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Energetic Evaluation of the Heat Recovery Unit HRV2 Q Plus

Client: Titon Hardware Ltd (Clive Hudson)
International House Peartree Road Stanway
England UK-C03 0JL Colchester

Component: Residential air ventilation unit with heat recovery

Type/Model: HRV2 Q Plus

Serial Number: 09392/0411/R&D

Year of Manufacture: 2011

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Introduction

As mandated by the manufacturer, the Passive House Institute has investigated the energetic properties of the submitted ventilation unit according to the PHI test procedure, *"Requirements and testing procedures for energetic and acoustical assessment of Passive House ventilation systems < 600m^3/h for Certification as Passive House suitable component", Revised June 24th, 2009.*

The following tests were performed in order to collect measurement data used to determine magnitudes of efficiency compliant to PHI criteria:

- Determination of the operational air flow range
- Determination of the external and internal air flow leakage
- Thermodynamical testing
- Determination of the electrical efficiency

The following criteria were not investigated or tested further:

- Comfort criterion
- Freeze-protection behaviour
- Assessment of acoustic-response properties

The measurements were performed by the test laboratory shown in Table 1. The displayed document and results of the testing were submitted to PHI for evaluation.

The included test report documents the steps and procedures of the evaluation.

Test laboratory:	TÜV SÜD Industrie Service GmbH Center of Competense für Kälte- und Klimatechnik, Ridlerstr. 65 80339 München
Test report:	WRG 272
Author(s):	Thomas Busler
Date:	20.04.2011
Additional information	./.

Table 1: Document(s) referencing the evaluation of the unit

Properties of the Air Ventilation Unit

An exhaustive, complete description of the ventilation unit is given in the unit's technical manual. Additional information can be found there.

Dimensions (LxWxH) [mm]	710x425x490
Chassis Construction	Insulated chassis made of powder-coated sheet steel
Pipe Connections	DN125 / DN150
Ventilator Arrangement	Supply and exhaust flow ventilated
Summer Bypass	Not included

Operational Range According to Air-Tightness Testing

The operational range of the unit (with respect to its ventilatory properties) is determined by the measurements conducted by the test laboratory. The results of the thermodynamic testing are summarized in Table 2. The reference volumetric flow for the determination of the air-tightness is given by the average of the range limits. The evaluation of the acoustic properties will generally be performed at the higher limit of the operational range of the unit.

Minimum at 49 Pa ext. Pressure	100 m³/h
Maximum at 49 Pa ext. Pressure	192 m³/h
Operating Range	143 - 148 m³/h

Range	Operational Range		Average	Reference Volumetric Flow
	Minimum	Maximum	(Test Point)	
	m³/h	m³/h	Nominal / Actual [m³/h]	[m³/h]
1	143	148	146 / 145	145

Table 2: Volumetric Flow Min/Max, Operational Range, Test Points

Air-Tightness and Heat Insulation

An investigation of the thermal bridges was not conducted in the framework of the testing. The thermal bridges do however play a role in determining the effective heat recovery, therefore it is prudent to mention here.

Before the thermodynamic testing was performed, the unit was evaluated for internal and external leakages, per the PHI guidelines. The leakage volumetric flow may not be larger than 3% of the referenced average volumetric flow of the operational range, for both over and under pressure.

Overpressure	Pressure Difference EHA/ETA - ODA/SUP (nominal)	[Pa]	50	100	200	300
	Leakage Flow	[m³/h]	0.5	0.9	1.5	2.0
Underpressure	Pressure Difference EHA/ETA - ODA/SUP (nominal)	[Pa]	50	100	200	300
	Leakage Flow	[m³/h]	0.5	0.9	1.5	2.0

V'(L,Over) = 0.0249 * dp^(0.772)

V'(L,Under) = 0.0249 * dp^(0.772)

Leakage Flow at 100 Pa	Nominal Pressure	[Pa]	100
	Reference Volumetric Flow	[m³/h]	145
	Leakage Flow (Over/Underpressure)	[m³/h]	0.87 / 0.87
	Leakage Rate	–	0.60%

Table 3: Results of the air-tightness test (i.e. external leakage)

Overpressure	Pressure Difference EHA/ETA - ODA/SUP (nominal)	[Pa]	50	100	200	300
	Leakage Flow	[m³/h]	0.3	0.5	0.9	1.2
Underpressure	Pressure Difference EHA/ETA - ODA/SUP (nominal)	[Pa]	50	100	200	300
	Leakage Flow	[m³/h]	0.3	0.4	0.9	1.1

V'(L,Over) = 0.0139 * dp^(0.783)

V'(L,Under) = 0.0132 * dp^(0.7777)

Leakage Flow at 100 Pa	Nominal Pressure	[Pa]	100
	Reference Volumetric Flow	[m³/h]	145
	Leakage Flow (Over/Underpressure)	[m³/h]	0.51 / 0.47
	Leakage Rate	–	0.34%

Table 4: Results of the air-tightness test (i.e. internal leakage)

The results of the air-tightness test are documented in Tables 3 and 4. The leakage volumetric flow (at 100 Pa) was calculated via a linear fit using the measurement data. The laboratory measurement at 100 Pa confirms the consistency of the fit. The boundary value of a maximal 3% of the referenced average volumetric flow for internal and external leakages was held in the testing.

Room Air Hygiene: Utilisation of Air Filters

The Passive House Institute recommends the equipping of an outdoor air filter of minimum grade F7, as this prevents the compromising of the entire system due to incoming dirt and dust. In the extract air canal, a G4 grade filter is recommended.

