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STS 301

Test Report S132EN

System model	**NATURAL SOL 280**
Contract party	IMMERGAS S.p.A. Via Cisa Ligure 95 IT-42041 Brescello (RE) Italy Phone: +39 0522-689011 Fax: +39 0522-680617 E-mail: immergas@immergas.com Internet: www.immergas.com
Testing Laboratory:	Institut für Solartechnik SPF Hochschule für Technik Rapperswil HSR Oberseestrasse 10 CH-8640 Rapperswil Switzerland Phone: +41 (0)55 222 48 21 Fax: +41 (0)55 222 48 44 E-mail: spf@solarenergy.ch Internet: www.solarenergy.ch
Sample received:	18.04.2008
Start of test:	11.08.2008
End of test:	22.10.2008
Test standard:	EN 12976:2006
Note:	Manufacturers' information is printed in *italics*.

Content:

1 Description of the system

1.1 Manufacturer

Name:	IMMERGAS S.p.A.
Address:	Via Cisa Ligure 95
Postcode / City:	IT-42041 Brescello (RE)
Country:	Italy
Phone:	+39 0522-689011
Fax:	+39 0522-680617
E-mail:	immergas@immergas.com

1.2 Test pattern

System model:	NATURAL SOL 280
Serial number of tested unit:	IB28000198

1.3 System Classification

System type:	Thermosiphon
Heat transfer:	Indirect
Solar system:	Closed
Collector loop:	Filled
Location of heat storage:	Close-coupled system
Other (specify):	--

1.4 Heat transfer medium:

Specification:	*Water-propylene glycol mixture / concentration of glycol 25 % vol.*
Total medium content:	5 kg

1.5 Antifreeze protection: cp. 1.4

1.6 Number of collector modules: 2

1.7 Collector

Type:	Flat plate collector
Model name:	ARIS 2003
Certifications:	Solar Keymark, Register Nr. 011-7S493 F
Test report:	08COL676 (ITW)
Serial number:	SA140800277, SA140800278
Gross area:	2.095 m^2
Aperture area:	1.905 m^2
Number of covers:	1
Cover material(s)/ Manufacturer:	Low-iron tempered solar glass
Cover thickness:	4 mm
Insulation material(s):	Rock wool
Insulation thickness:	40 mm, 20 mm (side)
Casing material:	Aluminium
Fluid volume of Collector area (without the connection piping between the collector(s) and the tank):	3 l
Weight of collector without fluid:	40 kg/collector
Gross dimensions (L x W x H):	2.032 m x 1.031 m x 0.093 m

1.8 Absorber

Manufacturer:	*Prime Laser Tech*
Material(s):	Aluminium sheet with copper tubes
Type of absorber:	Plane
Flow type:	Parallel
Number of tubes / channels:	10
Absorber tube dimensions:	Outer diameter 8 mm x wall thickness 0.5 mm
Distance between tubes:	90 mm
Area of absorber:	1.831 m^2
Sheet thickness:	0.4 mm
Bonding Technique	Laser welding

Coating of Absorber

Manufacturer	*Elval*
Coating	*Black paint*

1.9 Storage tank

Manufacturer:	SAMMLER
Serial number:	IB28000198
Model name / Type:	S300 / horizontal
Material:	Steel, enamelled
Volume:	282 l
Outside diameter:	0.580 m
Insulation material:	Rigid polyurethane
Insulation thickness	35 mm
Heat exchanger(s):	Mantle heat exchanger
Max. operating pressure:	6 bar (domestic hot water)
Protection against corrosion:	Enamelled, Mg sacrificial anode

