LAB N° 1785L

Test report

Test on VGE Eco Air M19 heat pump according to UNI EN14511:2022 and UNI EN 14825:2022 for medium temperature application

Institute for Renewable Energy
Heat Pump Lab

Customer:
Solgen
Ignacego Łukasiewicza 3,
31-429 Kraków

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Written by:
Laboratory Engineer

Fabio Bertoletti

Authorised by:
Quality Referent

Diego Menegon

Digitally signed

Eurac Research – Institute for Renewable Energy
A. Volta Straße/Via A. Volta 13/A, 39100 - Bozen/Bolzano, Italy
Tel +39 0471 055 600   Fax +39 0471 055 699   renewable.energy@eurac.edu
TIN 94032590211   VAT 01659400210   Registration at CCIA BZ 154590

Contents

This report no. 23/092.v1 of the 16/04/2024 cancels and replaces the previous report no. 23/092 of the 15/04/24.
The applied corrections are:

- Added “Summary of results”, page 3;

The corrections are also identified with a sidebar.

Summary of results

Seasonal heating efficiency according to UNI EN 14825:2022.

Model	**VGE Eco Air M19-F3.R32.0**			
Serial number	**PPAL06023050892**			
Function		Reversible		
Typology		Monobloc A/W		
Climate		Average		
Temperature		Medium		U
Rated heat output	P_{rated}	kW	16.5	0.10
Seasonal space heating energy efficiency	η_{sH}	%	139.8%	3.2%
Seasonal COP	SCOP		3.57	0.10
Seasonal COP in active mode	SCOPon		3.57	0.10
Net Seasonal COP	SCOPnet		3.70	0.10

Conformity verification to class A++ of Table 1 of reg. EU 811/2013

ID Sample	Seasonal heating efficiency / %	PFA* / %	Conformity status
VGE Eco Air M19-F3.R32.0 s.n. PPAL06023050892	139.8	0	PASS

1 Test sample

On 23/02/2024 the Customer delivered nr. 2 monobloc air-to-water heat pump. The laboratory has selected the unit as identified below:

Table 1. Test sample[1]

Monobloc unit	
Manufacturer	VGE
Type	Monobloc reversible air-to-water heat pump
Model	VGE Eco Air M19-F3.R32.0
Serial	PPAL06023050892
Production year	2023
Power supply	400V/3Ph/50-60Hz

Refrigerant	
Type of refrigerant	R32
Refrigerant charge	2700 g

Working fluid (provided by Laboratory)	Water

The laboratory proceeded to identify the sample with the identifier 23/092_unit1.

Test results apply to the sample as received.

2 Performed tests

The requested test has been assigned the following order number 23/092. The following tests were carried out.

The tests were executed in different days according to the following Table.

Table 2. Tests.

Denomination	Standard	Date	Point	Identification number of test
Preliminary activities Unit installation	UNI EN 14511-3:2022	05/03/2024	N.A.	N.A.
ACTIVITY 1 Nominal performance in heating mode	UNI EN 14511-3:2022	12/03/2024	7/55	2112
ACTIVITY 2 Seasonal performance in heating mode	UNI EN 14825:2022	08/03/2024	A	2110
		07/03/2024	B	2109
		26/03/2024	C	2123
		25/03/2024	D	2122
		14/03/2024	E	2114

2.1 Activity 1 – Test in heating mode according to UNI EN 14511-3:2022

For the measurement of the heating capacity the laboratory applied the direct method (liquid enthalpy).

The heating capacity is calculated according to the following equation:

$$\Phi_{thi} = \frac{q \cdot \rho \cdot (c_{p,out} \cdot T_{out} - c_{p,in} \cdot T_{in})}{3600} \qquad \text{Equation 1}$$

Where:

- Φ_{thi} is the heating capacity, expressed in kW;
- q is the volumetric flow of the internal heat exchanger, expressed in m^3/h;
- ρ is the density, expressed in kg/m^3;
- cp is the specific heat, expressed in J/kgK;

– T is the temperature, expressed in °C.

The thermodynamic properties of the water are defined as a function of the temperature according to the tables of the “Perry’s Chamical Engineering Handbook, 7th Edition, 1997”.

The heating capacity and the power input are corrected to consider the presence of the liquid pumps and the fan.

The corrections for the integrated liquid pumps are:

$$corr_{P_{th}} = q \cdot \Delta p_e \cdot \frac{1-\eta}{\eta}$$ Equation 2

$$corr_{P_{el}} = \frac{q \cdot \Delta p_e}{\eta}$$ Equation 3

where:

– q is the volumetric flow of the internal heat exchanger, expressed in m3/h;

– ΔPe is the external static pressure difference, expressed in Pascal;

– η is the efficiency of the pump calculated according to Annex F of UNI EN 14511-3:2022.

