\ UVU} = \frac{\Delta p_{Fan} - \Delta p_{s,ext}}{\eta_{Fan}} \cdot \frac{P_{FAN}}{P_{Fan,ext}}$
- Values are inserted with numerical values for Δp. All values are calculated for SUP or EHA for UVU's depending on whether it is a SUP or EHA fan unit and calculated values for SUP and EHA for BVU's.
- $\mathrm{SFP}_{int\ BVU} = \frac{\Delta p_{Fan,SUP} - \Delta p_{s,ext,SUP}}{\eta_{Fan,SUP}} \cdot \frac{P_{Fan,SUP}}{P_{Fan,ext,SUP}} + \frac{\Delta p_{Fan,EHA} - \Delta p_{s,ext,EHA}}{\eta_{Fan,EHA}} \cdot \frac{P_{Fan,EHA}}{P_{Fan,ext,EHA}}$

SFPint Alternative

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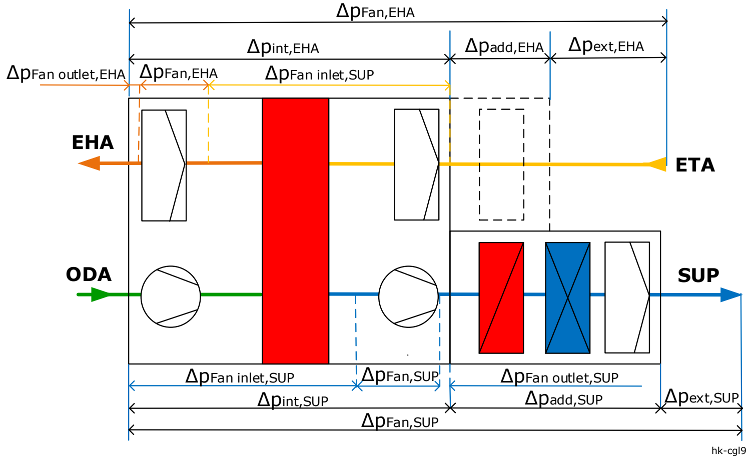
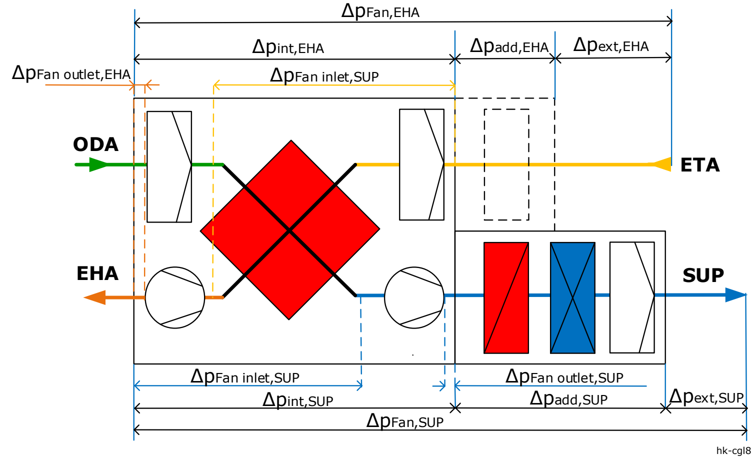
SFPint determination for VU where internal pressure measurements <u>cannot</u> be performed

- $$SFP_{int\ BVU} = \frac{\Delta p_{Fan,SUP} - \Delta p_{s,ext,SUP}}{\eta_{Fan,SUP}} \cdot \frac{P_{Fan,SUP}}{P_{Fan,ext,SUP}} + \frac{\Delta p_{Fan,EHA} - \Delta p_{s,ext,EHA}}{\eta_{Fan,EHA}} \cdot \frac{P_{Fan,EHA}}{P_{Fan,ext,EHA}}$$