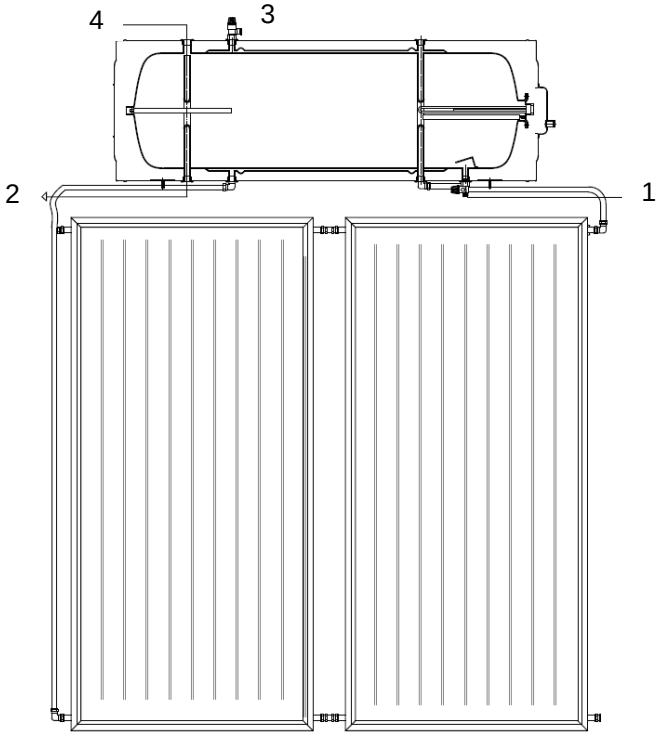
1.10 Pump

Manufacturer:	--
Model name / Type:	--
Electrical power:	-- W (for recommended settings)

1.11 Controller

Manufacturer:	--
Model name / Type:	--

1.12 Schematic of system



1: Cold water inlet
2: Hot water outlet
3: Pressure relief valve (3 bar)
4: Temperature and pressure relief valve (93°C, 6 bar)

1.13 Picture of system

Fig. 1 Thermosiphonsystem NATURAL SOL 280

1.14 Connecting piping between the collector(s) and the tank

Diameter:	19.05 mm, corrugated pipe
Length:	2.8 m return (cold); 1.0 m flow (hot)
Material:	Stainless steel
Insulation material:	Elastomeric insulation coated with a polymer membrane (UV protection)
Insulation thickness:	20 mm

1.15 System data

Recommended tilt angle of collector area[1]:	45° to horizontal; min. 15°, max. 50°
Collector mounting:	Tilted roof, flat roof with support
Module orientation during test:	Vertical
Collector loop flow rate:	n/a
Remarks:	--

1.16 Comments on system design

The drinking water circuit has a temperature and pressure relief valve (93°C, 6 bar). The collector loop is fitted with a pressure relief valve of 3 bar.

1.17 Documentation

Documents for the installer: The system is accompanied by an installer manual according to the requirements of the EN 12976-1:2006 chapter 4.6. The following information is missing in the installation manual:

- Technical data:
  - Working limits: admissible temperature
- Support frame:
  - Maximum values of s_K (snow load) and v_m (mean wind velocity) according to ENV 1991-1-3 and ENV 1991-1-4
- Safety equipment:
  - Type and size of the safety and security devices and their draining
  - The assembly instruction shall demand that any pressure relief valves from which steam can escape during normal or stagnation conditions shall be mounted, in such a way that no injuries, harm or damage can be caused by the escape of steam.

[1] - Support frame for flat roof installation (40° to horizontal) of manufacturer was used during test at SPF.

Documents for the user: The system is accompanied by an owner's manual according to the requirements of the EN 12976-1:2006 chapter 4.6. The following information is missing in the owner's manual:

- Existing safety and security components and their thermostat adjustment
- Performance data for the system:
  - The solar fraction of the annual performance prediction for Athens for a demand volume of 250 l/d in accordance with EN 12976-2 does not correspond with the test results.

2 Freeze resistance

Test in accordance with EN 12976-2, Chapter 5.1

Specification:	Flat plate collector with anti-freeze fluid in the collector loop with the following specification: Water- / Propyleneglycol mixture MPG – Industrial, Shell Chemicals
Measured after the system test:	Glycol concentration: approx. 25 vol. % Freeze resistance: approx. -10°C
Test result	No major failure
Remarks	The glycol concentration could not be exactly determined. No data is available for the refractive index of this product. The freeze resistance was estimated according to general physical properties of propylene glycol.
Date of test	22.10.2008

