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Proposal for information requirements in the revised Regulation 1253/2014 for Non-Residential Ventilation Units including an HRS and a Heat Pump for the primary purpose of heat recovery

In a nutshell

This Position Paper proposes a harmonized approach for the evaluation of performance of bidirectional NRVUs solely with a passive HRS and NRVUs with an HRS and a Heat Pump for heat recovery. It aims at an unequivocal comparison of heat recovery efficiency and specific electric power input for these two different types of NRVUs. A set of performance indicators to be included in the information requirements is also put forward.

1. Background

In the Discussion Document for the second stakeholder meeting on the review of VU Regulation, the study consultant brought up a need for defining information requirements for bidirectional NRVUs that use the Heat Pump and HRS for heat recovery. Reporting the performance indicators for this kind of Ventilation Units would enable collecting data for the next review and possibly setting the minimum ecodesign requirements in the future. The members of Eurovent Product Group 'Air Handling Units' welcome this proposal and put forward a straightforward method to assess the performance of both types of units in a comparable way.

2. Introduction

Today, the EU regulation 1253/2014 does not cover NRVUs with heat exchangers (HRS) and heat pumps (HP), primarily designed for the purpose of heat recovery from exhaust to supply air, supporting the passive heat recovery system. This situation creates a loophole for manufacturers, to design units with low energy efficient heat recovery systems, combined with simple designed heat pumps, which are out of scope of any ecodesign regulation. Therefore, we come to the conclusion, to include those units into the regulation 1253/2014 for NRVUs, together with a new (third) way of evaluating these heat recovery systems. The new evaluation method demonstrates whether the efficiency of such systems matches the efficiency of heat recovery systems other than run around systems. Although, the surplus of energy generated by the heat pump can be utilised for various, non-ventilation functions (like DHW production or space heating), the proposed evaluation method takes into account only the part of energy used for ventilation. The objective of this method is to unify and standardise the comparison of the heat recovery efficiency for BVU NRVUs both with passive HRS or passive HRS and a heat pump.

Goal

The goal of the new proposed method includes:

- Closing the loophole of unregulated NRVUs with heat recovery and heat pump, by including those units into EU regulation 1253/2014
- Establishing a new way of evaluating those units within 1253/2014

3. Method proposal

The new proposed method consists in the following evaluation steps.

a. If a unit with a heat pump and an HRS can fulfil the limits of 1253/2014, like units with normal/passive heat recovery systems, it can be treated as a normal NRVU by the rules of 1253/2014 as is. If such unit cannot fulfil those requirements, it shall be evaluated in a new way for units with HP and HRS.
b. The new evaluation shall be based on unit calculations for a fixed temperature difference between extract and outdoor air, a humidity ratio of 0 kg/kg$_{dry\ air}$ (no possible condensation) and expected maximum air volume flow through HRS and HP during heating period without thermal bypass in use. The proposed dry temperature difference between extract and outdoor air shall be 15K and at the extract air temperature of 25°C.
c. Introduction of the specific heat recovery capacity of the entire system (HRS + HP) in kJ/kg$_{dry\ air}$, instead of the heat recovery efficiency in percent as a criterion for the heat recovery capacity from the exhaust air of the ventilation unit.
d. Introduction of the specific electrical power consumption of the entire system (fans with air-side pressure loss of heat recovery, heat pump coils and filter plus HP compressor) in kJ/kg$_{dryair}$, instead of the specific fan power as the criterion for maximum ventilation power consumption. The new value shall be called SSP_{int} (Specific System Power).
e. Introducing a heat recovery limit of 10.95 kJ/kg$_{dry\ air}$, corresponding to the current η_{nrvu} limit of 73%.
f. Maintaining the efficiency bonus E, that is, the more kJ/kg$_{dry\ air}$ of thermal energy is recovered from the exhaust air, above the minimum requirement 10.95 kJ/kg, the higher the SSP can be.

   E = ((recovered heat capacity - 10.95 kJ/kg) / 0.15 kJ/kg) / 100 * 3000

   However, to take into account only that part of the heat recovered by HP that is used for ventilation, the E bonus is limited to a max. value corresponding to the heat recovery efficiency of 100%.

   E_{max} = ((10.95/0.73 - 10.95 kJ/kg) / 0.15 kJ/kg) / 100 * 3000

g. With reference to the current requirements for SFP_{int_limit}, the maximum internal specific system power of ventilation components and compressor powered (SSP_{int_limit}) in kJ/kg$_{dryair}$ is defined as follow:

   (1 100 + E - 300 * q_{nom} /2 – F) / (1.204 * 1 000) if $q_{nom} < 2$ m³/s, and
   (800 + E - F) / (1.204 * 1 000) if $q_{nom} \geq 2$ m³/s

   Air density at standard air conditions 20 °C, 0 kg/ kg$_{dry\ air}$ and 101 325 Pa: 1.204 kg/m³

4. Explanation of the method

Right now, regulation 1253/2014 only knows two heat recovery systems, run around and other heat recovery systems. These systems can be called passive heat recovery systems, as there is no additional power, apart from the fan motors, needed, to operate the heat exchanging process. The efficiency of such recovery systems is expressed as a percentage value of the dry temperature efficiency and can be seen as a constant value.