- Δp_{Fan} means the static pressure difference of the fan <u>measured outside the unit</u> according to the fan regulation, not at best efficiency point (BEP), but corresponding to the nominal flow and rpm regarding the unit regulation (according to the measurements conducted on the unit).
- $\Delta p_{s,ext}$ means the static nominal external pressure drop as described under Annex A1.2.3 <u>measured at the terminals of the unit</u>.
- η_{Fan} means the static efficiency including motor and drive efficiency of the individual fan(s) in the ventilation unit (reference configuration) determined at nominal air flow and nominal external and internal pressure drop (and corresponding revolutions of the fan installed inside the unit) <u>measured outside the unit according to the fan regulation</u>. The static efficiency is the ratio between the nominal air flow multiplied by the static pressure rise of the fan (equal to the sum of pressure drops for all ventilations components, clean and dry, and the nominal external pressure) divided by the electrical power to the fan drive).
- P_{Fan} is the 'nominal electric power input (P)' (expressed in W) and means the effective electric power input of the fan drives, including any motor control equipment, at the nominal external pressure and the nominal airflow, <u>measured on the unit</u>.
- $P_{Fan,ext}$ control is the 'nominal electric power input (P)' (expressed in W) and means the effective electric power input of the fan drives, including any motor equipment, at the nominal airflow and revolutions of the fan installed inside the unit and corresponding Δp_{Fan} <u>measured outside the unit according to the fan regulation</u>
- **If the unit is equipped with control equipment (inverter, etc.) η_{fan} must be reduced and $P_{el,fan,ext}$ must be increased with the loss of the control unit. Alternatively, the data from the fan manufacturer must have been measured with the same equipment.**

SFPint Alternative

Proposal from Stakeholder/WG5 - Rewriting of alternative SFPint

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$$SFP_{int\ UVU} = \frac{\Delta p_{Fan} - \Delta p_{s,ext}}{\eta_{Fan}} * \frac{P_{Fan}}{P_{Fan,ext}}$$

but

$$\eta_{Fan} = \frac{q * \Delta p_{Fan}}{P_{Fan,ext}}$$

so

$$SFP_{int\ UVU} = \frac{\Delta p_{Fan} - \Delta p_{s,ext}}{\Delta p_{Fan}} * \frac{P_{Fan} * P_{Fan,ext}}{q * P_{Fan,ext}} = \left(1 - \frac{\Delta p_{s,ext}}{\Delta p_{Fan}}\right) * \frac{P_{Fan}}{q}$$

but

$$SFP_{Fan,unit} = \frac{P_{Fan}}{q}$$

so it can also be written

$$SFP_{int\ UVU} = \left(1 - \frac{\Delta p_{s,ext}}{\Delta p_{Fan}}\right) * SFP_{Fan,unit}$$

- The first formula is with eta_fan as in Regulation 1253/2014
- For the practical application a simplification is useful.

SFPint Alternative

Test of alternative determination of SFPint

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Measurement	**Unit**	**Laboratory (ref)** Measured in unit	**Fan data** Data from fan manufacture P=Constant	 RPM=Constant	**Manufacture** Production selection programe
Flow	[m3/h]	**5000**	**5000**	**5000**	5000
Eletric power input	W	**2006**	**2006**	1811	1830
Revolution	RPM	**1811**	1867	**1811**	**1811**
Total Pressure	Pa	773	867	778	796
Ekstern pressure	Pa	392	392	392	415
Intern pressure = dptotal-dpekstern	Pa	381	475	386	381
Eff. of fan	[%]	53,5%	59,7%	59,7%	57,0%
Calculated	[%]	53,5%	60,0%	59,7%	60,4%
SFPall	[%]	1444	1444	1304	1318