3 Over temperature protection

Test in accordance with EN 12976-2, Chapter 5.2

Inclination of collector plane:	40°
Type of over temperature protection:	Combined temperature and pressure relief valve (93 °C / 6 bar).
Number of days	3, solar irradiation on the collector plane has exceeded 20 MJ/m^2 per day.
Test result	No major failure
Remarks	The maximal fluid temperature in the storage tank exceeded temperatures of 100°C. The manufacturer added a T, p-relief valve to solve the problem. The over temperature protection was retested successfully (see Appendix A).
Date of test	20.08. till 27.08.2007

4 Pressure resistance

Test in accordance with EN 12976-2, Chapter 5.3

Draw-off loop Date of test: 27.08.2008

Working pressure [bar]	6.0	
	Test pressure [bar]	Test duration [min]
Pressure at begin of test	9.0	21
Pressure at end of test	9.0	

Collector loop Date of test: 11.08.2008

Working pressure [bar]	3.0	
	Test pressure [bar]	Test duration [min]
Pressure at begin of test	4.5	38
Pressure at end of test	4.5	

Test result	No major failure
Remarks	A retest was necessary. The gasket of the flange for an optional electrical heater failed. The redesigned storage tank (see Appendix A) was tested successfully after the high temperature test sequence.
Date of test	27.08.2008

5 Water contamination

Test in accordance with EN 12976-2, Chapter 5.4

Test result	No major failure
Remarks	None
Date of test	27.08.2008

6 Safety equipment

Test in accordance with EN 12976-2, Chapter 5.6

Safety valves	Comply with the requirements according to EN 12976:2006
Safety and expansion lines	Not required
Blow-off lines	Comply with the requirements according to EN 12976:2006
Test result	No major failure
Remarks	The maximum temperature in the storage was not limited. A redesign and a retest was necessary; S99/2
Date of test	27.08.2008

7 Labelling

Test in accordance with EN 12976-2, Chapter 5.7

Labelling of the Solar heating system

Place of label plate	Storage, collector
Labelling	The label contains all major information required in accordance with EN12976:2006
Test result	No major failure
Remarks	None
Date of test	15.12.2009

8 Thermal performance characterisation

The performance and reference conditions are in accordance with EN 12976-2 Chapter 5.8
Test method: ISO/DIS 9459-5:1997

8.1 Description of the measured data

The solar radiation is an average value of the solar irradiation in the collector plane. For a valid day, the irradiation in the collector plane shall exceed 12 MJ/m^2 during this day. The ambient air temperature is an average value measured close to the collector array.

$S_{sol}A$: The aim is to acquire information about collector array performance at high efficiencies. The draw-offs specified are designed to keep the collector inlet cold.

$S_{sol}B$: The aim is to acquire information about store heat loss and collector array performance at low efficiencies. The draw-offs are specified are designed to allow the system to become as hot as possible for as long as possible. Overheating of the store is avoided.

S_{sto}: The test sequence is to identify the overall store losses. The store is heated up by sun for two consecutive days. Subsequently the collectors are covered and no draw-offs are specified for 36 to 48 hours.

S_{aux}: This sequence is intended to determine the heat losses and the volume fraction of the auxiliary heated portion of the store.

Sequence number	1	2	3	4
Sequence type	$S_{sol}A$	$S_{sol}B$	S_{sto}	S_{aux}
Solar radiation [W/m^2]	218	199	154	n/a
Ambient air temperature [°C]	19.3	17.3	18.5	n/a
Start date	18.08.2008	22.08.2008	08.09.2008	n/a
Number of days	4	5	4	n/a
Number of valid days	3	3	2	n/a

8.2 System Parameters

Determined according to the test method ISO/DIS 9459-5

Effective collector area	A_C*	2.059	m^2
Effective collector loss coefficient	u_C*	9.012	W m^{-2} K^{-1}
Total store heat loss coefficient	U_S	2.156	W/K
Total store heat capacity	C_S	1.133	MJ/K
Fraction of the store used for auxiliary heating	f_{aux}	n/a	-
Mixing constant	D_L	0.1572	-
Stratification parameter	S_C	0.3541	-
Thermal resistance of load heat exchanger	R_L	n/a	K/W
Wind speed dependence of u_C*		n/a	
Wind option used		W_{ignore}	
Wind correction used	n/a		

8.3 Annual performance prediction in accordance with EN 12976-2 for European locations

Q_d Heat demand.
Q_L Heat delivered by the solar heating system (load).
f_{sol} Solar fraction: the energy supplied by the solar part of the system divided by the total system load.
Q_{par} Parasitic energy (electricity) e.g. for pump, controller etc.