During the examination, the ventilation unit was equipped with the following filter configuration:

Outdoor Air (ODA) Filter	G3
Extract Air (ETA) Filter	G3

Filter classes G4 and G7 are offered by the manufacturer as accessories and are the standard filter setup which PHI mandates. For hygienic reasons, it should be ensured that the relative air humidity does not exceed 80% for longer than approximately three (3) days.

The filters must be regularly monitored and checked, and if dirty to the point of air blockage, should be immediately replaced. Filter replacement should precede the complete blocking of the outdoor air filter, usually at a frequency of 1 - 2 times per year.

Comfort Criterion: Minimum Supply Air Temperature

The comfort criterion for ventilation units in Passive Houses demands a minimum supply air temperature of at least 16.5 °C when the outdoor air temperature drops to a value of -10 °C. The activation of a frost-protection strategy should go into effect once this criterion is reached.

The testing related to the comfort criterion was not conducted within the framework of the testing.

Thermodynamical Testing: Efficiency Criterion of Heat

The unit was investigated under standard test conditions: 100 Pa, balanced mass flow in the outdoor and exhaust canals, no condensation in the supply or exhaust air canals (ensuring dry supply air). Under these conditions, the effective, dry heat recovery must have a value of at least 75%.

The test measurements are available in the laboratory test report. The filter configuration in the unit during the measurements was kept at the OEM standard.

			Test Point 1
Temp	ODA	°C	3.6
Temp	SUP	°C	19.6
Temp	ETA	°C	21
Temp	EHA	°C	6.1
Vol. Flow	ODA	m³/h	137
Vol. Flow	SUP	m³/h	145
Vol. Flow	ETA	m³/h	143
Vol. Flow	EHA	m³/h	135
rel. Humidity	ODA	%	56
rel. Humidity	SUP	%	19
rel. Humidity	ETA	%	19
rel. Humidity	EHA	%	53
Mass Flow	ODA	kg/h	164
Mass Flow	SUP	kg/h	164
Mass Flow	ETA	kg/h	161
Mass Flow	EHA	kg/h	160

Table 5: Temperature, Volumetric Flow, Relative Humidity und Mass Flows

With the assumption of mass flow balance, the effective, dry heat recovery can be calculated with:

$$\eta_{eff} = \frac{(\vartheta_{ETA} - \vartheta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\vartheta_{ETA} - \vartheta_{ODA})}$$

The effective heat recovery value was determined by assessing the following test point within the operational range:

Operating Point, Ideal Volume Flow	Heat Recovery Rate η
[m³/h]	[%]
145	89%

Table 6: Average Heat Recovery Efficiency Rate

Therefore, an effective heat recovery efficiency of 89% was achieved.

Electrical Efficiency Criterion

The total specific electrical power of a ventilation unit may not exceed 0.45 Wh/m³ specific electrical consumption in its in-service, operating state. The testing produced the following values for the averaged specific power consumption.

Volumetric Flow [m³/h]	Power Consumption [W]	Specific Power Consumption [W/(m³/h)]
145	45.4	0.31

Table 7: Electrical Power Consumption

The specific power consumption complies with the criterion.

Balance and Air Regulation of the Unit

The user can (depending on demand) choose between three (3) operating levels for the volumetric air flow.

The adjustability of the ventilator fans is to be conducted at the unit startup: At this time, the supply and exhaust ventilator fans may be separately configured with a corresponding potentiometer.

The unit makes use of two (2) volume-flow-constant ventilator fans. When the volumetric flows are correctly configured, the flows can be held constant, despite pressure loss fluctuations in the system's canal network.

Frost Protection of the Heat Exchanger

The frost protection described in the technical manual of the unit is not sufficient to meet the standards of a certified passive house. PHI recommends either an adequately dimensioned external frost protection element be equipped or another method of frost protection (e.g. subterranean heat exchanger) be used in order to satisfy this need.

The frost protection attributes of the unit were not evaluated in the framework of this testing.

Frost Protection of a Hydraulic Heating Element

In order to protect a potentially installed hydraulic heating element, the unit shall be shut off upon undershooting a supply air temperature of 5 °C.

In the framework of the technical investigation of the unit, this function was not tested.

The Passive House Institute recommends that an external thermostat should be planned and accomodated for in the supply air duct, which is coupled to the power supply of the unit. By the undershooting of a pre-configured value, the unit would then be cut-off from the power supply.

Unit Behavior after Power Outage

This function was not to be investigated in the framework of this testing. According to information provided by the manufacturer, the unit returns to the previously configured level after recovering from a power outage.

Bypass of the Heat Recovery

A summer bypass is not an included component of the unit. However, the unit does make use of a summer ventilation mode, which can be manually configured when needed.

Summarizing Characteristics of the Energetic Properties of the Ventilation Unit

The unit maintained an effective heat recovery rate of 89%.

The air-tightness testing showed that the boundary condition for both the internal and external leakage of 3% of the referenced average volumetric flow is met.

The electrical efficiency adhered to the boundary value of 0.45 Wh/m³.

The standby power consumption was not investigated in the framework of the testing.

The frost protection strategy described in the technical manual of the ventilation unit (simple reduction of the supply air volumetric flow) does not meet the standards expected for Passive Houses. Project-specific dimensionalisation for frost protection should be taken into account for any corresponding future application.