Heat recovery systems, designed with a heat exchanger and a heat pump, cannot be valued this way, because they can still recover heat, even when there is no temperature difference between outdoor and extract air. In passive heat exchanger with 73% temperature efficiency is shown in in Diagram 1, displaying the recovered energy in kJ/kg over the dry temperature difference.

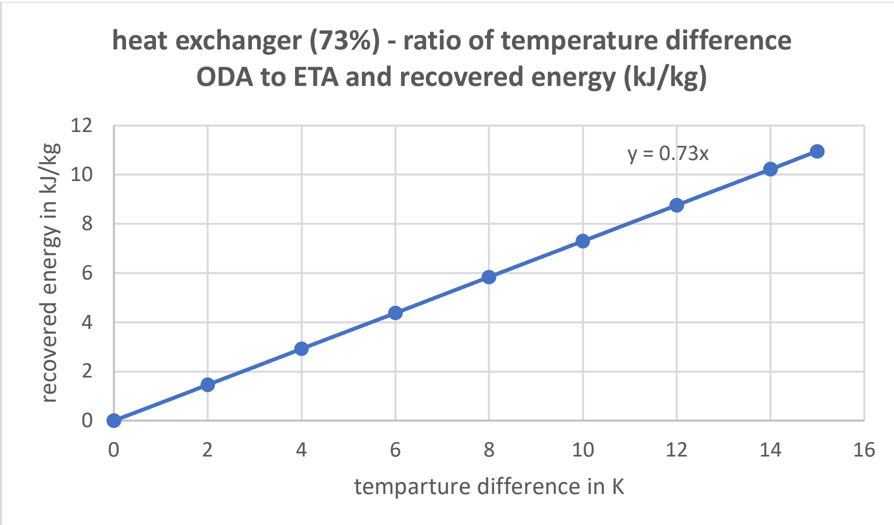

Diagram 1. HRS - ratio of temperature difference ODA to ETA and recovered energy (kJ/kg)

The next Diagram 2 shows the results of a heat pump. The heat pump loses efficiency, as the temperature difference between air in of condenser and evaporator increases

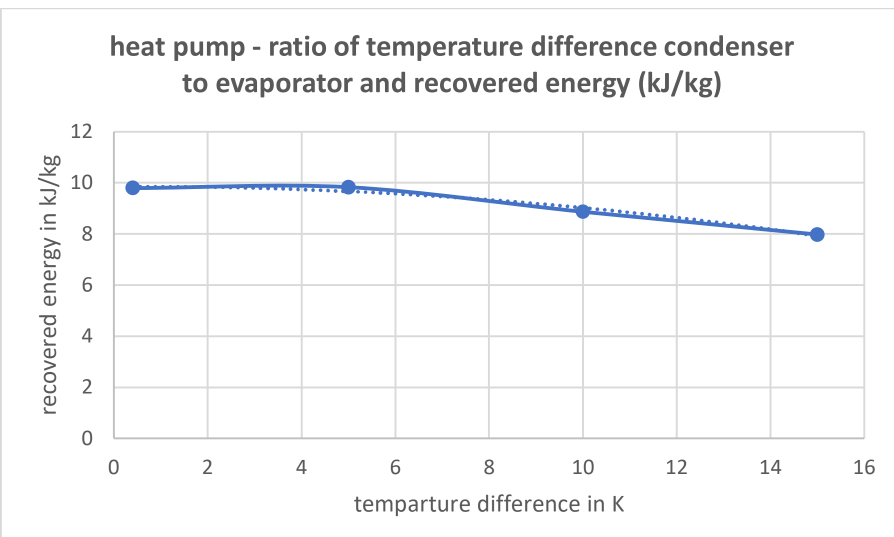

Diagram 2. heat pump - ratio of temperature difference condenser to evaporator and recovered energy (kJ/kg)

The two systems combined as one heat recovery system then show this behaviour as illustrated in Diagram 3.