The coefficient of performance is calculated considering the corrections:

$$COP = \frac{P_{th} - corr_{P_{th}}}{P_T - corr_{P_{el-pump}}}$$ Equation 4

2.2 Activity 2 – Test in heating mode according to UNI EN 14825:2022

The seasonal heating efficiency is calculated according to EN 14825:2022. The seasonal efficiency in heating, expressed in % is calculated according to:

$$\eta_{s,h} = \frac{1}{\mathrm{CC}} \cdot SCOP - \sum F(i)$$ Equation 5

$$SCOP = \frac{Q_H}{Q_{HE}}$$ Equation 6

Where:

- CC is the coefficient for electricity generation efficiency, equal to 2.5;
- SCOP is the seasonal COP;
- F(i) are the correction factors, F(1) = 3% for the control temperature, (F2) = 5% for the water (or brine) source;
- QH is the reference annual heating demand, expressed in in kWh;
- QHE is the annual energy consumption, expressed in kWh.

The reference annual heating demand is calculated according to:

$$Q_H = P_{design,h} \cdot H_{HE} \quad \text{Equation 7}$$

Where:

- $Pdesign$,h is the design load, in kW;
- H_{HE} is the equivalent active mode hours for heating; defined in the Annex B of the standard.

The annual energy consumption is calculated as:

$$Q_{HE} = \frac{Q_H}{SCOP_{on}} + H_{TO} \cdot P_{TO} + H_{SB} \cdot P_{SB} + H_{CK} \cdot P_{CK} + H_{OFF} \cdot P_{OFF} \quad \text{Equation 8}$$

Where:

- QH is the reference annual heating demand, expressed in in kWh;
- HTO, HSB, HCK, $HOFF$ are the number of hours in the thermostat off mode, standby mode, crankcase heater mode e off mode as specified in the Annex B of the standard;
- $P_{TO}, P_{SB}, P_{CK}, P_{OFF}$ are the power inputs, expressed in kW;
- $SCOP_{on}$ is the seasonal COP in active mode, expressed in kWh/kWh.

The seasonal COP in active mode is calculated according to:

$$SCOP_{on} = \frac{\sum_{j=1}^{n} h_j \cdot [P_h(T_j)]}{\sum_{j=1}^{n} h_j \cdot \left[\frac{P_h(T_j) - elbu(T_j)}{COP_{bin}(T_j)} + elbu(T_j)\right]} \quad \text{Equation 9}$$

$$SCOP_{net} = \frac{\sum_{j=1}^{n} h_j \cdot [P_h(T_j) - elbu(T_j)]}{\sum_{j=1}^{n} h_j \cdot \left[\frac{P_h(T_j) - elbu(T_j)}{COP_{bin}(T_j)}\right]} \quad \text{Equation 10}$$

Where:

- Tj is the bin temperature, expressed in °C;
- j is the number of bin;

- n is the total number of bins;
- $Ph\ (Tj)$ is the heating loat at the Tj temperature of the j-th bin, expressed in kW;
- hj is the number of hours of the j-th bin at the temperature Tj;
- $COPbin(Tj)$ is the COP of the j-th bin at the temperature Tj;
- $elbu(Tj)$ is the backup consumption of the j-th bin at the temperature Tj.

The values of j, Tj, hj are defined in the Annex B of the standard.

The load of the j-th bin, $Ph\ (Tj)$ is calculated as part load condition of the design capacity:

$$P_h = P_{design,h} \cdot \frac{T_j - 16}{T_{design,h} - 16}$$ Equation 11

where:

- $Tdesign$,h is the design temperature (-10°C for the average climate);
- Tj is the temperature of the j-th bin, in °C;
- $P_{design,h}$ is the design load, in kW;

The values of COP and capacity are defined for each bin by interpolation of the tested points defined in EN14825. The part loads are obtained with a tolerance of ±10% by modulating the compressor capacity. The COPbin is calculated according to:

$$COP_{bin} = COP_d \cdot \frac{CR}{C_d \cdot CR + (1 - C_d)}$$ Equation 12

where:

- COPd is the declared COP calculated from the part load measurements in the conditions A, B, C, D, E;
- CR is the ratio between the part load capacity and the declared capacity;
- Cd is the degradation coefficient (applied if CR<1), Cd is calculated for each point.

3 Test equipment

The tests have been performed using the following instruments with valid calibration state.

Table 3. Test equipment.