Performance indicators for solar-only and solar preheat systems on annual base for a demand volume of **80 l/d**

Location (latitude)	Q_d MJ	Q_L MJ	f_{sol} %	Q_{par} MJ
Stockholm (59.6° N)	4478	2821	63.0	0
Würzburg (49.5° N)	4289	2912	67.9	0
Davos (46.8° N)	4857	4347	89.5	0
Athens (38.0° N)	3343	2771	82.9	0

Performance indicators for solar-only and solar preheat systems on annual base for a demand volume of **110 l/d**

Location (latitude)	Q_d MJ	Q_L MJ	f_{sol} %	Q_{par} MJ
Stockholm (59.6° N)	6150	3634	59.1	0
Würzburg (49.5° N)	5897	3774	64.0	0
Davos (46.8° N)	6654	5643	84.8	0
Athens (38.0° N)	4573	3649	79.8	0

Performance indicators for solar-only and solar preheat systems on annual base for a demand volume of **140 l/d**

Location (latitude)	Q_d MJ	Q_L MJ	f_{sol} %	Q_{par} MJ
Stockholm (59.6° N)	7821	4302	55.0	0
Würzburg (49.5° N)	7506	4503	60.0	0
Davos (46.8° N)	8483	6702	79.0	0
Athens (38.0° N)	5834	4440	76.1	0

Performance indicators for solar-only and solar preheat systems on annual base for a demand volume of **170 l/d**				
Location (latitude)	Q_d MJ	Q_L MJ	f_{sol} %	Q_{par} MJ
Stockholm (59.6° N)	9492	4860	51.2	0
Würzburg (49.5° N)	9114	5177	56.8	0
Davos (46.8° N)	10281	7597	73.9	0
Athens (38.0° N)	7064	5143	72.8	0

Performance indicators for solar-only and solar preheat systems on annual base for a demand volume of **200 l/d**				
Location (latitude)	Q_d MJ	Q_L MJ	f_{sol} %	Q_{par} MJ
Stockholm (59.6° N)	11164	5336	47.8	0
Würzburg (49.5° N)	10691	5741	53.7	0
Davos (46.8° N)	12110	8344	68.9	0
Athens (38.0° N)	8326	5803	69.7	0

Performance indicators for solar-only and solar preheat systems on annual base for a demand volume of **250 l/d**				
Location (latitude)	Q_d MJ	Q_L MJ	f_{sol} %	Q_{par} MJ
Stockholm (59.6° N)	13939	5910	42.4	0
Würzburg (49.5° N)	13371	6512	48.7	0
Davos (46.8° N)	15137	9203	60.8	0
Athens (38.0° N)	10407	6723	64.6	0

Performance indicators for solar-only and solar preheat systems on annual base for a demand volume of **300 l/d**				
Location (latitude)	Q_d MJ	Q_L MJ	f_{sol} %	Q_{par} MJ
Stockholm (59.6° N)	16746	6263	37.4	0
Würzburg (49.5° N)	16052	7047	43.9	0
Davos (46.8° N)	18165	9736	53.6	0
Athens (38.0° N)	12488	7468	59.8	0

9 Reverse flow protection

Test in accordance with EN 12976-2, Chapter 5.10

Test result	No major failure
Remarks	None
Date of test	27.08.2008

10 Electrical safety

Test in accordance with EN 12976-2, Chapter 5.11

Test result	--
Remarks	The system does not contain any electrical devices.
Date of test	27.08.2008

11 Remarks

The applied test methods meet the requirements of the European Standard EN 12976-2:2006, “Thermal solar systems and components – Factory made systems – Part 2: Test methods“. The thermal performance of the system is carried out according ISO/DIS 9459-5:1997.

This report may not be copied except in full.
This test report refers only to the tested system.
This test report is issued according to the requirements of EN 12976 and ISO 17025.