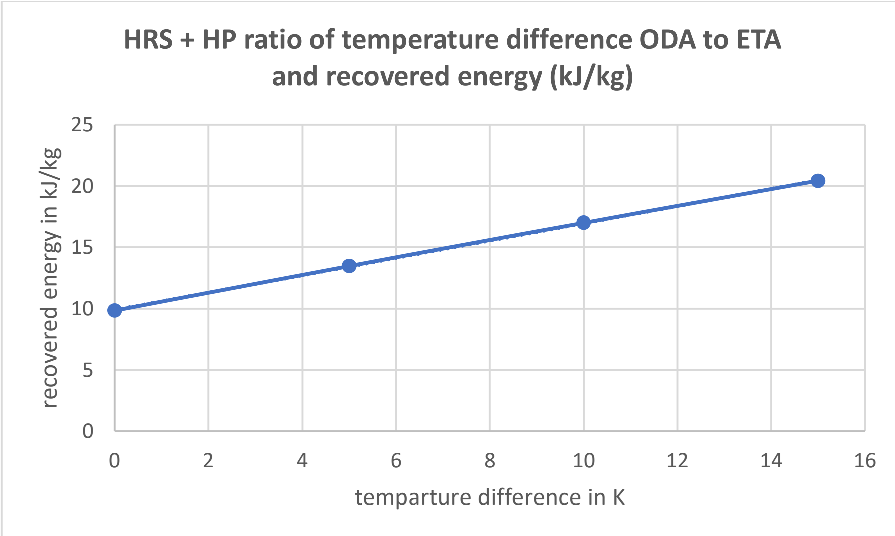

Diagram 3. HRS + HP ratio of temperature difference ODA to ETA and recovered energy (kJ/kg)

To compare a standard HRS with this combined HRS, we can now use the specific recovered heat energy of both systems. To do so, it is essential to agree on an average temperature difference throughout a whole year in Europe. We believe that a difference between 10 to 15K represents the average climate situation. Therefore, the ongoing explanation continues with 15K as the extreme of this temperature range. With 15K, a standard HRS with an efficiency of 73% can recover 10.95 kJ heat energy per kilogram dry air. This recovery value shall be the reference limit for the minimum heat recovery capacity of an HR + heat pump system.

To compare the electric power consumption of the two systems, the heat pump system must include the power consumption of the fans to overcome the pressure loss of the heat exchanger, the condenser and the evaporator. The power consumption of the compressor must be added, too. This will be then a new value, as proposed in point 3.d. At the minimum heat recovery capacity, the new specific electrical power consumption SSP shall not exceed the SFP_{limit} of a standard HRS.

A new efficiency bonus formula is needed, following the same principle of the old efficiency bonus, but now based on the amount of extra heat recovery capacity, exceeding the limit of the heat recovery capacity of 10.95 kJ/kg. To compare it to the old bonus, we can say that 1% of increase in efficiency of a passive HRS at a temperature difference of 15K equals an increase of recovered energy by 0.15 kJ/kg. To keep the bonus in line with the bonus for passive HRS, the new formula shall look like this.

Efficiency bonus = ((recovered heat capacity - 10.95 kJ/kg) / 0.15 kJ/kg) / 100 * 3000

However, given that the assumption is to consider in the assessment only ventilation, the max. Efficiency bonus shall be limited to a value corresponding to heat recovery efficiency of 100%.

Max. Efficiency bonus = ((10.95/0.73 - 10.95 kJ/kg) / 0.15 kJ/kg) / 100 * 3000

5. Proposal for information requirements. NRVU with HP and HRS

It is proposed to include in the Information Requirements for NRVUs including a HP and an HRS the following parameters:

a. **Air flow rate,** (m^3/s)
   (expected maximum air volume flow through HRS and HP during heating period without thermal bypass in use)
   Reference test standard: EN 13053 / EN ISO 5801
b. **Heat recovery thermal efficiency of the passive heat recovery**, (%)
   Reference test standard: EN 13053 / EN 308
c. **Heat recovery thermal efficiency of the heat recovery system, including HP**, (%)
   defined as the ratio of the supply air temperature rise in the passive heat recovery and condenser coil and the difference between the temperature of exhaust air inlet and temperature of supply air inlet (equal to 15K).
   Reference test standard: EN 308
d. **Internal pressure drop of ventilation components for SUP and ETA**, (Pa)
   Reference test standard: EN 13053, EN ISO 16890, EN 1216 (evaporator and condenser coils)
e. **Internal specific system power SSP_{int}**, (expressed both in kJ/kg_{dryair} and $W/m^3/s$)

   SSP_{int} ($W/m^3/s$) = SSPint (kJ/kg_{dryair}) * 1.204 * 1000

   SSP_{int} expressed in ($W/m^3/s$) is a value that can be directly compared with SFP_{int} ($W/m^3/s$) of a NRVU equipped only with the passive heat recovery in order to evaluate specific electric energy consumption of both types of units.

   Reference test standard: EN 13053 (fan power input), EN 14511 (for compressor power input)

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