Description	ID
Laboratory HPL Monitoring and Control System	AS10002
Air temperature and humidity E+E Elektronik 211 Temperature: -40:60°C Humidity: 0-100%	T.TC1:AS05 - ID01140 T.TC1:AS06 - ID01138 T.TC1:AS07 - ID01144 T.TC1:AS08 - ID01129
Temepratura - PT100 4 wires – class 1/5 DIN -40:100°C	W.US3:TM01 - ID02037 W.US3:TM02 – ID02038
Water differential pressure Endress Hauser Deltabar PMD55 pressure 0-500 mbar	W.US3:PM01 – ID01174
Water Flow rate Siemens SITRANS MAG 1100 flow 0-10 m^3/h	W.US3:FM01– ID02744
Virtual Power Analyser: Verivolt Isoblock 3x LEM600	T.TC3:EMV01 - ID02895 ID02071 ID02073 + ID02074 + ID02075
Refrigerant pressure – Huba 520 0 - 50 bar rel	T.TC1:PM13 – ID3093 T.TC1:PM11 – ID3091
Refrigerant temperature - PT100 4 wires – class 1/3 DIN -40:150°C	T.TC1:TM07 – ID3082 T.TC1:TM08 – ID3083 T.TC1:TM10 – ID3085
Ambient pressure GHM GROUP – Greisinger GMUD-MP – S	E.A11:PM01 – ID02070

The unit has been installed in the chamber A1 of the laboratory.

Figure 1. Installation of the test sample.

4 Test Results

4.1 Activity 1 – Heating mode A/W unit according to UNI EN 14511-3:2022

The following table presents the performance according to UNI EN 14511-3:2022 for the nominal point and for the part load conditions as defined by UNI EN 14825:2022.

Table 4. Test results according to UNI EN 14511-3:2022.

		Nom	E	A	B	C	D
Outdoor heat exchanger							
Air temperature, dry bulb	°C	6.71	-10.12	-6.86	1.88	6.94	11.82
Air temperature, wet bulb	°C	5.87	-11.07	-8.01	0.86	5.97	10.76
Relative humidity	%	88.96	71.62	74.24	83.54	87.21	88.22
Atmospheric pressure	Pa	98441	98975	98495	98589	97559	97763
Indoor heat exchanger							
Air temperature, dry bulb	°C	6.57	-10.12	-6.86	1.88	6.94	11.82
Liquid inlet temperature	°C	46.81	48.76	45.12	38.05	32.14	25.73
Liquid outlet temperature	°C	54.98	55.12	52.19	42.02	36.01	29.99
Temperature difference	K	8.17	6.37	7.07	3.96	3.87	4.26
Flow rate	m3/h	1.85	1.85	1.85	1.85	1.85	1.85
Static pressure difference	mbar	439	438	438	438	438	435
Total capacity	kW	17.41	13.55	15.02	8.43	8.24	9.08
Pump corrections	kW	0.05	0.05	0.05	0.05	0.05	0.05
Electrical Quantities							
Voltage	V	232.4	232.6	232.6	232.6	232.7	232.6
Current	A	9.21	10.97	10.73	4.51	3.42	2.76
Total eletrical power input	kW	5.68	6.91	6.67	2.42	1.80	1.41
Power input correction	kW	0.07	0.07	0.07	0.07	0.07	0.07
Refrigerant circuit							
Compressor frequency[1]	Hz	70	80	80	35	30	30
EEV Main[1]	step	120	110	120	94	100	130
EEV Assistance[1]	step	150	60	50	30	30	50
Fan[1]	rpm	800	850	900	600	600	600
Pump[1]	%	50	50	50	50	50	50
Condensing pressure	bar abs	34.80	34.91	32.65	25.06	22.41	19.16
Evaporating pressure	bar abs	7.47	4.40	4.82	6.31	8.73	9.76
Discharge temperature	°C	93.9	86.7	95.9	N.A.	52.2	58.8
Liquid temperature	°C	51.3	50.0	47.2	39.2	33.9	28.3
Bubble point temperature	°C	0.6	-16.0	-13.8	-2.7	2.5	7.7
Effective electrical power input	**kW**	**5.61**	**6.84**	**6.60**	**2.35**	**1.72**	**1.34**
Effective capacity in heating	**kW**	**17.36**	**13.50**	**14.97**	**8.38**	**8.19**	**9.03**
COP	**kW/kW**	**3.093**	**1.974**	**2.270**	**3.569**	**4.750**	**6.738**

4.2 Activity 2 – Heating mode A/W unit according to UNI EN 14825:2022

Table 5. Test results according to UNI EN 14825:2022.