Rapperswil, 15.12.2009

Dr. Andreas Bohren
Head of SPF-Testing

Carlo Vassella
Test engineer

Appendix A: Summary

System test according to EN 12976

Test	Results
Freeze resistance	Passed
Over temperature protection	Passed
Pressure resistance	Passed
Water contamination	Passed
Safety equipment	Passed
Labelling	Passed
Thermal performance characterisation	See chapter 8
Reverse flow protection	Passed
Electrical safety	Not applicable

Remarks: The pressure resistance test of the storage tank as well as the over temperature protection have been done with a redesigned storage tank. The manufacturer changed the design of the storage tank to be able to add a T, p-relief valve.

Appendix B: Reference conditions for performance presentation

in accordance with EN 12976-2
Reference conditions for system performance

Collector tilt angle	45°
Collector orientation	South
Draw-off flow rate	10 dm^3/min
Daily load volume	50 to 600 litres per day
Daily load pattern	100 % at 6 h after solar noon
Desired temperature T_D (if the temperature exceeds T_D, cold water will be mixed to reach T_D.)	45°C
Cold water supply temperature	s. the following table
Store ambient temperature For systems where the store is located outside, the ambient temperature from the climate data shall be used.	15°C
Temperature of integrated auxiliary heating	52.5°C

Data for calculation of the cold water temperature and the energy of solar radiation received in the collector array over one year at the reference locations.

	Data correspond to EN 12976-2			
	Average cold water supply temperature [°C]	Amplitude [K]	Solar radiation [kWh m^{-2} a^{-1}]	Ambient temperature [°C]
Athens	17.8	7.4	1338	17.7
Davos	5.4	0.8	1684	3.2
Stockholm	8.5	6.4	1113	6.9
Würzburg	10.0	3.0	1230	9.0

Appendix C: Annual performance prediction for Swiss locations *)

*) Performance prediction according to SPF-internal guidelines.

The solar radiation indicated in the table specifies the received energy of solar radiation in the collector plane over one year. Q_L is the heat delivered by the solar heating system (load) if applicable minus the supplementary energy.

Climate data and locations	Rapperswil[2]	Davos[2]	Sion[2]
Latitude	47.2 N	46.8 N	47.2 N
Solar radiation [kWh m^{-2} a^{-1}]	1200	1710	1570
Ambient air temperature [°C]	9.6	3.3	9.6
Daily heat demand [kWh/d]	Q_L [kWh/a]	Q_L [kWh/a]	Q_L [kWh/a]
5	1141	1452	1423
7	1432	1824	1829
10	1735	2192	2265

SPF reference conditions for the annual performance prediction

Collector tilt angle	Latitude
Collector orientation	South
Draw-off flow rate	10 dm^3/min
1. Hot water withdrawal (fraction, Time of day)	15%, 07:00
2. Hot water withdrawal (fraction, Time of day)	15%, 08:00
3. Hot water withdrawal (fraction, Time of day)	10%, 11:00
4. Hot water withdrawal (fraction, Time of day)	10%, 13:00
5. Hot water withdrawal (fraction, Time of day)	12.5%, 16:00
6. Hot water withdrawal (fraction, Time of day)	12.5%, 18:00
7. Hot water withdrawal (fraction, Time of day)	12.5%, 20:00
8. Hot water withdrawal (fraction, Time of day)	12.5%, 22:00
Desired temperature T_D (if the temperature exceeds 45°, cold water will be mixed to reach T_D.)	50°C
Cold water supply temperature	10°C
Store ambient temperature For systems where the store is located outside, the ambient temperature from the climate data shall be used.	15°C
Temperature of integrated auxiliary heating	52.5°C

Differences of the SPF reference conditions for the annual performance prediction to the reference conditons of EN12976

Location	Deflection to the Standard
Rapperswil, Davos, Sion	Negative load was considered (Option SkipNegativLoad: Off)
Rapperswil, Davos, Sion	Desired hot water temperature T_D is 50°C

[2] The weather data was generated with the program Meteonorm 3.0. Meteorological database for solar energy use - Edition '97, 3.9.1997, CH-3012 Bern, office@meteotest.ch