SFPint_regulation $\mathrm{SFPint} = \frac{\Delta p_{int}}{\eta_{intern}}$	[W/m3/s]	$\frac{381\ Pa}{0{,}535}$ 713			$\frac{381\ Pa}{0{,}57}$ 669 631
SFPint_1 $\mathrm{SFPint} = \frac{\Delta p_{fan} - \Delta p_{s\_ext}}{\eta_{fan}}$	[W/m3/s]		$\frac{475\ Pa}{0{,}597}$ 796	$\frac{386\ Pa}{0{,}597}$ 647	
SFPint_2 $\mathrm{SFPint} = \frac{\Delta p_{fan} - \Delta p_{s\_ext}}{\eta_{fan}} \cdot \frac{P_{el\_AHU}}{P_{el_{fan-outside}}}$	[W/m3/s]		$\frac{386\ Pa}{0{,}597} \cdot \frac{1867 rpm}{1811 rpm}$ 772	$\frac{386\ Pa}{0{,}597} \cdot \frac{2006\ W}{1811\ W}$ 717	$\frac{381 Pa}{0{,}57} \cdot \frac{2006\ W}{1830\ W}$ 734
SFPint_3 $\mathrm{SFPint} = \mathrm{SFPall} \cdot \frac{\Delta p\_int}{\Delta p\_all}$	[W/m3/s]	$1444 \cdot \frac{381\ Pa}{773\ Pa}$ 713			$1318 \cdot \frac{381\ Pa}{796\ Pa}$ 631

Rewriting of SFPint_2 $\mathrm{SFPint} = \mathrm{SFPall, unit} \cdot \left(1 - \frac{\Delta p_{s\_ext}}{\Delta p_{Fan}}\right)$			792	717	

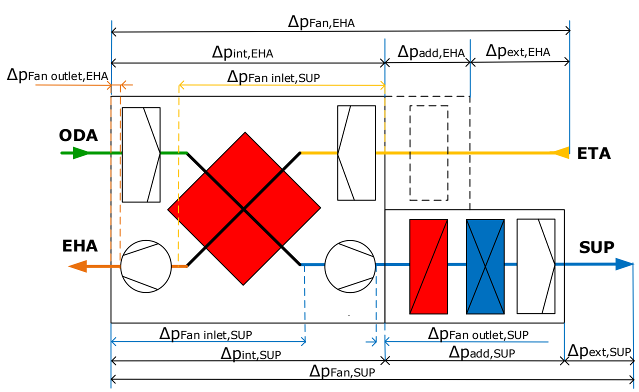
SFPint Alternative

Measured with/without additional ventilation components

- If the unit has additional components
  1. Measure the external static pressure <u>with</u> add. components
  2. Measure the external static pressure <u>without</u> add. components
     I. RPM = constant
     II. Airflow = constant
     III. External static pressure increased by damper until flow is equal to 1.
  3. $SFP_{int} = \frac{\Delta p_{fan\ outside} - \Delta p_{s\_ext}}{\eta_{fan\ outside}} \cdot \frac{P_{unit}}{P_{Fan\ outside}}$ where $\Delta p_{s\_ext} = \Delta p_{s\_ext}III$
  4. Otherwise

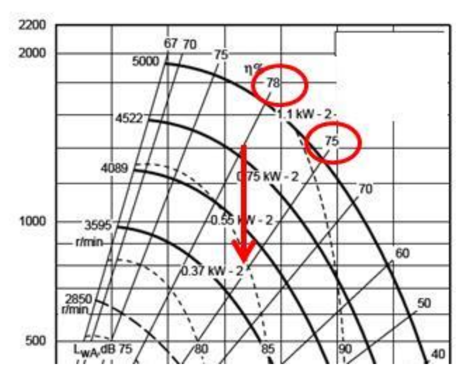
Too low pressure
(just measured with add. comp):

$$SFP_{int} = \frac{778Pa - \cancel{392Pa}\ 300Pa}{0{,}597} \cdot \frac{2006\ W}{1811\ W}$$



Too low efficiency
(reduced rpm)

$$SFP_{int} = \frac{778Pa - 392Pa}{\cancel{0{,}597}\ 0{,}55} \cdot \frac{1848\ W}{1668\ W}$$



SFPint Roadmap

Status and other proposals

TEKNOLOGISK
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- Then the determination dp_int is the key element for the calculation of SFP int. There are different option to do this:
  1. Measurement
     a. Direct dP measurement
     b. Indirect measurement by removing components
  2. Reliable component data
     a. Calculation from component data
  3. Indirect determination by comparison of fan curve and unit curve
- Declaration of method used
  - Which method for which units
  - Tolerances
- **Experience with the methods 1+3 – from stakeholders.**