Model		**VGE Eco Air M19-F3.R32.0**				
Serial number		**PPAL06023050892**				
Function					Reversible	
Typology					A/W	
Climate					Average	
Temperature					Medium	U
Rated heat output		P_{rated}		kW	16.5	0.10
Seasonal space heating energy efficiency		η_{sH}		%	139.8%	3.2%
Seasonal COP		SCOP			3.57	0.10
Seasonal COP in active mode		SCOPon			3.57	0.10
Seasonal COP net		SCOPnet			3.70	0.10
Design temperature		Tdesignh		°C	-10	
Bivalent temperature		T_{biv}		°C	-7	
Operation limit temperature		TOL		°C	-10	
Declared capacity for heating at indoor conditions 20°C and outdoor temperature T_j	Climate (average, warmer or colder)	T_j = -7°C	Pdh_A	kW	14.97	0.34
		T_j = 2°C	Pdh_B	kW	8.38	0.31
		T_j = 7°C	Pdh_C	kW	8.19	0.31
		T_j = 12°C	Pdh_D	kW	9.03	0.31
		T_j = bivalent temp.	Pdh_F	kW	14.97	0.34
		T_j = operation limit	Pdh_E	kW	13.50	0.33
Declared coefficient of performance for heating at indoor conditions 20°C and outdoor temperature T_j		T_j = -7°C	COP_d_A	-	2.27	0.03
		T_j = 2°C	COP_d_B	-	3.57	0.07
		T_j = 7°C	COP_d_C	-	4.75	0.12
		T_j = 12°C	COP_d_D	-	6.84	0.16
		T_j = bivalent temp.	COP_d_F	-	2.27	0.03
		T_j = operation limit	COP_d_E	-	1.97	0.03
Degradation coefficient		T_j = -7°C	Cdh_A	-	1.00	
		T_j = 2°C	Cdh_B	-	1.00	
		T_j = 7°C	Cdh_C	-	0.99	
		T_j = 12°C	Cdh_D	-	0.99	
		T_j = bivalent temp.	Cdh_F	-	1.00	

	T_j = operation limit	Cdh_E	-	1.00	
Power input in modes other than active mode	Off mode	P_{OFF}	W	11.6	0.1
	Thermostat-off mode	P_{TO}	W	0	4.0
	Standby mode	P_{SB}	W	11.6	0.1
	Crankcase heater mode	P_{CK}	W	0.0	0.2
Supplementary heater	Type of energy input			Electric	
Other items	Capacity control			Variable	
	Annual energy	Q_H	kWh	22044	67
		Q_{HE}	kWh	9548	104
Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k = 2.					

5 Measurement Uncertainty

The uncertainty values of the results are expressed with a level of confidence of approximately 95% using a coverage factor k=2, as indicated in the Table.

Table 6. Uncertainty values of measurements

Measurements	Uncertainty
Fluid inlet temperature	0.10 °C
Fluid outlet temperature	0.10 °C
Fluid Temperature difference	0.14 K
Fluid volumetric flow rate	1%
Fluid internal static pressure difference	5 mbar
Environmental pressure	100 Pa
Air temperature, dry bulb	0.2 °C
Air temperature, wet bulb	0.3 °C
Current	0.2%
Voltage	0.2%
Electric power	0.5%

6 Conformity verification

6.1 Applied decision parameters

The conformity verification considers the limits of Table 1 of reg. EU 811/2013 for the class A++

Table 1

Seasonal space heating energy efficiency classes of heaters, with the exception of low-temperature heat pumps and heat pump space heaters for low-temperature application

Seasonal space heating energy efficiency class	Seasonal space heating energy efficiency η_s in %
A^{+++}	$\eta_s \geq 150$
A^{++}	$125 \leq \eta_s < 150$
A^{+}	$98 \leq \eta_s < 125$
A	$90 \leq \eta_s < 98$
B	$82 \leq \eta_s < 90$
C	$75 \leq \eta_s < 82$
D	$36 \leq \eta_s < 75$
E	$34 \leq \eta_s < 36$
F	$30 \leq \eta_s < 34$
G	$\eta_s < 30$

Source: Reg. EU 811/2013.

- Class A++
- Specification area: bilateral 125 - 150 %
- Accepted level of risk: 50%
- Decision rule: binary

6.2 Conformity statement

ID Sample	Seasonal heating efficiency / %	PFA* / %	Conformity status
VGE Eco Air M19-F3.R32.0 - s.n. PPAL06023050892	139.8	0	PASS

[1] Identify information provided by client, for which the Laboratory declines responsibility.
* PFA: Probability of False Acceptance